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# Potassium and Cultivar Effects on Carbohydrate Partitioning in Upland Cotton

Jenny Dale Clement

*University of Tennessee - Knoxville*

To the Graduate Council:

I am submitting herewith a thesis written by Jenny Dale Clement entitled "Potassium and Cultivar Effects on Carbohydrate Partitioning in Upland Cotton." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant Sciences.

C. Owen Gwathmey, Major Professor

We have read this thesis and recommend its acceptance:

Carl E. Sams, Robert Auge

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Graduate Studies

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# POTASSIUM AND CULTIVAR EFFECTS ON CARBOHYDRATE PARTITIONING IN UPLAND COTTON

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Jenny Dale Clement
May 2006

## DEDICATION

I would like to dedicate this thesis to my family, Nana, and soon to be husband, Mike Bailey. Thank you for your support, love and patience as I have continued my education. God has truly blessed me.

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A sincere appreciation is given to Dr. C. Owen Gwathmey, for his guidance, patience and demand for excellence. I am also very grateful for this opportunity which has enhanced my education.

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**ABSTRACT**

The indeterminate growth habit of upland cotton (*Gossypium hirsutum* L.) reduces the efficiency of yield formation when grown as an annual for its lint. Altering the determinacy may provide greater carbohydrate partitioning to reproductive structures, allowing higher yields. Another factor that may influence partitioning is potassium (K) nutrition. Potassium is essential for physiological and biochemical processes including translocation. It is necessary for ATP production, which is crucial for phloem loading and unloading. A three-year experiment was conducted at the West Tennessee Research and Education Center to evaluate carbohydrate partitioning in Paymaster 1218BG/RR (PM1218), a relatively determinate cultivar, and Deltapine 555BG/RR (DP555), a more indeterminate variety. The two cultivars were grown in the field under two levels of potassium fertilization, 60 and 120 lbs $K_2O$/acre/year, representing adequate and excessive K fertility, respectively. Plots containing cultivars and K treatments were arranged in randomized complete blocks with six replications per year. Plant samples were harvested at early bloom and after cutout, to evaluate partitioning during boll filling. Eight stem samples per plot were collected immediately below the cotyledonary node, freeze dried and ground for carbohydrate analysis by enzymatic methods. The two sampling dates were treated as subplots in the statistical analysis. Plots were mechanically harvested and samples of seedcotton were ginned to determine lint yields. Results showed that K had significant effects on monosaccharide concentrations of both cultivars and on lint yields of PM1218. Lint yields of PM1218 were lower than DP555 with 60 lb $K_2O$/ac/yr, but were equivalent at 120 lb $K_2O$/ac/yr. Total soluble sugar

concentrations were higher in DP555 than in PM1218 at early bloom but declined to equivalent concentrations after cutout. Starch analysis revealed both a cultivar and harvest sample date interaction. In all years, PM1218 had more starch than DP555 at early bloom. Accumulation or depletion of starch reserves during boll filling differed by year, along with lint yields. Relating these results to shoot biomass data, also collected at both harvest dates for another study, confirms that the determinate variety PM1218 allotted more photoassimilates for reproductive growth during this time than DP555, despite similar lint yields. Previous research has found decreased vegetative growth during reproductive development in more determinate cultivars. Lower lint yields in PM1218 at 60 lbs $K_2O$/ac/yr could be due to soil nutrient uptake efficiency and may explain the need for additional potassium in the more determinate cultivar. The two cultivars differed in carbohydrate concentrations at early bloom but by cutout were similar. Further investigation into the components of carbohydrate sink strength, such as seed constituents and root growth, may help in determining the carbohydrate partitioning trends of cultivars. Additional research is needed to establish potassium fertilization for optimum reproductive partitioning in determinate cultivars.

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List of Abbreviations

ATP- Adenosine triose phosphate

BG/RR- Bollgard (*Bt*)/Roundup Ready (glyphosate resistant)

DAP- Days after planting

DF- Degrees of freedom

DP555- Deltapine 555 BG/RR

LSD- Least Significant difference

NADH- Nicotinamide adenine dinucleotide

PM1218- Paymaster 1218 BG/RR

SAS- Statistical analysis system

TNC- Total Nonstructural Carbohydrates

TSS- Total Soluble Sugars

# CHAPTER I:

# INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a complex crop to grow due to its indeterminate growth habit and its production as an annual. This growth habit allows vegetative growth to continue during the reproductive phase of its lifecycle (Mauney, 1986). An annual plant typically has specific growth stages; growth, reproduction, maturation, senescence and eventually death in a relatively short period of time. Cotton, however, is a woody perennial; its vegetative parts grow continuously while the fruit matures for harvesting as an annual. The technical term for cotton's fruit is a boll; the main economic product of a boll is lint, a fibrous mass composed of nearly pure cellulose. The perennial characteristics of cotton are not advantageous when grown as an annual.

Cotton is a thermophilic plant, seen by its tropical origins (Brubaker et al., 1999). Temperature, measured in heat units, determines the growth rate of cotton. The heat units required from plant to harvest are approximately 2,600 degree-days at a base of 60°F (Oosterhuis, 1990). There are only seventeen states in the U.S. that have adequate climates to support cotton production, collectively known as the cotton belt. Tennessee is located on the northern edge of the cotton belt, limiting its yield and production potential due to cooler climates and shorter growing seasons. To provide a more efficient plant for these conditions, a better understanding of carbohydrate physiology is needed.

Photoassimilates are products of photosynthesis formed in the leaves of plants. The disaccharide sucrose, composed of glucose and fructose, is the form of carbohydrate transported to vegetative and reproductive sinks (Salisbury and Ross, 1992). The ability to partition more photoassimilates to reproductive sinks could potentially increase boll size and number allowing higher amounts of lint. Increasing lint production would mean increasing the amount of available cellulose. Cellulose is a polymer of glucose, therefore increasing glucose concentrations to bolls is theoretically a way to improve lint production. However, glucose is also stored as starch in the plant. Starch is the primary reserve carbohydrate needed when photoassimilates are limited. Remobilizing more starch to reproductive growth during boll filling and partitioning more glucose in favor of cellulose production is of primary interest.

Breeding efforts through the years have produced more determinate cotton cultivars that limit excessive vegetative growth during reproductive development. Theoretically this could cause indeterminate and more determinate cultivars to differ in their partitioning strategies. It would suggest better utilization of storage reserves in the more determinate plant, due to less vegetative growth generating less photoassimilate when compared to an indeterminate cultivar. Gwathmey (2005) found more vegetative growth in the indeterminate and more reproductive growth in the determinate cultivar when comparing their biomass partitioning.

Another area to consider for increasing lint formation is mineral nutrition. Potassium is an essential nutrient for plant production. It is particularly vital for the fruiting phase of cotton. From flowering through early boll filling it is required in large amounts. Bennett et al. (1965) found a direct correlation between boll size and the amount of applied potassium. Potassium is indirectly involved in partitioning by supplying ample ATP for phloem loading and unloading. It is also a catalyst for many enzymes (Salisbury and Ross, 1992) and is involved with the distribution of photoassimilates. Perhaps increasing potassium fertilization could alter the amount of carbohydrate partitioning to various sinks and increase remobilization of starch reserves during boll filling. Utilizing proper management tools will aid in maximizing a crop's potential.

**Objectives**

The objectives of this research are:

1. To characterize the storage and remobilization of nonstructural carbohydrates in two contemporary cotton cultivars with contrasting growth habits. The main hypotheses are that: A.) stored starch reserves are depleted during boll filling; B.) starch reserves are depleted more in the determinate cultivar than the indeterminate cultivar; and C.) there is more sucrose transport in the more indeterminate cultivar.
2. To determine if additional potassium fertility promotes the remobilization or transport of nonstructural carbohydrates in contrasting cultivars. The main hypothesis is that additional potassium promotes translocation of stored carbohydrates to support lint yield formation during boll filling.

## CHAPTER II:

## LITERATURE REVIEW

The family Malvaceae hosts approximately 40 wild and cultivated species of cotton (Brubaker et al., 1999). Originating in tropical latitudes, this fibrous plant is a perennial, which partitions photoassimilates more in favor of parent plant survival than to reproduction. Domestication of the upland cotton species *(Gossypium hirsutum* L.) allowed it to be grown commercially as an annual crop harvested for its lint. As a commercial crop, producers need to maximize its reproductive potential. To achieve this, cotton's growth habit and perennialistic nature need improvement. Perhaps understanding cotton's physiology will aid in maximizing yields.

Photoassimilates are partitioned either to support current metabolic processes, to produce growth of new plant tissue, or to fortify storage reserves for future use. Starch, the primary storage carbohydrate, is an alternative energy source for the developing plant. Its synthesis is labile, allowing the uptake and release of glucose. It is frequently stored in roots and stems, which are vegetative sinks (Salisbury and Ross, 1992). De Souza and Vieira da Silva (1987) found higher concentrations of starch in roots of perennial type cotton than in more annual cotton. They attributed the higher starch to the extensive rooting system in perennials that make it more resistant to drought. This in turn reduced the amount of reproductive fruit the first year of their study. However, perennials in the following years have adequate starch supplies that are remobilized to readily support reproduction (Kramer and Kozlowski, 1979). In cotton, it is hypothesized that starch reserves are depleted during reproductive growth allowing the free glucose to be converted into cellulose.

Cellulose, a structural carbohydrate, is the major component of cell walls, including the fiber cells that produce cotton's lint (DeLanghe, 1986). Its synthesis is a strong, irreversible carbon sink in cotton. Cotton fiber development begins with an increased growth of the ovary at anthesis, the day of flowering. Select outer ovule epidermal cells protrude through the epidermal surface, creating fiber initials. This initiation phase occurs for three days, followed by cell elongation. Consisting of a thin cuticulum, a thin primary wall and an enormous vacuole, the cells begin elongation at a rapid pace lasting approximately 10 days. At this point the secondary wall biosynthesis initiates by depositing nearly pure cellulose on the inner surface of the primary wall, shrinking the vacuole. Approximately 50 to 60 days after flowering, depending on the growing season, fiber development reaches maturity by drying out, a process induced by the opening of the boll (Basra, 1999, Mauney et al., 1986). Because fiber cells are specialized epidermal cells on the surface of cotton seed, it is possible to classify lint as part of the reproductive sink.

Increases in lint yields are directly related to greater partitioning of assimilate to reproductive growth over vegetative growth or storage (Wells and Meredith, 1984). Yields are based on number of bolls that assimilate supply can support, but Kerby and Buxton (1981) proved that cotton plants produce more fruiting forms than available assimilates can support. A greater pool of photoassimilates could support more bolls, thus higher yields (Kerby and Buxton, 1981; Constable and Rawson, 1980). The location of source and sinks influence transport patterns and photoassimilate partitioning (Dixon, 1992). Ashley (1972) found that the main source of new photosynthate for developing fruit was the subtending leaf, but that the main concentration of photoassimilates came from the main-stem leaves. However, in early stages of growth, roots and lower stem had the highest total available carbohydrates, indicating areas where carbohydrates are actively stored (Saleem and Buxton, 1976). During peak boll filling, stem carbohydrates were depleted but later restored when boll filling ceased. This indicates that there may be an extra source of carbohydrate for filling bolls, in the roots and lower stems.

Improving crop yields has been the object of breeders for decades and advanced cultivars have resulted in cotton (Wells, 2002). Overcoming perennial and indeterminate characteristics has to some extent been achieved. Altering carbohydrate partitioning to reproductive over vegetative structures has improved cotton yields. Modern cultivars partition a greater proportion of dry matter into reproductive organs, and do so earlier than obsolete cultivars (Wells and Meredith, 1984). Pace et al. (1999) and Gwathmey (2005) have confirmed that more determinate cultivars have greater reproductive partitioning.

Though partitioning is directly related to the genetic background of cotton, nutritional requirements should be considered. Potassium is an essential element needed in both physiological and biochemical processes, especially translocation (Huber, 1985). Photoassimilates are transported through the phloem to various sinks. Energy in the form of ATP is necessary for this movement to occur. Potassium helps balance the ionic charge in ATP production. If K is inadequate, less ATP is available, and the transport system breaks down. Photoassimilates begin to build up in the leaves, and photosynthetic rates are reduced. Also, potassium promotes the loading of phloem sieve cells, by increasing water uptake, enabling an elevated flow rate. Exactly how potassium does this is still unclear (Mengel, 1985). Mengel (1996) found that tissue K concentration influenced the distribution of labeled photosynthate. Phloem loading and unloading requires a substantial amount of ATP, which is indirectly supported by potassium. Work by Ashley and Goodson (1972) showed a decline in translocation when potassium was limited. In cotton, potassium is important in boll filling by promoting sink metabolism, acting as an osmoregulatory solute for turgor pressure needed in fiber elongation (Dhindsa, 1975).

Extensive work has shown a detrimental effect on cotton when potassium is deficient (Pettigrew, 1999; Cassman et al., 1989). A typical symptom is small bolls. Leaf area is decreased, lowering the photosynthetic capacity and therefore reducing lint yields and fiber quality (Pettigrew, 1999). Cassman et al. (1989) determined that there was not a significant yield difference between two Acala cultivars when potassium was not limited. However, when potassium levels were inadequate, the more determinate cultivar was able to utilize the mineral for reproductive growth more efficiently than the indeterminate cultivar. The result was 29 and 35% higher yields in 1986 and 1987.

Tennessee soil fertility recommendations (Savoy and Joines, 2001) show that applying 60 lbs $K_2O$/acre is adequate for economic yield formation in cotton; when Mehlich I test levels of soil potassium are high (Hanlon, 2001). Higher amounts have not shown any economic return, although foliar tissue testing may indicate greater uptake when excess fertilizer K is applied (Kerby and Adams, 1985).

# CHAPTER III:

# MATERIALS AND METHODS

## Field Study

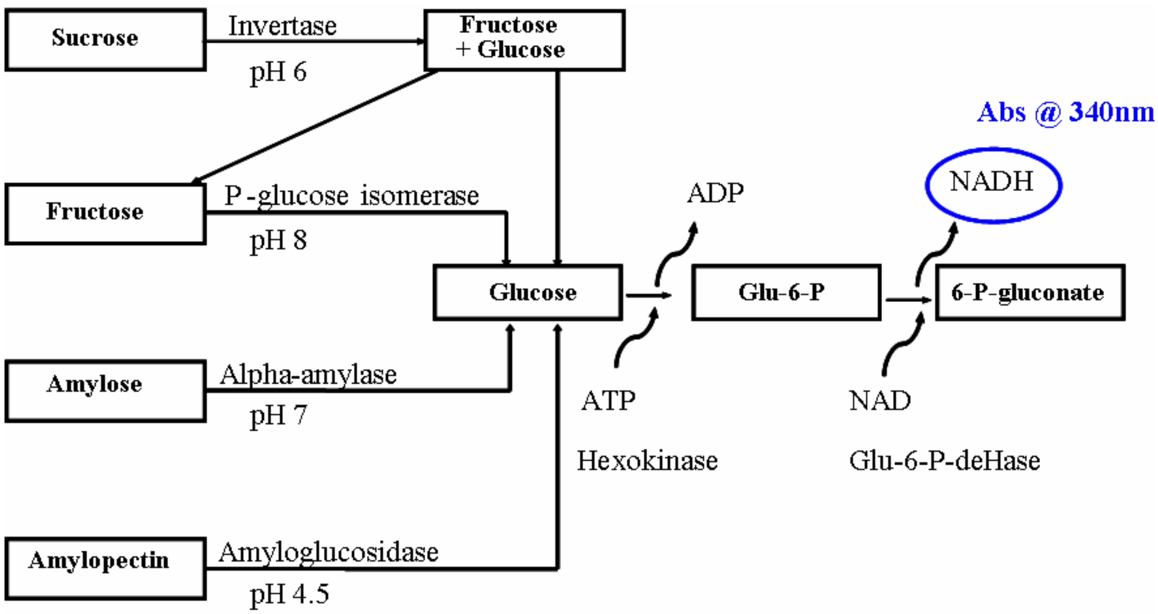
A three-year field experiment was conducted on a Memphis-Loring silt loam with long term K fertility plots at the West Tennessee Education and Research Center, Jackson TN in 2003, 2004 and 2005. This was done to evaluate carbohydrate partitioning in Paymaster1218BG/RR, (PM1218) a relatively determinate cultivar, and Deltapine 555BG/RR, (DP555) a more indeterminate cultivar under two levels of potassium fertilization (60 and 120 lb $K_2O$/ac/yr) (Gwathmey, 2005). Characteristics of the two cultivars were described by Albers et al. (1999) and Legé and Leske (2003) when commercially released.

Four hundred square foot plots containing cultivars and K treatments were arranged in a randomized complete block design with six replications per year. In the winter prior to each season, soil samples were collected from all plots to determine residual (carryover) K fertility. Between March and April each year, specified quantities of potassium chloride were applied by hand to the plots. Planting occurred on April 30$^{th}$ in 2003, and on May 5$^{th}$ in 2004 and 2005. Cultivars were planted in 38-inch rows in 4-row plots with a no-till planter. The inner 2 rows were used for data collection and sampling, and were thinned for uniformity shortly after emergence. Agricultural Extension Service guidelines for Bollgard (*Bt*)/Roundup Ready (glyphosate resistant) cotton were used to manage the crop. A mepiquat plant growth regulator was applied at three separate times each year. In 2003, 33oz/ac of PixPlus was applied between 55 and 87 days after planting (DAP). In 2004, 38oz/ac of Mepex® was used between 37 and 69 DAP and in 2005, 26 oz/ac of Mepex® was applied during 54 and 78 DAP.

Plant sampling occurred on two separate dates; early bloom, when boll set begins; and cutout, which is the cessation of flowering. This was performed so that carbohydrate analysis would demonstrate the amount of partitioning during boll filling. The two sampling dates were treated as subplots in the experimental design. Plants were sampled around solar noon on 89 and 118 DAP in 2003, at 69 and 112 DAP in 2004, and 74 and 109 DAP in 2005.  Eight consecutive plants from a row were cut at the soil level and a 2-cm sample of stem tissue below the cotyledonary node was cut and immediately placed on dried ice. The samples were then freeze dried and ground through a 20-mesh screen with a Wiley mill. The ground tissue was then stored with desiccant until carbohydrate analysis could be performed. The remaining plant was dissected and dried at 60°C for biomass partitioning analysis.

**Carbohydrate Analysis**

Glucose, fructose, sucrose and starch concentrations were determined colorimetrically by methods developed by Hendrix (1993). Each carbohydrate was enzymatically converted to glucose (Figure 1). Glucose was then converted to 6-phosphogluconate; this two-part reaction releases one NADH molecule per glucose converted. The NADH absorbance was read using a microplate reader (Multiskan MCC/340, Thermo Labsystems, Helsinki, Finland) at a wavelength of




**Adapted from D.L. Hendrix.(1993).**

**Figure 1. A diagram of enzymes needed to convert carbohydrates to glucose, and for colorimetric assay of glucose.**

340 nanometers and unknown glucose concentrations were calculated with a standard curve ranging from 0.05 to 0.8 mg/ml.

To begin analysis, one hundred milligrams of ground stem tissue from each plant was subjected to a series of three hot ethanolic washes to extract the soluble sugars for thirty minutes. After each wash, the tubes were centrifuged to separate the soluble and insoluble fractions. The ethanolic extract was then decanted. The combined extract was brought to a volume of 10 ml, and a 1.5 ml aliquot was purified with twenty mg of activated charcoal, and centrifuged. Twenty microliters of the aliquot was placed in a separate well of a microplate and dried overnight to evaporate the remaining ethanol.

Subsamples were made by placing aliquots of the same sample in two separate wells, providing two absorbance readings. The sugars were resolubilized with 20 microliters of water for twenty minutes. Glucose assay reagents (Sigma glucose kit GAHK-20) were brought to volume with water as noted in the instructions with the kit (Sigma Aldrich, 1997). The glucose kit contained the enzymes hexokinase and glucose-6-phosphate dehydrogenase. One hundred microliters of this preparation was then added to each well and allowed to sit for fifteen minutes. Absorbance at 340 nanometers was then read by a microplate reader. Ten microliters of phosphoglucose isomerase (Sigma P-9544) preparation was then added to each well, converting fructose to glucose and the absorbance was read again. This enzyme was prepared by adding 1.0 milliliter of a 0.2M Hepes buffer, pH 7.6, to 1000 units of the enzyme. The absorbance was read at 340nm. An increase in absorbance was noted due to the conversion of fructose to glucose. The difference between the two readings indicated fructose concentration. The last enzyme added was invertase (Sigma I-4504). Eighty-three enzyme units were needed per well to convert sucrose into glucose and fructose. This invertase solution was prepared by adding 50 milligrams of powdered enzyme to a 5 milliliter 0.1 M citrate buffer (pH 6.0). The increase in absorbance was attributed to sucrose. In each case, absorbances were compared to a standard curve to determine sugar concentrations.

Starch analysis was performed on the pellet remaining after soluble sugar extraction. It was treated with one milliliter of 0.1M KOH and each tube was placed in a hot water bath for an hour to gelatinize the starch. Once cooled, pH was lowered between 6.6 and 7.5 with acetic acid. Three hundred and sixty units of the prepared enzyme, α-amylase (Sigma A3-3403) was added and placed in an 80°C bath for thirty minutes. This enzyme is responsible for breaking the straight α-1,4 glucose bonds present in starch. The α-amylase was prepared by diluting ten fold in 1M Tris acetate buffer (pH 7.2). The enzyme was dialyzed against water to rid any glucose that might have been present. The test tubes were allowed to cool and the pH was lowered to 5 by adding 0.1M acetic acid. One hundred and twenty two units of prepared enzyme, amyloglucosidase (Sigma A-3042) was then added and placed in a 55°C bath for one hour. Amyloglucosidase was prepared by diluting fifty fold with sodium acetate buffer (pH 4.5) and dialyzing against the same buffer overnight. This enzyme breaks starch's branching α-1,6 glucose linkages. To stop all reactions, the samples were immediately placed in boiling water for four minutes. Aliquots were taken, centrifuged and placed in wells for analysis. One hundred microliters of glucose assay reagent was added and absorbance read at 340nm.

**Statistical Analysis**

Data were analyzed using the Mixed Procedure in SAS 9.0 and means were separated using pairwise LSD comparisons at p=0.05. Years, treatments, and sampling dates were fixed effects with replications being random effects. The year effects were tested with reps within years; sampling dates were treated as subplots nested within the whole plots of cultivar and potassium rates.

## CHAPTER IV:

## RESULTS AND DISCUSSION

### Analyses of Variance

Results of analysis of variance of fixed effects on monosaccharide concentrations are presented in Table 1. Effects on sucrose and total soluble sugars are presented in Table 2, and effects on starch and total nonstructural concentrations are shown in Table 3. Cultivars had significant effects on all nonstructural carbohydrates whereas potassium (K) fertilization had significant effects only on the monosaccharides. The sampling date had significant effects on all carbohydrates except glucose (Table 1, 2, 3). The year*cultivar*date interaction was significant only in the soluble sugars (Table 1, 2).

**Table 1. Analysis of variance of fixed effects on monosaccharide concentrations in cotton stem tissue. Significant (p<.05) effects are highlighted in bold.**

| | | | Glucose | | Fructose | |
|---|---|---|---|---|---|---|
| Effect | Num DF | Den DF | F Value | PR>F | F Value | PR>F |
| Year | 2 | 15 | 5.25 | **0.0187** | 141.33 | **<.0001** |
| Cultivar | 1 | 45 | 39.12 | **<.0001** | 1.38 | 0.2459 |
| Year*Cultivar | 2 | 45 | 0.73 | 0.4863 | 0.79 | 0.4614 |
| K | 1 | 45 | 18.43 | **<.0001** | 4.51 | **0.0392** |
| Year*K | 2 | 45 | 0.88 | 0.4202 | 4.63 | **0.0149** |
| Cultivar*K | 1 | 45 | 0.31 | 0.5805 | 0.17 | 0.6856 |
| Year*Cultivar*K | 2 | 45 | 2.87 | 0.0668 | 1.40 | 0.2582 |
| Date | 1 | 60 | 2.85 | 0.0966 | 26.70 | **<.0001** |
| Year*Date | 2 | 60 | 30.39 | **<.0001** | 8.19 | **0.0007** |
| Cultivar*Date | 1 | 60 | 0.54 | 0.4664 | 0.57 | 0.4531 |
| Year*Cultivar*Date | 2 | 60 | 8.57 | **0.0005** | 4.64 | **0.0134** |
| K*Date | 1 | 60 | 1.45 | 0.2328 | 0.23 | 0.6300 |
| Year*K*Date | 2 | 60 | 1.14 | 0.3255 | 0.82 | 0.4435 |
| Cultivar*K*Date | 1 | 60 | 2.33 | 0.1323 | 3.08 | 0.0846 |
| Year*Cultivar*K*Date | 2 | 60 | 0.02 | 0.9815 | 0.05 | 0.9533 |

**Table 2. Analysis of variance of fixed effects on sucrose and total soluble sugar concentrations in cotton stem tissue. Significant (p<.05) effects are highlighted in bold.**

| Effect | Num DF | Den DF | Sucrose F Value | Sucrose PR>F | Total Soluble Sugars F Value | Total Soluble Sugars PR>F |
|---|---|---|---|---|---|---|
| Year | 2 | 15 | 2.06 | 0.1626 | 6.15 | **0.0112** |
| Cultivar | 1 | 45 | 9.99 | **0.0028** | 9.57 | **0.0034** |
| Year*Cultivar | 2 | 45 | 4.57 | **0.0156** | 2.94 | 0.0632 |
| K | 1 | 45 | 0.69 | 0.4094 | 0.04 | 0.8339 |
| Year*K | 2 | 45 | 1.00 | 0.3751 | 0.8 | 0.4552 |
| Cultivar*K | 1 | 45 | 0.64 | 0.4285 | 0.38 | 0.5428 |
| Year*Cultivar*K | 2 | 45 | 2.01 | 0.1457 | 2.43 | 0.0994 |
| Date | 1 | 60 | 57.06 | **<.0001** | 27.9 | **<.0001** |
| Year*Date | 2 | 60 | 38.37 | **<.0001** | 33.89 | **<.0001** |
| Cultivar*Date | 1 | 60 | 0.99 | 0.3232 | 0.61 | 0.4372 |
| Year*Cultivar*Date | 2 | 60 | 4.08 | **0.0218** | 5.5 | **0.0064** |
| K*Date | 1 | 60 | 0.84 | 0.3627 | 0.91 | 0.3427 |
| Year*K*Date | 2 | 60 | 0.30 | 0.7420 | 0.24 | 0.7845 |
| Cultivar*K*Date | 1 | 60 | 3.27 | 0.0740 | 3.36 | 0.0716 |
| Year*Cultivar*K*Date | 2 | 60 | 0.21 | 0.8088 | 0.13 | 0.8823 |

**Table 3. Analysis of variance of fixed effects on starch and total nonstructural carbohydrate concentrations in cotton stem tissue. Significant (p<.05) effects are highlighted in bold.**

| Effect | Num DF | Den DF | Starch F Value | Starch PR>F | Total Nonstructural Carbohydrates F Value | Total Nonstructural Carbohydrates PR>F |
|---|---|---|---|---|---|---|
| Year | 2 | 15 | 37.87 | **<.0001** | 24.55 | **<.0001** |
| Cultivar | 1 | 45 | 47.04 | **<.0001** | 27.21 | **<.0001** |
| Year*Cultivar | 2 | 45 | 3.36 | **0.0438** | 2.75 | 0.0749 |
| K | 1 | 45 | 0.93 | 0.3396 | 0.97 | 0.3308 |
| Year*K | 2 | 45 | 0.36 | 0.7015 | 0.05 | 0.956 |
| Cultivar*K | 1 | 45 | 0.02 | 0.8781 | 0 | 0.9458 |
| Year*Cultivar*K | 2 | 45 | 0.28 | 0.7599 | 0.11 | 0.8925 |
| Date | 1 | 60 | 102.41 | **<.0001** | 52.16 | **<.0001** |
| Year*Date | 2 | 60 | 187.15 | **<.0001** | 185.61 | **<.0001** |
| Cultivar*Date | 1 | 60 | 38.71 | **<.0001** | 30.38 | **<.0001** |
| Year*Cultivar*Date | 2 | 60 | 0.67 | 0.5170 | 0.54 | 0.5856 |
| K*Date | 1 | 60 | 2.17 | 0.1456 | 3.84 | 0.0546 |
| Year*K*Date | 2 | 60 | 0.52 | 0.5971 | 0.23 | 0.7981 |
| Cultivar*K*Date | 1 | 60 | 0.01 | 0.9330 | 0.71 | 0.4014 |
| Year*Cultivar*K*Date | 2 | 60 | 0.19 | 0.8282 | 0.11 | 0.8921 |

**Potassium Effects**

The soil test potassium noted in the following table (Table 4) is an indicator for the amount of potassium fertilization needed according to the Mehlich I test (Hanlon, 2001). When soil potassium concentrations are high (161 to 320 lb K/ac), application of 60 lbs $K_2O$/acre is recommended as adequate for cotton production, but anything exceeding 60 lbs/acre is considered excessive (Savoy and Joines, 2001). For soil test K levels above 320 lb K/ac, no potassium fertilization is recommended (Savoy and Joines, 2001). Study plots receiving 60 lb $K_2O$/ac/yr had adequate K fertility, but plots receiving 120 lb $K_2O$/ac/yr had excessive K fertility (Table 4). Across years, potassium treatments showed a decrease in monosaccharide concentration for 120 lbs/ac/yr when compared to 60 lbs/ac/yr (Table 4). This could be an indication that more cellulose synthesis occurred in stem tissue with excessive K fertility.

**Table 4. Glucose and fructose concentrations in cotton stem tissue at two potassium fertilization rates, averaged across cultivars.**

| Year | Soil Test K | K Tmt. | Glucose | | Fructose | |
|---|---|---|---|---|---|---|
| | lb K/ac | lb $K_2O$/ac/yr | mg/g dry wgt | | mg/g dry wgt | |
| | 200 | 60 | 4.94 | a | 4.44 | a |
| | 335 | 120 | 4.21 | b | 4.06 | b |
| 2003 | 206 | 60 | 5.29 | | 4.58 | b |
| 2003 | 301 | 120 | 4.49 | | 3.47 | c |
| 2004 | 219 | 60 | 5.17 | | 2.55 | d |
| 2004 | 396 | 120 | 4.21 | | 2.28 | d |
| 2005 | 177 | 60 | 4.36 | | 6.20 | a |
| 2005 | 307 | 120 | 3.94 | | 6.43 | a |

Within groups, means followed by the same letter do not differ at p=0.05.
Absence of letters indicates P(F) >0.05.

The significant year*K interaction in Table 1 was due to the potassium rates significantly influencing fructose concentrations only in 2003.

There was no significant response to K in sucrose, total soluble carbohydrates, or starch concentrations (Tables 2 and 3). This is consistent with the findings of Pettigrew (1999) that potassium fertilizer treatments have more effect on monosaccharide concentrations. The interaction effects of K and sampling date on total nonstructural carbohydrates approached statistical significance ($p=0.0546$) (Table 3). This interaction was due to a decrease in carbohydrate concentration in response to additional K at early bloom, but no difference in concentration at cutout (data not shown).

**Cultivar Effects**

Across years and sampling dates, glucose concentrations were higher in main stems of DP555 than PM1218, but cultivars did not differ significantly in fructose (Table 5). In PM1218, there was a significant increase in glucose during boll filling only in 2005. In DP555, glucose concentrations decreased between early bloom and cutout in 2003 and increased between dates in 2005. Fructose concentrations increased significantly between sample dates in both cultivars only in 2003. This indicates that the indeterminate cultivar required more free glucose during early boll filling; perhaps these stem carbohydrates are needed to maintain a balance between new reproductive and continued vegetative growth. A further look at sucrose and starch concentrations may provide insight as to what was occurring in the cultivars.

**Table 5. Monosaccharide concentrations in stem tissue of two cultivars sampled at early bloom and cutout, averaged across potassium treatments.**

| Year | Cultivar | Sampling Date* | Glucose | | Fructose | |
|---|---|---|---|---|---|---|
| | | | mg/g dry wgt | | mg/g dry wgt | |
| | | EB | 4.43 | | 3.78 | b |
| | | CO | 4.72 | | 4.72 | a |
| | PM 1218 | | 4.04 | b | 4.35 | |
| | DP555 | | 5.10 | a | 4.14 | |
| 2003 | PM 1218 | EB | 4.38 | cd | 2.98 | ef |
| 2003 | PM 1218 | CO | 4.08 | cd | 5.60 | bc |
| 2003 | DP555 | EB | 6.24 | a | 3.18 | ef |
| 2003 | DP555 | CO | 4.84 | bcd | 4.34 | d |
| 2004 | PM 1218 | EB | 4.29 | cd | 2.23 | f |
| 2004 | PM 1218 | CO | 4.02 | de | 2.61 | ef |
| 2004 | DP555 | EB | 5.53 | ab | 2.49 | ef |
| 2004 | DP555 | CO | 4.92 | bc | 2.32 | ef |
| 2005 | PM 1218 | EB | 3.22 | ef | 6.25 | abc |
| 2005 | PM 1218 | CO | 4.27 | cd | 6.47 | ab |
| 2005 | DP555 | EB | 2.93 | f | 5.56 | c |
| 2005 | DP555 | CO | 6.17 | a | 6.97 | c |

*Early bloom (EB) and Cutout (CO)
Within groups, means followed by the same letter do not differ at p=0.05. Absence of letters indicates P(F) >0.05.

The indeterminate cultivar, DP555, had higher concentrations of the main soluble sugar, sucrose, than the more determinate cultivar (Table 6). Sucrose and total soluble sugar (TSS) concentrations changed significantly with time, with higher concentrations at early bloom and a decline by cutout. Sucrose and total soluble sugars declined in concentration in both cultivars between early bloom and cutout in 2003 and 2004. DP555 had higher concentrations at early bloom but by cutout the concentrations of both cultivars were equivalent. However in 2005, DP555 had an increase in sucrose and TSS concentrations while there was no significant change in PM1218.

Starch concentrations were higher in PM1218 than in DP555 at early bloom, but by cutout, both cultivars had equivalent concentrations (Table 6). In 2003, starch reserves were depleted between early bloom and cutout but in the following years starch accumulated. The starch concentrations are consistent with observations by Wells (2002) who also found year and cultivar effects. An explanation for the depletion of starch in 2003 may be due to variations in sampling date and possibly the environmental conditions that favored lint yield formation.

As the indeterminate cultivar had higher TSS at early bloom, the more determinate had higher starch concentrations. Since the determinate plant has less vegetative growth during boll filling, it could account for an excess of photoassimilates that are readily converted to starch. Halevy (1976) found that more determinate cultivars have a decreased root-to-shoot ratio when compared to indeterminate cultivars. The amount of starch present in the lower stem of the PM1218 may be directly related

**Table 6. Sucrose, total soluble sugar (TSS) and starch concentrations in stem tissue of two cultivars sampled at early bloom and cutout, averaged across potassium levels.**

| Year | Cultivar | Sampling Date * | Sucrose | | TSS | | Starch | |
|---|---|---|---|---|---|---|---|---|
| | | | mg/g dry wgt | | mg/g dry wgt | | mg/g dry wgt | |
| | PM 1218 | | 32.3 | b | 40.9 | b | 76.3 | a |
| | DP555 | | 35.5 | a | 44.8 | a | 58.7 | b |
| | | EB | 37.7 | a | 46.2 | a | 54.5 | b |
| | | CO | 30.1 | b | 39.5 | b | 80.4 | a |
| 2003 | PM 1218 | EB | 35.2 | bc | 42.6 | cd | 116.5 | a |
| 2003 | PM 1218 | CO | 29.6 | de | 39.3 | d | 56.8 | cd |
| 2003 | DP555 | EB | 43.9 | a | 53.6 | a | 73.2 | b |
| 2003 | DP555 | CO | 30.3 | cde | 39.5 | d | 46.2 | de |
| 2004 | PM 1218 | EB | 37.1 | bc | 44.5 | bcd | 63.7 | bc |
| 2004 | PM 1218 | CO | 21.7 | f | 28.4 | e | 114.4 | a |
| 2004 | DP555 | EB | 45.1 | a | 53.2 | a | 30.6 | f |
| 2004 | DP555 | CO | 25.7 | ef | 32.7 | e | 119.9 | a |
| 2005 | PM 1218 | EB | 34.6 | bcd | 44.1 | cd | 33.6 | ef |
| 2005 | PM 1218 | CO | 35.7 | b | 46.5 | bc | 72.6 | b |
| 2005 | DP555 | EB | 30.6 | cde | 30.1 | d | 9.4 | g |
| 2005 | DP555 | CO | 37.6 | b | 50.7 | ab | 72.7 | b |

* Early bloom (EB) and Cutout (CO)

Within groups, means followed by the same letter do not differ at p=0.05.

to its rooting system. Where PM1218 may store starch in the lower stem due to its decreased rooting system, DP555's sucrose levels may be an indication of movement to the roots for starch storage or continued root growth.

The indeterminate cultivar, DP555, could have a higher root-to-shoot ratio due to its more perennial characteristics which would require more carbohydrate partitioning to vegetative growth. PM1218, the more determinate cultivar, has higher seed oil content, shown by the National Cotton Variety Test 2003. This could potentially increase the sink strength of the reproductive fruit, resulting in greater photoassimilate demand than in DP555. Variations in sampling date along with environmental conditions from year to year may be responsible for the differences in starch accumulation and depletion in different years.

**Lint Yield**

Potassium and cultivars had significant effects on lint yields, and there was a significant K-by-cultivar interaction. The total lint yield showed a significant response to additional potassium only in the more determinate cultivar (Table 7). The more determinate cultivar, PM1218, had lower yields with 60 lbs/acre/year potassium fertilizer regimen, but DP555 did not. Perhaps a higher potassium fertilizer rate is needed in the more determinate cultivar to increase lint production. This is consistent with findings of Cassman et al. (1989) that a more determinate cultivar had a greater lint yield response to additional potassium. The indeterminate cultivar seems to produce higher yields with limited K fertility when compared with the more determinate cultivar. Cassman et al.

**Table 7. Total lint yields of two cultivars with two potassium fertilization treatments averaged across three years.**

| Cultivar | Soil Test K | K | Total Lint Yield | |
|---|---|---|---|---|
| | lb K/ac | lb $K_2O$/ac/yr | lb/ac | |
| PM1218 | 194 | 60 | 1496 | b |
| PM1218 | 335 | 120 | 1648 | a |
| DP555 | 206 | 60 | 1669 | a |
| DP555 | 333 | 120 | 1676 | a |

Means followed by the same letter do not differ at p=0.05.

(1989) also noted that the determinate cultivar had a higher uptake of potassium during boll development. Perhaps the indeterminate cultivar has a more extensive rooting system, allowing it to extract potassium more readily from the soil, in contrast to the determinate cultivar which may have had an insufficient rooting system to meet the needs for reproductive growth under lower potassium levels.

The relationship between lint yield and the accumulation or depletion of starch reserves was examined by linear regression (Fig. 2). The significant linear regression (Figure 2) indicates that as lint yields increased, starch reserves were not depleted as hypothesized, but rather accumulated. Within each year, there was no significant correlation of lint yield to change in stem starch between early bloom and cutout. The results suggest that stem starch reserves tended to increase in years with higher lint yields, and to decrease in a year (2003) with lower lint yields.

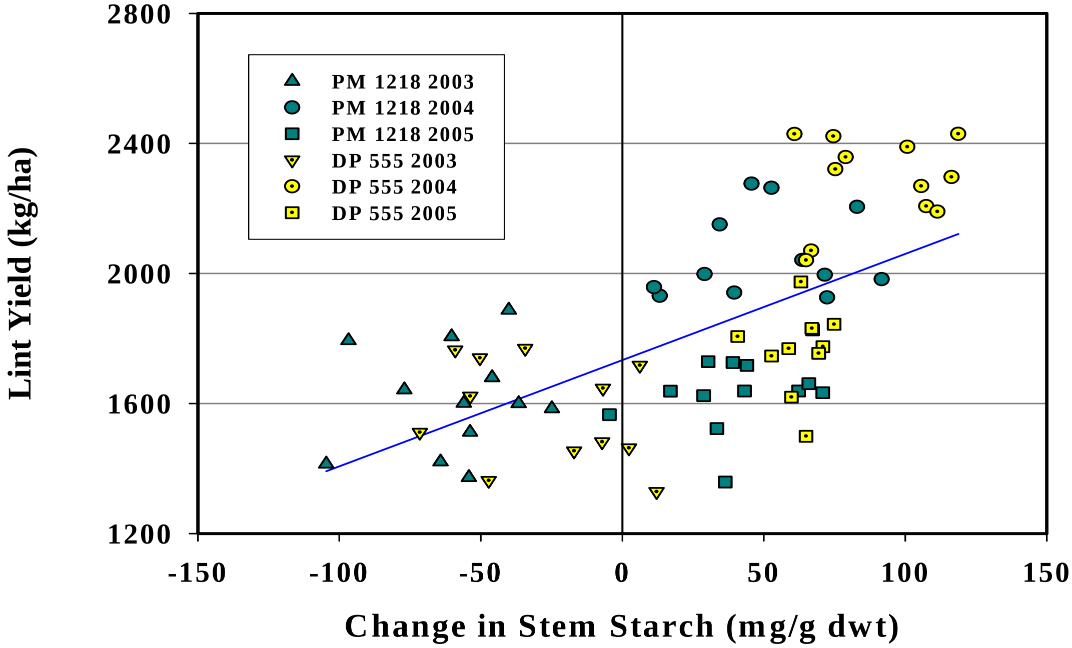



**Figure 2. Change in stem starch from early bloom to cutout relative to lint yield formation in two cultivars 2003-2005.**

# CHAPTER V:

# CONCLUSIONS

In conclusion, the cultivars had different concentrations of soluble sugars and storage carbohydrates in stem tissue at early bloom, but were statistically the same by cutout. Therefore the carbohydrate partitioning in indeterminate and determinate cultivars differed more in the early stages of reproductive development than later in boll filling. The starch reserves were not depleted as hypothesized, but rather accumulated between early bloom and cutout in two of three years. Evidently these stored photoassimilates were not remobilized to support reproductive growth during this period. The amount of sucrose transport was higher in the indeterminate cultivar at early bloom. The direction of transport is not determined in this study, but is assumed to move from source to sink.

Indeterminate cultivars tend to continue vegetative growth during reproductive development; this allows for higher above ground biomass as described by Gwathmey (2005) and a more extensive rooting system (Halevy, 1976) when compared to more determinate cultivars. The leaf area associated with more vegetative biomass increases the relative amount of photoassimilates, so as bolls develop there is an adequate supply of carbohydrates for reproductive development, hence less demand for remobilization of lower stem/root starch. The high amounts of sucrose at early bloom may be due to its transportation to the roots where it may support root growth or be stored as starch.

On the other hand, more determinate cultivars tend to decrease in vegetative growth during reproductive onset. This decrease affects not only the shoot which limits photoassimilate supplies, but possibly the root system, limiting soil nutrient uptake.

Though bred to improve lint yields, perhaps the determinate plant can not support the new reproductive demands under the same potassium management conditions as indeterminate plants.

Additional potassium fertilization had an effect only on the monosaccharides but it was sufficient to increase the lint yields in the determinate cultivar. If the findings of Gwathmey (2005) on differences in vegetative biomass extend to the root system, then the yield response to potassium may relate to differences in uptake at the root level. However, cultivar differences in potassium response were not seen in the transport or storage carbohydrates. The hypothesis of greater remobilization and transport of carbohydrates with additional potassium fertility is not supported by these results.

Future work on potassium fertility is necessary to determine if additional potassium plays a role in maximizing lint yields in the more determinate cultivars. Further research needs to be conducted on the components of carbohydrate sink strength, such as seed constituents and root to shoot ratios. Determining cotton's use of soluble sugar and labile starch reserves would provide a better understanding of its vegetative and reproductive requirements. This would help in identifying particular carbohydrate partitioning strategies in cultivars with contrasting growth habits.

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# APPENDICES

Appendix A: Field Study Plot Assignments

**Table 8. 2003 N&K Study: Variety response to K.**

| Cul. No. | Cultivar | lbs/acre K2O | Rep. I. | Rep. II. | Rep. III. | Rep. IV. | Rep. V. | Rep. VI. |
|---|---|---|---|---|---|---|---|---|
| 1 | PM 1218 | 60 | 102 | 211 | 301 | 412 | 509 | 603 |
| 1 | PM 1218 | 120 | 206 | 109 | 306 | 407 | 505 | 605 |
| 2 | DP 555 | 60 | 205 | 108 | 404 | 311 | 512 | 606 |
| 2 | DP 555 | 120 | 303 | 111 | 405 | 208 | 501 | 602 |

**Table 9. 2004 N&K Study: Variety response to K.**

| Cul. No. | Cultivar | lbs/acre K2O | Rep. I. | Rep. II. | Rep. III. | Rep. IV. | Rep. V. | Rep. VI. |
|---|---|---|---|---|---|---|---|---|
| 1 | PM 1218 | 60 | 108 | 205 | 311 | 404 | 512 | 606 |
| 1 | PM 1218 | 120 | 111 | 208 | 303 | 405 | 501 | 602 |
| 2 | DP 555 | 60 | 102 | 211 | 301 | 412 | 509 | 603 |
| 2 | DP 555 | 120 | 109 | 206 | 306 | 407 | 505 | 605 |

**Table 10. 2005 N&K Study: Variety response to K.**

| Cul. No. | Cultivar | lbs/acre K2O | Rep. I. | Rep. II. | Rep. III. | Rep. IV. | Rep. V. | Rep. VI. |
|---|---|---|---|---|---|---|---|---|
| 1 | PM 1218 | 60 | 102 | 211 | 301 | 412 | 509 | 603 |
| 1 | PM 1218 | 120 | 109 | 206 | 306 | 407 | 505 | 605 |
| 2 | DP 555 | 60 | 108 | 205 | 311 | 404 | 512 | 606 |
| 2 | DP 555 | 120 | 111 | 208 | 303 | 405 | 501 | 602 |

Appendix B: Weather Data

**Table 11. Summary of weather conditions by week of the 2003 growing season at Jackson TN.**

| WTES Week Ending | TEMPERATURE (F) | | | | PRECIPITATION (in.) | | | | GDD BASE 60F Since April 1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HIGH | LOW | AVG | DFN | Current Week | Rainy Days | Cumul. Since 1-Apr | Departure From Normal | Total | DFN |
| 5/4/2003 | 86 | 53 | 70 | 6 | 0.33 | 1 | 13.37 | -5.73 | 153 | 50 |
| 5/11/2003 | 86 | 58 | 74 | 9 | 6.8 | 6 | 20.17 | -0.21 | 252 | 103 |
| 5/18/2003 | 84 | 52 | 68 | 1 | 2.13 | 2 | 22.3 | 0.66 | 309 | 103 |
| 5/25/2003 | 78 | 54 | 67 | -3 | 0.85 | 2 | 23.15 | 0.28 | 360 | 85 |
| 6/1/2003 | 82 | 51 | 66 | -6 | 0.09 | 1 | 23.24 | -0.76 | 405 | 49 |
| 6/8/2003 | 80 | 53 | 66 | -7 | 1.3 | 2 | 24.54 | -0.48 | 451 | 1 |
| 6/15/2003 | 89 | 56 | 75 | 0 | 0.96 | 3 | 25.5 | -0.46 | 556 | 1 |
| 6/22/2003 | 84 | 55 | 73 | -4 | 3.55 | 5 | 29.05 | 2.18 | 651 | -18 |
| 6/29/2003 | 91 | 58 | 75 | -3 | 0.22 | 1 | 29.27 | 1.47 | 760 | -31 |
| 7/6/2003 | 92 | 66 | 79 | 1 | 0.56 | 2 | 29.83 | 1.05 | 891 | -29 |
| 7/13/2003 | 92 | 69 | 81 | 3 | 0.08 | 1 | 29.91 | 0.1 | 1037 | -16 |
| 7/20/2003 | 94 | 68 | 81 | 3 | 0.51 | 2 | 30.42 | -0.37 | 1184 | -2 |
| 7/27/2003 | 92 | 59 | 77 | -3 | 0.48 | 2 | 30.9 | -0.8 | 1302 | -20 |
| 8/3/2003 | 95 | 68 | 79 | -1 | 2.63 | 5 | 33.53 | 1.04 | 1436 | -19 |
| 8/10/2003 | 88 | 67 | 77 | -2 | 0.83 | 2 | 34.36 | 1.22 | 1557 | -31 |
| 8/17/2003 | 91 | 65 | 78 | 0 | 1.17 | 2 | 35.53 | 1.79 | 1684 | -30 |
| 8/24/2003 | 94 | 68 | 82 | 5 | 0.24 | 2 | 35.77 | 1.4 | 1837 | 2 |
| 8/31/2003 | 93 | 67 | 81 | 6 | 0.1 | 1 | 35.87 | 0.79 | 1987 | 40 |
| 9/7/2003 | 90 | 60 | 75 | 0 | 1.82 | 4 | 37.69 | 1.76 | 2095 | 47 |
| 9/14/2003 | 89 | 55 | 73 | 0 | 0.63 | 1 | 38.32 | 1.45 | 2190 | 52 |
| 9/21/2003 | 89 | 49 | 67 | -4 | 0.02 | 1 | 38.34 | 0.49 | 2242 | 28 |
| 9/28/2003 | 87 | 47 | 68 | -1 | 1.35 | 3 | 39.69 | 0.94 | 2301 | 24 |
| 10/5/2003 | 77 | 36 | 56 | -10 | 0.07 | 1 | 39.76 | 0.21 | 2306 | -18 |
| 10/12/2003 | 80 | 53 | 66 | 5 | 0.6 | 4 | 40.36 | 0.11 | 2352 | -6 |
| 10/19/2003 | 76 | 40 | 60 | 0 | 1.02 | 4 | 41.38 | 0.43 | 2366 | -15 |
| 10/26/2003 | 84 | 46 | 64 | 8 | 2.79 | 1 | 44.17 | 2.5 | 2399 | 4 |

GDD = Growing Degree-Days (base 60 F). DFN = Departure from normal.

Source: Tennessee Agricultural Statistics Service, Nashville TN.

Table 12. Summary of weather conditions by week of the 2004 growing season at Jackson TN.

| WTES | TEMPERATURE (F) | | | | PRECIPITATION (in.) | | | | Cumul. Degree-Base 60F Since April 1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Week Ending | HIGH | LOW | AVG | DFN | Current Week | Rainy Days | Cumul. Since 1-Apr | Departure From Normal | Total | DFN |
| 5/2/2004 | 78 | 44 | 63 | -2 | 1.27 | 3 | 16.95 | -1.96 | 117 | 21 |
| 5/9/2004 | 86 | 39 | 65 | -2 | 0.2 | 1 | 19.37 | -1.19 | 179 | 12 |
| 5/16/2004 | 87 | 58 | 71 | 3 | 2.87 | 4 | 22.24 | 0.42 | 255 | 26 |
| 5/23/2004 | 88 | 64 | 76 | 7 | 0.08 | 3 | 22.32 | -0.71 | 371 | 68 |
| 5/30/2004 | 88 | 62 | 77 | 5 | 2.41 | 3 | 24.73 | 0.43 | 509 | 106 |
| 6/6/2004 | 88 | 53 | 72 | -4 | 3.15 | 2 | 25.58 | 0.41 | 575 | 85 |
| 6/13/2004 | 92 | 64 | 79 | 5 | 0.07 | 2 | 25.07 | -0.75 | 712 | 174 |
| 6/20/2004 | 91 | 66 | 79 | 4 | 0.9 | 4 | 25.97 | -0.76 | 848 | 197 |
| 6/27/2004 | 86 | 63 | 74 | -4 | 1.08 | 5 | 27.05 | -0.6 | 949 | 177 |
| 7/4/2004 | 86 | 68 | 77 | -2 | 0.72 | 4 | 27.77 | -0.86 | 1067 | 167 |
| 7/11/2004 | 92 | 67 | 80 | 2 | 1.24 | 2 | 29.01 | -0.65 | 1208 | 175 |
| 7/18/2004 | 95 | 68 | 80 | 2 | 0.44 | 1 | 29.45 | -1.19 | 1353 | 187 |
| 7/25/2004 | 93 | 62 | 78 | -1 | 2.1 | 2 | 31.55 | -0.02 | 1482 | 180 |
| 8/1/2004 | 88 | 57 | 74 | -6 | 0.59 | 3 | 32.14 | -0.24 | 1580 | 145 |
| 8/8/2004 | 92 | 57 | 75 | -4 | 0.5 | 1 | 32.64 | -0.4 | 1691 | 123 |
| 8/15/2004 | 90 | 48 | 70 | -9 | 0.05 | 1 | 32.69 | -0.96 | 1762 | 67 |
| 8/22/2004 | 93 | 52 | 74 | -5 | 2.2 | 3 | 34.89 | 0.62 | 1859 | 42 |
| 8/29/2004 | 89 | 65 | 79 | 3 | 2.14 | 3 | 37.03 | 2.07 | 1993 | 62 |
| 9/5/2004 | 88 | 59 | 74 | -1 | 0.04 | 1 | 37.07 | 1.28 | 2094 | 61 |
| 9/12/2004 | 91 | 58 | 73 | 0 | 0 | 0 | 37.07 | 0.35 | 2189 | 64 |
| 9/19/2004 | 87 | 53 | 74 | 3 | 0.68 | 3 | 37.75 | 0.05 | 2285 | 82 |
| 9/26/2004 | 84 | 51 | 70 | 2 | 0.01 | 1 | 37.76 | -0.86 | 2355 | 87 |
| 10/3/2004 | 84 | 42 | 64 | -2 | 0.01 | 1 | 37.77 | -1.66 | 2390 | 73 |
| 10/10/2004 | 84 | 42 | 65 | 2 | 0 | 0 | 37.77 | -2.37 | 2424 | 71 |
| 10/17/2004 | 75 | 40 | 58 | -2 | 3.01 | 5 | 40.78 | -0.06 | 2444 | 66 |
| 10/24/2004 | 81 | 48 | 65 | 9 | 2.41 | 5 | 43.19 | 1.64 | 2484 | 92 |

DFN = departure from normal

Source: Tennessee Agricultural Statistics Service, Nashvill

Table 13. **Summary of weather conditions by week of the 2005 growing season at Jackson TN.**

| **WTREC Jackson TN** | High Temp | Low Temp | Avg. Temp | Temp DFN[†] | Precip. Week | Rainy Days | Cumul. Precip. | Cumul DFN[†] | GDD Base 60°F Since April 1 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Week ending | °F | °F | °F | °F | in. | d. | in. | in. | Total | DFN[†] |
| | | | | | | | | | | |
| 1-May-05 | 70 | 36 | 54 | -10 | 2.05 | 5 | 20.97 | 2.41 | 94 | 7 |
| 8-May-05 | 80 | 38 | 57 | -9 | 0 | 0 | 20.97 | 1.14 | 103 | -25 |
| 15-May-05 | 91 | 54 | 73 | 7 | 0.36 | 3 | 21.33 | 0.23 | 196 | 16 |
| 22-May-05 | 87 | 44 | 68 | -1 | 0 | 0 | 21.33 | -1.03 | 259 | 15 |
| 29-May-05 | 86 | 50 | 70 | -1 | 0 | 0 | 21.33 | -2.2 | 330 | 10 |
| 5-Jun-05 | 90 | 57 | 71 | -2 | 3.13 | 2 | 24.46 | -0.14 | 409 | 1 |
| 12-Jun-05 | 92 | 64 | 78 | 5 | 2.79 | 3 | 27.25 | 1.68 | 536 | 27 |
| 19-Jun-05 | 91 | 59 | 74 | -3 | 0.86 | 1 | 28.11 | 1.63 | 636 | 17 |
| 26-Jun-05 | 93 | 62 | 77 | 1 | 0.04 | 1 | 28.15 | 0.76 | 759 | 22 |
| 3-Jul-05 | 95 | 67 | 80 | 3 | 0.27 | 3 | 28.42 | 0.06 | 899 | 36 |
| 10-Jul-05 | 93 | 66 | 79 | 1 | 1.66 | 3 | 30.08 | 0.71 | 1034 | 38 |
| 17-Jul-05 | 88 | 67 | 77 | -3 | 2.88 | 5 | 32.96 | 2.59 | 1156 | 27 |
| 24-Jul-05 | 95 | 72 | 83 | 5 | 0.08 | 1 | 33.04 | 1.72 | 1319 | 55 |
| 31-Jul-05 | 96 | 66 | 80 | 2 | 0.66 | 1 | 33.7 | 1.53 | 1464 | 66 |
| 7-Aug-05 | 94 | 67 | 81 | 2 | 0.16 | 1 | 33.86 | 0.99 | 1611 | 80 |
| 14-Aug-05 | 97 | 68 | 82 | 5 | 0.65 | 1 | 34.51 | 1.01 | 1768 | 108 |
| 21-Aug-05 | 98 | 71 | 85 | 8 | 0.98 | 3 | 35.49 | 1.39 | 1943 | 159 |
| 28-Aug-05 | 95 | 69 | 81 | 5 | 2.94 | 3 | 38.43 | 3.67 | 2092 | 192 |
| 4-Sep-05 | 89 | 56 | 75 | -2 | 2.54 | 2 | 40.97 | 5.42 | 2198 | 192 |
| 11-Sep-05 | 89 | 59 | 75 | 2 | 0 | 0 | 40.97 | 4.52 | 2303 | 202 |
| 18-Sep-05 | 90 | 59 | 75 | 4 | 1.99 | 1 | 42.96 | 5.53 | 2412 | 229 |
| 25-Sep-05 | 93 | 63 | 80 | 11 | 0 | 0 | 42.96 | 4.59 | 2550 | 298 |
| 2-Oct-05 | 87 | 45 | 68 | 2 | 1.98 | 3 | 44.94 | 5.72 | 2613 | 307 |
| 9-Oct-05 | 88 | 46 | 68 | 5 | 0.01 | 1 | 44.95 | 5 | 2682 | 337 |
| 16-Oct-05 | 83 | 42 | 61 | 1 | 0.07 | 1 | 45.02 | 4.37 | 2703 | 331 |
| 24-Oct-05 | 90 | 41 | 65 | 7 | 0 | 0 | 45.02 | 3.67 | 2747 | 358 |
| 30-Oct-05 | 64 | 30 | 46 | -11 | 0.02 | 1 | 45.04 | 2.91 | 2747 | 347 |

[†]DFN = departure from normal. GDD = Growing degree-days (base 60 F).

Source: Tennessee Agricultural Statistics Service

Appendix C: Hendrix Protocol

## Hendrix $CH_2O$ Extraction and Analysis Protocol Outline and Supply List

Revised 5/12/05

| I. Soluble Sugar Extraction | Materials |
|---|---|
| 1. Scratch-mark clean poly tubes at 6.0 mL level, label these tubes to correspond to tissue samples. Label clean cylinders to match poly tube labels. | - (13 x 100 mm) polypropylene tubes.<br>- Pipetter set on 6.0 mL.<br>- Extra-fine Sharpie pen.<br>- Rack(s) for tubes. |
| 2. Weigh 100 mg (dry wt.) of each sub-sample of plant tissue into labeled poly tubes for extraction. Batch size = 48 | - Labeling tape.<br>- Analytical balance precise to 0.1 mg.<br>- Spatula.<br>- Weigh funnel (match tube size). |
| 3. Add ~2 mL 80% ethanol to each tube. Set tubes in 70 °C waterbath for 30 min., with slow oscillation. | - Prepared 80% v/v aqueous ethanol in dispenser-top bottle. |
| 4. Remove tubes from waterbath. Centrifuge at low speed to separate solid from liquid. Decant ethanolic extract by pipette into corresponding graduated cylinders. | - Heated waterbath w/thermometer.<br>- Timer.<br>- Low-speed centrifuge<br>- Disposable 6-in. transfer pipettes |
| 5. Repeat Step I-4. Vortex tubes lightly to resuspend solids. | - Prepared 80% v/v aqueous ethanol<br>- Vortex shaker. |
| 6. Repeat Steps I-5, I-6 (2nd extract), and I-7 also Repeat Steps I-5 and I-6 (3rd extract). | - 80% v/v aqueous ethanol in squeeze bottle.<br>- Parafilm |
| 7. Bring contents of cylinder to 10-ml volume with ethanol. Mix by gentle inversion. | - Refrigerator set between 2 - 8 °C. |
| 8. Refrigerate ethanolic extracts and residual solid samples. | |

[May pause here]

## II. Soluble Sugar Sample Prep.

1. Label microfuge tubes to match graduated cylinder from sugar extraction (or from starch digestion tubes in step VI-13).
2. Add ~20 mg finely divided charcoal (Norit SA-3) to each microfuge tube.
3. Pipette 1.5 ml of extract from graduated cylinder (or from starch digestion tubes) into corresponding microfuge tubes.
4. Close microfuge tubes tightly and vortex. Centrifuge tubes at 2200 g, 15 min. Set tubes gently into rack in sequence for microplate wells.
5. Label microplate wells to match microfuge tubes. Label wells for standards and blanks. Standards = 0.1, 0.25, 0.5, 0.8, 1.0ug/uL each of glucose, fructose, and sucrose. Also need water blanks for zeroing the microplate reader.
6. Carefully pipette 20uL of extract solution from each tube into corresponding wells on microplate. Avoid charcoal granules. Aliquot size may need adjustment for different [GLU] in different samples. Record any changes in aliquot size.
7. Close residual extract microfuge tubes and store them in refrigerator (in case needed for re-analysis).
8. Cover microplate(s) very loosely with aluminum foil and dry overnight in forced air oven at 55 $^{o}$C. All ethanol must be evaporated before proceeding.

[May pause here.]

## Materials

- Microfuge tubes, 1.5 ml,
- Norit SA-3
- Spatula marked for ~20 mg aliquot
- Micropipetter for 1.5 mL.
- Disposable micropipette tips, 1.5 mL.
- Vortex shaker.
- Microcentrifuge w/timer.
- Microfuge tube rack.
- 96-well microplate(s)
- Microplate well orienter and well pad
- Well plate stand
- Micropipetter set at 20 uL.
- 12x disposable micropipette tips, 20 uL.
- Refrigerator set between 2 - 8 $^{o}$C.
- Aluminum foil
- Forced air oven set at 55 $^{o}$C.

## III. Enzyme Prep for Sugar Analyses

1. Reconsititute Glucose [HK] assay reagent with 20 ml deionized water. Invert vial to mix. May store at 2 - 8 $^{o}$C up to 4 weeks. Makes enough for 200 samples or standards at 100 uL each.

2. Prepare glucose standards = 0.1, 0.25, 0.5, 0.8, 1.0 ug/uL from glucose standard solution.

3. Prepare phosphoglucose isomerase solution by adding 1.0 mL of 0.2 M HEPES (pH 7.8) to a vial containing 1000 EU of phosphoglucose isomerase. Makes enough for 100 samples or standards at 10 uL each. Store in refrigerator.

4. Prepare invertase solution by adding 5.0 mL of 0.1 M citrate buffer (pH 6.0) to 50 mg powdered invertase preparation. Makes enough for 214 samples or standards at 23uL each. Refrigerate.

[May pause here]

## Materials

- 1x Glucose [HK] assay reagent (Sigma product G2020 in Sigma kit GAHK-20).
- deionized water.
- 20 ml pipette.
- Refrigerator set at 2- 8 $^{o}$C.

- Glucose standard (Sigma G-3285), 1 mg/mL
- 10 ml pipette.
- Deionized water.

- Phosphoglucose isomerase (Sigma P-9544)
- HEPES (Sigma H-3375)
- Labeled vial with cap.
- Pipette for 1.0 mL.

- Invertase (Sigma I-4504), 825 EU/mg.
- Sodium citrate buffer (Sigma 82588), pH 6.0
- Labeled vial with cap.
- Pipette for 5.0 mL.

## IV. Sugar Analyses

1. Add 20 uL of distilled water to each microplate well containing samples and standards.

2.Add 100uL of reconstituted glucose [HK] reagent to each microplate well containing dried samples, standards, and reagent blank.

3. Gently tap sides of microplate(s) to mix well contents as described by Hendrix.

4. Incubate 15 min. at room temperature (18-35 $^{o}$C)

5. Measure absorbances of each well at 340 nm with microplate reader.

6. Calculate [GLU] by the slope of the standard curve. Assume that all sample [GLU] are within range of standards before continuing. If not, change aliquot size in step II.7 and repeat.

7. Add 10 uL of solution containing phosphoglucose isomerase to each well containing samples.

8. Repeat steps IV-2, IV-3, IV- 4, and IV-5 above. Increase in [GLU] is attributed to fructose in sample.

9. Add 23 uL of solution containing invertase to each well containing samples.

10. Repeat steps IV-2, IV-3, IV-4, and IV-5 above. Increase in [GLU] is attributed to sucrose in sample.

[May pause here]

## Materials

- Reconstituted [HK] glucose reagent prepared in step III-1 above).
- Pipetter set on 100 uL

- Microplate reader with 340 nm filter.

Slope- y = mx + b
- Phosphoglucose isomerase solution prepared in step III-3 above.
- Pipetter set on 10 uL.

- Microplate reader with 340 nm filter.
- Slope- y = mx + b
- Phosphoglucose isomerase solution prepared in step III-3 above.
- Pipetter set on 10 uL.

- Microplate reader with 340 nm filter.

- Invertase solution prepared in step III-4 above.
- Pipetter set on 10 uL.

- Microplate reader with 340 nm filter.

## V. Enzyme prep for starch analysis

1. For each batch (48 samples, dilute 17,280 EU of alpha amylase solution 10x with 1 M Tris-acetate buffer (pH 7.2). (One mL of undiluted enzyme solution contains 21,390 EU.) *Need 360EU/sample

2. Dialyze diluted alpha-amylase solution against distilled water overnight at room temp. Place each 10-mL aliquot in a separate, labelled dialysis tube floating in a 500ml Erlenmeyer flask.

3. For each batch (48 samples), dilute 5,856 EU of amyloglucosidase solution 50x with 50 mM sodium acetate buffer (pH 4.5). (One mL of undiluted enzyme solution contains 11,500 EU.) *Need 122EU/sample

4. Dialyze diluted amyloglucosidase solution against sodium acetate buffer overnight at room temp. Place each 10-mL aliquot in a separate, labeled dialysis tube floating in separate 100ml graduated cylinder. Note: At some point will have to transfer to fresh buffer and dialyze for remainder of time.

5. Next morning, transfer dialyzed alpha-amylase and amyloglucosidase preparations to labeled and covered erhlenmeyer flasks. Store in refrigerator if not used soon.

[May pause here]

## Materials

- Alpha-amylase (Sigma A-3403)
- Tris-acetate buffer (Sigma T-9650 is 0.4M, pH 8.3)
- Pipette
- Labeled vial

- Dialysis tubes, floatable, 10 ml capacity, 25 KDa membrane.
- 10 mL pipette
- Large Erlenmeyer flask
- Distilled water

- Amyloglucosidase (Sigma A-3042)
- Sodium acetate buffer (Sigma 36050 is pH 4.65). Need ~ 60 mL/12 samples.

- Dialysis tubes, floatable, 10 ml capacity, 25 KDa membrane.
- 10-mL pipette
- large beaker
- Sodium acetate buffer

- Erlenmeyer flasks
- Parafilm
- Refrigerator

## VI. Starch digestion

1. Add 1.0 mL of 0.1 M KOH to each poly tube containing solid residues from step I-11.

2. Place tubes in a beaker of boiling water for 1 hr. Adjust water volume to avoid splashing into tubes.

3. Remove beaker from hotplate to cool. Transfer tubes to rack to cool more.

4. Add 0.2 mL of 1.0 M acetic acid to each tube.

5. Adjust pH to ~7.2 with dilute (0.1 M) acetic acid. Add 0.17 mL (360 EU) of dialyzed alpha-amylase preparation to each tube.

6. Place tubes in water bath at 80 °C for 30 min., with gentle oscillation.

7. Remove tubes from water and cool in rack. Adjust pH to 5.0 with dilute (0.1 M) acetic acid.

8. Add .52 mL (122 EU) of dialyzed amyloglucosidase preparation to each tube.

9. Place tubes in water bath at 55 °C for 60 min., with gentle oscillation. Adjust speed and water volume in bath to avoid splashing into tubes.

10. Transfer tubes to boiling water bath for 4 min. to stop digestion.

11. Bring tubes to 6.0 mL volume with distilled water (use the 6.0 mL marks made in step I-1.) Mix contents of tubes by inversion. Refrigerate if not used soon.

12. Go to steps II-1 thru II-9 (skip II-2), III-1 and III-2, and IV-1 thru IV-5.

## Materials

- KOH (0.1 M) in dispenser set for 1.0 mL.

- Glass beaker (sized for number of tubes).
- Tap water.
- Hot plate.
- Timer.
- Lined gloves
- Test tube rack(s)

- Acetic acid (1.0 M) in dispenser set for 0.2 mL.

- pH meter
- 0.1 M acetic acid in squeeze bottle

- Dialyzed alpha-amylase from step V-5.
- Pipetter set on 0.2 mL.

- Shaker water bath w/thermometer.
- Timer

- 0.1 M acetic acid in squeeze bottle

- Dialyzed amyloglucosidase from step V-5.
- Pipetter set on 1.0 mL.

- Shaker water bath w/thermometer.
- Timer

- Materials used in step VI-2.

- Squeeze bottle of distilled $H_2$

## Calculations for absorbance @340nm

### I. Glucose:

1. Find the net absorbance of your glucose standards
netAbs= grossAbs(glu)- reagent blank
2. Take the net abs and the glucose standards and form a standard curve, using linear regression.
3. Using the slope, generated by the curve, one can now calculate the concentration of diluted glucose in each well. Y=(netAbs*constant)+coefficient
4. Multiply by dilution factor to receive the concentration of undiluted glucose in each well.
5. Lastly, to determine the amount of sugar /100mg dry wgt, multiply by 10.

### II. Fructose:

1. Find the net absorbance of fructose.
netAbs= grossAbs(fruc)- reagent blank
2. The net abs is then subtracted from the glucose abs giving a fructose abs.
3. Take the fructose abs and apply Step I. Glucose#3-5. This gives the fructose absorbance.

### III. Sucrose:

1. Find the net absorbance of sucrose.
netAbs=grossAbs(suc)-reagent blank
2. Subtract the netAbs(suc) from the netAbs(fru) to get the sucrose abs.
3. Take the sucrose abs and apply Step I. Glucose #3-5 finding the sucrose absorbance.

Appendix D: N&K Study SAS data

N&K Starch
SAS Input

**Variety 1= PM1218**
**2= DP555**
**K 1= 60lbs $K_2O$/acre/yr**
**2= 120lbs $K_2O$/acre/yr**
**Date 1= Early Bloom**
**2= Cutout**

```
Starch is in mg/g dry weight
data NKStarch;
input Batch Plot Year Rep   Variety   K      Starch Date;
cards;
16      102     2003    1       1       1       96.41   1
16      108     2003    2       2       1       49.30   1
16      109     2003    2       1       2       84.94   1
16      111     2003    2       2       2       58.60   1
16      205     2003    1       2       1       88.12   1
16      206     2003    1       1       2       113.18  1
16      208     2003    4       2       2       19.26   1
16      211     2003    2       1       1       101.48  1
16      301     2003    3       1       1       88.20   1
16      303     2003    1       2       2       93.84   1
16      306     2003    3       1       2       77.87   1
16      311     2003    4       2       1       34.13   1
16      404     2003    3       2       1       53.73   1
16      405     2003    3       2       2       100.49  1
16      407     2003    4       1       2       139.39  1
16      412     2003    4       1       1       127.58  1
16      501     2003    5       2       2       61.39   1
16      505     2003    5       1       2       82.30   1
16      509     2003    5       1       1       107.91  1
16      512     2003    5       2       1       91.50   1
16      602     2003    6       2       2       40.10   1
16      603     2003    6       1       1       105.38  1
16      605     2003    6       1       2       85.71   1
16      606     2003    6       2       1       81.83   1
16      102     2003    1       1       1       83.18   1
16      108     2003    2       2       1       22.74   1
16      109     2003    2       1       2       88.79   1
16      111     2003    2       2       2       35.16   1
16      205     2003    1       2       1       84.94   1
16      206     2003    1       1       2       119.34  1
16      208     2003    4       2       2       15.96   1
16      211     2003    2       1       1       109.44  1
16      301     2003    3       1       1       94.21   1
16      303     2003    1       2       2       102.12  1
16      306     2003    3       1       2       80.11   1
16      311     2003    4       2       1       51.20   1
16      404     2003    3       2       1       99.44   1
16      405     2003    3       2       2       84.11   1
16      407     2003    4       1       2       108.62  1
16      412     2003    4       1       1       19.59   1
16      501     2003    5       2       2       41.75   1
16      505     2003    5       1       2       74.36   1
16      509     2003    5       1       1       98.75   1
16      512     2003    5       2       1       81.35   1
16      602     2003    6       2       2       41.13   1
16      603     2003    6       1       1       108.62  1
16      605     2003    6       1       2       87.62   1
16      606     2003    6       2       1       42.30   1
17      102     2003    1       1       1       144.76  1
17      108     2003    2       2       1       55.80   1
17      109     2003    2       1       2       126.19  1
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | 111 | 2003 | 2 | 2 | 2 | 71.19 | 1 |
| 17 | 205 | 2003 | 1 | 2 | 1 | 127.12 | 1 |
| 17 | 206 | 2003 | 1 | 1 | 2 | 143.55 | 1 |
| 17 | 208 | 2003 | 4 | 2 | 2 | 51.90 | 1 |
| 17 | 211 | 2003 | 2 | 1 | 1 | 151.52 | 1 |
| 17 | 301 | 2003 | 3 | 1 | 1 | 149.38 | 1 |
| 17 | 303 | 2003 | 1 | 2 | 2 | 129.49 | 1 |
| 17 | 306 | 2003 | 3 | 1 | 2 | 145.53 | 1 |
| 17 | 311 | 2003 | 4 | 2 | 1 | 59.92 | 1 |
| 17 | 404 | 2003 | 3 | 2 | 1 | 140.48 | 1 |
| 17 | 405 | 2003 | 3 | 2 | 2 | 101.19 | 1 |
| 17 | 407 | 2003 | 4 | 1 | 2 | 152.79 | 1 |
| 17 | 412 | 2003 | 4 | 1 | 1 | 168.94 | 1 |
| 17 | 501 | 2003 | 5 | 2 | 2 | 51.57 | 1 |
| 17 | 505 | 2003 | 5 | 1 | 2 | 95.91 | 1 |
| 17 | 509 | 2003 | 5 | 1 | 1 | 156.74 | 1 |
| 17 | 512 | 2003 | 5 | 2 | 1 | 93.33 | 1 |
| 17 | 602 | 2003 | 6 | 2 | 2 | 80.58 | 1 |
| 17 | 603 | 2003 | 6 | 1 | 1 | 135.26 | 1 |
| 17 | 605 | 2003 | 6 | 1 | 2 | 104.60 | 1 |
| 17 | 606 | 2003 | 6 | 2 | 1 | 87.84 | 1 |
| 17 | 102 | 2003 | 1 | 1 | 1 | 164.38 | 1 |
| 17 | 108 | 2003 | 2 | 2 | 1 | 54.98 | 1 |
| 17 | 109 | 2003 | 2 | 1 | 2 | 132.89 | 1 |
| 17 | 111 | 2003 | 2 | 2 | 2 | 44.37 | 1 |
| 17 | 205 | 2003 | 1 | 2 | 1 | 99.92 | 1 |
| 17 | 206 | 2003 | 1 | 1 | 2 | 167.62 | 1 |
| 17 | 208 | 2003 | 4 | 2 | 2 | 57.78 | 1 |
| 17 | 211 | 2003 | 2 | 1 | 1 | 148.99 | 1 |
| 17 | 301 | 2003 | 3 | 1 | 1 | 166.74 | 1 |
| 17 | 303 | 2003 | 1 | 2 | 2 | 135.26 | 1 |
| 17 | 306 | 2003 | 3 | 1 | 2 | 86.24 | 1 |
| 17 | 311 | 2003 | 4 | 2 | 1 | 41.35 | 1 |
| 17 | 404 | 2003 | 3 | 2 | 1 | 138.66 | 1 |
| 17 | 405 | 2003 | 3 | 2 | 2 | 105.36 | 1 |
| 17 | 407 | 2003 | 4 | 1 | 2 | 147.02 | 1 |
| 17 | 412 | 2003 | 4 | 1 | 1 | 148.61 | 1 |
| 17 | 501 | 2003 | 5 | 2 | 2 | 36.18 | 1 |
| 17 | 505 | 2003 | 5 | 1 | 2 | 159.38 | 1 |
| 17 | 509 | 2003 | 5 | 1 | 1 | 107.73 | 1 |
| 17 | 512 | 2003 | 5 | 2 | 1 | 117.51 | 1 |
| 17 | 602 | 2003 | 6 | 2 | 2 | 88.93 | 1 |
| 17 | 603 | 2003 | 6 | 1 | 1 | 110.04 | 1 |
| 17 | 605 | 2003 | 6 | 1 | 2 | 96.52 | 1 |
| 17 | 606 | 2003 | 6 | 2 | 1 | 89.04 | 1 |
| 18 | 102 | 2003 | 1 | 1 | 1 | 125.98 | 1 |
| 18 | 108 | 2003 | 2 | 2 | 1 | 30.04 | 1 |
| 18 | 109 | 2003 | 2 | 1 | 2 | 148.84 | 1 |
| 18 | 111 | 2003 | 2 | 2 | 2 | 26.14 | 1 |
| 18 | 205 | 2003 | 1 | 2 | 1 | 107.58 | 1 |
| 18 | 206 | 2003 | 1 | 1 | 2 | 127.41 | 1 |
| 18 | 208 | 2003 | 4 | 2 | 2 | 45.43 | 1 |
| 18 | 211 | 2003 | 2 | 1 | 1 | 155.77 | 1 |
| 18 | 301 | 2003 | 3 | 1 | 1 | 147.36 | 1 |
| 18 | 303 | 2003 | 1 | 2 | 2 | 131.15 | 1 |
| 18 | 306 | 2003 | 3 | 1 | 2 | 128.68 | 1 |
| 18 | 311 | 2003 | 4 | 2 | 1 | 44.66 | 1 |
| 18 | 404 | 2003 | 3 | 2 | 1 | 112.19 | 1 |
| 18 | 405 | 2003 | 3 | 2 | 2 | 113.95 | 1 |
| 18 | 407 | 2003 | 4 | 1 | 2 | 78.18 | 1 |
| 18 | 412 | 2003 | 4 | 1 | 1 | 99.94 | 1 |
| 18 | 501 | 2003 | 5 | 2 | 2 | 39.71 | 1 |
| 18 | 505 | 2003 | 5 | 1 | 2 | 98.84 | 1 |
| 18 | 509 | 2003 | 5 | 1 | 1 | 89.66 | 1 |
| 18 | 512 | 2003 | 5 | 2 | 1 | 79.55 | 1 |
| 18 | 602 | 2003 | 6 | 2 | 2 | 63.56 | 1 |
| 18 | 603 | 2003 | 6 | 1 | 1 | 119.66 | 1 |
| 18 | 605 | 2003 | 6 | 1 | 2 | 74.83 | 1 |
| 18 | 606 | 2003 | 6 | 2 | 1 | 67.74 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | 102 | 2003 | 1 | 1 | 1 | 108.57 | 2 |
| 18 | 108 | 2003 | 2 | 2 | 1 | 19.38 | 2 |
| 18 | 109 | 2003 | 2 | 1 | 2 | 72.74 | 2 |
| 18 | 111 | 2003 | 2 | 2 | 2 | 47.35 | 2 |
| 18 | 205 | 2003 | 1 | 2 | 1 | 38.62 | 2 |
| 18 | 206 | 2003 | 1 | 1 | 2 | 56.42 | 2 |
| 18 | 208 | 2003 | 4 | 2 | 2 | 53.01 | 2 |
| 18 | 211 | 2003 | 2 | 1 | 1 | 13.28 | 2 |
| 18 | 301 | 2003 | 3 | 1 | 1 | 39.17 | 2 |
| 18 | 303 | 2003 | 1 | 2 | 2 | 76.04 | 2 |
| 18 | 306 | 2003 | 3 | 1 | 2 | 80.32 | 2 |
| 18 | 311 | 2003 | 4 | 2 | 1 | 40.76 | 2 |
| 18 | 404 | 2003 | 3 | 2 | 1 | 74.83 | 2 |
| 18 | 405 | 2003 | 3 | 2 | 2 | 46.42 | 2 |
| 18 | 407 | 2003 | 4 | 1 | 2 | 39.00 | 2 |
| 18 | 412 | 2003 | 4 | 1 | 1 | 66.25 | 2 |
| 18 | 501 | 2003 | 5 | 2 | 2 | 27.96 | 2 |
| 18 | 505 | 2003 | 5 | 1 | 2 | 72.57 | 2 |
| 18 | 509 | 2003 | 5 | 1 | 1 | 19.60 | 2 |
| 18 | 512 | 2003 | 5 | 2 | 1 | 53.07 | 2 |
| 18 | 602 | 2003 | 6 | 2 | 2 | 73.89 | 2 |
| 18 | 603 | 2003 | 6 | 1 | 1 | 76.92 | 2 |
| 18 | 605 | 2003 | 6 | 1 | 2 | 69.28 | 2 |
| 18 | 606 | 2003 | 6 | 2 | 1 | 31.53 | 2 |
| 19 | 102 | 2003 | 1 | 1 | 1 | 94.39 | 2 |
| 19 | 108 | 2003 | 2 | 2 | 1 | 59.22 | 2 |
| 19 | 109 | 2003 | 2 | 1 | 2 | 93.07 | 2 |
| 19 | 111 | 2003 | 2 | 2 | 2 | 64.77 | 2 |
| 19 | 205 | 2003 | 1 | 2 | 1 | 53.07 | 2 |
| 19 | 206 | 2003 | 1 | 1 | 2 | 28.23 | 2 |
| 19 | 208 | 2003 | 4 | 2 | 2 | 44.33 | 2 |
| 19 | 211 | 2003 | 2 | 1 | 1 | 14.77 | 2 |
| 19 | 301 | 2003 | 3 | 1 | 1 | 60.05 | 2 |
| 19 | 303 | 2003 | 1 | 2 | 2 | 42.24 | 2 |
| 19 | 306 | 2003 | 3 | 1 | 2 | 54.39 | 2 |
| 19 | 311 | 2003 | 4 | 2 | 1 | 52.74 | 2 |
| 19 | 404 | 2003 | 3 | 2 | 1 | 47.68 | 2 |
| 19 | 405 | 2003 | 3 | 2 | 2 | 31.75 | 2 |
| 19 | 407 | 2003 | 4 | 1 | 2 | . | 2 |
| 19 | 412 | 2003 | 4 | 1 | 1 | 93.12 | 2 |
| 19 | 501 | 2003 | 5 | 2 | 2 | 48.73 | 2 |
| 19 | 505 | 2003 | 5 | 1 | 2 | 70.49 | 2 |
| 19 | 509 | 2003 | 5 | 1 | 1 | 59.06 | 2 |
| 19 | 512 | 2003 | 5 | 2 | 1 | 33.18 | 2 |
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| 27 | 501 | 2005 | 5 | 2 | 2 | 1.89 | 1 |
| 27 | 505 | 2005 | 5 | 1 | 2 | 10.89 | 1 |
| 27 | 509 | 2005 | 5 | 1 | 1 | 10.31 | 1 |
| 27 | 512 | 2005 | 5 | 2 | 1 | 3.47 | 1 |
| 27 | 602 | 2005 | 6 | 2 | 2 | 1.45 | 1 |
| 27 | 603 | 2005 | 6 | 1 | 1 | 17.21 | 1 |
| 27 | 605 | 2005 | 6 | 1 | 2 | 23.72 | 1 |
| 27 | 606 | 2005 | 6 | 2 | 1 | 2.56 | 1 |
| 27 | 102 | 2005 | 1 | 1 | 1 | 87.97 | 1 |
| 27 | 108 | 2005 | 1 | 2 | 1 | 15.63 | 1 |
| 27 | 109 | 2005 | 1 | 1 | 2 | 40.00 | 1 |
| 27 | 111 | 2005 | 1 | 2 | 2 | 8.06 | 1 |
| 27 | 205 | 2005 | 2 | 2 | 1 | 14.00 | 1 |
| 27 | 206 | 2005 | 2 | 1 | 2 | 39.95 | 1 |
| 27 | 208 | 2005 | 2 | 2 | 2 | 3.66 | 1 |
| 27 | 211 | 2005 | 2 | 1 | 1 | 19.27 | 1 |
| 27 | 301 | 2005 | 3 | 1 | 1 | 62.07 | 1 |
| 27 | 303 | 2005 | 3 | 2 | 2 | 14.05 | 1 |
| 27 | 306 | 2005 | 3 | 1 | 2 | 47.99 | 1 |
| 27 | 311 | 2005 | 3 | 2 | 1 | 4.52 | 1 |
| 27 | 404 | 2005 | 4 | 2 | 1 | 14.86 | 1 |
| 27 | 405 | 2005 | 4 | 2 | 2 | 28.94 | 1 |
| 27 | 407 | 2005 | 4 | 1 | 2 | 15.20 | 1 |
| 27 | 412 | 2005 | 4 | 1 | 1 | 15.58 | 1 |
| 27 | 501 | 2005 | 5 | 2 | 2 | 3.23 | 1 |
| 27 | 505 | 2005 | 5 | 1 | 2 | 8.64 | 1 |
| 27 | 509 | 2005 | 5 | 1 | 1 | 24.44 | 1 |
| 27 | 512 | 2005 | 5 | 2 | 1 | 4.14 | 1 |
| 27 | 602 | 2005 | 6 | 2 | 2 | 2.70 | 1 |
| 27 | 603 | 2005 | 6 | 1 | 1 | 6.43 | 1 |
| 27 | 605 | 2005 | 6 | 1 | 2 | 21.71 | 1 |
| 27 | 606 | 2005 | 6 | 2 | 1 | 4.14 | 1 |
| 28 | 102 | 2005 | 1 | 1 | 1 | 43.83 | 1 |
| 28 | 108 | 2005 | 1 | 2 | 1 | 10.98 | 1 |
| 28 | 109 | 2005 | 1 | 1 | 2 | 44.31 | 1 |
| 28 | 111 | 2005 | 1 | 2 | 2 | 2.41 | 1 |
| 28 | 205 | 2005 | 2 | 2 | 1 | 19.46 | 1 |
| 28 | 206 | 2005 | 2 | 1 | 2 | 63.46 | 1 |
| 28 | 208 | 2005 | 2 | 2 | 2 | 5.00 | 1 |
| 28 | 211 | 2005 | 2 | 1 | 1 | 27.55 | 1 |
| 28 | 301 | 2005 | 3 | 1 | 1 | 75.72 | 1 |
| 28 | 303 | 2005 | 3 | 2 | 2 | 5.00 | 1 |
| 28 | 306 | 2005 | 3 | 1 | 2 | 33.25 | 1 |
| 28 | 311 | 2005 | 3 | 2 | 1 | 9.55 | 1 |
| 28 | 404 | 2005 | 4 | 2 | 1 | 9.59 | 1 |
| 28 | 405 | 2005 | 4 | 2 | 2 | 22.43 | 1 |
| 28 | 407 | 2005 | 4 | 1 | 2 | 27.65 | 1 |
| 28 | 412 | 2005 | 4 | 1 | 1 | 32.29 | 1 |
| 28 | 501 | 2005 | 5 | 2 | 2 | 4.71 | 1 |
| 28 | 505 | 2005 | 5 | 1 | 2 | 6.15 | 1 |
| 28 | 509 | 2005 | 5 | 1 | 1 | 21.09 | 1 |
| 28 | 512 | 2005 | 5 | 2 | 1 | 2.17 | 1 |
| 28 | 602 | 2005 | 6 | 2 | 2 | 2.03 | 1 |
| 28 | 603 | 2005 | 6 | 1 | 1 | 8.64 | 1 |
| 28 | 605 | 2005 | 6 | 1 | 2 | 32.00 | 1 |
| 28 | 606 | 2005 | 6 | 2 | 1 | 2.03 | 1 |
| 28 | 102 | 2005 | 1 | 1 | 1 | 72.03 | 2 |
| 28 | 108 | 2005 | 1 | 2 | 1 | 85.34 | 2 |
| 28 | 109 | 2005 | 1 | 1 | 2 | 40.81 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 28 | 111 | 2005 | 1 | 2 | 2 | 71.07 | 2 |
| 28 | 205 | 2005 | 2 | 2 | 1 | 95.59 | 2 |
| 28 | 206 | 2005 | 2 | 1 | 2 | 52.50 | 2 |
| 28 | 208 | 2005 | 2 | 2 | 2 | 72.22 | 2 |
| 28 | 211 | 2005 | 2 | 1 | 1 | 83.90 | 2 |
| 28 | 301 | 2005 | 3 | 1 | 1 | 45.79 | 2 |
| 28 | 303 | 2005 | 3 | 2 | 2 | 99.23 | 2 |
| 28 | 306 | 2005 | 3 | 1 | 2 | 103.34 | 2 |
| 28 | 311 | 2005 | 3 | 2 | 1 | 58.19 | 2 |
| 28 | 404 | 2005 | 4 | 2 | 1 | 87.54 | 2 |
| 28 | 405 | 2005 | 4 | 2 | 2 | 73.04 | 2 |
| 28 | 407 | 2005 | 4 | 1 | 2 | 105.64 | 2 |
| 28 | 412 | 2005 | 4 | 1 | 1 | 31.95 | 2 |
| 28 | 501 | 2005 | 5 | 2 | 2 | 75.67 | 2 |
| 28 | 505 | 2005 | 5 | 1 | 2 | 93.67 | 2 |
| 28 | 509 | 2005 | 5 | 1 | 1 | 53.26 | 2 |
| 28 | 512 | 2005 | 5 | 2 | 1 | 62.93 | 2 |
| 28 | 602 | 2005 | 6 | 2 | 2 | 49.57 | 2 |
| 28 | 603 | 2005 | 6 | 1 | 1 | 80.41 | 2 |
| 28 | 605 | 2005 | 6 | 1 | 2 | 61.54 | 2 |
| 28 | 606 | 2005 | 6 | 2 | 1 | 61.50 | 2 |
| 29 | 102 | 2005 | 1 | 1 | 1 | 110.86 | 2 |
| 29 | 108 | 2005 | 1 | 2 | 1 | 65.33 | 2 |
| 29 | 109 | 2005 | 1 | 1 | 2 | 73.42 | 2 |
| 29 | 111 | 2005 | 1 | 2 | 2 | 54.70 | 2 |
| 29 | 205 | 2005 | 2 | 2 | 1 | 84.91 | 2 |
| 29 | 206 | 2005 | 2 | 1 | 2 | 98.65 | 2 |
| 29 | 208 | 2005 | 2 | 2 | 2 | 99.08 | 2 |
| 29 | 211 | 2005 | 2 | 1 | 1 | 53.41 | 2 |
| 29 | 301 | 2005 | 3 | 1 | 1 | 69.16 | 2 |
| 29 | 303 | 2005 | 3 | 2 | 2 | 80.07 | 2 |
| 29 | 306 | 2005 | 3 | 1 | 2 | 77.49 | 2 |
| 29 | 311 | 2005 | 3 | 2 | 1 | 58.91 | 2 |
| 29 | 404 | 2005 | 4 | 2 | 1 | 27.84 | 2 |
| 29 | 405 | 2005 | 4 | 2 | 2 | 75.38 | 2 |
| 29 | 407 | 2005 | 4 | 1 | 2 | 77.44 | 2 |
| 29 | 412 | 2005 | 4 | 1 | 1 | 100.66 | 2 |
| 29 | 501 | 2005 | 5 | 2 | 2 | 88.74 | 2 |
| 29 | 505 | 2005 | 5 | 1 | 2 | 58.10 | 2 |
| 29 | 509 | 2005 | 5 | 1 | 1 | 134.32 | 2 |
| 29 | 512 | 2005 | 5 | 2 | 1 | 77.92 | 2 |
| 29 | 602 | 2005 | 6 | 2 | 2 | 67.10 | 2 |
| 29 | 603 | 2005 | 6 | 1 | 1 | 88.36 | 2 |
| 29 | 605 | 2005 | 6 | 1 | 2 | 57.47 | 2 |
| 29 | 606 | 2005 | 6 | 2 | 1 | 38.13 | 2 |
| 29 | 102 | 2005 | 1 | 1 | 1 | 135.33 | 2 |
| 29 | 108 | 2005 | 1 | 2 | 1 | 75.14 | 2 |
| 29 | 109 | 2005 | 1 | 1 | 2 | 67.19 | 2 |
| 29 | 111 | 2005 | 1 | 2 | 2 | 73.71 | 2 |
| 29 | 205 | 2005 | 2 | 2 | 1 | 112.01 | 2 |
| 29 | 206 | 2005 | 2 | 1 | 2 | 26.11 | 2 |
| 29 | 208 | 2005 | 2 | 2 | 2 | 72.22 | 2 |
| 29 | 211 | 2005 | 2 | 1 | 1 | 75.91 | 2 |
| 29 | 301 | 2005 | 3 | 1 | 1 | 79.21 | 2 |
| 29 | 303 | 2005 | 3 | 2 | 2 | 70.79 | 2 |
| 29 | 306 | 2005 | 3 | 1 | 2 | 122.21 | 2 |
| 29 | 311 | 2005 | 3 | 2 | 1 | 97.50 | 2 |
| 29 | 404 | 2005 | 4 | 2 | 1 | 69.21 | 2 |
| 29 | 405 | 2005 | 4 | 2 | 2 | 82.80 | 2 |
| 29 | 407 | 2005 | 4 | 1 | 2 | 71.93 | 2 |
| 29 | 412 | 2005 | 4 | 1 | 1 | 105.64 | 2 |
| 29 | 501 | 2005 | 5 | 2 | 2 | 74.52 | 2 |
| 29 | 505 | 2005 | 5 | 1 | 2 | 107.75 | 2 |
| 29 | 509 | 2005 | 5 | 1 | 1 | 105.79 | 2 |
| 29 | 512 | 2005 | 5 | 2 | 1 | 76.67 | 2 |
| 29 | 602 | 2005 | 6 | 2 | 2 | 38.71 | 2 |
| 29 | 603 | 2005 | 6 | 1 | 1 | 107.13 | 2 |
| 29 | 605 | 2005 | 6 | 1 | 2 | 63.32 | 2 |
| 29 | 606 | 2005 | 6 | 2 | 1 | 102.29 | 2 |

```
30      102     2005    1       1       1       85.58   2
30      108     2005    1       2       1       95.92   2
30      109     2005    1       1       2       60.16   2
30      111     2005    1       2       2       73.61   2
30      205     2005    2       2       1       32.58   2
30      206     2005    2       1       2       79.69   2
30      208     2005    2       2       2       33.77   2
30      211     2005    2       1       1       48.09   2
30      301     2005    3       1       1       74.71   2
30      303     2005    3       2       2       65.66   2
30      306     2005    3       1       2       61.45   2
30      311     2005    3       2       1       89.70   2
30      404     2005    4       2       1       68.39   2
30      405     2005    4       2       2       84.77   2
30      407     2005    4       1       2       37.08   2
30      412     2005    4       1       1       88.02   2
30      501     2005    5       2       2       35.88   2
30      505     2005    5       1       2       53.84   2
30      509     2005    5       1       1       40.38   2
30      512     2005    5       2       1       145.53  2
30      602     2005    6       2       2       80.03   2
30      603     2005    6       1       1       51.92   2
30      605     2005    6       1       2       .       2
30      606     2005    6       2       1       104.40  2
30      102     2005    1       1       1       91.57   2
30      108     2005    1       2       1       86.20   2
30      109     2005    1       1       2       78.25   2
30      111     2005    1       2       2       127.67  2
30      205     2005    2       2       1       102.72  2
30      206     2005    2       1       2       52.59   2
30      208     2005    2       2       2       40.72   2
30      211     2005    2       1       1       41.58   2
30      301     2005    3       1       1       78.21   2
30      303     2005    3       2       2       72.80   2
30      306     2005    3       1       2       85.87   2
30      311     2005    3       2       1       87.74   2
30      404     2005    4       2       1       21.18   2
30      405     2005    4       2       2       97.46   2
30      407     2005    4       1       2       11.94   2
30      412     2005    4       1       1       23.38   2
30      501     2005    5       2       2       73.23   2
30      505     2005    5       1       2       99.04   2
30      509     2005    5       1       1       70.50   2
30      512     2005    5       2       1       21.56   2
30      602     2005    6       2       2       47.28   2
30      603     2005    6       1       1       66.48   2
30      605     2005    6       1       2       23.91   2
30      606     2005    6       2       1       15.15   2
;

%include'c:\danda.sas';
%mmaov(NKStarch,starch, Class=Year Rep Variety K Date,fixed=Year |Variety |K  |Date,
   random = Rep(Year) Variety*K*Rep(Year) Variety*Date*K*rep(year), DDFM=CONTAIN  );
```

N&K Starch
SAS Output

```
                                        The Mixed Procedure

                                        Model Information

                      Data Set                       WORK.NKSTARCH
                      Dependent Variable             Starch
                      Covariance Structure           Variance Components
                      Estimation Method              REML
                      Residual Variance Method       Profile
                      Fixed Effects SE Method        Model-Based
                      Degrees of Freedom Method      Containment
```

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 2003 2004 2005 |
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 1 2 |
| Date | 2 | 1 2 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 4 |
| Columns in X | 108 |
| Columns in Z | 234 |
| Subjects | 1 |
| Max Obs Per Subject | 720 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 720 |
| Number of Observations Used | 707 |
| Number of Observations Not Used | 13 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 6460.33354644 | |
| 1 | 3 | 6413.55050626 | 0.00008084 |
| 2 | 1 | 6413.32644312 | 0.00000136 |
| 3 | 1 | 6413.32288254 | 0.00000000 |

Mixed ANOVA for starch

The Mixed Procedure

Convergence criteria met.

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(Year) | 23.3007 | 19.7180 | 1.18 | 0.1187 |
| Rep*Variety*K(Year) | 0 | . | . | . |
| Rep*Var*K*Date(Year) | 126.63 | 33.1582 | 3.82 | <.0001 |
| Residual | 536.70 | 31.9643 | 16.79 | <.0001 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 6413.3 |
| AIC (smaller is better) | 6419.3 |
| AICC (smaller is better) | 6419.4 |
| BIC (smaller is better) | 6422.0 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 15 | 37.87 | <.0001 |
| Variety | 1 | 45 | 47.04 | <.0001 |

| | | | | |
|---|---|---|---|---|
| Year*Variety | 2 | 45 | 3.36 | 0.0438 |
| K | 1 | 45 | 0.93 | 0.3396 |
| Year*K | 2 | 45 | 0.36 | 0.7015 |
| Variety*K | 1 | 45 | 0.02 | 0.8781 |
| Year*Variety*K | 2 | 45 | 0.28 | 0.7599 |
| Date | 1 | 60 | 102.41 | <.0001 |
| Year*Date | 2 | 60 | 187.15 | <.0001 |
| Variety*Date | 1 | 60 | 38.71 | <.0001 |
| Year*Variety*Date | 2 | 60 | 0.67 | 0.5170 |
| K*Date | 1 | 60 | 2.17 | 0.1456 |
| Year*K*Date | 2 | 60 | 0.52 | 0.5971 |
| Variety*K*Date | 1 | 60 | 0.01 | 0.9330 |
| Year*Variety*K*Date | 2 | 60 | 0.19 | 0.8282 |

---------------------------- Effect=Year   Method=LSD(P<.05)   Set=1 -----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | _ | 73.1835 | 2.9686 | B |
| 2 | 2004 | _ | _ | _ | 82.1681 | 2.9737 | A |
| 3 | 2005 | _ | _ | _ | 47.0364 | 2.9612 | C |

--------------------------- Effect=Variety   Method=LSD(P<.05)   Set=2 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | _ | 76.2499 | 2.1351 | A |
| 5 | _ | 2 | _ | _ | 58.6755 | 2.1440 | B |

------------------------- Effect=Year*Variety   Method=LSD(P<.05)   Set=3 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | _ | 86.6387 | 3.7040 | A |
| 7 | 2003 | 2 | _ | _ | 59.7282 | 3.7101 | C |
| 8 | 2004 | 1 | _ | _ | 89.0453 | 3.6922 | A |
| 9 | 2004 | 2 | _ | _ | 75.2910 | 3.7380 | B |
| 10 | 2005 | 1 | _ | _ | 53.0655 | 3.6980 | C |
| 11 | 2005 | 2 | _ | _ | 41.0073 | 3.6922 | D |

------------------------------ Effect=K   Method=LSD(P<.05)   Set=4 -------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 12 | _ | _ | 1 | _ | 68.6993 | 2.1390 | A |
| 13 | _ | _ | 2 | _ | 66.2261 | 2.1401 | A |

---------------------------- Effect=Year*K   Method=LSD(P<.05)   Set=5 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 1 | _ | 74.5558 | 3.7101 | A |
| 15 | 2003 | _ | 2 | _ | 71.8111 | 3.7040 | A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16 | 2004 | _ | 1 | _ | 82.0154 | 3.7120 | A |
| 17 | 2004 | _ | 2 | _ | 82.3209 | 3.7184 | A |
| 18 | 2005 | _ | 1 | _ | 49.5266 | 3.6922 | B |
| 19 | 2005 | _ | 2 | _ | 44.5463 | 3.6980 | B |

------------------------- Effect=Variety*K   Method=LSD(P<.05)   Set=6 ---------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 20 | _ | 1 | 1 | _ | 77.6841 | 2.7917 | A |
| 21 | _ | 1 | 2 | _ | 74.8157 | 2.8020 | A |
| 22 | _ | 2 | 1 | _ | 59.7144 | 2.8138 | B |
| 23 | _ | 2 | 2 | _ | 57.6366 | 2.8071 | B |

------------------------ Effect=Year*Variety*K   Method=LSD(P<.05)   Set=7 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 1 | _ | 86.9205 | 4.8354 | AB |
| 25 | 2003 | 1 | 2 | _ | 86.3570 | 4.8712 | AB |
| 26 | 2003 | 2 | 1 | _ | 62.1911 | 4.8900 | CD |
| 27 | 2003 | 2 | 2 | _ | 57.2653 | 4.8354 | D |
| 28 | 2004 | 1 | 1 | _ | 89.3980 | 4.8354 | A |
| 29 | 2004 | 1 | 2 | _ | 88.6927 | 4.8354 | A |
| 30 | 2004 | 2 | 1 | _ | 74.6327 | 4.8956 | BC |
| 31 | 2004 | 2 | 2 | _ | 75.9492 | 4.9150 | BC |
| 32 | 2005 | 1 | 1 | _ | 56.7337 | 4.8354 | D |
| 33 | 2005 | 1 | 2 | _ | 49.3973 | 4.8531 | DE |
| 34 | 2005 | 2 | 1 | _ | 42.3195 | 4.8354 | E |
| 35 | 2005 | 2 | 2 | _ | 39.6952 | 4.8354 | E |

----------------------------- Effect=Date   Method=LSD(P<.05)   Set=8 -----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 36 | _ | _ | _ | 1 | 54.4967 | 2.1405 | B |
| 37 | _ | _ | _ | 2 | 80.4287 | 2.1385 | A |

------------------------- Effect=Year*Date   Method=LSD(P<.05)   Set=9 ---------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 38 | 2003 | _ | _ | 1 | 94.8783 | 3.6922 | B |
| 39 | 2003 | _ | _ | 2 | 51.4886 | 3.7218 | D |
| 40 | 2004 | _ | _ | 1 | 47.1518 | 3.7380 | D |
| 41 | 2004 | _ | _ | 2 | 117.18 | 3.6922 | A |
| 42 | 2005 | _ | _ | 1 | 21.4599 | 3.6922 | E |
| 43 | 2005 | _ | _ | 2 | 72.6129 | 3.6980 | C |

------------------------ Effect=Variety*Date   Method=LSD(P<.05)   Set=10 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 44 | _ | 1 | _ | 1 | 71.2557 | 2.7917 | B |
| 45 | _ | 1 | _ | 2 | 81.2440 | 2.8020 | A |
| 46 | _ | 2 | _ | 1 | 37.7377 | 2.8187 | C |
| 47 | _ | 2 | _ | 2 | 79.6133 | 2.8023 | A |

---------------------- Effect=Year*Variety*Date   Method=LSD(P<.05)   Set=11 ----------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 48 | 2003 | 1 | _ | 1 | 116.49 | 4.8354 | A |
| 49 | 2003 | 1 | _ | 2 | 56.7865 | 4.8712 | CD |
| 50 | 2003 | 2 | _ | 1 | 73.2657 | 4.8354 | B |
| 51 | 2003 | 2 | _ | 2 | 46.1908 | 4.8900 | DE |
| 52 | 2004 | 1 | _ | 1 | 63.7122 | 4.8354 | BC |
| 53 | 2004 | 1 | _ | 2 | 114.38 | 4.8354 | A |
| 54 | 2004 | 2 | _ | 1 | 30.5914 | 4.9742 | F |
| 55 | 2004 | 2 | _ | 2 | 119.99 | 4.8354 | A |
| 56 | 2005 | 1 | _ | 1 | 33.5638 | 4.8354 | EF |
| 57 | 2005 | 1 | _ | 2 | 72.5672 | 4.8531 | B |
| 58 | 2005 | 2 | _ | 1 | 9.3560 | 4.8354 | G |
| 59 | 2005 | 2 | _ | 2 | 72.6587 | 4.8354 | B |

--------------------------- Effect=K*Date   Method=LSD(P<.05)   Set=12 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 60 | _ | _ | 1 | 1 | 57.6223 | 2.8034 | B |
| 61 | _ | _ | 1 | 2 | 79.7762 | 2.8023 | A |
| 62 | _ | _ | 2 | 1 | 51.3710 | 2.8071 | B |
| 63 | _ | _ | 2 | 2 | 81.0812 | 2.8020 | A |

------------------------- Effect=Year*K*Date   Method=LSD(P<.05)   Set=13 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 64 | 2003 | _ | 1 | 1 | 99.3417 | 4.8354 | B |
| 65 | 2003 | _ | 1 | 2 | 49.7700 | 4.8900 | D |
| 66 | 2003 | _ | 2 | 1 | 90.4150 | 4.8354 | B |
| 67 | 2003 | _ | 2 | 2 | 53.2073 | 4.8712 | D |
| 68 | 2004 | _ | 1 | 1 | 49.4982 | 4.8956 | D |
| 69 | 2004 | _ | 1 | 2 | 114.53 | 4.8354 | A |

------------------------- Effect=Year*K*Date Method=LSD(P<.05) Set=13 -------------------------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 70 | 2004 | _ | 2 | 1 | 44.8054 | 4.9150 | D |
| 71 | 2004 | _ | 2 | 2 | 119.84 | 4.8354 | A |
| 72 | 2005 | _ | 1 | 1 | 24.0272 | 4.8354 | E |
| 73 | 2005 | _ | 1 | 2 | 75.0260 | 4.8354 | C |
| 74 | 2005 | _ | 2 | 1 | 18.8927 | 4.8354 | E |
| 75 | 2005 | _ | 2 | 2 | 70.1998 | 4.8531 | C |

----------------------- Effect=Variety*K*Date Method=LSD(P<.05) Set=14 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 76 | _ | 1 | 1 | 1 | 74.6871 | 3.7806 | AB |
| 77 | _ | 1 | 1 | 2 | 80.6810 | 3.7806 | A |
| 78 | _ | 1 | 2 | 1 | 67.8242 | 3.7806 | B |
| 79 | _ | 1 | 2 | 2 | 81.8071 | 3.8110 | A |
| 80 | _ | 2 | 1 | 1 | 40.5576 | 3.8149 | C |
| 81 | _ | 2 | 1 | 2 | 78.8713 | 3.8117 | A |
| 82 | _ | 2 | 2 | 1 | 34.9178 | 3.8260 | C |
| 83 | _ | 2 | 2 | 2 | 80.3553 | 3.7806 | A |

--------------------- Effect=Year*Variety*K*Date Method=LSD(P<.05) Set=15 ---------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 84 | 2003 | 1 | 1 | 1 | 121.07 | 6.5482 | A |
| 85 | 2003 | 1 | 1 | 2 | 52.7673 | 6.5482 | CDE |
| 86 | 2003 | 1 | 2 | 1 | 111.91 | 6.5482 | A |
| 87 | 2003 | 1 | 2 | 2 | 60.8056 | 6.6535 | BCD |
| 88 | 2003 | 2 | 1 | 1 | 77.6097 | 6.5482 | B |
| 89 | 2003 | 2 | 1 | 2 | 46.7726 | 6.7082 | DEF |
| 90 | 2003 | 2 | 2 | 1 | 68.9217 | 6.5482 | BC |
| 91 | 2003 | 2 | 2 | 2 | 45.6090 | 6.5482 | DEF |
| 92 | 2004 | 1 | 1 | 1 | 65.9717 | 6.5482 | BC |
| 93 | 2004 | 1 | 1 | 2 | 112.82 | 6.5482 | A |
| 94 | 2004 | 1 | 2 | 1 | 61.4527 | 6.5482 | BCD |
| 95 | 2004 | 1 | 2 | 2 | 115.93 | 6.5482 | A |
| 96 | 2004 | 2 | 1 | 1 | 33.0248 | 6.7246 | F |
| 97 | 2004 | 2 | 1 | 2 | 116.24 | 6.5482 | A |
| 98 | 2004 | 2 | 2 | 1 | 28.1581 | 6.7811 | FG |
| 99 | 2004 | 2 | 2 | 2 | 123.74 | 6.5482 | A |
| 100 | 2005 | 1 | 1 | 1 | 37.0160 | 6.5482 | EF |
| 101 | 2005 | 1 | 1 | 2 | 76.4513 | 6.5482 | B |

Mean separation for starch

--------------------- Effect=Year*Variety*K*Date Method=LSD(P<.05) Set=15 ---------------------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 102 | 2005 | 1 | 2 | 1 | 30.1117 | 6.5482 | F |
| 103 | 2005 | 1 | 2 | 2 | 68.6830 | 6.6002 | BC |
| 104 | 2005 | 2 | 1 | 1 | 11.0383 | 6.5482 | GH |
| 105 | 2005 | 2 | 1 | 2 | 73.6007 | 6.5482 | B |
| 106 | 2005 | 2 | 2 | 1 | 7.6737 | 6.5482 | H |
| 107 | 2005 | 2 | 2 | 2 | 71.7167 | 6.5482 | B |

Check on normality for starch

The UNIVARIATE Procedure
Variable: Resid (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.991007 | Pr < W | 0.0003 |
| Kolmogorov-Smirnov | D | 0.051051 | Pr > D | <0.0100 |
| Cramer-von Mises | W-Sq | 0.405516 | Pr > W-Sq | <0.0050 |
| Anderson-Darling | A-Sq | 2.195717 | Pr > A-Sq | <0.0050 |

Extreme Observations

| ------Lowest----- | | -----Highest----- | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -96.1271 | 40 | 54.4120 | 421 |
| -70.5030 | 474 | 56.1387 | 643 |
| -57.8913 | 404 | 60.9588 | 394 |
| -54.0312 | 370 | 70.7824 | 692 |
| -53.9112 | 466 | 71.4578 | 183 |

Missing Values

| Missing Value | Count | -----Percent Of----- All Obs | Missing Obs |
|---|---|---|---|
| . | 13 | 1.81 | 100.00 |

```
                   Histogram                       #             Boxplot
 70+*                                              3                0
   .*****                                         30                0
   .**************                                80                |
   .*************************************        224             +--+--+
-10+*****************************************    249             *-----*
   .*****************                            102                |
   .***                                           17                0
   .*                                              1                0
-90+*                                              1                *
    ----+----+----+----+----+----+----+----+--
    * may represent up to 6 counts
```

Check on normality for starch

```
                    The UNIVARIATE Procedure
                  Variable:  Resid  (Residual)

                        Normal Probability Plot
          70+                                                      *
            |                                              *********
            |                                       ********+
            |                                  +**********
         -10+                        ***********
            |      **********
            |*******
            |*
         -90+*
             +----+----+----+----+----+----+----+----+----+----+
                 -2        -1         0        +1        +2
```

Check equality of stddev for y= starch

| Levene Obs | Year | Variety | K | Date | nobs | rawmean_ y | stddev_y | stderr_y | LeveneF_df | P |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 1 | 1 | 30 | 121.074 | 32.6879 | 5.96796 | 4.641(23,683) | 0.0000 |
| 2 | 2003 | 1 | 1 | 2 | 30 | 52.767 | 27.8113 | 5.07762 | | |
| 3 | 2003 | 1 | 2 | 1 | 30 | 111.908 | 29.1419 | 5.32056 | | |
| 4 | 2003 | 1 | 2 | 2 | 28 | 60.671 | 27.3659 | 5.17167 | | . |
| 5 | 2003 | 2 | 1 | 1 | 30 | 77.610 | 32.1339 | 5.86683 | | . |
| 6 | 2003 | 2 | 1 | 2 | 27 | 47.257 | 18.8039 | 3.61881 | | . |
| 7 | 2003 | 2 | 2 | 1 | 30 | 68.922 | 34.4411 | 6.28806 | | |
| 8 | 2003 | 2 | 2 | 2 | 30 | 45.609 | 17.1540 | 3.13188 | | |
| 9 | 2004 | 1 | 1 | 1 | 30 | 65.972 | 19.9097 | 3.63499 | | . |
| 10 | 2004 | 1 | 1 | 2 | 30 | 112.824 | 39.2288 | 7.16216 | | |
| 11 | 2004 | 1 | 2 | 1 | 30 | 61.453 | 22.1940 | 4.05205 | | |
| 12 | 2004 | 1 | 2 | 2 | 30 | 115.933 | 32.0286 | 5.84759 | | . |
| 13 | 2004 | 2 | 1 | 1 | 27 | 33.988 | 18.6508 | 3.58935 | | . |
| 14 | 2004 | 2 | 1 | 2 | 30 | 116.241 | 26.0386 | 4.75397 | | . |
| 15 | 2004 | 2 | 2 | 1 | 26 | 28.350 | 15.8679 | 3.11195 | | . |
| 16 | 2004 | 2 | 2 | 2 | 30 | 123.740 | 31.9070 | 5.82539 | | . |
| 17 | 2005 | 1 | 1 | 1 | 30 | 37.016 | 25.1439 | 4.59063 | | . |
| 18 | 2005 | 1 | 1 | 2 | 30 | 76.451 | 28.0694 | 5.12474 | | . |
| 19 | 2005 | 1 | 2 | 1 | 30 | 30.112 | 16.3556 | 2.98612 | | |
| 20 | 2005 | 1 | 2 | 2 | 29 | 69.048 | 26.7876 | 4.97432 | | |
| 21 | 2005 | 2 | 1 | 1 | 30 | 11.038 | 5.7563 | 1.05095 | | . |
| 22 | 2005 | 2 | 1 | 2 | 30 | 73.601 | 30.3235 | 5.53628 | | |
| 23 | 2005 | 2 | 2 | 1 | 30 | 7.674 | 6.5857 | 1.20238 | | . |
| 24 | 2005 | 2 | 2 | 2 | 30 | 71.717 | 20.5797 | 3.75733 | | |

Glucose Standard Curve for N&K Starch

| | |
|---|---|
| Intercept | -0.01091 |
| NetABS | 0.610538 |
| *Regression Statistics* | |
| Multiple R | 0.997701 |
| R Square | 0.995408 |

N&K Total Nonstructural Carbohydrates-
Combined total of Glucose, Fructose, Sucrose and Starch in mg/g dry weight.
SAS Input

**Variety 1= PM1218**
**2= DP555**
**K 1= 60lbs $K_2O$/acre/yr**
**2= 120lbs $K_2O$/acre/yr**
**Date 1= Early Bloom**
**2= Cutout**

```
Data NKSol;
Input plot year Rep Variety K  TotalNonstructural Date ;
Cards;
102     2003    1       1       1       131.77  1
108     2003    2       2       1       129.4   1
109     2003    2       1       2       131.58  1
111     2003    2       2       2       123.08  1
205     2003    1       2       1       132.43  1
206     2003    1       1       2       157.49  1
208     2003    4       2       2       83.02   1
211     2003    2       1       1       164.67  1
301     2003    3       1       1       120.01  1
303     2003    1       2       2       138.69  1
306     2003    3       1       2       116.99  1
311     2003    4       2       1       120.97  1
404     2003    3       2       1       100.57  1
405     2003    3       2       2       165.58  1
407     2003    4       1       2       176.09  1
412     2003    4       1       1       158.33  1
501     2003    5       2       2       117.6   1
505     2003    5       1       2       135.8   1
509     2003    5       1       1       164.42  1
512     2003    5       2       1       127.48  1
602     2003    6       2       2       93.68   1
603     2003    6       1       1       149.59  1
605     2003    6       1       2       147.82  1
606     2003    6       2       1       170.66  1
102     2003    1       1       1       122.1   1
108     2003    2       2       1       78.3    1
109     2003    2       1       2       142.26  1
111     2003    2       2       2       109.2   1
205     2003    1       2       1       138.07  1
206     2003    1       1       2       161.38  1
208     2003    4       2       2       67.77   1
211     2003    2       1       1       137.61  1
301     2003    3       1       1       130.46  1
303     2003    1       2       2       154.01  1
306     2003    3       1       2       118.95  1
311     2003    4       2       1       115.21  1
404     2003    3       2       1       154.02  1
405     2003    3       2       2       140.41  1
407     2003    4       1       2       148.92  1
412     2003    4       1       1       62.07   1
501     2003    5       2       2       107.85  1
505     2003    5       1       2       120.7   1
509     2003    5       1       1       144.49  1
512     2003    5       2       1       131.91  1
602     2003    6       2       2       .       1
603     2003    6       1       1       165.24  1
605     2003    6       1       2       145.06  1
606     2003    6       2       1       114.2   1
102     2003    1       1       1       175.09  1
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 108 | 2003 | 2 | 2 | 1 | 96.63 | 1 |
| 109 | 2003 | 2 | 1 | 2 | 161.99 | 1 |
| 111 | 2003 | 2 | 2 | 2 | 114.72 | 1 |
| 205 | 2003 | 1 | 2 | 1 | 154.43 | 1 |
| 206 | 2003 | 1 | 1 | 2 | 176.52 | 1 |
| 208 | 2003 | 4 | 2 | 2 | 113.34 | 1 |
| 211 | 2003 | 2 | 1 | 1 | 195.84 | 1 |
| 301 | 2003 | 3 | 1 | 1 | 193.02 | 1 |
| 303 | 2003 | 1 | 2 | 2 | 174.04 | 1 |
| 306 | 2003 | 3 | 1 | 2 | 185.86 | 1 |
| 311 | 2003 | 4 | 2 | 1 | 114.97 | 1 |
| 404 | 2003 | 3 | 2 | 1 | 180.39 | 1 |
| 405 | 2003 | 3 | 2 | 2 | 142.06 | 1 |
| 407 | 2003 | 4 | 1 | 2 | 201.27 | 1 |
| 412 | 2003 | 4 | 1 | 1 | 212.46 | 1 |
| 501 | 2003 | 5 | 2 | 2 | 104.34 | 1 |
| 505 | 2003 | 5 | 1 | 2 | 141.04 | 1 |
| 509 | 2003 | 5 | 1 | 1 | 207.66 | 1 |
| 512 | 2003 | 5 | 2 | 1 | 140.84 | 1 |
| 602 | 2003 | 6 | 2 | 2 | 132.93 | 1 |
| 603 | 2003 | 6 | 1 | 1 | 191.01 | 1 |
| 605 | 2003 | 6 | 1 | 2 | 164.48 | 1 |
| 606 | 2003 | 6 | 2 | 1 | 161.17 | 1 |
| 102 | 2003 | 1 | 1 | 1 | 192.76 | 1 |
| 108 | 2003 | 2 | 2 | 1 | 94.88 | 1 |
| 109 | 2003 | 2 | 1 | 2 | 146.92 | 1 |
| 111 | 2003 | 2 | 2 | 2 | 82.87 | 1 |
| 205 | 2003 | 1 | 2 | 1 | 120.37 | 1 |
| 206 | 2003 | 1 | 1 | 2 | 199.54 | 1 |
| 208 | 2003 | 4 | 2 | 2 | 123.73 | 1 |
| 211 | 2003 | 2 | 1 | 1 | 200.94 | 1 |
| 301 | 2003 | 3 | 1 | 1 | 202.46 | 1 |
| 303 | 2003 | 1 | 2 | 2 | 176.31 | 1 |
| 306 | 2003 | 3 | 1 | 2 | 134.02 | 1 |
| 311 | 2003 | 4 | 2 | 1 | 102.2 | 1 |
| 404 | 2003 | 3 | 2 | 1 | 177.08 | 1 |
| 405 | 2003 | 3 | 2 | 2 | 156.69 | 1 |
| 407 | 2003 | 4 | 1 | 2 | 192.73 | 1 |
| 412 | 2003 | 4 | 1 | 1 | 191.17 | 1 |
| 501 | 2003 | 5 | 2 | 2 | 78.7 | 1 |
| 505 | 2003 | 5 | 1 | 2 | 199.36 | 1 |
| 509 | 2003 | 5 | 1 | 1 | 150.41 | 1 |
| 512 | 2003 | 5 | 2 | 1 | 166.52 | 1 |
| 602 | 2003 | 6 | 2 | 2 | . | 1 |
| 603 | 2003 | 6 | 1 | 1 | 162.97 | 1 |
| 605 | 2003 | 6 | 1 | 2 | 148.86 | 1 |
| 606 | 2003 | 6 | 2 | 1 | 150.8 | 1 |
| 102 | 2003 | 1 | 1 | 1 | 169.79 | 1 |
| 108 | 2003 | 2 | 2 | 1 | 87.87 | 1 |
| 109 | 2003 | 2 | 1 | 2 | 198.76 | 1 |
| 111 | 2003 | 2 | 2 | 2 | 79.41 | 1 |
| 205 | 2003 | 1 | 2 | 1 | 161 | 1 |
| 206 | 2003 | 1 | 1 | 2 | 165.01 | 1 |
| 208 | 2003 | 4 | 2 | 2 | 112.08 | 1 |
| 211 | 2003 | 2 | 1 | 1 | 200.66 | 1 |
| 301 | 2003 | 3 | 1 | 1 | 184.95 | 1 |
| 303 | 2003 | 1 | 2 | 2 | 190.43 | 1 |
| 306 | 2003 | 3 | 1 | 2 | 172.79 | 1 |
| 311 | 2003 | 4 | 2 | 1 | 110.02 | 1 |
| 404 | 2003 | 3 | 2 | 1 | 166.61 | 1 |
| 405 | 2003 | 3 | 2 | 2 | 156.74 | 1 |
| 407 | 2003 | 4 | 1 | 2 | 112.85 | 1 |
| 412 | 2003 | 4 | 1 | 1 | 138.3 | 1 |
| 501 | 2003 | 5 | 2 | 2 | 105.36 | 1 |
| 505 | 2003 | 5 | 1 | 2 | 128.54 | 1 |
| 509 | 2003 | 5 | 1 | 1 | 129.15 | 1 |
| 512 | 2003 | 5 | 2 | 1 | 117.54 | 1 |
| 602 | 2003 | 6 | 2 | 2 | 97.48 | 1 |
| 603 | 2003 | 6 | 1 | 1 | 151.06 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 605 | 2003 | 6 | 1 | 2 | 109.26 | 1 |
| 606 | 2003 | 6 | 2 | 1 | 120.6 | 1 |
| 102 | 2003 | 1 | 1 | 1 | 167.76 | 2 |
| 108 | 2003 | 2 | 2 | 1 | 69.74 | 2 |
| 109 | 2003 | 2 | 1 | 2 | 116.55 | 2 |
| 111 | 2003 | 2 | 2 | 2 | 70.41 | 2 |
| 205 | 2003 | 1 | 2 | 1 | 73.54 | 2 |
| 206 | 2003 | 1 | 1 | 2 | 110.14 | 2 |
| 208 | 2003 | 4 | 2 | 2 | 77.98 | 2 |
| 211 | 2003 | 2 | 1 | 1 | 26.74 | 2 |
| 301 | 2003 | 3 | 1 | 1 | 117.53 | 2 |
| 303 | 2003 | 1 | 2 | 2 | 120.39 | 2 |
| 306 | 2003 | 3 | 1 | 2 | 139.09 | 2 |
| 311 | 2003 | 4 | 2 | 1 | 48.38 | 2 |
| 404 | 2003 | 3 | 2 | 1 | 125.81 | 2 |
| 405 | 2003 | 3 | 2 | 2 | 101.17 | 2 |
| 407 | 2003 | 4 | 1 | 2 | 98.46 | 2 |
| 412 | 2003 | 4 | 1 | 1 | 92.59 | 2 |
| 501 | 2003 | 5 | 2 | 2 | 70.41 | 2 |
| 505 | 2003 | 5 | 1 | 2 | 103.26 | 2 |
| 509 | 2003 | 5 | 1 | 1 | 50.73 | 2 |
| 512 | 2003 | 5 | 2 | 1 | 94.01 | 2 |
| 602 | 2003 | 6 | 2 | 2 | 143.48 | 2 |
| 603 | 2003 | 6 | 1 | 1 | 118.08 | 2 |
| 605 | 2003 | 6 | 1 | 2 | 91.69 | 2 |
| 606 | 2003 | 6 | 2 | 1 | 63.88 | 2 |
| 102 | 2003 | 1 | 1 | 1 | 156.37 | 2 |
| 108 | 2003 | 2 | 2 | 1 | 99.53 | 2 |
| 109 | 2003 | 2 | 1 | 2 | 131.77 | 2 |
| 111 | 2003 | 2 | 2 | 2 | 92.35 | 2 |
| 205 | 2003 | 1 | 2 | 1 | 76.28 | 2 |
| 206 | 2003 | 1 | 1 | 2 | 73.15 | 2 |
| 208 | 2003 | 4 | 2 | 2 | 83 | 2 |
| 211 | 2003 | 2 | 1 | 1 | 54.52 | 2 |
| 301 | 2003 | 3 | 1 | 1 | 88.22 | 2 |
| 303 | 2003 | 1 | 2 | 2 | 83.93 | 2 |
| 306 | 2003 | 3 | 1 | 2 | 80.89 | 2 |
| 311 | 2003 | 4 | 2 | 1 | 75.95 | 2 |
| 404 | 2003 | 3 | 2 | 1 | 63.35 | 2 |
| 405 | 2003 | 3 | 2 | 2 | 79.84 | 2 |
| 407 | 2003 | 4 | 1 | 2 | . | 2 |
| 412 | 2003 | 4 | 1 | 1 | 115.7 | 2 |
| 501 | 2003 | 5 | 2 | 2 | 91.67 | 2 |
| 505 | 2003 | 5 | 1 | 2 | 85.73 | 2 |
| 509 | 2003 | 5 | 1 | 1 | 81.19 | 2 |
| 512 | 2003 | 5 | 2 | 1 | 41.97 | 2 |
| 602 | 2003 | 6 | 2 | 2 | 86.94 | 2 |
| 603 | 2003 | 6 | 1 | 1 | 113.47 | 2 |
| 605 | 2003 | 6 | 1 | 2 | 89.58 | 2 |
| 606 | 2003 | 6 | 2 | 1 | 113.6 | 2 |
| 102 | 2003 | 1 | 1 | 1 | 82.85 | 2 |
| 108 | 2003 | 2 | 2 | 1 | 40.46 | 2 |
| 109 | 2003 | 2 | 1 | 2 | 79.67 | 2 |
| 111 | 2003 | 2 | 2 | 2 | 88.7 | 2 |
| 205 | 2003 | 1 | 2 | 1 | 57.39 | 2 |
| 206 | 2003 | 1 | 1 | 2 | 54.78 | 2 |
| 208 | 2003 | 4 | 2 | 2 | 85.24 | 2 |
| 211 | 2003 | 2 | 1 | 1 | 36.72 | 2 |
| 301 | 2003 | 3 | 1 | 1 | 121.33 | 2 |
| 303 | 2003 | 1 | 2 | 2 | 113.1 | 2 |
| 306 | 2003 | 3 | 1 | 2 | 80.68 | 2 |
| 311 | 2003 | 4 | 2 | 1 | 118.38 | 2 |
| 404 | 2003 | 3 | 2 | 1 | 115.99 | 2 |
| 405 | 2003 | 3 | 2 | 2 | 83.66 | 2 |
| 407 | 2003 | 4 | 1 | 2 | 160.28 | 2 |
| 412 | 2003 | 4 | 1 | 1 | 90.01 | 2 |
| 501 | 2003 | 5 | 2 | 2 | 104.03 | 2 |
| 505 | 2003 | 5 | 1 | 2 | 121.21 | 2 |
| 509 | 2003 | 5 | 1 | 1 | 141.42 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 512 | 2003 | 5 | 2 | 1 | 69.11 | 2 |
| 602 | 2003 | 6 | 2 | 2 | 93.04 | 2 |
| 603 | 2003 | 6 | 1 | 1 | 59.8 | 2 |
| 605 | 2003 | 6 | 1 | 2 | 96.22 | 2 |
| 606 | 2003 | 6 | 2 | 1 | 77.92 | 2 |
| 102 | 2003 | 1 | 1 | 1 | 76.13 | 2 |
| 108 | 2003 | 2 | 2 | 1 | . | 2 |
| 109 | 2003 | 2 | 1 | 2 | . | 2 |
| 111 | 2003 | 2 | 2 | 2 | 81.53 | 2 |
| 205 | 2003 | 1 | 2 | 1 | 91.71 | 2 |
| 206 | 2003 | 1 | 1 | 2 | 77.34 | 2 |
| 208 | 2003 | 4 | 2 | 2 | 82.13 | 2 |
| 211 | 2003 | 2 | 1 | 1 | 96.56 | 2 |
| 301 | 2003 | 3 | 1 | 1 | 97.98 | 2 |
| 303 | 2003 | 1 | 2 | 2 | 92.01 | 2 |
| 306 | 2003 | 3 | 1 | 2 | 157.68 | 2 |
| 311 | 2003 | 4 | 2 | 1 | 74.53 | 2 |
| 404 | 2003 | 3 | 2 | 1 | 105.05 | 2 |
| 405 | 2003 | 3 | 2 | 2 | 93.62 | 2 |
| 407 | 2003 | 4 | 1 | 2 | 73.4 | 2 |
| 412 | 2003 | 4 | 1 | 1 | 70.18 | 2 |
| 501 | 2003 | 5 | 2 | 2 | 74.61 | 2 |
| 505 | 2003 | 5 | 1 | 2 | 112.58 | 2 |
| 509 | 2003 | 5 | 1 | 1 | 106.97 | 2 |
| 512 | 2003 | 5 | 2 | 1 | 80.41 | 2 |
| 602 | 2003 | 6 | 2 | 2 | 73.17 | 2 |
| 603 | 2003 | 6 | 1 | 1 | 95.9 | 2 |
| 605 | 2003 | 6 | 1 | 2 | 26.62 | 2 |
| 606 | 2003 | 6 | 2 | 1 | 38.65 | 2 |
| 102 | 2003 | 1 | 1 | 1 | 66.35 | 2 |
| 108 | 2003 | 2 | 2 | 1 | 67.24 | 2 |
| 109 | 2003 | 2 | 1 | 2 | 77.79 | 2 |
| 111 | 2003 | 2 | 2 | 2 | 63.68 | 2 |
| 205 | 2003 | 1 | 2 | 1 | 152.62 | 2 |
| 206 | 2003 | 1 | 1 | 2 | 118.31 | 2 |
| 208 | 2003 | 4 | 2 | 2 | 122.41 | 2 |
| 211 | 2003 | 2 | 1 | 1 | 122.11 | 2 |
| 301 | 2003 | 3 | 1 | 1 | 128.56 | 2 |
| 303 | 2003 | 1 | 2 | 2 | 77.35 | 2 |
| 306 | 2003 | 3 | 1 | 2 | 112.98 | 2 |
| 311 | 2003 | 4 | 2 | 1 | 97.39 | 2 |
| 404 | 2003 | 3 | 2 | 1 | 109.87 | 2 |
| 405 | 2003 | 3 | 2 | 2 | 78.32 | 2 |
| 407 | 2003 | 4 | 1 | 2 | 89.29 | 2 |
| 412 | 2003 | 4 | 1 | 1 | 80.43 | 2 |
| 501 | 2003 | 5 | 2 | 2 | 75.03 | 2 |
| 505 | 2003 | 5 | 1 | 2 | 67.12 | 2 |
| 509 | 2003 | 5 | 1 | 1 | 112.52 | 2 |
| 512 | 2003 | 5 | 2 | 1 | . | 2 |
| 602 | 2003 | 6 | 2 | 2 | 74.79 | 2 |
| 603 | 2003 | 6 | 1 | 1 | 70.28 | 2 |
| 605 | 2003 | 6 | 1 | 2 | 128.06 | 2 |
| 606 | 2003 | 6 | 2 | 1 | . | 2 |
| 102 | 2004 | 1 | 2 | 1 | 117.11 | 1 |
| 108 | 2004 | 1 | 1 | 1 | 110.17 | 1 |
| 109 | 2004 | 1 | 2 | 2 | 122.5 | 1 |
| 111 | 2004 | 1 | 1 | 2 | 150.45 | 1 |
| 205 | 2004 | 2 | 1 | 1 | 110.94 | 1 |
| 206 | 2004 | 2 | 2 | 2 | . | 1 |
| 208 | 2004 | 2 | 1 | 2 | 76.78 | 1 |
| 211 | 2004 | 2 | 2 | 1 | 93.5 | 1 |
| 301 | 2004 | 3 | 2 | 1 | 62.35 | 1 |
| 303 | 2004 | 3 | 1 | 2 | 131.22 | 1 |
| 306 | 2004 | 3 | 2 | 2 | 91.18 | 1 |
| 311 | 2004 | 3 | 1 | 1 | 103.37 | 1 |
| 404 | 2004 | 4 | 1 | 1 | 126.63 | 1 |
| 405 | 2004 | 4 | 1 | 2 | 105.05 | 1 |
| 407 | 2004 | 4 | 2 | 2 | 65.18 | 1 |
| 412 | 2004 | 4 | 2 | 1 | 97.1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 501 | 2004 | 5 | 1 | 2 | 157.79 | 1 |
| 505 | 2004 | 5 | 2 | 2 | 98.49 | 1 |
| 509 | 2004 | 5 | 2 | 1 | 123.15 | 1 |
| 512 | 2004 | 5 | 1 | 1 | 109.39 | 1 |
| 602 | 2004 | 6 | 1 | 2 | 93.79 | 1 |
| 603 | 2004 | 6 | 2 | 1 | . | 1 |
| 605 | 2004 | 6 | 2 | 2 | . | 1 |
| 606 | 2004 | 6 | 1 | 1 | 94.86 | 1 |
| 102 | 2004 | 1 | 2 | 1 | 111.12 | 1 |
| 108 | 2004 | 1 | 1 | 1 | 135.34 | 1 |
| 109 | 2004 | 1 | 2 | 2 | 85.77 | 1 |
| 111 | 2004 | 1 | 1 | 2 | 103.7 | 1 |
| 205 | 2004 | 2 | 1 | 1 | 98.5 | 1 |
| 206 | 2004 | 2 | 2 | 2 | 76.03 | 1 |
| 208 | 2004 | 2 | 1 | 2 | 111.8 | 1 |
| 211 | 2004 | 2 | 2 | 1 | 108.63 | 1 |
| 301 | 2004 | 3 | 2 | 1 | 91.45 | 1 |
| 303 | 2004 | 3 | 1 | 2 | 134.25 | 1 |
| 306 | 2004 | 3 | 2 | 2 | 83.39 | 1 |
| 311 | 2004 | 3 | 1 | 1 | 107.13 | 1 |
| 404 | 2004 | 4 | 1 | 1 | 160.48 | 1 |
| 405 | 2004 | 4 | 1 | 2 | 108.78 | 1 |
| 407 | 2004 | 4 | 2 | 2 | 124.84 | 1 |
| 412 | 2004 | 4 | 2 | 1 | 70.02 | 1 |
| 501 | 2004 | 5 | 1 | 2 | 98.79 | 1 |
| 505 | 2004 | 5 | 2 | 2 | 108.94 | 1 |
| 509 | 2004 | 5 | 2 | 1 | 108.95 | 1 |
| 512 | 2004 | 5 | 1 | 1 | 123.83 | 1 |
| 602 | 2004 | 6 | 1 | 2 | 107.74 | 1 |
| 603 | 2004 | 6 | 2 | 1 | 97.78 | 1 |
| 605 | 2004 | 6 | 2 | 2 | 61.98 | 1 |
| 606 | 2004 | 6 | 1 | 1 | 108.44 | 1 |
| 102 | 2004 | 1 | 2 | 1 | 73.11 | 1 |
| 108 | 2004 | 1 | 1 | 1 | 119.21 | 1 |
| 109 | 2004 | 1 | 2 | 2 | 79.28 | 1 |
| 111 | 2004 | 1 | 1 | 2 | 107.93 | 1 |
| 205 | 2004 | 2 | 1 | 1 | 115.51 | 1 |
| 206 | 2004 | 2 | 2 | 2 | 74.48 | 1 |
| 208 | 2004 | 2 | 1 | 2 | 92.52 | 1 |
| 211 | 2004 | 2 | 2 | 1 | 116.83 | 1 |
| 301 | 2004 | 3 | 2 | 1 | 67.43 | 1 |
| 303 | 2004 | 3 | 1 | 2 | 106.43 | 1 |
| 306 | 2004 | 3 | 2 | 2 | 65.71 | 1 |
| 311 | 2004 | 3 | 1 | 1 | 101.48 | 1 |
| 404 | 2004 | 4 | 1 | 1 | 147.61 | 1 |
| 405 | 2004 | 4 | 1 | 2 | 99.27 | 1 |
| 407 | 2004 | 4 | 2 | 2 | . | 1 |
| 412 | 2004 | 4 | 2 | 1 | 77.6 | 1 |
| 501 | 2004 | 5 | 1 | 2 | 99.78 | 1 |
| 505 | 2004 | 5 | 2 | 2 | 74.63 | 1 |
| 509 | 2004 | 5 | 2 | 1 | 81.98 | 1 |
| 512 | 2004 | 5 | 1 | 1 | 91.42 | 1 |
| 602 | 2004 | 6 | 1 | 2 | 105.63 | 1 |
| 603 | 2004 | 6 | 2 | 1 | . | 1 |
| 605 | 2004 | 6 | 2 | 2 | 43.37 | 1 |
| 606 | 2004 | 6 | 1 | 1 | 98.83 | 1 |
| 102 | 2004 | 1 | 2 | 1 | 81.12 | 1 |
| 108 | 2004 | 1 | 1 | 1 | 102.93 | 1 |
| 109 | 2004 | 1 | 2 | 2 | 67.82 | 1 |
| 111 | 2004 | 1 | 1 | 2 | 95.43 | 1 |
| 205 | 2004 | 2 | 1 | 1 | 116.4 | 1 |
| 206 | 2004 | 2 | 2 | 2 | 79 | 1 |
| 208 | 2004 | 2 | 1 | 2 | 96.07 | 1 |
| 211 | 2004 | 2 | 2 | 1 | 93.57 | 1 |
| 301 | 2004 | 3 | 2 | 1 | . | 1 |
| 303 | 2004 | 3 | 1 | 2 | 81.25 | 1 |
| 306 | 2004 | 3 | 2 | 2 | 69.38 | 1 |
| 311 | 2004 | 3 | 1 | 1 | 51.23 | 1 |
| 404 | 2004 | 4 | 1 | 1 | 91.5 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 405 | 2004 | 4 | 1 | 2 | 69.16 | 1 |
| 407 | 2004 | 4 | 2 | 2 | 92.74 | 1 |
| 412 | 2004 | 4 | 2 | 1 | 95.57 | 1 |
| 501 | 2004 | 5 | 1 | 2 | 135.8 | 1 |
| 505 | 2004 | 5 | 2 | 2 | 75.41 | 1 |
| 509 | 2004 | 5 | 2 | 1 | 69.53 | 1 |
| 512 | 2004 | 5 | 1 | 1 | 90.5 | 1 |
| 602 | 2004 | 6 | 1 | 2 | 84.06 | 1 |
| 603 | 2004 | 6 | 2 | 1 | 57.13 | 1 |
| 605 | 2004 | 6 | 2 | 2 | 50.44 | 1 |
| 606 | 2004 | 6 | 1 | 1 | 103.9 | 1 |
| 102 | 2004 | 1 | 2 | 1 | 101.43 | 1 |
| 108 | 2004 | 1 | 1 | 1 | . | 1 |
| 109 | 2004 | 1 | 2 | 2 | 67.83 | 1 |
| 111 | 2004 | 1 | 1 | 2 | 95 | 1 |
| 205 | 2004 | 2 | 1 | 1 | 116.09 | 1 |
| 206 | 2004 | 2 | 2 | 2 | . | 1 |
| 208 | 2004 | 2 | 1 | 2 | 101.55 | 1 |
| 211 | 2004 | 2 | 2 | 1 | 107.39 | 1 |
| 301 | 2004 | 3 | 2 | 1 | 79.5 | 1 |
| 303 | 2004 | 3 | 1 | 2 | . | 1 |
| 306 | 2004 | 3 | 2 | 2 | 64.52 | 1 |
| 311 | 2004 | 3 | 1 | 1 | 99.81 | 1 |
| 404 | 2004 | 4 | 1 | 1 | 130.38 | 1 |
| 405 | 2004 | 4 | 1 | 2 | 86.82 | 1 |
| 407 | 2004 | 4 | 2 | 2 | 61.77 | 1 |
| 412 | 2004 | 4 | 2 | 1 | 84.07 | 1 |
| 501 | 2004 | 5 | 1 | 2 | 124.61 | 1 |
| 505 | 2004 | 5 | 2 | 2 | 73.16 | 1 |
| 509 | 2004 | 5 | 2 | 1 | 138.74 | 1 |
| 512 | 2004 | 5 | 1 | 1 | 89.82 | 1 |
| 602 | 2004 | 6 | 1 | 2 | 123.18 | 1 |
| 603 | 2004 | 6 | 2 | 1 | . | 1 |
| 605 | 2004 | 6 | 2 | 2 | 75.99 | 1 |
| 606 | 2004 | 6 | 1 | 1 | 99.22 | 1 |
| 102 | 2004 | 1 | 2 | 1 | 101.08 | 2 |
| 108 | 2004 | 1 | 1 | 1 | 107.02 | 2 |
| 109 | 2004 | 1 | 2 | 2 | 148.08 | 2 |
| 111 | 2004 | 1 | 1 | 2 | 142.15 | 2 |
| 205 | 2004 | 2 | 1 | 1 | 120.02 | 2 |
| 206 | 2004 | 2 | 2 | 2 | 149.45 | 2 |
| 208 | 2004 | 2 | 1 | 2 | 164.34 | 2 |
| 211 | 2004 | 2 | 2 | 1 | 154.3 | 2 |
| 301 | 2004 | 3 | 2 | 1 | 116.24 | 2 |
| 303 | 2004 | 3 | 1 | 2 | 77.21 | 2 |
| 306 | 2004 | 3 | 2 | 2 | 133.23 | 2 |
| 311 | 2004 | 3 | 1 | 1 | 120.06 | 2 |
| 404 | 2004 | 4 | 1 | 1 | 106.49 | 2 |
| 405 | 2004 | 4 | 1 | 2 | 154.29 | 2 |
| 407 | 2004 | 4 | 2 | 2 | 174.54 | 2 |
| 412 | 2004 | 4 | 2 | 1 | 154.94 | 2 |
| 501 | 2004 | 5 | 1 | 2 | 109.96 | 2 |
| 505 | 2004 | 5 | 2 | 2 | 160.38 | 2 |
| 509 | 2004 | 5 | 2 | 1 | 123.8 | 2 |
| 512 | 2004 | 5 | 1 | 1 | 135.28 | 2 |
| 602 | 2004 | 6 | 1 | 2 | 125.14 | 2 |
| 603 | 2004 | 6 | 2 | 1 | 158.37 | 2 |
| 605 | 2004 | 6 | 2 | 2 | 176.75 | 2 |
| 606 | 2004 | 6 | 1 | 1 | 101.23 | 2 |
| 102 | 2004 | 1 | 2 | 1 | 168.51 | 2 |
| 108 | 2004 | 1 | 1 | 1 | 170.56 | 2 |
| 109 | 2004 | 1 | 2 | 2 | 92.56 | 2 |
| 111 | 2004 | 1 | 1 | 2 | 158.22 | 2 |
| 205 | 2004 | 2 | 1 | 1 | 193.86 | 2 |
| 206 | 2004 | 2 | 2 | 2 | 146.57 | 2 |
| 208 | 2004 | 2 | 1 | 2 | 183.95 | 2 |
| 211 | 2004 | 2 | 2 | 1 | 163.94 | 2 |
| 301 | 2004 | 3 | 2 | 1 | 211.39 | 2 |
| 303 | 2004 | 3 | 1 | 2 | 200.55 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 306 | 2004 | 3 | 2 | 2 | 223.8 | 2 |
| 311 | 2004 | 3 | 1 | 1 | 211.79 | 2 |
| 404 | 2004 | 4 | 1 | 1 | 89.83 | 2 |
| 405 | 2004 | 4 | 1 | 2 | 123.03 | 2 |
| 407 | 2004 | 4 | 2 | 2 | 214.8 | 2 |
| 412 | 2004 | 4 | 2 | 1 | 111.61 | 2 |
| 501 | 2004 | 5 | 1 | 2 | 167.07 | 2 |
| 505 | 2004 | 5 | 2 | 2 | 179.2 | 2 |
| 509 | 2004 | 5 | 2 | 1 | 167.08 | 2 |
| 512 | 2004 | 5 | 1 | 1 | 64.52 | 2 |
| 602 | 2004 | 6 | 1 | 2 | 176.87 | 2 |
| 603 | 2004 | 6 | 2 | 1 | 171.87 | 2 |
| 605 | 2004 | 6 | 2 | 2 | 142.31 | 2 |
| 606 | 2004 | 6 | 1 | 1 | 205.36 | 2 |
| 102 | 2004 | 1 | 2 | 1 | 136.86 | 2 |
| 108 | 2004 | 1 | 1 | 1 | 164.81 | 2 |
| 109 | 2004 | 1 | 2 | 2 | 150.47 | 2 |
| 111 | 2004 | 1 | 1 | 2 | 178.2 | 2 |
| 205 | 2004 | 2 | 1 | 1 | 205.58 | 2 |
| 206 | 2004 | 2 | 2 | 2 | 170.67 | 2 |
| 208 | 2004 | 2 | 1 | 2 | 198.95 | 2 |
| 211 | 2004 | 2 | 2 | 1 | 151.45 | 2 |
| 301 | 2004 | 3 | 2 | 1 | 157.15 | 2 |
| 303 | 2004 | 3 | 1 | 2 | 195.81 | 2 |
| 306 | 2004 | 3 | 2 | 2 | 158.18 | 2 |
| 311 | 2004 | 3 | 1 | 1 | 199.88 | 2 |
| 404 | 2004 | 4 | 1 | 1 | 182.85 | 2 |
| 405 | 2004 | 4 | 1 | 2 | 138.3 | 2 |
| 407 | 2004 | 4 | 2 | 2 | 214.91 | 2 |
| 412 | 2004 | 4 | 2 | 1 | 161 | 2 |
| 501 | 2004 | 5 | 1 | 2 | 115.37 | 2 |
| 505 | 2004 | 5 | 2 | 2 | 137.07 | 2 |
| 509 | 2004 | 5 | 2 | 1 | 173.24 | 2 |
| 512 | 2004 | 5 | 1 | 1 | 142.13 | 2 |
| 602 | 2004 | 6 | 1 | 2 | 116.72 | 2 |
| 603 | 2004 | 6 | 2 | 1 | 181.32 | 2 |
| 605 | 2004 | 6 | 2 | 2 | 181.74 | 2 |
| 606 | 2004 | 6 | 1 | 1 | 183.43 | 2 |
| 102 | 2004 | 1 | 2 | 1 | 166.36 | 2 |
| 108 | 2004 | 1 | 1 | 1 | 78.83 | 2 |
| 109 | 2004 | 1 | 2 | 2 | 84.41 | 2 |
| 111 | 2004 | 1 | 1 | 2 | 82.75 | 2 |
| 205 | 2004 | 2 | 1 | 1 | 153.06 | 2 |
| 206 | 2004 | 2 | 2 | 2 | 111.35 | 2 |
| 208 | 2004 | 2 | 1 | 2 | 136.51 | 2 |
| 211 | 2004 | 2 | 2 | 1 | . | 2 |
| 301 | 2004 | 3 | 2 | 1 | 181.72 | 2 |
| 303 | 2004 | 3 | 1 | 2 | 126.38 | 2 |
| 306 | 2004 | 3 | 2 | 2 | 162.32 | 2 |
| 311 | 2004 | 3 | 1 | 1 | 167.95 | 2 |
| 404 | 2004 | 4 | 1 | 1 | 88.91 | 2 |
| 405 | 2004 | 4 | 1 | 2 | 120.82 | 2 |
| 407 | 2004 | 4 | 2 | 2 | 198.19 | 2 |
| 412 | 2004 | 4 | 2 | 1 | 107.48 | 2 |
| 501 | 2004 | 5 | 1 | 2 | 130.63 | 2 |
| 505 | 2004 | 5 | 2 | 2 | 116.28 | 2 |
| 509 | 2004 | 5 | 2 | 1 | 126.08 | 2 |
| 512 | 2004 | 5 | 1 | 1 | 78.02 | 2 |
| 602 | 2004 | 6 | 1 | 2 | . | 2 |
| 603 | 2004 | 6 | 2 | 1 | 141.51 | 2 |
| 605 | 2004 | 6 | 2 | 2 | 142.13 | 2 |
| 606 | 2004 | 6 | 1 | 1 | 160.46 | 2 |
| 102 | 2004 | 1 | 2 | 1 | 114.02 | 2 |
| 108 | 2004 | 1 | 1 | 1 | 88.99 | 2 |
| 109 | 2004 | 1 | 2 | 2 | 132.68 | 2 |
| 111 | 2004 | 1 | 1 | 2 | 135.76 | 2 |
| 205 | 2004 | 2 | 1 | 1 | 130.05 | 2 |
| 206 | 2004 | 2 | 2 | 2 | . | 2 |
| 208 | 2004 | 2 | 1 | 2 | 174.55 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 211 | 2004 | 2 | 2 | 1 | 146.09 | 2 |
| 301 | 2004 | 3 | 2 | 1 | 147.9 | 2 |
| 303 | 2004 | 3 | 1 | 2 | 90.06 | 2 |
| 306 | 2004 | 3 | 2 | 2 | 146.49 | 2 |
| 311 | 2004 | 3 | 1 | 1 | 155.95 | 2 |
| 404 | 2004 | 4 | 1 | 1 | 158.87 | 2 |
| 405 | 2004 | 4 | 1 | 2 | 133.29 | 2 |
| 407 | 2004 | 4 | 2 | 2 | . | 2 |
| 412 | 2004 | 4 | 2 | 1 | 126.78 | 2 |
| 501 | 2004 | 5 | 1 | 2 | 145.72 | 2 |
| 505 | 2004 | 5 | 2 | 2 | 89.05 | 2 |
| 509 | 2004 | 5 | 2 | 1 | 128.07 | 2 |
| 512 | 2004 | 5 | 1 | 1 | 119.87 | 2 |
| 602 | 2004 | 6 | 1 | 2 | . | 2 |
| 603 | 2004 | 6 | 2 | 1 | . | 2 |
| 605 | 2004 | 6 | 2 | 2 | . | 2 |
| 606 | 2004 | 6 | 1 | 1 | 145.39 | 2 |
| 102 | 2005 | 1 | 1 | 1 | 90.6 | 1 |
| 108 | 2005 | 1 | 2 | 1 | 48.18 | 1 |
| 109 | 2005 | 1 | 1 | 2 | 76 | 1 |
| 111 | 2005 | 1 | 2 | 2 | 42.24 | 1 |
| 205 | 2005 | 2 | 2 | 1 | 73.52 | 1 |
| 206 | 2005 | 2 | 1 | 2 | 98.64 | 1 |
| 208 | 2005 | 2 | 2 | 2 | 59.8 | 1 |
| 211 | 2005 | 2 | 1 | 1 | 96.06 | 1 |
| 301 | 2005 | 3 | 1 | 1 | 121.09 | 1 |
| 303 | 2005 | 3 | 2 | 2 | 52.4 | 1 |
| 306 | 2005 | 3 | 1 | 2 | 72.9 | 1 |
| 311 | 2005 | 3 | 2 | 1 | 36.99 | 1 |
| 404 | 2005 | 4 | 2 | 1 | 61.72 | 1 |
| 405 | 2005 | 4 | 2 | 2 | 73.85 | 1 |
| 407 | 2005 | 4 | 1 | 2 | 71.22 | 1 |
| 412 | 2005 | 4 | 1 | 1 | 108.94 | 1 |
| 501 | 2005 | 5 | 2 | 2 | 54.9 | 1 |
| 505 | 2005 | 5 | 1 | 2 | 38.2 | 1 |
| 509 | 2005 | 5 | 1 | 1 | 47.61 | 1 |
| 512 | 2005 | 5 | 2 | 1 | 46.75 | 1 |
| 602 | 2005 | 6 | 2 | 2 | 38.9 | 1 |
| 603 | 2005 | 6 | 1 | 1 | 63.47 | 1 |
| 605 | 2005 | 6 | 1 | 2 | 59.32 | 1 |
| 606 | 2005 | 6 | 2 | 1 | 66.96 | 1 |
| 102 | 2005 | 1 | 1 | 1 | 100.77 | 1 |
| 108 | 2005 | 1 | 2 | 1 | 60.41 | 1 |
| 109 | 2005 | 1 | 1 | 2 | 72.94 | 1 |
| 111 | 2005 | 1 | 2 | 2 | 25.85 | 1 |
| 205 | 2005 | 2 | 2 | 1 | 49.97 | 1 |
| 206 | 2005 | 2 | 1 | 2 | 54.49 | 1 |
| 208 | 2005 | 2 | 2 | 2 | 45.5 | 1 |
| 211 | 2005 | 2 | 1 | 1 | 94.78 | 1 |
| 301 | 2005 | 3 | 1 | 1 | 143.35 | 1 |
| 303 | 2005 | 3 | 2 | 2 | 32.39 | 1 |
| 306 | 2005 | 3 | 1 | 2 | 107.28 | 1 |
| 311 | 2005 | 3 | 2 | 1 | 50.8 | 1 |
| 404 | 2005 | 4 | 2 | 1 | 66.29 | 1 |
| 405 | 2005 | 4 | 2 | 2 | 45.53 | 1 |
| 407 | 2005 | 4 | 1 | 2 | 72.86 | 1 |
| 412 | 2005 | 4 | 1 | 1 | 62.52 | 1 |
| 501 | 2005 | 5 | 2 | 2 | 56.74 | 1 |
| 505 | 2005 | 5 | 1 | 2 | 77.14 | 1 |
| 509 | 2005 | 5 | 1 | 1 | 66.85 | 1 |
| 512 | 2005 | 5 | 2 | 1 | 31.54 | 1 |
| 602 | 2005 | 6 | 2 | 2 | 24.42 | 1 |
| 603 | 2005 | 6 | 1 | 1 | 44.27 | 1 |
| 605 | 2005 | 6 | 1 | 2 | 52.73 | 1 |
| 606 | 2005 | 6 | 2 | 1 | 48.05 | 1 |
| 102 | 2005 | 1 | 1 | 1 | 105.37 | 1 |
| 108 | 2005 | 1 | 2 | 1 | 76.18 | 1 |
| 109 | 2005 | 1 | 1 | 2 | 70.79 | 1 |
| 111 | 2005 | 1 | 2 | 2 | 22.96 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 205 | 2005 | 2 | 2 | 1 | 57.6 | 1 |
| 206 | 2005 | 2 | 1 | 2 | 76.12 | 1 |
| 208 | 2005 | 2 | 2 | 2 | 46.73 | 1 |
| 211 | 2005 | 2 | 1 | 1 | 57.38 | 1 |
| 301 | 2005 | 3 | 1 | 1 | 92.11 | 1 |
| 303 | 2005 | 3 | 2 | 2 | 38.26 | 1 |
| 306 | 2005 | 3 | 1 | 2 | 87.99 | 1 |
| 311 | 2005 | 3 | 2 | 1 | 62.47 | 1 |
| 404 | 2005 | 4 | 2 | 1 | 53.93 | 1 |
| 405 | 2005 | 4 | 2 | 2 | 55.34 | 1 |
| 407 | 2005 | 4 | 1 | 2 | 88.99 | 1 |
| 412 | 2005 | 4 | 1 | 1 | 70.37 | 1 |
| 501 | 2005 | 5 | 2 | 2 | 56.53 | 1 |
| 505 | 2005 | 5 | 1 | 2 | 62.23 | 1 |
| 509 | 2005 | 5 | 1 | 1 | 41.51 | 1 |
| 512 | 2005 | 5 | 2 | 1 | 48.27 | 1 |
| 602 | 2005 | 6 | 2 | 2 | . | 1 |
| 603 | 2005 | 6 | 1 | 1 | 69.89 | 1 |
| 605 | 2005 | 6 | 1 | 2 | 63.37 | 1 |
| 606 | 2005 | 6 | 2 | 1 | 42.95 | 1 |
| 102 | 2005 | 1 | 1 | 1 | 112.74 | 1 |
| 108 | 2005 | 1 | 2 | 1 | 57.54 | 1 |
| 109 | 2005 | 1 | 1 | 2 | 89.16 | 1 |
| 111 | 2005 | 1 | 2 | 2 | 55.01 | 1 |
| 205 | 2005 | 2 | 2 | 1 | 29.26 | 1 |
| 206 | 2005 | 2 | 1 | 2 | 77.59 | 1 |
| 208 | 2005 | 2 | 2 | 2 | 35.85 | 1 |
| 211 | 2005 | 2 | 1 | 1 | 71.71 | 1 |
| 301 | 2005 | 3 | 1 | 1 | 96.94 | 1 |
| 303 | 2005 | 3 | 2 | 2 | 42.13 | 1 |
| 306 | 2005 | 3 | 1 | 2 | 95.31 | 1 |
| 311 | 2005 | 3 | 2 | 1 | 59.52 | 1 |
| 404 | 2005 | 4 | 2 | 1 | 50.56 | 1 |
| 405 | 2005 | 4 | 2 | 2 | 67.11 | 1 |
| 407 | 2005 | 4 | 1 | 2 | 50.55 | 1 |
| 412 | 2005 | 4 | 1 | 1 | 69.7 | 1 |
| 501 | 2005 | 5 | 2 | 2 | 42.99 | 1 |
| 505 | 2005 | 5 | 1 | 2 | . | 1 |
| 509 | 2005 | 5 | 1 | 1 | 57.14 | 1 |
| 512 | 2005 | 5 | 2 | 1 | 42.73 | 1 |
| 602 | 2005 | 6 | 2 | 2 | 35.68 | 1 |
| 603 | 2005 | 6 | 1 | 1 | 80.13 | 1 |
| 605 | 2005 | 6 | 1 | 2 | 94.61 | 1 |
| 606 | 2005 | 6 | 2 | 1 | 65.21 | 1 |
| 102 | 2005 | 1 | 1 | 1 | 89.89 | 1 |
| 108 | 2005 | 1 | 2 | 1 | 68.61 | 1 |
| 109 | 2005 | 1 | 1 | 2 | . | 1 |
| 111 | 2005 | 1 | 2 | 2 | 24.57 | 1 |
| 205 | 2005 | 2 | 2 | 1 | 61.65 | 1 |
| 206 | 2005 | 2 | 1 | 2 | 120.66 | 1 |
| 208 | 2005 | 2 | 2 | 2 | 49.04 | 1 |
| 211 | 2005 | 2 | 1 | 1 | 56.23 | 1 |
| 301 | 2005 | 3 | 1 | 1 | 126.29 | 1 |
| 303 | 2005 | 3 | 2 | 2 | 34.06 | 1 |
| 306 | 2005 | 3 | 1 | 2 | 77.34 | 1 |
| 311 | 2005 | 3 | 2 | 1 | 49.8 | 1 |
| 404 | 2005 | 4 | 2 | 1 | 35.34 | 1 |
| 405 | 2005 | 4 | 2 | 2 | 51.23 | 1 |
| 407 | 2005 | 4 | 1 | 2 | 53.29 | 1 |
| 412 | 2005 | 4 | 1 | 1 | 73.65 | 1 |
| 501 | 2005 | 5 | 2 | 2 | 52.25 | 1 |
| 505 | 2005 | 5 | 1 | 2 | 70.38 | 1 |
| 509 | 2005 | 5 | 1 | 1 | 47.63 | 1 |
| 512 | 2005 | 5 | 2 | 1 | 42.48 | 1 |
| 602 | 2005 | 6 | 2 | 2 | 37.51 | 1 |
| 603 | 2005 | 6 | 1 | 1 | 45.96 | 1 |
| 605 | 2005 | 6 | 1 | 2 | 77.61 | 1 |
| 606 | 2005 | 6 | 2 | 1 | 24.52 | 1 |
| 102 | 2005 | 1 | 1 | 1 | 128.99 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 108 | 2005 | 1 | 2 | 1 | 140.95 | 2 |
| 109 | 2005 | 1 | 1 | 2 | 81.94 | 2 |
| 111 | 2005 | 1 | 2 | 2 | 128.99 | 2 |
| 205 | 2005 | 2 | 2 | 1 | 152.7 | 2 |
| 206 | 2005 | 2 | 1 | 2 | 114.62 | 2 |
| 208 | 2005 | 2 | 2 | 2 | 121.92 | 2 |
| 211 | 2005 | 2 | 1 | 1 | 144.21 | 2 |
| 301 | 2005 | 3 | 1 | 1 | 118.35 | 2 |
| 303 | 2005 | 3 | 2 | 2 | 184.5 | 2 |
| 306 | 2005 | 3 | 1 | 2 | 157.82 | 2 |
| 311 | 2005 | 3 | 2 | 1 | 83.58 | 2 |
| 404 | 2005 | 4 | 2 | 1 | 128.24 | 2 |
| 405 | 2005 | 4 | 2 | 2 | 132.99 | 2 |
| 407 | 2005 | 4 | 1 | 2 | 179.88 | 2 |
| 412 | 2005 | 4 | 1 | 1 | 68.01 | 2 |
| 501 | 2005 | 5 | 2 | 2 | 117.9 | 2 |
| 505 | 2005 | 5 | 1 | 2 | 157.31 | 2 |
| 509 | 2005 | 5 | 1 | 1 | 90.85 | 2 |
| 512 | 2005 | 5 | 2 | 1 | 114.56 | 2 |
| 602 | 2005 | 6 | 2 | 2 | 102.37 | 2 |
| 603 | 2005 | 6 | 1 | 1 | 122.1 | 2 |
| 605 | 2005 | 6 | 1 | 2 | 107.51 | 2 |
| 606 | 2005 | 6 | 2 | 1 | 95.79 | 2 |
| 102 | 2005 | 1 | 1 | 1 | 160.55 | 2 |
| 108 | 2005 | 1 | 2 | 1 | 98.59 | 2 |
| 109 | 2005 | 1 | 1 | 2 | 129.25 | 2 |
| 111 | 2005 | 1 | 2 | 2 | 95.55 | 2 |
| 205 | 2005 | 2 | 2 | 1 | 129.26 | 2 |
| 206 | 2005 | 2 | 1 | 2 | 142.15 | 2 |
| 208 | 2005 | 2 | 2 | 2 | 133.35 | 2 |
| 211 | 2005 | 2 | 1 | 1 | 96.95 | 2 |
| 301 | 2005 | 3 | 1 | 1 | 117.61 | 2 |
| 303 | 2005 | 3 | 2 | 2 | 146.51 | 2 |
| 306 | 2005 | 3 | 1 | 2 | 118.7 | 2 |
| 311 | 2005 | 3 | 2 | 1 | 106.98 | 2 |
| 404 | 2005 | 4 | 2 | 1 | 100.93 | 2 |
| 405 | 2005 | 4 | 2 | 2 | 137.46 | 2 |
| 407 | 2005 | 4 | 1 | 2 | 132.25 | 2 |
| 412 | 2005 | 4 | 1 | 1 | 145.2 | 2 |
| 501 | 2005 | 5 | 2 | 2 | 132.9 | 2 |
| 505 | 2005 | 5 | 1 | 2 | 100.8 | 2 |
| 509 | 2005 | 5 | 1 | 1 | 164.89 | 2 |
| 512 | 2005 | 5 | 2 | 1 | 121.31 | 2 |
| 602 | 2005 | 6 | 2 | 2 | 134.98 | 2 |
| 603 | 2005 | 6 | 1 | 1 | 139.91 | 2 |
| 605 | 2005 | 6 | 1 | 2 | 99.08 | 2 |
| 606 | 2005 | 6 | 2 | 1 | 87.64 | 2 |
| 102 | 2005 | 1 | 1 | 1 | 170.68 | 2 |
| 108 | 2005 | 1 | 2 | 1 | 110.55 | 2 |
| 109 | 2005 | 1 | 1 | 2 | 100.34 | 2 |
| 111 | 2005 | 1 | 2 | 2 | 117.89 | 2 |
| 205 | 2005 | 2 | 2 | 1 | 154.01 | 2 |
| 206 | 2005 | 2 | 1 | 2 | 66.81 | 2 |
| 208 | 2005 | 2 | 2 | 2 | 92.3 | 2 |
| 211 | 2005 | 2 | 1 | 1 | 112.91 | 2 |
| 301 | 2005 | 3 | 1 | 1 | 123.53 | 2 |
| 303 | 2005 | 3 | 2 | 2 | 123.42 | 2 |
| 306 | 2005 | 3 | 1 | 2 | 160.47 | 2 |
| 311 | 2005 | 3 | 2 | 1 | 153.44 | 2 |
| 404 | 2005 | 4 | 2 | 1 | 141.84 | 2 |
| 405 | 2005 | 4 | 2 | 2 | 137.07 | 2 |
| 407 | 2005 | 4 | 1 | 2 | 115.44 | 2 |
| 412 | 2005 | 4 | 1 | 1 | 138.07 | 2 |
| 501 | 2005 | 5 | 2 | 2 | 115.2 | 2 |
| 505 | 2005 | 5 | 1 | 2 | 142.12 | 2 |
| 509 | 2005 | 5 | 1 | 1 | 125.14 | 2 |
| 512 | 2005 | 5 | 2 | 1 | 100.63 | 2 |
| 602 | 2005 | 6 | 2 | 2 | 80.96 | 2 |
| 603 | 2005 | 6 | 1 | 1 | 149.8 | 2 |

```
605     2005    6       1       2       107.26  2
606     2005    6       2       1       145.44  2
102     2005    1       1       1       154.64  2
108     2005    1       2       1       147.79  2
109     2005    1       1       2       111.18  2
111     2005    1       2       2       135.61  2
205     2005    2       2       1       113.54  2
206     2005    2       1       2       142.43  2
208     2005    2       2       2       80.81   2
211     2005    2       1       1       94.17   2
301     2005    3       1       1       166.23  2
303     2005    3       2       2       139.82  2
306     2005    3       1       2       132.81  2
311     2005    3       2       1       132.8   2
404     2005    4       2       1       133.35  2
405     2005    4       2       2       158.35  2
407     2005    4       1       2       83.11   2
412     2005    4       1       1       121.6   2
501     2005    5       2       2       79.71   2
505     2005    5       1       2       118.85  2
509     2005    5       1       1       73.06   2
512     2005    5       2       1       196.9   2
602     2005    6       2       2       126.46  2
603     2005    6       1       1       110.3   2
605     2005    6       1       2       .       2
606     2005    6       2       1       137.27  2
102     2005    1       1       1       130.22  2
108     2005    1       2       1       145     2
109     2005    1       1       2       116.44  2
111     2005    1       2       2       182.34  2
205     2005    2       2       1       152.72  2
206     2005    2       1       2       86.78   2
208     2005    2       2       2       77.12   2
211     2005    2       1       1       68.65   2
301     2005    3       1       1       131.3   2
303     2005    3       2       2       141.71  2
306     2005    3       1       2       138.24  2
311     2005    3       2       1       124.51  2
404     2005    4       2       1       67.5    2
405     2005    4       2       2       154.62  2
407     2005    4       1       2       54.05   2
412     2005    4       1       1       70.58   2
501     2005    5       2       2       128.74  2
505     2005    5       1       2       158.05  2
509     2005    5       1       1       95.08   2
512     2005    5       2       1       85.19   2
602     2005    6       2       2       90.72   2
603     2005    6       1       1       106.7   2
605     2005    6       1       2       60.9    2
606     2005    6       2       1       66.11   2

;
%include'c:\danda.sas';
%mmaov(NKSol,totalnonstructural,Class=Year Rep Variety K Date, fixed=Year |Variety |K |Date,
   random = Rep(Year) Variety*K*Rep(Year) Variety*Date*K*rep(year),DDFM=CONTAIN);
```

N&K Total Soluble Sugars

SAS Output                    The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.NKSOL |
| Dependent Variable | TotalNonstructural |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| year | 3 | 2003 2004 2005 |
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 1 2 |
| Date | 2 | 1 2 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 4 |
| Columns in X | 108 |
| Columns in Z | 234 |
| Subjects | 1 |
| Max Obs Per Subject | 720 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 720 |
| Number of Observations Used | 692 |
| Number of Observations Not Used | 28 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 6416.99383457 | |
| 1 | 3 | 6384.15816765 | 0.00000313 |
| 2 | 1 | 6384.14994092 | 0.00000000 |

Convergence criteria met.

Mixed ANOVA for totalnonstructural

The Mixed Procedure

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(year) | 30.1593 | 22.4841 | 1.34 | 0.0899 |
| Rep*Variety*K(year) | 0 | . | . | . |
| Rep*Var*K*Date(year) | 109.31 | 34.6815 | 3.15 | 0.0008 |
| Residual | 650.06 | 39.2263 | 16.57 | <.0001 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 6384.1 |
| AIC (smaller is better) | 6390.1 |
| AICC (smaller is better) | 6390.2 |
| BIC (smaller is better) | 6392.8 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| year | 2 | 15 | 24.55 | <.0001 |

| | | | | |
|---|---|---|---|---|
| Variety | 1 | 45 | 27.21 | <.0001 |
| year*Variety | 2 | 45 | 2.75 | 0.0749 |
| K | 1 | 45 | 0.97 | 0.3308 |
| year*K | 2 | 45 | 0.05 | 0.9560 |
| Variety*K | 1 | 45 | 0.00 | 0.9458 |
| year*Variety*K | 2 | 45 | 0.11 | 0.8925 |
| Date | 1 | 60 | 52.16 | <.0001 |
| year*Date | 2 | 60 | 185.61 | <.0001 |
| Variety*Date | 1 | 60 | 30.38 | <.0001 |
| year*Variety*Date | 2 | 60 | 0.54 | 0.5856 |
| K*Date | 1 | 60 | 3.84 | 0.0546 |
| year*K*Date | 2 | 60 | 0.23 | 0.7981 |
| Variety*K*Date | 1 | 60 | 0.71 | 0.4014 |
| year*Variety*K*Date | 2 | 60 | 0.11 | 0.8921 |

Mean separation for total nonstructural

---------------------------- Effect=year Method=LSD(P<.05) Set=1 -----------------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | _ | 116.98 | 3.1793 | A |
| 2 | 2004 | _ | _ | _ | 121.48 | 3.2032 | A |
| 3 | 2005 | _ | _ | _ | 92.2099 | 3.1724 | B |

-------------------------- Effect=Variety Method=LSD(P<.05) Set=2 ----------------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | _ | 117.03 | 2.2478 | A |
| 5 | _ | 2 | _ | _ | 103.41 | 2.2630 | B |

------------------------ Effect=year*Variety Method=LSD(P<.05) Set=3 -------------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | _ | 127.77 | 3.8862 | A |
| 7 | 2003 | 2 | _ | _ | 106.18 | 3.9084 | B |
| 8 | 2004 | 1 | _ | _ | 124.81 | 3.9009 | A |
| 9 | 2004 | 2 | _ | _ | 118.15 | 3.9708 | A |
| 10 | 2005 | 1 | _ | _ | 98.5196 | 3.8927 | B |
| 11 | 2005 | 2 | _ | _ | 85.9002 | 3.8794 | C |

------------------------------ Effect=K Method=LSD(P<.05) Set=4 -------------------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 12 | _ | _ | 1 | _ | 111.50 | 2.2504 | A |
| 13 | _ | _ | 2 | _ | 108.94 | 2.2604 | A |

---------------------------- Effect=year*K Method=LSD(P<.05) Set=5 ----------------------------

Standard Letter

| Obs | year | Variety | K | Date | Estimate | Error | Group |
|---|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 1 | _ | 117.90 | 3.8933 | A |
| 15 | 2003 | _ | 2 | _ | 116.05 | 3.9012 | A |
| 16 | 2004 | _ | 1 | _ | 122.58 | 3.9270 | A |
| 17 | 2004 | _ | 2 | _ | 120.37 | 3.9445 | A |
| 18 | 2005 | _ | 1 | _ | 94.0346 | 3.8728 | B |
| 19 | 2005 | _ | 2 | _ | 90.3852 | 3.8993 | B |

Mean separation for totalnonstructural

------------------------- Effect=Variety*K Method=LSD(P<.05) Set=6 -----------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 20 | _ | 1 | 1 | _ | 118.23 | 2.8890 | A |
| 21 | _ | 1 | 2 | _ | 115.84 | 2.9177 | A |
| 22 | _ | 2 | 1 | _ | 104.78 | 2.9257 | B |
| 23 | _ | 2 | 2 | _ | 102.04 | 2.9279 | B |

------------------------ Effect=year*Variety*K Method=LSD(P<.05) Set=7 --------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 1 | _ | 128.99 | 4.9970 | A |
| 25 | 2003 | 1 | 2 | _ | 126.56 | 5.0385 | A |
| 26 | 2003 | 2 | 1 | _ | 106.80 | 5.0603 | BCD |
| 27 | 2003 | 2 | 2 | _ | 105.55 | 5.0438 | CD |
| 28 | 2004 | 1 | 1 | _ | 124.94 | 5.0174 | A |
| 29 | 2004 | 1 | 2 | _ | 124.68 | 5.0639 | A |
| 30 | 2004 | 2 | 1 | _ | 120.23 | 5.1439 | AB |
| 31 | 2004 | 2 | 2 | _ | 116.07 | 5.1515 | ABC |
| 32 | 2005 | 1 | 1 | _ | 100.75 | 4.9970 | D |
| 33 | 2005 | 1 | 2 | _ | 96.2853 | 5.0586 | DE |
| 34 | 2005 | 2 | 1 | _ | 87.3153 | 4.9970 | E |
| 35 | 2005 | 2 | 2 | _ | 84.4851 | 5.0174 | E |

---------------------------- Effect=Date Method=LSD(P<.05) Set=8 -------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 36 | _ | _ | _ | 1 | 100.79 | 2.2575 | B |
| 37 | _ | _ | _ | 2 | 119.65 | 2.2532 | A |

------------------------- Effect=year*Date Method=LSD(P<.05) Set=9 -----------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 38 | 2003 | _ | _ | 1 | 142.96 | 3.8879 | A |
| 39 | 2003 | _ | _ | 2 | 90.9878 | 3.9066 | C |
| 40 | 2004 | _ | _ | 1 | 96.3451 | 3.9492 | C |
| 41 | 2004 | _ | _ | 2 | 146.61 | 3.9220 | A |
| 42 | 2005 | _ | _ | 1 | 63.0631 | 3.8927 | D |
| 43 | 2005 | _ | _ | 2 | 121.36 | 3.8794 | B |

Mean separation for totalnonstructural

------------------------ Effect=Variety*Date Method=LSD(P<.05) Set=10 ---------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 44 | _ | 1 | _ | 1 | 114.80 | 2.9009 | A |
| 45 | _ | 1 | _ | 2 | 119.27 | 2.9059 | A |
| 46 | _ | 2 | _ | 1 | 86.7793 | 2.9359 | B |
| 47 | _ | 2 | _ | 2 | 120.04 | 2.9175 | A |

---------------------- Effect=year*Variety*Date Method=LSD(P<.05) Set=11 ------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 48 | 2003 | 1 | _ | 1 | 159.05 | 4.9970 | A |
| 49 | 2003 | 1 | _ | 2 | 96.4929 | 5.0385 | EF |
| 50 | 2003 | 2 | _ | 1 | 126.87 | 5.0438 | C |
| 51 | 2003 | 2 | _ | 2 | 85.4827 | 5.0603 | FG |
| 52 | 2004 | 1 | _ | 1 | 107.67 | 5.0377 | DE |
| 53 | 2004 | 1 | _ | 2 | 141.95 | 5.0438 | B |
| 54 | 2004 | 2 | _ | 1 | 85.0225 | 5.1924 | FG |
| 55 | 2004 | 2 | _ | 2 | 151.27 | 5.1016 | AB |
| 56 | 2005 | 1 | _ | 1 | 77.6822 | 5.0385 | G |
| 57 | 2005 | 1 | _ | 2 | 119.36 | 5.0174 | CD |
| 58 | 2005 | 2 | _ | 1 | 48.4439 | 5.0174 | H |
| 59 | 2005 | 2 | _ | 2 | 123.36 | 4.9970 | C |

-------------------------- Effect=K*Date Method=LSD(P<.05) Set=12 ------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 60 | _ | _ | 1 | 1 | 104.63 | 2.9093 | B |
| 61 | _ | _ | 1 | 2 | 118.38 | 2.9052 | A |
| 62 | _ | _ | 2 | 1 | 96.9462 | 2.9274 | C |
| 63 | _ | _ | 2 | 2 | 120.93 | 2.9182 | A |

------------------------ Effect=year*K*Date Method=LSD(P<.05) Set=13 ---------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 64 | 2003 | _ | 1 | 1 | 147.29 | 4.9970 | A |
| 65 | 2003 | _ | 1 | 2 | 88.4995 | 5.0603 | C |
| 66 | 2003 | _ | 2 | 1 | 138.63 | 5.0438 | A |
| 67 | 2003 | _ | 2 | 2 | 93.4761 | 5.0385 | C |
| 68 | 2004 | _ | 1 | 1 | 100.37 | 5.1222 | C |
| 69 | 2004 | _ | 1 | 2 | 144.80 | 5.0385 | A |

Mean separation for totalnonstructural

------------------------- Effect=year*K*Date Method=LSD(P<.05) Set=13 -------------------------

(continued)

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 70 | 2004 | _ | 2 | 1 | 92.3250 | 5.1084 | C |
| 71 | 2004 | _ | 2 | 2 | 148.42 | 5.1069 | A |
| 72 | 2005 | _ | 1 | 1 | 66.2458 | 4.9970 | D |
| 73 | 2005 | _ | 1 | 2 | 121.82 | 4.9970 | B |
| 74 | 2005 | _ | 2 | 1 | 59.8803 | 5.0586 | D |
| 75 | 2005 | _ | 2 | 2 | 120.89 | 5.0174 | B |

---------------------- Effect=Variety*K*Date Method=LSD(P<.05) Set=14 ------------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 76 | _ | 1 | 1 | 1 | 117.45 | 3.8810 | A |
| 77 | _ | 1 | 1 | 2 | 119.00 | 3.8693 | A |
| 78 | _ | 1 | 2 | 1 | 112.15 | 3.9047 | A |
| 79 | _ | 1 | 2 | 2 | 119.53 | 3.9314 | A |
| 80 | _ | 2 | 1 | 1 | 91.8165 | 3.9300 | B |
| 81 | _ | 2 | 1 | 2 | 117.75 | 3.9293 | A |
| 82 | _ | 2 | 2 | 1 | 81.7421 | 3.9599 | B |
| 83 | _ | 2 | 2 | 2 | 122.33 | 3.9057 | A |

-------------------- Effect=year*Variety*K*Date Method=LSD(P<.05) Set=15 ---------------------

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 84 | 2003 | 1 | 1 | 1 | 163.35 | 6.7018 | A |
| 85 | 2003 | 1 | 1 | 2 | 94.6333 | 6.7018 | IJKL |
| 86 | 2003 | 1 | 2 | 1 | 154.76 | 6.7018 | AB |
| 87 | 2003 | 1 | 2 | 2 | 98.3526 | 6.8249 | HIJK |
| 88 | 2003 | 2 | 1 | 1 | 131.24 | 6.7018 | CDEF |
| 89 | 2003 | 2 | 1 | 2 | 82.3658 | 6.8892 | KLM |
| 90 | 2003 | 2 | 2 | 1 | 122.51 | 6.8404 | EFG |
| 91 | 2003 | 2 | 2 | 2 | 88.5997 | 6.7018 | JKLM |
| 92 | 2004 | 1 | 1 | 1 | 108.85 | 6.7624 | GHI |
| 93 | 2004 | 1 | 1 | 2 | 141.04 | 6.7018 | BCDE |
| 94 | 2004 | 1 | 2 | 1 | 106.49 | 6.7624 | GHIJ |
| 95 | 2004 | 1 | 2 | 2 | 142.86 | 6.8405 | BCD |
| 96 | 2004 | 2 | 1 | 1 | 91.8848 | 7.0126 | IJKLM |
| 97 | 2004 | 2 | 1 | 2 | 148.57 | 6.8249 | ABC |
| 98 | 2004 | 2 | 2 | 1 | 78.1602 | 6.9720 | LM |
| 99 | 2004 | 2 | 2 | 2 | 153.98 | 6.8892 | AB |
| 100 | 2005 | 1 | 1 | 1 | 80.1650 | 6.7018 | KLM |
| 101 | 2005 | 1 | 1 | 2 | 121.34 | 6.7018 | FG |

Mean separation for totalnonstructural

--------------------- Effect=year*Variety*K*Date   Method=LSD(P<.05)   Set=15 ---------------------

(continued)

| Obs | year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 102 | 2005 | 1 | 2 | 1 | 75.1994 | 6.8248 | M |
| 103 | 2005 | 1 | 2 | 2 | 117.37 | 6.7624 | FGH |
| 104 | 2005 | 2 | 1 | 1 | 52.3267 | 6.7018 | N |
| 105 | 2005 | 2 | 1 | 2 | 122.30 | 6.7018 | EFG |
| 106 | 2005 | 2 | 2 | 1 | 44.5611 | 6.7624 | N |
| 107 | 2005 | 2 | 2 | 2 | 124.41 | 6.7018 | DEFG |

Check on normality for totalnonstructural

The UNIVARIATE Procedure
Variable: Resid (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.996324 | Pr < W | 0.1086 |
| Kolmogorov-Smirnov | D | 0.041533 | Pr > D | <0.0100 |
| Cramer-von Mises | W-Sq | 0.180735 | Pr > W-Sq | 0.0094 |
| Anderson-Darling | A-Sq | 0.92103 | Pr > A-Sq | 0.0205 |

Extreme Observations

| ------Lowest----- | | -----Highest----- | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -95.0397 | 40 | 63.2001 | 121 |
| -65.3603 | 215 | 63.6695 | 221 |
| -64.1970 | 370 | 64.1132 | 395 |
| -61.2668 | 711 | 64.5632 | 615 |
| -60.2124 | 404 | 75.4302 | 692 |

Missing Values

| Missing Value | Count | -----Percent Of----- All Obs | Missing Obs |
|---|---|---|---|
| . | 28 | 3.89 | 100.00 |

```
                      Histogram                       #
Boxplot
        70+**                                         6             0
          .*******                                   34             |
          .********************                      97             |
          .***************************************  195          +--+--
+
       -10+************************************************  236          *-----
*
          .******************                        87             |
          .*******                                   32             |
          .*                                          4             0
       -90+*                                          1             0
           ----+----+----+----+----+----+----+----+---
           * may represent up to 5 counts
```

Check on normality for  totalnonstructural

The UNIVARIATE Procedure
Variable:  Resid  (Residual)

```
                       Normal Probability Plot
  70+                                                 **
    |                                         ********++
    |                                  ********
    |                             +********
 -10+                    **********
    |             ********
    |+*********
    |*
 -90+*
     +----+----+----+----+----+----+----+----+----+----+
         -2        -1         0        +1        +2
```

Check equality of stddev for y= totalnonstructural

| Obs | year | Variety | K | Date | nobs | rawmean_ y | stddev_y | stderr_y | LeveneF_df | Levene P |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 1 | 1 | 30 | 163.349 | 33.7165 | 6.15575 | 3.938(23,668) | 0.0000 |
| 2 | 2003 | 1 | 1 | 2 | 30 | 94.633 | 33.1988 | 6.06124 | | |
| 3 | 2003 | 1 | 2 | 1 | 30 | 154.761 | 27.7839 | 5.07262 | | . |
| 4 | 2003 | 1 | 2 | 2 | 28 | 98.369 | 30.0125 | 5.67183 | | . |
| 5 | 2003 | 2 | 1 | 1 | 30 | 131.238 | 27.9901 | 5.11027 | | . |
| 6 | 2003 | 2 | 1 | 2 | 27 | 83.065 | 28.2934 | 5.44507 | | . |
| 7 | 2003 | 2 | 2 | 1 | 28 | 122.933 | 32.8159 | 6.20162 | | . |
| 8 | 2003 | 2 | 2 | 2 | 30 | 88.600 | 17.5564 | 3.20534 | | . |
| 9 | 2004 | 1 | 1 | 1 | 29 | 108.790 | 20.2570 | 3.76163 | | . |
| 10 | 2004 | 1 | 1 | 2 | 30 | 141.035 | 42.9570 | 7.84284 | | . |
| 11 | 2004 | 1 | 2 | 1 | 29 | 106.367 | 20.8421 | 3.87029 | | . |
| 12 | 2004 | 1 | 2 | 2 | 28 | 142.950 | 33.8014 | 6.38786 | | . |
| 13 | 2004 | 2 | 1 | 1 | 26 | 92.545 | 20.4113 | 4.00298 | | . |
| 14 | 2004 | 2 | 1 | 2 | 28 | 148.220 | 26.3322 | 4.97631 | | . |
| 15 | 2004 | 2 | 2 | 1 | 26 | 78.224 | 19.3414 | 3.79315 | | . |
| 16 | 2004 | 2 | 2 | 2 | 27 | 153.245 | 36.5183 | 7.02795 | | . |
| 17 | 2005 | 1 | 1 | 1 | 30 | 80.165 | 26.7318 | 4.88053 | | . |
| 18 | 2005 | 1 | 1 | 2 | 30 | 121.343 | 29.7613 | 5.43364 | | . |
| . 19 | 2005 | 1 | 2 | 1 | 28 | 75.347 | 18.2786 | 3.45434 | | . |
| 20 | 2005 | 1 | 2 | 2 | 29 | 117.813 | 31.5148 | 5.85215 | | . |
| 21 | 2005 | 2 | 1 | 1 | 30 | 52.327 | 13.0643 | 2.38520 | | . |
| 22 | 2005 | 2 | 1 | 2 | 30 | 122.304 | 29.5394 | 5.39314 | | . |
| 23 | 2005 | 2 | 2 | 1 | 29 | 44.820 | 12.7929 | 2.37559 | | . |
| 24 | 2005 | 2 | 2 | 2 | 30 | 124.409 | 27.9029 | 5.09436 | | |

N&K Soluble Sugar-
Glucose, Fructose and Sucrose and the sum of all three
SAS Input

**Variety 1= PM1218**
**2= DP555**
**K 1= 60lbs $K_2O$/acre/yr**
**2= 120lbs $K_2O$/acre/yr**
**Date 1= Early Bloom**
**2= Cutout**

**- all sugars are in mg/g dry weight**

```
Data NKSol;
Input plot Rep Variety K Glu Fruc Suc Total  Date Year;
Cards;

102     1       1       1       5.00    2.24    28.12   35.37   1       2003
108     2       2       1       10.69   4.24    65.17   80.10   1       2003
109     2       1       2       3.84    4.11    38.69   46.65   1       2003
111     2       2       2       7.55    3.81    53.12   64.48   1       2003
205     1       2       1       6.81    0.64    36.86   44.31   1       2003
206     1       1       2       4.30    0.94    39.07   44.31   1       2003
208     4       2       2       7.44    3.20    53.12   63.76   1       2003
211     2       1       1       8.59    5.59    49.01   63.20   1       2003
301     3       1       1       3.25    2.16    26.40   31.81   1       2003
303     1       2       2       4.24    1.85    38.76   44.85   1       2003
306     3       1       2       2.01    1.46    35.65   39.12   1       2003
311     4       2       1       11.54   5.98    69.32   86.83   1       2003
404     3       2       1       6.05    1.20    39.59   46.84   1       2003
405     3       2       2       5.37    2.38    57.34   65.08   1       2003
407     4       1       2       2.85    2.51    31.34   36.70   1       2003
412     4       1       1       1.86    2.42    26.47   30.75   1       2003
501     5       2       2       5.91    3.50    46.80   56.22   1       2003
505     5       1       2       5.96    7.33    40.21   53.50   1       2003
509     5       1       1       5.91    7.46    43.14   56.51   1       2003
512     5       2       1       5.43    6.81    23.74   35.97   1       2003
602     6       2       2       5.68    1.68    46.22   53.58   1       2003
603     6       1       1       4.86    1.07    38.28   44.21   1       2003
605     6       1       2       5.06    1.72    55.33   62.12   1       2003
606     6       2       1       13.68   6.94    68.21   88.83   1       2003
102     1       1       1       6.02    1.46    31.44   38.92   1       2003
108     2       2       1       5.40    2.46    47.70   55.56   1       2003
109     2       1       2       4.98    2.38    46.11   53.46   1       2003
111     2       2       2       8.17    6.15    59.72   74.04   1       2003
205     1       2       1       9.56    3.64    39.93   53.12   1       2003
206     1       1       2       2.74    1.33    37.97   42.04   1       2003
208     4       2       2       4.61    1.64    45.56   51.81   1       2003
211     2       1       1       5.06    5.76    17.35   28.18   1       2003
301     3       1       1       3.82    2.68    29.75   36.24   1       2003
303     1       2       2       5.26    2.24    44.39   51.89   1       2003
306     3       1       2       3.02    2.07    33.75   38.85   1       2003
311     4       2       1       6.19    3.11    54.71   64.02   1       2003
404     3       2       1       6.47    2.38    45.73   54.58   1       2003
405     3       2       2       6.73    1.94    47.63   56.30   1       2003
407     4       1       2       2.80    1.12    36.38   40.29   1       2003
412     4       1       1       3.84    4.68    33.96   42.48   1       2003
501     5       2       2       8.34    1.81    55.95   66.11   1       2003
505     5       1       2       3.73    4.16    38.45   46.34   1       2003
509     5       1       1       5.29    3.42    37.03   45.74   1       2003
512     5       2       1       6.87    4.03    39.66   50.55   1       2003
602     6       2       2       5.51     .      38.79    .      1       2003
603     6       1       1       6.39    6.46    43.77   56.61   1       2003
605     6       1       2       6.22    1.72    49.50   57.44   1       2003
606     6       2       1       8.76    4.42    58.72   71.90   1       2003
102     1       1       1       4.69    0.38    25.26   30.33   1       2003
108     2       2       1       4.89    0.46    35.48   40.83   1       2003
109     2       1       2       3.39    1.25    31.16   35.80   1       2003
111     2       2       2       5.65    1.85    36.03   43.54   1       2003
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 205 | 1 | 2 | 1 | 3.90 | 0.81 | 22.60 | 27.31 | 1 | 2003 |
| 206 | 1 | 1 | 2 | 3.17 | 1.33 | 28.47 | 32.97 | 1 | 2003 |
| 208 | 4 | 2 | 2 | 6.95 | 3.37 | 51.12 | 61.45 | 1 | 2003 |
| 211 | 2 | 1 | 1 | 5.14 | 4.46 | 34.72 | 44.33 | 1 | 2003 |
| 301 | 3 | 1 | 1 | 5.17 | 4.72 | 33.75 | 43.65 | 1 | 2003 |
| 303 | 1 | 2 | 2 | 4.52 | 3.20 | 36.83 | 44.55 | 1 | 2003 |
| 306 | 3 | 1 | 2 | 3.11 | 1.46 | 35.76 | 40.33 | 1 | 2003 |
| 311 | 4 | 2 | 1 | 6.36 | 2.64 | 46.05 | 55.04 | 1 | 2003 |
| 404 | 3 | 2 | 1 | 4.27 | 3.68 | 31.96 | 39.90 | 1 | 2003 |
| 405 | 3 | 2 | 2 | 4.49 | 1.94 | 34.44 | 40.88 | 1 | 2003 |
| 407 | 4 | 1 | 2 | 3.70 | 2.98 | 41.80 | 48.48 | 1 | 2003 |
| 412 | 4 | 1 | 1 | 4.81 | 5.68 | 33.03 | 43.51 | 1 | 2003 |
| 501 | 5 | 2 | 2 | 4.58 | 2.77 | 45.42 | 52.77 | 1 | 2003 |
| 505 | 5 | 1 | 2 | 4.86 | 5.03 | 35.24 | 45.13 | 1 | 2003 |
| 509 | 5 | 1 | 1 | 6.22 | 5.11 | 39.59 | 50.92 | 1 | 2003 |
| 512 | 5 | 2 | 1 | 6.56 | 5.85 | 35.10 | 47.51 | 1 | 2003 |
| 602 | 6 | 2 | 2 | 5.20 | 3.59 | 43.56 | 52.35 | 1 | 2003 |
| 603 | 6 | 1 | 1 | 6.22 | 4.94 | 44.59 | 55.75 | 1 | 2003 |
| 605 | 6 | 1 | 2 | 6.13 | 4.42 | 49.33 | 59.88 | 1 | 2003 |
| 606 | 6 | 2 | 1 | 10.18 | 6.50 | 56.65 | 73.33 | 1 | 2003 |
| 102 | 1 | 1 | 1 | 4.35 | 0.77 | 23.26 | 28.38 | 1 | 2003 |
| 108 | 2 | 2 | 1 | 4.47 | 2.68 | 32.75 | 39.90 | 1 | 2003 |
| 109 | 2 | 1 | 2 | 1.33 | 0.25 | 12.45 | 14.02 | 1 | 2003 |
| 111 | 2 | 2 | 2 | 4.49 | 1.12 | 32.89 | 38.50 | 1 | 2003 |
| 205 | 1 | 2 | 1 | 2.23 | 1.94 | 16.28 | 20.45 | 1 | 2003 |
| 206 | 1 | 1 | 2 | 2.46 | 0.33 | 29.13 | 31.92 | 1 | 2003 |
| 208 | 4 | 2 | 2 | 8.17 | 2.24 | 55.54 | 65.96 | 1 | 2003 |
| 211 | 2 | 1 | 1 | 6.87 | 4.11 | 40.97 | 51.95 | 1 | 2003 |
| 301 | 3 | 1 | 1 | 3.93 | 3.94 | 27.85 | 35.72 | 1 | 2003 |
| 303 | 1 | 2 | 2 | 4.13 | 2.20 | 34.72 | 41.05 | 1 | 2003 |
| 306 | 3 | 1 | 2 | 4.49 | 2.77 | 40.52 | 47.78 | 1 | 2003 |
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| 111 | 2 | 2 | 2 | 4.83 | 4.20 | 39.35 | 48.38 | 2 | 2003 |
| 205 | 1 | 2 | 1 | 9.53 | 12.80 | 48.50 | 70.83 | 2 | 2003 |
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| 208 | 4 | 2 | 2 | 6.45 | 5.98 | 38.79 | 51.22 | 2 | 2003 |
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| 412 | 4 | 1 | 1 | 6.16 | 8.67 | 36.83 | 51.66 | 2 | 2003 |
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| 509 | 5 | 1 | 1 | 7.72 | 10.41 | 39.14 | 57.27 | 2 | 2003 |
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| 102 | 1 | 1 | 1 | 5.17 | 6.78 | 45.01 | 56.97 | 2 | 2005 |
| 108 | 1 | 2 | 1 | 6.74 | 8.64 | 40.23 | 55.61 | 2 | 2005 |
| 109 | 1 | 1 | 2 | 3.12 | 6.54 | 31.47 | 41.13 | 2 | 2005 |
| 111 | 1 | 2 | 2 | 6.87 | 8.18 | 42.87 | 57.93 | 2 | 2005 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 205 | 2 | 2 | 1 | 6.71 | 7.32 | 43.08 | 57.11 | 2 | 2005 |
| 206 | 2 | 1 | 2 | 4.48 | 10.40 | 47.24 | 62.12 | 2 | 2005 |
| 208 | 2 | 2 | 2 | 5.68 | 6.13 | 37.89 | 49.69 | 2 | 2005 |
| 211 | 2 | 1 | 1 | 6.15 | 8.27 | 45.89 | 60.31 | 2 | 2005 |
| 301 | 3 | 1 | 1 | 8.20 | 10.53 | 53.83 | 72.56 | 2 | 2005 |
| 303 | 3 | 2 | 2 | 10.49 | 13.86 | 60.92 | 85.28 | 2 | 2005 |
| 306 | 3 | 1 | 2 | 4.64 | 7.61 | 42.23 | 54.47 | 2 | 2005 |
| 311 | 3 | 2 | 1 | 2.38 | 4.81 | 18.20 | 25.38 | 2 | 2005 |
| 404 | 4 | 2 | 1 | 3.47 | 8.10 | 29.13 | 40.70 | 2 | 2005 |
| 405 | 4 | 2 | 2 | 5.49 | 8.72 | 45.74 | 59.95 | 2 | 2005 |
| 407 | 4 | 1 | 2 | 7.62 | 9.83 | 56.79 | 74.24 | 2 | 2005 |
| 412 | 4 | 1 | 1 | 3.23 | 5.96 | 26.87 | 36.06 | 2 | 2005 |
| 501 | 5 | 2 | 2 | 3.57 | 6.37 | 32.29 | 42.24 | 2 | 2005 |
| 505 | 5 | 1 | 2 | 5.97 | 6.62 | 51.05 | 63.64 | 2 | 2005 |
| 509 | 5 | 1 | 1 | 5.33 | 6.21 | 26.05 | 37.59 | 2 | 2005 |
| 512 | 5 | 2 | 1 | 9.67 | 6.62 | 35.34 | 51.63 | 2 | 2005 |
| 602 | 6 | 2 | 2 | 6.26 | 9.21 | 37.33 | 52.81 | 2 | 2005 |
| 603 | 6 | 1 | 1 | 3.55 | 6.99 | 31.15 | 41.69 | 2 | 2005 |
| 605 | 6 | 1 | 2 | 3.79 | 6.25 | 35.93 | 45.96 | 2 | 2005 |
| 606 | 6 | 2 | 1 | 4.67 | 5.39 | 24.23 | 34.28 | 2 | 2005 |
| 102 | 1 | 1 | 1 | 5.33 | 7.03 | 37.33 | 49.69 | 2 | 2005 |
| 108 | 1 | 2 | 1 | 4.21 | 5.43 | 23.62 | 33.26 | 2 | 2005 |
| 109 | 1 | 1 | 2 | 3.18 | 8.96 | 43.69 | 55.83 | 2 | 2005 |
| 111 | 1 | 2 | 2 | 3.34 | 7.15 | 30.36 | 40.85 | 2 | 2005 |
| 205 | 2 | 2 | 1 | 5.20 | 4.89 | 34.26 | 44.34 | 2 | 2005 |
| 206 | 2 | 1 | 2 | 3.47 | 7.94 | 32.09 | 43.49 | 2 | 2005 |
| 208 | 2 | 2 | 2 | 4.21 | 4.65 | 25.41 | 34.26 | 2 | 2005 |
| 211 | 2 | 1 | 1 | 3.84 | 6.21 | 33.49 | 43.54 | 2 | 2005 |
| 301 | 3 | 1 | 1 | 3.47 | 6.21 | 38.77 | 48.45 | 2 | 2005 |
| 303 | 3 | 2 | 2 | 8.87 | 9.83 | 47.74 | 66.43 | 2 | 2005 |
| 306 | 3 | 1 | 2 | 3.12 | 6.00 | 32.09 | 41.21 | 2 | 2005 |
| 311 | 3 | 2 | 1 | 5.04 | 5.26 | 37.77 | 48.07 | 2 | 2005 |
| 404 | 4 | 2 | 1 | 10.89 | 8.10 | 54.10 | 73.09 | 2 | 2005 |
| 405 | 4 | 2 | 2 | 9.40 | 7.61 | 45.07 | 62.08 | 2 | 2005 |
| 407 | 4 | 1 | 2 | 6.50 | 6.17 | 42.14 | 54.81 | 2 | 2005 |
| 412 | 4 | 1 | 1 | 5.68 | 5.22 | 33.64 | 44.54 | 2 | 2005 |
| 501 | 5 | 2 | 2 | 5.62 | 6.78 | 31.76 | 44.17 | 2 | 2005 |
| 505 | 5 | 1 | 2 | 4.72 | 5.92 | 32.06 | 42.70 | 2 | 2005 |
| 509 | 5 | 1 | 1 | 2.78 | 4.52 | 23.27 | 30.56 | 2 | 2005 |
| 512 | 5 | 2 | 1 | 4.03 | 7.07 | 32.29 | 43.39 | 2 | 2005 |
| 602 | 6 | 2 | 2 | 9.40 | 9.66 | 48.82 | 67.89 | 2 | 2005 |
| 603 | 6 | 1 | 1 | 5.84 | 5.30 | 40.41 | 51.55 | 2 | 2005 |
| 605 | 6 | 1 | 2 | 3.97 | 6.46 | 31.18 | 41.61 | 2 | 2005 |
| 606 | 6 | 2 | 1 | 7.27 | 6.17 | 36.07 | 49.51 | 2 | 2005 |
| 102 | 1 | 1 | 1 | 2.62 | 5.30 | 27.43 | 35.35 | 2 | 2005 |
| 108 | 1 | 2 | 1 | 4.69 | 7.28 | 23.44 | 35.41 | 2 | 2005 |
| 109 | 1 | 1 | 2 | 2.30 | 5.53 | 25.32 | 33.15 | 2 | 2005 |
| 111 | 1 | 2 | 2 | 5.84 | 7.57 | 30.77 | 44.17 | 2 | 2005 |
| 205 | 2 | 2 | 1 | 5.12 | 5.67 | 31.21 | 42.00 | 2 | 2005 |
| 206 | 2 | 1 | 2 | 2.99 | 5.30 | 32.41 | 40.70 | 2 | 2005 |
| 208 | 2 | 2 | 2 | 1.58 | 4.32 | 14.18 | 20.08 | 2 | 2005 |
| 211 | 2 | 1 | 1 | 4.00 | 6.54 | 26.46 | 37.00 | 2 | 2005 |
| 301 | 3 | 1 | 1 | 3.92 | 8.31 | 32.09 | 44.31 | 2 | 2005 |
| 303 | 3 | 2 | 2 | 6.34 | 6.50 | 39.79 | 52.63 | 2 | 2005 |
| 306 | 3 | 1 | 2 | 2.72 | 6.09 | 29.45 | 38.26 | 2 | 2005 |
| 311 | 3 | 2 | 1 | 6.90 | 8.31 | 40.73 | 55.94 | 2 | 2005 |
| 404 | 4 | 2 | 1 | 10.81 | 9.83 | 51.99 | 72.62 | 2 | 2005 |
| 405 | 4 | 2 | 2 | 5.60 | 9.34 | 39.33 | 54.26 | 2 | 2005 |
| 407 | 4 | 1 | 2 | 3.39 | 6.83 | 33.29 | 43.50 | 2 | 2005 |
| 412 | 4 | 1 | 1 | 2.51 | 5.22 | 24.70 | 32.43 | 2 | 2005 |
| 501 | 5 | 2 | 2 | 2.22 | 8.10 | 30.36 | 40.68 | 2 | 2005 |
| 505 | 5 | 1 | 2 | 5.25 | 2.22 | 26.90 | 34.37 | 2 | 2005 |
| 509 | 5 | 1 | 1 | 1.77 | 3.90 | 13.68 | 19.35 | 2 | 2005 |
| 512 | 5 | 2 | 1 | 1.39 | 4.73 | 17.84 | 23.96 | 2 | 2005 |
| 602 | 6 | 2 | 2 | 6.10 | 6.58 | 29.57 | 42.25 | 2 | 2005 |
| 603 | 6 | 1 | 1 | 5.14 | 3.66 | 33.87 | 42.68 | 2 | 2005 |
| 605 | 6 | 1 | 2 | 4.61 | 6.13 | 33.20 | 43.94 | 2 | 2005 |
| 606 | 6 | 2 | 1 | 6.55 | 3.16 | 33.44 | 43.15 | 2 | 2005 |
| 102 | 1 | 1 | 1 | 7.91 | 9.46 | 51.69 | 69.06 | 2 | 2005 |

```
108     1       2       1       7.86    7.20    36.81   51.86   2       2005
109     1       1       2       5.14    6.58    39.30   51.02   2       2005
111     1       2       2       7.41    6.91    47.68   61.99   2       2005
205     2       2       1       11.77   13.57   55.62   80.96   2       2005
206     2       1       2       4.82    9.71    48.21   62.74   2       2005
208     2       2       2       3.39    4.73    38.92   47.03   2       2005
211     2       1       1       4.16    6.58    35.34   46.08   2       2005
301     3       1       1       12.43   11.84   67.25   91.53   2       2005
303     3       2       2       10.44   7.28    56.44   74.16   2       2005
306     3       1       2       5.92    6.66    58.78   71.36   2       2005
311     3       2       1       4.56    3.49    35.05   43.10   2       2005
404     4       2       1       9.11    10.16   45.69   64.95   2       2005
405     4       2       2       8.97    10.90   53.71   73.59   2       2005
407     4       1       2       3.20    6.41    36.42   46.04   2       2005
412     4       1       1       3.23    4.77    25.58   33.58   2       2005
501     5       2       2       4.72    4.77    34.34   43.83   2       2005
505     5       1       2       7.91    5.14    51.96   65.01   2       2005
509     5       1       1       4.13    4.52    24.03   32.68   2       2005
512     5       2       1       6.87    4.56    39.94   51.38   2       2005
602     6       2       2       5.28    5.22    35.93   46.42   2       2005
603     6       1       1       5.78    6.04    46.56   58.39   2       2005
605     6       1       2       1.05    4.23    20.54   25.82   2       2005
606     6       2       1       4.35    3.53    24.99   32.88   2       2005
102     1       1       1       1.90    5.43    31.32   38.65   2       2005
108     1       2       1       8.71    6.46    43.63   58.80   2       2005
109     1       1       2       3.28    5.96    28.95   38.19   2       2005
111     1       2       2       6.10    4.03    44.54   54.67   2       2005
205     2       2       1       6.05    4.60    39.35   50.01   2       2005
206     2       1       2       2.35    6.00    25.84   34.20   2       2005
208     2       2       2       3.26    5.10    28.04   36.40   2       2005
211     2       1       1       2.27    3.62    21.18   27.07   2       2005
301     3       1       1       4.00    6.95    42.14   53.09   2       2005
303     3       2       2       7.30    9.62    51.99   68.91   2       2005
306     3       1       2       3.65    7.11    41.61   52.38   2       2005
311     3       2       1       4.16    6.21    26.40   36.77   2       2005
404     4       2       1       4.32    5.96    36.04   46.32   2       2005
405     4       2       2       7.22    9.09    40.85   57.16   2       2005
407     4       1       2       3.73    6.29    32.09   42.11   2       2005
412     4       1       1       3.71    7.07    36.42   47.20   2       2005
501     5       2       2       5.97    7.69    41.85   55.50   2       2005
505     5       1       2       4.82    6.13    48.06   59.01   2       2005
509     5       1       1       1.58    3.90    19.10   24.59   2       2005
512     5       2       1       8.15    6.78    48.70   63.64   2       2005
602     6       2       2       3.63    7.69    32.12   43.43   2       2005
603     6       1       1       2.22    7.11    30.89   40.22   2       2005
605     6       1       2       2.54    7.81    26.64   36.99   2       2005
606     6       2       1       7.75    5.47    37.74   50.96   2       2005
;

%include'c:\danda.sas';
%mmaov(NKSol,glu,Class=Year Rep Variety K Date, fixed=Year |Variety |K  |Date,
   random = Rep(Year) Variety*K*Rep(Year) Variety*Date*K*rep(year),DDFM=CONTAIN);
%include'c:\danda.sas';
%mmaov(NKSol,fruc,Class=Year Rep Variety K Date,fixed=Year |Variety |K  |Date,
   random = Rep(Year) Variety*K*Rep(Year) Variety*Date*K*rep(year), DDFM=CONTAIN );
%include'c:\danda.sas';
%mmaov(NKSol,suc,Class=Year Rep Variety K Date, fixed=Year |Variety |K  |Date,
   random = Rep(Year) Variety*K*Rep(Year) Variety*Date*K*rep(year), DDFM=CONTAIN );

%include'c:\danda.sas';
%mmaov(NKSol,total, Class=Year Rep Variety K Date,fixed=Year |Variety |K  |Date,
   random = Rep(Year) Variety*K*Rep(Year) Variety*Date*K*rep(year),DDFM=CONTAIN  );
```

N&K Soluble Sugar-
Glucose, Fructose, Sucrose and the sum of all three.
SAS Output

Mixed ANOVA for glu

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.NKSOL |
| Dependent Variable | Glu |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 2003 2004 2005 |
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 1 2 |
| Date | 2 | 1 2 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 4 |
| Columns in X | 108 |
| Columns in Z | 234 |
| Subjects | 1 |
| Max Obs Per Subject | 720 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 720 |
| Number of Observations Used | 718 |
| Number of Observations Not Used | 2 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 3028.05162669 | |
| 1 | 3 | 3021.58570426 | 0.00002395 |
| 2 | 1 | 3021.56353181 | 0.00000023 |
| 3 | 1 | 3021.56332612 | 0.00000000 |





Convergence criteria met.

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(Year) | 0.03838 | 0.06367 | 0.60 | 0.2733 |
| Rep*Variety*K(Year) | 0 | . | . | . |
| Rep*Var*K*Date(Year) | 0.2667 | 0.1494 | 1.79 | 0.0371 |

| | | | | |
|---|---|---|---|---|
| Residual | 3.8237 | 0.2256 | 16.95 | <.0001 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 3021.6 |
| AIC (smaller is better) | 3027.6 |
| AICC (smaller is better) | 3027.6 |
| BIC (smaller is better) | 3030.2 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 15 | 5.25 | 0.0187 |
| Variety | 1 | 45 | 39.12 | <.0001 |
| Year*Variety | 2 | 45 | 0.73 | 0.4863 |
| K | 1 | 45 | 18.43 | <.0001 |
| Year*K | 2 | 45 | 0.88 | 0.4202 |
| Variety*K | 1 | 45 | 0.31 | 0.5805 |
| Year*Variety*K | 2 | 45 | 2.87 | 0.0668 |
| Date | 1 | 60 | 2.85 | 0.0966 |
| Year*Date | 2 | 60 | 30.39 | <.0001 |
| Variety*Date | 1 | 60 | 0.54 | 0.4664 |
| Year*Variety*Date | 2 | 60 | 8.57 | 0.0005 |
| K*Date | 1 | 60 | 1.45 | 0.2328 |
| Year*K*Date | 2 | 60 | 1.14 | 0.3255 |
| Variety*K*Date | 1 | 60 | 2.33 | 0.1323 |
| Year*Variety*K*Date | 2 | 60 | 0.02 | 0.9815 |

----------------------------- Effect=Year Method=LSD(P<.05) Set=1 -----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | _ | 4.8867 | 0.1670 | A |
| 2 | 2004 | _ | _ | _ | 4.6890 | 0.1670 | A |
| 3 | 2005 | _ | _ | _ | 4.1465 | 0.1674 | B |

--------------------------- Effect=Variety Method=LSD(P<.05) Set=2 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | _ | 4.0441 | 0.1284 | B |
| 5 | _ | 2 | _ | _ | 5.1040 | 0.1284 | A |

------------------------- Effect=Year*Variety Method=LSD(P<.05) Set=3 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | _ | 4.2335 | 0.2222 | BC |
| 7 | 2003 | 2 | _ | _ | 5.5400 | 0.2222 | A |
| 8 | 2004 | 1 | _ | _ | 4.1544 | 0.2222 | BC |
| 9 | 2004 | 2 | _ | _ | 5.2236 | 0.2222 | A |
| 10 | 2005 | 1 | _ | _ | 3.7445 | 0.2229 | C |
| 11 | 2005 | 2 | _ | _ | 4.5485 | 0.2229 | B |

------------------------------ Effect=K Method=LSD(P<.05) Set=4 -------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 12 | _ | _ | 1 | _ | 4.9378 | 0.1283 | A |
| 13 | _ | _ | 2 | _ | 4.2104 | 0.1285 | B |

---------------------------- Effect=Year*K   Method=LSD(P<.05)   Set=5 ------------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 1 | _ | 5.2884 | 0.2222 | A |
| 15 | 2003 | _ | 2 | _ | 4.4851 | 0.2222 | B |
| 16 | 2004 | _ | 1 | _ | 5.1679 | 0.2222 | A |
| 17 | 2004 | _ | 2 | _ | 4.2101 | 0.2222 | B |
| 18 | 2005 | _ | 1 | _ | 4.3572 | 0.2222 | B |
| 19 | 2005 | _ | 2 | _ | 3.9359 | 0.2235 | B |

-------------------------- Effect=Variety*K   Method=LSD(P<.05)   Set=6 -----------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 20 | _ | 1 | 1 | _ | 4.3607 | 0.1755 | B |
| 21 | _ | 1 | 2 | _ | 3.7276 | 0.1758 | C |
| 22 | _ | 2 | 1 | _ | 5.5149 | 0.1755 | A |
| 23 | _ | 2 | 2 | _ | 4.6931 | 0.1758 | B |

------------------------ Effect=Year*Variety*K   Method=LSD(P<.05)   Set=7 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 1 | _ | 4.8638 | 0.3039 | CD |
| 25 | 2003 | 1 | 2 | _ | 3.6032 | 0.3039 | F |
| 26 | 2003 | 2 | 1 | _ | 5.7130 | 0.3039 | AB |
| 27 | 2003 | 2 | 2 | _ | 5.3670 | 0.3039 | ABC |
| 28 | 2004 | 1 | 1 | _ | 4.3795 | 0.3039 | DEF |
| 29 | 2004 | 1 | 2 | _ | 3.9293 | 0.3039 | EF |
| 30 | 2004 | 2 | 1 | _ | 5.9563 | 0.3039 | A |
| 31 | 2004 | 2 | 2 | _ | 4.4908 | 0.3039 | DE |
| 32 | 2005 | 1 | 1 | _ | 3.8388 | 0.3039 | EF |
| 33 | 2005 | 1 | 2 | _ | 3.6502 | 0.3058 | EF |
| 34 | 2005 | 2 | 1 | _ | 4.8755 | 0.3039 | BCD |
| 35 | 2005 | 2 | 2 | _ | 4.2216 | 0.3058 | DEF |

----------------------------- Effect=Date   Method=LSD(P<.05)   Set=8 -----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 36 | _ | _ | _ | 1 | 4.4311 | 0.1285 | A |
| 37 | _ | _ | _ | 2 | 4.7171 | 0.1283 | A |

-------------------------- Effect=Year*Date   Method=LSD(P<.05)   Set=9 -----------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 38 | 2003 | _ | _ | 1 | 5.3093 | 0.2222 | A |
| 39 | 2003 | _ | _ | 2 | 4.4642 | 0.2222 | B |
| 40 | 2004 | _ | _ | 1 | 4.9081 | 0.2222 | AB |
| 41 | 2004 | _ | _ | 2 | 4.4699 | 0.2222 | B |
| 42 | 2005 | _ | _ | 1 | 3.0758 | 0.2235 | C |
| 43 | 2005 | _ | _ | 2 | 5.2172 | 0.2222 | A |

------------------------ Effect=Variety*Date   Method=LSD(P<.05)   Set=10 ---------------
----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 44 | _ | 1 | _ | 1 | 3.9632 | 0.1758 | B |
| 45 | _ | 1 | _ | 2 | 4.1251 | 0.1755 | B |
| 46 | _ | 2 | _ | 1 | 4.8989 | 0.1758 | A |
| 47 | _ | 2 | _ | 2 | 5.3092 | 0.1755 | A |

---------------------- Effect=Year*Variety*Date   Method=LSD(P<.05)   Set=11 ------------
----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 48 | 2003 | 1 | _ | 1 | 4.3827 | 0.3039 | CD |
| 49 | 2003 | 1 | _ | 2 | 4.0843 | 0.3039 | CD |
| 50 | 2003 | 2 | _ | 1 | 6.2360 | 0.3039 | A |
| 51 | 2003 | 2 | _ | 2 | 4.8440 | 0.3039 | BCD |
| 52 | 2004 | 1 | _ | 1 | 4.2863 | 0.3039 | CD |
| 53 | 2004 | 1 | _ | 2 | 4.0225 | 0.3039 | DE |
| 54 | 2004 | 2 | _ | 1 | 5.5298 | 0.3039 | AB |
| 55 | 2004 | 2 | _ | 2 | 4.9173 | 0.3039 | BC |
| 56 | 2005 | 1 | _ | 1 | 3.2207 | 0.3058 | EF |
| 57 | 2005 | 1 | _ | 2 | 4.2683 | 0.3039 | CD |
| 58 | 2005 | 2 | _ | 1 | 2.9309 | 0.3058 | F |
| 59 | 2005 | 2 | _ | 2 | 6.1662 | 0.3039 | A |

--------------------------- Effect=K*Date   Method=LSD(P<.05)   Set=12 ------------------
----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 60 | _ | _ | 1 | 1 | 4.8969 | 0.1755 | AB |
| 61 | _ | _ | 1 | 2 | 4.9787 | 0.1755 | A |
| 62 | _ | _ | 2 | 1 | 3.9652 | 0.1762 | C |
| 63 | _ | _ | 2 | 2 | 4.4555 | 0.1755 | B |

------------------------- Effect=Year*K*Date   Method=LSD(P<.05)   Set=13 ---------------
----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 64 | 2003 | _ | 1 | 1 | 5.9822 | 0.3039 | A |
| 65 | 2003 | _ | 1 | 2 | 4.5947 | 0.3039 | BCD |
| 66 | 2003 | _ | 2 | 1 | 4.6365 | 0.3039 | BCD |
| 67 | 2003 | _ | 2 | 2 | 4.3337 | 0.3039 | CD |
| 68 | 2004 | _ | 1 | 1 | 5.3485 | 0.3039 | AB |
| 69 | 2004 | _ | 1 | 2 | 4.9873 | 0.3039 | BC |

------------------------- Effect=Year*K*Date   Method=LSD(P<.05)   Set=13 -------------------------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 70 | 2004 | _ | 2 | 1 | 4.4677 | 0.3039 | CD |
| 71 | 2004 | _ | 2 | 2 | 3.9525 | 0.3039 | DE |
| 72 | 2005 | _ | 1 | 1 | 3.3602 | 0.3039 | EF |
| 73 | 2005 | _ | 1 | 2 | 5.3542 | 0.3039 | AB |
| 74 | 2005 | _ | 2 | 1 | 2.7914 | 0.3077 | F |
| 75 | 2005 | _ | 2 | 2 | 5.0803 | 0.3039 | BC |

----------------------- Effect=Variety*K*Date   Method=LSD(P<.05)   Set=14 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 76 | _ | 1 | 1 | 1 | 4.2527 | 0.2438 | CD |
| 77 | _ | 1 | 1 | 2 | 4.4688 | 0.2438 | BC |
| 78 | _ | 1 | 2 | 1 | 3.6738 | 0.2448 | D |
| 79 | _ | 1 | 2 | 2 | 3.7813 | 0.2438 | D |
| 80 | _ | 2 | 1 | 1 | 5.5412 | 0.2438 | A |
| 81 | _ | 2 | 1 | 2 | 5.4887 | 0.2438 | A |
| 82 | _ | 2 | 2 | 1 | 4.2566 | 0.2448 | CD |
| 83 | _ | 2 | 2 | 2 | 5.1297 | 0.2438 | AB |

--------------------- Effect=Year*Variety*K*Date   Method=LSD(P<.05)   Set=15 ---------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 84 | 2003 | 1 | 1 | 1 | 5.1433 | 0.4223 | CDEFG |
| 85 | 2003 | 1 | 1 | 2 | 4.5843 | 0.4223 | EFGHI |
| 86 | 2003 | 1 | 2 | 1 | 3.6220 | 0.4223 | HIJKL |
| 87 | 2003 | 1 | 2 | 2 | 3.5843 | 0.4223 | HIJKL |
| 88 | 2003 | 2 | 1 | 1 | 6.8210 | 0.4223 | A |
| 89 | 2003 | 2 | 1 | 2 | 4.6050 | 0.4223 | EFGHI |
| 90 | 2003 | 2 | 2 | 1 | 5.6510 | 0.4223 | ABCDE |
| 91 | 2003 | 2 | 2 | 2 | 5.0830 | 0.4223 | DEFG |
| 92 | 2004 | 1 | 1 | 1 | 4.3320 | 0.4223 | GHIJK |
| 93 | 2004 | 1 | 1 | 2 | 4.4270 | 0.4223 | FGHIJ |
| 94 | 2004 | 1 | 2 | 1 | 4.2407 | 0.4223 | GHIJK |
| 95 | 2004 | 1 | 2 | 2 | 3.6180 | 0.4223 | HIJKL |
| 96 | 2004 | 2 | 1 | 1 | 6.3650 | 0.4223 | AB |
| 97 | 2004 | 2 | 1 | 2 | 5.5477 | 0.4223 | BCDEF |
| 98 | 2004 | 2 | 2 | 1 | 4.6947 | 0.4223 | EFGH |
| 99 | 2004 | 2 | 2 | 2 | 4.2870 | 0.4223 | GHIJK |
| 100 | 2005 | 1 | 1 | 1 | 3.2827 | 0.4223 | JKL |
| 101 | 2005 | 1 | 1 | 2 | 4.3950 | 0.4223 | FGHIJ |

--------------------- Effect=Year*Variety*K*Date   Method=LSD(P<.05)   Set=15 -----------
----------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 102 | 2005 | 1 | 2 | 1 | 3.1587 | 0.4277 | KL |
| 103 | 2005 | 1 | 2 | 2 | 4.1417 | 0.4223 | GHIJK |
| 104 | 2005 | 2 | 1 | 1 | 3.4377 | 0.4223 | IJKL |
| 105 | 2005 | 2 | 1 | 2 | 6.3133 | 0.4223 | ABC |
| 106 | 2005 | 2 | 2 | 1 | 2.4242 | 0.4277 | L |
| 107 | 2005 | 2 | 2 | 2 | 6.0190 | 0.4223 | ABCD |

The UNIVARIATE Procedure
Variable:  Resid  (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.973936 | Pr < W | <0.0001 |
| Kolmogorov-Smirnov | D | 0.059641 | Pr > D | <0.0100 |
| Cramer-von Mises | W-Sq | 0.68041 | Pr > W-Sq | <0.0050 |
| Anderson-Darling | A-Sq | 4.135247 | Pr > A-Sq | <0.0050 |

Extreme Observations

| ------Lowest----- | | -----Highest----- | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -4.82644 | 668 | 5.72398 | 409 |
| -4.53902 | 440 | 5.78752 | 285 |
| -4.45021 | 77 | 6.16983 | 24 |
| -4.28602 | 433 | 7.49570 | 681 |
| -4.11602 | 361 | 9.29687 | 463 |

Missing Values

| Missing Value | Count | -----Percent Of----- All Obs | Missing Obs |
|---|---|---|---|
| . | 2 | 0.28 | 100.00 |

```
                 Histogram                          #             Boxplot
 9+*                                                1                *
  .*                                                2                0
  .****                                            22                0
  .***********                                     73                |
  .*********************************              229             +--+--+
  .*******************************************    300             *-----*
  .*************                                   86                |
-5+*                                                5                |
   ----+----+----+----+----+----+----+----+---
   * may represent up to 7 counts
```

Check on normality for glu

The UNIVARIATE Procedure
Variable: Resid (Residual)

```
                     Normal Probability Plot
  9+                                                  *
   |                                                  *
   |                                           ********
   |                                    ********+++
   |                         +***********
   |              *************
   | **************
 -5+*+++
    +----+----+----+----+----+----+----+----+----+----+
        -2        -1         0        +1        +2
```

Check equality of stddev for y= glu

rawmean_

| Levene Obs | Year | Variety | K | Date | nobs | y | stddev_y | stderr_y | LeveneF_df | P |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 1 | 1 | 30 | 5.14333 | 1.45028 | 0.26478 | 1.33(23,694) | .14 |
| 2 | 2003 | 1 | 1 | 2 | 30 | 4.58433 | 2.11409 | 0.38598 | | . |
| 3 | 2003 | 1 | 2 | 1 | 30 | 3.62200 | 1.25638 | 0.22938 | | . |
| 4 | 2003 | 1 | 2 | 2 | 30 | 3.58433 | 2.04529 | 0.37342 | | . |
| 5 | 2003 | 2 | 1 | 1 | 30 | 6.82100 | 2.43115 | 0.44387 | | . |
| 6 | 2003 | 2 | 1 | 2 | 30 | 4.60500 | 2.13985 | 0.39068 | | . |
| 7 | 2003 | 2 | 2 | 1 | 30 | 5.65100 | 1.51225 | 0.27610 | | . |
| 8 | 2003 | 2 | 2 | 2 | 30 | 5.08300 | 1.94589 | 0.35527 | | . |
| 9 | 2004 | 1 | 1 | 1 | 30 | 4.33200 | 2.18049 | 0.39810 | | . |
| 10 | 2004 | 1 | 1 | 2 | 30 | 4.42700 | 1.86859 | 0.34116 | | . |
| 11 | 2004 | 1 | 2 | 1 | 30 | 4.24067 | 2.28205 | 0.41664 | | . |
| 12 | 2004 | 1 | 2 | 2 | 30 | 3.61800 | 2.22563 | 0.40634 | | . |
| 13 | 2004 | 2 | 1 | 1 | 30 | 6.36500 | 1.72688 | 0.31528 | | . |
| 14 | 2004 | 2 | 1 | 2 | 30 | 5.54767 | 2.72752 | 0.49798 | | . |
| 15 | 2004 | 2 | 2 | 1 | 30 | 4.69467 | 2.00997 | 0.36697 | | . |
| 16 | 2004 | 2 | 2 | 2 | 30 | 4.28700 | 2.29127 | 0.41833 | | . |
| 17 | 2005 | 1 | 1 | 1 | 30 | 3.28267 | 1.70390 | 0.31109 | | . |
| 18 | 2005 | 1 | 1 | 2 | 30 | 4.39500 | 2.26182 | 0.41295 | | . |
| 19 | 2005 | 1 | 2 | 1 | 29 | 3.15759 | 1.89905 | 0.35265 | | . |
| 20 | 2005 | 1 | 2 | 2 | 30 | 4.14167 | 1.56164 | 0.28512 | | . |
| 21 | 2005 | 2 | 1 | 1 | 30 | 3.43767 | 1.69601 | 0.30965 | | . |
| 22 | 2005 | 2 | 1 | 2 | 30 | 6.31333 | 2.54768 | 0.46514 | | . |
| 23 | 2005 | 2 | 2 | 1 | 29 | 2.42448 | 1.43898 | 0.26721 | | . |
| 24 | 2005 | 2 | 2 | 2 | 30 | 6.01900 | 2.34126 | 0.42745 | | . |

Mixed ANOVA for fruc

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.NKSOL |
| Dependent Variable | Fruc |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 2003 2004 2005 |

| | | |
|---|---|---|
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 1 2 |
| Date | 2 | 1 2 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 4 |
| Columns in X | 108 |
| Columns in Z | 234 |
| Subjects | 1 |
| Max Obs Per Subject | 720 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 720 |
| Number of Observations Used | 707 |
| Number of Observations Not Used | 13 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 3046.45787817 | |
| 1 | 2 | 3040.49481375 | 0.00000009 |
| 2 | 1 | 3040.49472893 | 0.00000000 |

Mixed ANOVA for fruc

The Mixed Procedure

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(Year) | 0.01506 | 0.06344 | 0.24 | 0.4062 |
| Rep*Variety*K(Year) | 0 | . | . | . |
| Rep*Var*K*Date(Year) | 0.3240 | 0.1696 | 1.91 | 0.0281 |
| Residual | 4.2060 | 0.2506 | 16.79 | <.0001 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 3040.5 |
| AIC (smaller is better) | 3046.5 |
| AICC (smaller is better) | 3046.5 |
| BIC (smaller is better) | 3049.2 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 15 | 141.33 | <.0001 |
| Variety | 1 | 45 | 1.38 | 0.2459 |
| Year*Variety | 2 | 45 | 0.79 | 0.4614 |
| K | 1 | 45 | 4.51 | 0.0392 |
| Year*K | 2 | 45 | 4.63 | 0.0149 |
| Variety*K | 1 | 45 | 0.17 | 0.6856 |
| Year*Variety*K | 2 | 45 | 1.40 | 0.2582 |
| Date | 1 | 60 | 26.70 | <.0001 |
| Year*Date | 2 | 60 | 8.19 | 0.0007 |
| Variety*Date | 1 | 60 | 0.57 | 0.4531 |

| | | | | |
|---|---|---|---|---|
| Year*Variety*Date | 2 | 60 | 4.64 | 0.0134 |
| K*Date | 1 | 60 | 0.23 | 0.6300 |
| Year*K*Date | 2 | 60 | 0.82 | 0.4435 |
| Variety*K*Date | 1 | 60 | 3.08 | 0.0846 |
| Year*Variety*K*Date | 2 | 60 | 0.05 | 0.9533 |

---------------------------- Effect=Year   Method=LSD(P<.05)   Set=1 ------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | _ | 4.0266 | 0.1642 | B |
| 2 | 2004 | _ | _ | _ | 2.4118 | 0.1659 | C |
| 3 | 2005 | _ | _ | _ | 6.3138 | 0.1641 | A |

-------------------------- Effect=Variety   Method=LSD(P<.05)   Set=2 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | _ | 4.3572 | 0.1312 | A |
| 5 | _ | 2 | _ | _ | 4.1442 | 0.1316 | A |

------------------------ Effect=Year*Variety   Method=LSD(P<.05)   Set=3 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | _ | 4.2921 | 0.2260 | B |
| 7 | 2003 | 2 | _ | _ | 3.7611 | 0.2275 | B |
| 8 | 2004 | 1 | _ | _ | 2.4189 | 0.2289 | C |
| 9 | 2004 | 2 | _ | _ | 2.4047 | 0.2296 | C |
| 10 | 2005 | 1 | _ | _ | 6.3608 | 0.2267 | A |
| 11 | 2005 | 2 | _ | _ | 6.2668 | 0.2267 | A |

----------------------------- Effect=K   Method=LSD(P<.05)   Set=4 -------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 12 | _ | _ | 1 | _ | 4.4432 | 0.1309 | A |
| 13 | _ | _ | 2 | _ | 4.0583 | 0.1319 | B |

--------------------------- Effect=Year*K   Method=LSD(P<.05)   Set=5 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 1 | _ | 4.5801 | 0.2260 | B |
| 15 | 2003 | _ | 2 | _ | 3.4731 | 0.2275 | C |
| 16 | 2004 | _ | 1 | _ | 2.5477 | 0.2281 | D |
| 17 | 2004 | _ | 2 | _ | 2.2758 | 0.2304 | D |
| 18 | 2005 | _ | 1 | _ | 6.2017 | 0.2260 | A |
| 19 | 2005 | _ | 2 | _ | 6.4259 | 0.2274 | A |

------------------------- Effect=Variety*K Method=LSD(P<.05) Set=6 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 20 | _ | 1 | 1 | _ | 4.5866 | 0.1826 | A |
| 21 | _ | 1 | 2 | _ | 4.1279 | 0.1838 | AB |
| 22 | _ | 2 | 1 | _ | 4.2997 | 0.1830 | AB |
| 23 | _ | 2 | 2 | _ | 3.9886 | 0.1847 | B |

------------------------ Effect=Year*Variety*K Method=LSD(P<.05) Set=7 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 1 | _ | 5.0895 | 0.3156 | B |
| 25 | 2003 | 1 | 2 | _ | 3.4947 | 0.3156 | CD |
| 26 | 2003 | 2 | 1 | _ | 4.0707 | 0.3156 | C |
| 27 | 2003 | 2 | 2 | _ | 3.4515 | 0.3200 | CD |
| 28 | 2004 | 1 | 1 | _ | 2.4408 | 0.3176 | E |
| 29 | 2004 | 1 | 2 | _ | 2.3969 | 0.3220 | E |
| 30 | 2004 | 2 | 1 | _ | 2.6546 | 0.3196 | DE |
| 31 | 2004 | 2 | 2 | _ | 2.1547 | 0.3219 | E |
| 32 | 2005 | 1 | 1 | _ | 6.2295 | 0.3156 | A |
| 33 | 2005 | 1 | 2 | _ | 6.4921 | 0.3176 | A |
| 34 | 2005 | 2 | 1 | _ | 6.1738 | 0.3156 | A |
| 35 | 2005 | 2 | 2 | _ | 6.3597 | 0.3176 | A |

----------------------------- Effect=Date Method=LSD(P<.05) Set=8 -----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 36 | _ | _ | _ | 1 | 3.7824 | 0.1314 | B |
| 37 | _ | _ | _ | 2 | 4.7190 | 0.1313 | A |

------------------------- Effect=Year*Date Method=LSD(P<.05) Set=9 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 38 | 2003 | _ | _ | 1 | 3.0816 | 0.2275 | D |
| 39 | 2003 | _ | _ | 2 | 4.9716 | 0.2260 | C |
| 40 | 2004 | _ | _ | 1 | 2.3602 | 0.2281 | E |
| 41 | 2004 | _ | _ | 2 | 2.4633 | 0.2304 | DE |
| 42 | 2005 | _ | _ | 1 | 5.9056 | 0.2274 | B |
| 43 | 2005 | _ | _ | 2 | 6.7220 | 0.2260 | A |

------------------------ Effect=Variety*Date   Method=LSD(P<.05)   Set=10 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 44 | _ | 1 | _ | 1 | 3.8205 | 0.1834 | B |
| 45 | _ | 1 | _ | 2 | 4.8939 | 0.1831 | A |
| 46 | _ | 2 | _ | 1 | 3.7443 | 0.1838 | B |
| 47 | _ | 2 | _ | 2 | 4.5440 | 0.1838 | A |

---------------------- Effect=Year*Variety*Date   Method=LSD(P<.05)   Set=11 ----------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 48 | 2003 | 1 | _ | 1 | 2.9818 | 0.3156 | EF |
| 49 | 2003 | 1 | _ | 2 | 5.6023 | 0.3156 | BC |
| 50 | 2003 | 2 | _ | 1 | 3.1813 | 0.3200 | E |
| 51 | 2003 | 2 | _ | 2 | 4.3408 | 0.3156 | D |
| 52 | 2004 | 1 | _ | 1 | 2.2296 | 0.3196 | F |
| 53 | 2004 | 1 | _ | 2 | 2.6081 | 0.3200 | EF |
| 54 | 2004 | 2 | _ | 1 | 2.4908 | 0.3176 | EF |
| 55 | 2004 | 2 | _ | 2 | 2.3185 | 0.3239 | EF |
| 56 | 2005 | 1 | _ | 1 | 6.2503 | 0.3176 | ABC |
| 57 | 2005 | 1 | _ | 2 | 6.4713 | 0.3156 | AB |
| 58 | 2005 | 2 | _ | 1 | 5.5609 | 0.3176 | C |
| 59 | 2005 | 2 | _ | 2 | 6.9727 | 0.3156 | A |

--------------------------- Effect=K*Date   Method=LSD(P<.05)   Set=12 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 60 | _ | _ | 1 | 1 | 4.0188 | 0.1830 | B |
| 61 | _ | _ | 1 | 2 | 4.8675 | 0.1826 | A |
| 62 | _ | _ | 2 | 1 | 3.5461 | 0.1842 | B |
| 63 | _ | _ | 2 | 2 | 4.5704 | 0.1843 | A |

------------------------- Effect=Year*K*Date   Method=LSD(P<.05)   Set=13 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 64 | 2003 | _ | 1 | 1 | 3.6202 | 0.3156 | C |
| 65 | 2003 | _ | 1 | 2 | 5.5400 | 0.3156 | B |
| 66 | 2003 | _ | 2 | 1 | 2.5430 | 0.3200 | D |
| 67 | 2003 | _ | 2 | 2 | 4.4032 | 0.3156 | C |
| 68 | 2004 | _ | 1 | 1 | 2.4365 | 0.3196 | D |
| 69 | 2004 | _ | 1 | 2 | 2.6590 | 0.3176 | D |

------------------------- Effect=Year*K*Date   Method=LSD(P<.05)   Set=13 -------------------------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 70 | 2004 | _ | 2 | 1 | 2.2839 | 0.3176 | D |
| 71 | 2004 | _ | 2 | 2 | 2.2677 | 0.3262 | D |
| 72 | 2005 | _ | 1 | 1 | 5.9997 | 0.3156 | B |
| 73 | 2005 | _ | 1 | 2 | 6.4037 | 0.3156 | AB |
| 74 | 2005 | _ | 2 | 1 | 5.8115 | 0.3196 | B |
| 75 | 2005 | _ | 2 | 2 | 7.0403 | 0.3156 | A |

----------------------- Effect=Variety*K*Date   Method=LSD(P<.05)   Set=14 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 76 | _ | 1 | 1 | 1 | 3.9349 | 0.2572 | BC |
| 77 | _ | 1 | 1 | 2 | 5.2383 | 0.2561 | A |
| 78 | _ | 1 | 2 | 1 | 3.7062 | 0.2583 | C |
| 79 | _ | 1 | 2 | 2 | 4.5495 | 0.2585 | AB |
| 80 | _ | 2 | 1 | 1 | 4.1026 | 0.2572 | BC |
| 81 | _ | 2 | 1 | 2 | 4.4968 | 0.2572 | B |
| 82 | _ | 2 | 2 | 1 | 3.3860 | 0.2596 | C |
| 83 | _ | 2 | 2 | 2 | 4.5913 | 0.2595 | AB |

--------------------- Effect=Year*Variety*K*Date   Method=LSD(P<.05)   Set=15 ---------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 84 | 2003 | 1 | 1 | 1 | 3.5880 | 0.4435 | FGH |
| 85 | 2003 | 1 | 1 | 2 | 6.5910 | 0.4435 | AB |
| 86 | 2003 | 1 | 2 | 1 | 2.3757 | 0.4435 | HI |
| 87 | 2003 | 1 | 2 | 2 | 4.6137 | 0.4435 | DEF |
| 88 | 2003 | 2 | 1 | 1 | 3.6523 | 0.4435 | FG |
| 89 | 2003 | 2 | 1 | 2 | 4.4890 | 0.4435 | EF |
| 90 | 2003 | 2 | 2 | 1 | 2.7103 | 0.4559 | GHI |
| 91 | 2003 | 2 | 2 | 2 | 4.1927 | 0.4435 | EF |
| 92 | 2004 | 1 | 1 | 1 | 2.0727 | 0.4492 | I |
| 93 | 2004 | 1 | 1 | 2 | 2.8090 | 0.4435 | GHI |
| 94 | 2004 | 1 | 2 | 1 | 2.3864 | 0.4492 | HI |
| 95 | 2004 | 1 | 2 | 2 | 2.4073 | 0.4559 | GHI |
| 96 | 2004 | 2 | 1 | 1 | 2.8003 | 0.4492 | GHI |
| 97 | 2004 | 2 | 1 | 2 | 2.5089 | 0.4492 | GHI |
| 98 | 2004 | 2 | 2 | 1 | 2.1813 | 0.4435 | I |
| 99 | 2004 | 2 | 2 | 2 | 2.1281 | 0.4613 | I |
| 100 | 2005 | 1 | 1 | 1 | 6.1440 | 0.4435 | BC |
| 101 | 2005 | 1 | 1 | 2 | 6.3150 | 0.4435 | ABC |

```
--------------------- Effect=Year*Variety*K*Date   Method=LSD(P<.05)   Set=15 -----------
----------
```

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 102 | 2005 | 1 | 2 | 1 | 6.3565 | 0.4492 | ABC |
| 103 | 2005 | 1 | 2 | 2 | 6.6277 | 0.4435 | AB |
| 104 | 2005 | 2 | 1 | 1 | 5.8553 | 0.4435 | BCD |
| 105 | 2005 | 2 | 1 | 2 | 6.4923 | 0.4435 | ABC |
| 106 | 2005 | 2 | 2 | 1 | 5.2664 | 0.4492 | CDE |
| 107 | 2005 | 2 | 2 | 2 | 7.4530 | 0.4435 | A |

The UNIVARIATE Procedure
Variable:  Resid  (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.938718 | Pr < W | <0.0001 |
| Kolmogorov-Smirnov | D | 0.086561 | Pr > D | <0.0100 |
| Cramer-von Mises | W-Sq | 1.600962 | Pr > W-Sq | <0.0050 |
| Anderson-Darling | A-Sq | 9.135879 | Pr > A-Sq | <0.0050 |

Extreme Observations

| ------Lowest----- | | ------Highest----- | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -4.99413 | 184 | 7.02418 | 225 |
| -4.99382 | 163 | 8.02306 | 221 |
| -4.95055 | 176 | 8.55828 | 229 |
| -4.47413 | 160 | 9.34880 | 285 |
| -4.08928 | 166 | 11.64945 | 224 |

Missing Values

| Missing Value | Count | -----Percent Of----- All Obs | Missing Obs |
|---|---|---|---|
| . | 13 | 1.81 | 100.00 |

```
                 Histogram                         #            Boxplot
11+*                                               1               *
  .*                                               3               *
  .*                                               3               0
  .***                                            19               0
 3+**********                                     70               |
  .******************************                208            +--+--+
  .****************************************      321            *-----*
  .***********                                    76               |
-5+*                                               6               0
   ----+----+----+----+----+----+----+----+----+-
   * may represent up to 7 counts
```

Check on normality for  fruc

The UNIVARIATE Procedure
Variable:  Resid  (Residual)

```
                     Normal Probability Plot
 11+                                                   *
   |                                                   *
   |                                                  **
   |                                              ******++
  3+                                       ********++
   |                            ++**********
   |                      ***************
   | *************+
 -5+**+++
    +----+----+----+----+----+----+----+----+----+----+
        -2        -1         0        +1        +2
```



Check equality of stddev for y= fruc

| Obs | Year | Variety | K | Date | nobs | rawmean_ y | stddev_y | stderr_y | LeveneF_df | Levene P |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 1 | 1 | 30 | 3.58800 | 1.86322 | 0.34018 | 4.242(23,683) | |
| 2 | 2003 | 1 | 1 | 2 | 30 | 6.59100 | 4.26037 | 0.77783 | | . |
| 3 | 2003 | 1 | 2 | 1 | 30 | 2.37567 | 1.68343 | 0.30735 | | . |
| 4 | 2003 | 1 | 2 | 2 | 30 | 4.61367 | 2.95126 | 0.53882 | | . |
| 5 | 2003 | 2 | 1 | 1 | 30 | 3.65233 | 1.83292 | 0.33464 | | . |
| 6 | 2003 | 2 | 1 | 2 | 30 | 4.48900 | 3.35555 | 0.61264 | | . |
| 7 | 2003 | 2 | 2 | 1 | 28 | 2.72214 | 1.16814 | 0.22076 | | . |
| 8 | 2003 | 2 | 2 | 2 | 30 | 4.19267 | 2.45168 | 0.44761 | | . |
| 9 | 2004 | 1 | 1 | 1 | 29 | 2.07966 | 1.33123 | 0.24720 | | . |
| 10 | 2004 | 1 | 1 | 2 | 30 | 2.80900 | 2.15843 | 0.39407 | | . |
| 11 | 2004 | 1 | 2 | 1 | 29 | 2.39655 | 2.27497 | 0.42245 | | . |
| 12 | 2004 | 1 | 2 | 2 | 28 | 2.37429 | 1.58090 | 0.29876 | | . |
| 13 | 2004 | 2 | 1 | 1 | 29 | 2.78931 | 1.27320 | 0.23643 | | . |
| 14 | 2004 | 2 | 1 | 2 | 29 | 2.49448 | 1.82749 | 0.33936 | | . |
| 15 | 2004 | 2 | 2 | 1 | 30 | 2.18133 | 1.41615 | 0.25855 | | . |
| 16 | 2004 | 2 | 2 | 2 | 27 | 2.13370 | 1.51759 | 0.29206 | | . |
| 17 | 2005 | 1 | 1 | 1 | 30 | 6.14400 | 1.84190 | 0.33628 | | . |
| 18 | 2005 | 1 | 1 | 2 | 30 | 6.31500 | 1.94030 | 0.35425 | | . |
| 19 | 2005 | 1 | 2 | 1 | 29 | 6.35448 | 1.92993 | 0.35838 | | . |
| 20 | 2005 | 1 | 2 | 2 | 30 | 6.62767 | 1.63173 | 0.29791 | | . |
| 21 | 2005 | 2 | 1 | 1 | 30 | 5.85533 | 1.89220 | 0.34547 | | . |
| 22 | 2005 | 2 | 1 | 2 | 30 | 6.49233 | 2.20324 | 0.40225 | | . |
| 23 | 2005 | 2 | 2 | 1 | 29 | 5.26793 | 1.30128 | 0.24164 | | . |
| 24 | 2005 | 2 | 2 | 2 | 30 | 7.45300 | 2.19849 | 0.40139 | | . |

.

Mixed ANOVA for suc

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.NKSOL |
| Dependent Variable | Suc |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 2003 2004 2005 |
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 1 2 |
| Date | 2 | 1 2 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 4 |
| Columns in X | 108 |
| Columns in Z | 234 |
| Subjects | 1 |
| Max Obs Per Subject | 720 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 720 |
| Number of Observations Used | 716 |
| Number of Observations Not Used | 4 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 5302.33560979 | |
| 1 | 4 | 5277.52898886 | 0.00049260 |
| 2 | 2 | 5276.79022783 | . |
| 3 | 1 | 5276.66635690 | 0.00000127 |
| 4 | 1 | 5276.66376365 | 0.00000000 |

Mixed ANOVA for suc

The Mixed Procedure

Convergence criteria met.

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(Year) | 0.3626 | 1.9228 | 0.19 | 0.4252 |
| Rep*Variety*K(Year) | 0 | . | . | . |
| Rep*Var*K*Date(Year) | 17.8190 | 5.2092 | 3.42 | 0.0003 |
| Residual | 94.9854 | 5.6143 | 16.92 | <.0001 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 5276.7 |
| AIC (smaller is better) | 5282.7 |
| AICC (smaller is better) | 5282.7 |
| BIC (smaller is better) | 5285.3 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 15 | 2.06 | 0.1626 |
| Variety | 1 | 45 | 9.99 | 0.0028 |
| Year*Variety | 2 | 45 | 4.57 | 0.0156 |
| K | 1 | 45 | 0.69 | 0.4094 |
| Year*K | 2 | 45 | 1.00 | 0.3751 |
| Variety*K | 1 | 45 | 0.64 | 0.4285 |
| Year*Variety*K | 2 | 45 | 2.01 | 0.1457 |
| Date | 1 | 60 | 57.06 | <.0001 |
| Year*Date | 2 | 60 | 38.37 | <.0001 |
| Variety*Date | 1 | 60 | 0.99 | 0.3232 |
| Year*Variety*Date | 2 | 60 | 4.08 | 0.0218 |
| K*Date | 1 | 60 | 0.84 | 0.3627 |
| Year*K*Date | 2 | 60 | 0.30 | 0.7420 |
| Variety*K*Date | 1 | 60 | 3.27 | 0.0754 |
| Year*Variety*K*Date | 2 | 60 | 0.21 | 0.8088 |

Mean separation for suc

----------------------------- Effect=Year Method=LSD(P<.05) Set=1 -------------------
----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | _ | 34.7313 | 0.9096 | A |
| 2 | 2004 | _ | _ | _ | 32.4061 | 0.9107 | A |
| 3 | 2005 | _ | _ | _ | 34.5984 | 0.9127 | A |

--------------------------- Effect=Variety Method=LSD(P<.05) Set=2 ------------------
----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | _ | 32.3112 | 0.7302 | B |
| 5 | _ | 2 | _ | _ | 35.5127 | 0.7302 | A |

------------------------- Effect=Year*Variety   Method=LSD(P<.05)   Set=3 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | _ | 32.3832 | 1.2627 | BC |
| 7 | 2003 | 2 | _ | _ | 37.0794 | 1.2627 | A |
| 8 | 2004 | 1 | _ | _ | 29.4166 | 1.2627 | C |
| 9 | 2004 | 2 | _ | _ | 35.3957 | 1.2657 | AB |
| 10 | 2005 | 1 | _ | _ | 35.1337 | 1.2687 | AB |
| 11 | 2005 | 2 | _ | _ | 34.0631 | 1.2657 | AB |

------------------------------ Effect=K   Method=LSD(P<.05)   Set=4 -------------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 12 | _ | _ | 1 | _ | 33.4902 | 0.7296 | A |
| 13 | _ | _ | 2 | _ | 34.3337 | 0.7307 | A |

---------------------------- Effect=Year*K   Method=LSD(P<.05)   Set=5 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 1 | _ | 33.5682 | 1.2627 | AB |
| 15 | 2003 | _ | 2 | _ | 35.8944 | 1.2627 | A |
| 16 | 2004 | _ | 1 | _ | 32.9534 | 1.2657 | AB |
| 17 | 2004 | _ | 2 | _ | 31.8589 | 1.2627 | B |
| 18 | 2005 | _ | 1 | _ | 33.9492 | 1.2627 | AB |
| 19 | 2005 | _ | 2 | _ | 35.2476 | 1.2716 | AB |

-------------------------- Effect=Variety*K   Method=LSD(P<.05)   Set=6 ---------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 20 | _ | 1 | 1 | _ | 31.4848 | 1.0212 | B |
| 21 | _ | 1 | 2 | _ | 33.1375 | 1.0245 | AB |
| 22 | _ | 2 | 1 | _ | 35.4957 | 1.0228 | A |
| 23 | _ | 2 | 2 | _ | 35.5298 | 1.0228 | A |

------------------------ Effect=Year*Variety*K   Method=LSD(P<.05)   Set=7 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 1 | _ | 32.1172 | 1.7687 | CDE |
| 25 | 2003 | 1 | 2 | _ | 32.6492 | 1.7687 | BCDE |
| 26 | 2003 | 2 | 1 | _ | 35.0192 | 1.7687 | ABCD |
| 27 | 2003 | 2 | 2 | _ | 39.1397 | 1.7687 | A |
| 28 | 2004 | 1 | 1 | _ | 28.3853 | 1.7687 | E |
| 29 | 2004 | 1 | 2 | _ | 30.4478 | 1.7687 | DE |
| 30 | 2004 | 2 | 1 | _ | 37.5214 | 1.7771 | AB |
| 31 | 2004 | 2 | 2 | _ | 33.2700 | 1.7687 | BCDE |
| 32 | 2005 | 1 | 1 | _ | 33.9518 | 1.7687 | BCD |
| 33 | 2005 | 1 | 2 | _ | 36.3156 | 1.7858 | ABC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 34 | 2005 | 2 | 1 | _ | 33.9465 | 1.7687 | BCD |
| 35 | 2005 | 2 | 2 | _ | 34.1797 | 1.7771 | ABCD |

---------------------------- Effect=Date Method=LSD(P<.05) Set=8 -----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 36 | _ | _ | _ | 1 | 37.7375 | 0.7307 | A |
| 37 | _ | _ | _ | 2 | 30.0864 | 0.7296 | B |

-------------------------- Effect=Year*Date Method=LSD(P<.05) Set=9 ---------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 38 | 2003 | _ | _ | 1 | 39.5296 | 1.2627 | AB |
| 39 | 2003 | _ | _ | 2 | 29.9330 | 1.2627 | C |
| 40 | 2004 | _ | _ | 1 | 41.1188 | 1.2627 | A |
| 41 | 2004 | _ | _ | 2 | 23.6935 | 1.2657 | D |
| 42 | 2005 | _ | _ | 1 | 32.5642 | 1.2716 | C |
| 43 | 2005 | _ | _ | 2 | 36.6326 | 1.2627 | B |

------------------------ Effect=Variety*Date Method=LSD(P<.05) Set=10 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 44 | _ | 1 | _ | 1 | 35.6323 | 1.0245 | B |
| 45 | _ | 1 | _ | 2 | 28.9901 | 1.0212 | C |
| 46 | _ | 2 | _ | 1 | 39.8428 | 1.0228 | A |
| 47 | _ | 2 | _ | 2 | 31.1827 | 1.0228 | C |

---------------------- Effect=Year*Variety*Date Method=LSD(P<.05) Set=11 ----------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 48 | 2003 | 1 | _ | 1 | 35.1995 | 1.7687 | BC |
| 49 | 2003 | 1 | _ | 2 | 29.5668 | 1.7687 | DE |
| 50 | 2003 | 2 | _ | 1 | 43.8597 | 1.7687 | A |
| 51 | 2003 | 2 | _ | 2 | 30.2992 | 1.7687 | CDE |
| 52 | 2004 | 1 | _ | 1 | 37.1360 | 1.7687 | B |
| 53 | 2004 | 1 | _ | 2 | 21.6972 | 1.7687 | F |
| 54 | 2004 | 2 | _ | 1 | 45.1015 | 1.7687 | A |
| 55 | 2004 | 2 | _ | 2 | 25.6899 | 1.7771 | EF |
| 56 | 2005 | 1 | _ | 1 | 34.5613 | 1.7858 | BCD |
| 57 | 2005 | 1 | _ | 2 | 35.7062 | 1.7687 | B |
| 58 | 2005 | 2 | _ | 1 | 30.5672 | 1.7771 | CDE |
| 59 | 2005 | 2 | _ | 2 | 37.5590 | 1.7687 | B |

-------------------------- Effect=K*Date Method=LSD(P<.05) Set=12 ----------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 60 | _ | _ | 1 | 1 | 37.7804 | 1.0212 | A |
| 61 | _ | _ | 1 | 2 | 29.2001 | 1.0228 | B |
| 62 | _ | _ | 2 | 1 | 37.6947 | 1.0261 | A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 63 | _ | _ | 2 | 2 | 30.9727 | 1.0212 | B |

------------------------ Effect=Year*K*Date Method=LSD(P<.05) Set=13 -------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 64 | 2003 | _ | 1 | 1 | 38.3493 | 1.7687 | AB |
| 65 | 2003 | _ | 1 | 2 | 28.7870 | 1.7687 | DE |
| 66 | 2003 | _ | 2 | 1 | 40.7098 | 1.7687 | A |
| 67 | 2003 | _ | 2 | 2 | 31.0790 | 1.7687 | CD |
| 68 | 2004 | _ | 1 | 1 | 42.1330 | 1.7687 | A |
| 69 | 2004 | _ | 1 | 2 | 23.7737 | 1.7771 | EF |

------------------------ Effect=Year*K*Date Method=LSD(P<.05) Set=13 -------------------------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 70 | 2004 | _ | 2 | 1 | 40.1045 | 1.7687 | A |
| 71 | 2004 | _ | 2 | 2 | 23.6133 | 1.7687 | F |
| 72 | 2005 | _ | 1 | 1 | 32.8588 | 1.7687 | CD |
| 73 | 2005 | _ | 1 | 2 | 35.0395 | 1.7687 | BC |
| 74 | 2005 | _ | 2 | 1 | 32.2696 | 1.7942 | CD |
| 75 | 2005 | _ | 2 | 2 | 38.2257 | 1.7687 | AB |

---------------------- Effect=Variety*K*Date Method=LSD(P<.05) Set=14 ------------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 76 | _ | 1 | 1 | 1 | 34.3540 | 1.4372 | CD |
| 77 | _ | 1 | 1 | 2 | 28.6156 | 1.4372 | E |
| 78 | _ | 1 | 2 | 1 | 36.9105 | 1.4465 | BC |
| 79 | _ | 1 | 2 | 2 | 29.3646 | 1.4372 | E |
| 80 | _ | 2 | 1 | 1 | 41.2068 | 1.4372 | A |
| 81 | _ | 2 | 1 | 2 | 29.7846 | 1.4418 | E |
| 82 | _ | 2 | 2 | 1 | 38.4788 | 1.4418 | AB |
| 83 | _ | 2 | 2 | 2 | 32.5808 | 1.4372 | DE |

-------------------- Effect=Year*Variety*K*Date Method=LSD(P<.05) Set=15 ---------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 84 | 2003 | 1 | 1 | 1 | 33.5437 | 2.4893 | EFGHIJK |
| 85 | 2003 | 1 | 1 | 2 | 30.6907 | 2.4893 | GHIJKL |
| 86 | 2003 | 1 | 2 | 1 | 36.8553 | 2.4893 | CDEFG |
| 87 | 2003 | 1 | 2 | 2 | 28.4430 | 2.4893 | IJKLM |
| 88 | 2003 | 2 | 1 | 1 | 43.1550 | 2.4893 | ABC |
| 89 | 2003 | 2 | 1 | 2 | 26.8833 | 2.4893 | JKLMN |
| 90 | 2003 | 2 | 2 | 1 | 44.5643 | 2.4893 | AB |
| 91 | 2003 | 2 | 2 | 2 | 33.7150 | 2.4893 | EFGHIJ |
| 92 | 2004 | 1 | 1 | 1 | 35.7960 | 2.4893 | DEFGH |
| 93 | 2004 | 1 | 1 | 2 | 20.9747 | 2.4893 | N |
| 94 | 2004 | 1 | 2 | 1 | 38.4760 | 2.4893 | BCDEF |
| 95 | 2004 | 1 | 2 | 2 | 22.4197 | 2.4893 | MN |
| 96 | 2004 | 2 | 1 | 1 | 48.4700 | 2.4893 | A |
| 97 | 2004 | 2 | 1 | 2 | 26.5728 | 2.5131 | KLMN |
| 98 | 2004 | 2 | 2 | 1 | 41.7330 | 2.4893 | ABCD |
| 99 | 2004 | 2 | 2 | 2 | 24.8070 | 2.4893 | LMN |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 100 | 2005 | 1 | 1 | 1 | 33.7223 | 2.4893 | EFGHIJ |
| 101 | 2005 | 1 | 1 | 2 | 34.1813 | 2.4893 | EFGHI |

--------------------- Effect=Year*Variety*K*Date   Method=LSD(P<.05)   Set=15 ---------------------

(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 102 | 2005 | 1 | 2 | 1 | 35.4002 | 2.5376 | DEFGHI |
| 103 | 2005 | 1 | 2 | 2 | 37.2310 | 2.4893 | CDEFG |
| 104 | 2005 | 2 | 1 | 1 | 31.9953 | 2.4893 | FGHIJK |
| 105 | 2005 | 2 | 1 | 2 | 35.8977 | 2.4893 | DEFGH |
| 106 | 2005 | 2 | 2 | 1 | 29.1391 | 2.5131 | HIJKLM |
| 107 | 2005 | 2 | 2 | 2 | 39.2203 | 2.4893 | BCDE |

Check on normality for suc

The UNIVARIATE Procedure
Variable: Resid (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.995909 | Pr < W | 0.0578 |
| Kolmogorov-Smirnov | D | 0.031286 | Pr > D | 0.0876 |
| Cramer-von Mises | W-Sq | 0.104713 | Pr > W-Sq | 0.0982 |
| Anderson-Darling | A-Sq | 0.62991 | Pr > A-Sq | 0.1003 |

Extreme Observations

| ------Lowest----- Value | Obs | -----Highest----- Value | Obs |
|---|---|---|---|
| -26.5398 | 338 | 26.8309 | 284 |
| -24.0991 | 356 | 26.8674 | 681 |
| -23.9461 | 339 | 27.5808 | 227 |
| -22.7597 | 75 | 32.7430 | 463 |
| -22.3040 | 361 | 32.8770 | 386 |

Missing Values

| Missing Value | Count | -----Percent Of----- All Obs | Missing Obs |
|---|---|---|---|
| . | 4 | 0.56 | 100.00 |

```
                 Histogram                        #             Boxplot
  32.5+*                                          2                0
      .*                                          4                0
      .**                                         8                |
      .*****                                     20                |
      .****************                          61                |
      .************************                  95             +-----+
   2.5+********************************************  176         *--+--*
      .**************************************   150             |     |
      .***************************              108             +-----+
      .**************                            53                |
      .*******                                   27                |
      .***                                       11                0
 -27.5+*                                          1                0
       ----+----+----+----+----+----+----+----+----
```

Check on normality for suc

The UNIVARIATE Procedure
Variable: Resid (Residual)

```
                         Normal Probability Plot
   32.5+                                                  *
       |                                                 **
       |                                              ****+
       |                                          ****+
       |                                    *******
       |                               ******
    2.5+                         *******
       |                   *******
       |              ******
       |         ******
       |    ******
       |*****
  -27.5+*
        +----+----+----+----+----+----+----+----+----+----+
            -2        -1         0        +1        +2
```

Check equality of stddev for y= suc

rawmean_

Levene

| Obs | Year | Variety | K | Date | nobs | y | stddev_y | stderr_y | LeveneF_df | P |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 1 | 1 | 30 | 33.5437 | 7.1983 | 1.31423 | 1.7(23,692) | 0.044 |
| 2 | 2003 | 1 | 1 | 2 | 30 | 30.6907 | 12.9043 | 2.35599 | | |
| 3 | 2003 | 1 | 2 | 1 | 30 | 36.8553 | 8.1613 | 1.49004 | | . |
| 4 | 2003 | 1 | 2 | 2 | 30 | 28.4430 | 13.8019 | 2.51987 | | . |
| 5 | 2003 | 2 | 1 | 1 | 30 | 43.1550 | 12.9824 | 2.37025 | | . |
| 6 | 2003 | 2 | 1 | 2 | 30 | 26.8833 | 11.8188 | 2.15780 | | . |
| 7 | 2003 | 2 | 2 | 1 | 30 | 44.5643 | 8.5949 | 1.56920 | | . |
| 8 | 2003 | 2 | 2 | 2 | 30 | 33.7150 | 8.9061 | 1.62602 | | . |
| 9 | 2004 | 1 | 1 | 1 | 30 | 35.7960 | 12.1271 | 2.21409 | | . |
| 10 | 2004 | 1 | 1 | 2 | 30 | 20.9747 | 9.5340 | 1.74066 | | . |
| 11 | 2004 | 1 | 2 | 1 | 30 | 38.4760 | 12.3902 | 2.26212 | | . |
| 12 | 2004 | 1 | 2 | 2 | 30 | 22.4197 | 9.6222 | 1.75677 | | . |
| 13 | 2004 | 2 | 1 | 1 | 30 | 48.4700 | 7.2905 | 1.33106 | | . |
| 14 | 2004 | 2 | 1 | 2 | 29 | 26.6028 | 12.9531 | 2.40533 | | . |
| 15 | 2004 | 2 | 2 | 1 | 30 | 41.7330 | 11.0925 | 2.02520 | | . |
| 16 | 2004 | 2 | 2 | 2 | 30 | 24.8070 | 10.2482 | 1.87106 | | . |
| 17 | 2005 | 1 | 1 | 1 | 30 | 33.7223 | 10.0807 | 1.84047 | | . |
| 18 | 2005 | 1 | 1 | 2 | 30 | 34.1813 | 11.4383 | 2.08834 | | . |
| 19 | 2005 | 1 | 2 | 1 | 28 | 35.3571 | 9.4523 | 1.78631 | | . |
| 20 | 2005 | 1 | 2 | 2 | 30 | 37.2310 | 9.8934 | 1.80628 | | . |
| 21 | 2005 | 2 | 1 | 1 | 30 | 31.9953 | 9.3555 | 1.70807 | | . |
| 22 | 2005 | 2 | 1 | 2 | 30 | 35.8977 | 9.8430 | 1.79708 | | . |
| 23 | 2005 | 2 | 2 | 1 | 29 | 29.2390 | 8.9268 | 1.65766 | | . |
| 24 | 2005 | 2 | 2 | 2 | 30 | 39.2203 | 10.1088 | 1.84560 | | . |

Mixed ANOVA for total

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.NKSOL |
| Dependent Variable | Total |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 2003 2004 2005 |
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 1 2 |
| Date | 2 | 1 2 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 4 |
| Columns in X | 108 |
| Columns in Z | 234 |
| Subjects | 1 |
| Max Obs Per Subject | 720 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 720 |
| Number of Observations Used | 705 |
| Number of Observations Not Used | 15 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 5564.20689485 | |
| 1 | 4 | 5547.55716104 | 0.00043582 |
| 2 | 2 | 5546.84828665 | . |
| 3 | 1 | 5546.75311387 | 0.00000050 |
| 4 | 1 | 5546.75202553 | 0.00000000 |

The Mixed Procedure

Convergence criteria met.

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(Year) | 0.3882 | 3.0034 | 0.13 | 0.4486 |
| Rep*Variety*K(Year) | 0 | . | . | . |
| Rep*Var*K*Date(Year) | 24.5553 | 8.1837 | 3.00 | 0.0013 |
| Residual | 162.28 | 9.6887 | 16.75 | <.0001 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 5546.8 |
| AIC (smaller is better) | 5552.8 |
| AICC (smaller is better) | 5552.8 |
| BIC (smaller is better) | 5555.4 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 15 | 6.15 | 0.0112 |
| Variety | 1 | 45 | 9.57 | 0.0034 |
| Year*Variety | 2 | 45 | 2.94 | 0.0632 |
| K | 1 | 45 | 0.04 | 0.8339 |

| | | | | |
|---|---|---|---|---|
| Year*K | 2 | 45 | 0.80 | 0.4552 |
| Variety*K | 1 | 45 | 0.38 | 0.5428 |
| Year*Variety*K | 2 | 45 | 2.43 | 0.0994 |
| Date | 1 | 60 | 27.90 | <.0001 |
| Year*Date | 2 | 60 | 33.89 | <.0001 |
| Variety*Date | 1 | 60 | 0.61 | 0.4372 |
| Year*Variety*Date | 2 | 60 | 5.50 | 0.0064 |
| K*Date | 1 | 60 | 0.91 | 0.3427 |
| Year*K*Date | 2 | 60 | 0.24 | 0.7845 |
| Variety*K*Date | 1 | 60 | 3.36 | 0.0716 |
| Year*Variety*K*Date | 2 | 60 | 0.13 | 0.8823 |

Mean separation for total

---------------------------- Effect=Year Method=LSD(P<.05) Set=1 -------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | _ | 43.7259 | 1.1223 | A |
| 2 | 2004 | _ | _ | _ | 39.6930 | 1.1337 | B |
| 3 | 2005 | _ | _ | _ | 45.0766 | 1.1234 | A |

-------------------------- Effect=Variety Method=LSD(P<.05) Set=2 ------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | _ | 40.8720 | 0.9068 | B |
| 5 | _ | 2 | _ | _ | 44.7916 | 0.9092 | A |

------------------------ Effect=Year*Variety Method=LSD(P<.05) Set=3 ---------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | _ | 40.9083 | 1.5621 | BC |
| 7 | 2003 | 2 | _ | _ | 46.5436 | 1.5712 | A |
| 8 | 2004 | 1 | _ | _ | 36.4355 | 1.5792 | C |
| 9 | 2004 | 2 | _ | _ | 42.9505 | 1.5868 | AB |
| 10 | 2005 | 1 | _ | _ | 45.2724 | 1.5703 | AB |
| 11 | 2005 | 2 | _ | _ | 44.8808 | 1.5661 | AB |

----------------------------- Effect=K Method=LSD(P<.05) Set=4 ---------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 12 | _ | _ | 1 | _ | 42.9654 | 0.9050 | A |
| 13 | _ | _ | 2 | _ | 42.6982 | 0.9109 | A |

--------------------------- Effect=Year*K Method=LSD(P<.05) Set=5 ------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 1 | _ | 43.4351 | 1.5621 | AB |
| 15 | 2003 | _ | 2 | _ | 44.0168 | 1.5712 | AB |
| 16 | 2004 | _ | 1 | _ | 40.9530 | 1.5783 | BC |
| 17 | 2004 | _ | 2 | _ | 38.4329 | 1.5877 | C |
| 18 | 2005 | _ | 1 | _ | 44.5082 | 1.5621 | AB |
| 19 | 2005 | _ | 2 | _ | 45.6450 | 1.5743 | A |

Mean separation for total

------------------------- Effect=Variety*K   Method=LSD(P<.05)   Set=6 -----------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 20 | _ | 1 | 1 | _ | 40.6171 | 1.2692 | C |
| 21 | _ | 1 | 2 | _ | 41.1270 | 1.2787 | BC |
| 22 | _ | 2 | 1 | _ | 45.3138 | 1.2737 | A |
| 23 | _ | 2 | 2 | _ | 44.2695 | 1.2810 | AB |

------------------------ Effect=Year*Variety*K   Method=LSD(P<.05)   Set=7 --------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 1 | _ | 42.0692 | 2.1945 | ABC |
| 25 | 2003 | 1 | 2 | _ | 39.7473 | 2.1945 | BCD |
| 26 | 2003 | 2 | 1 | _ | 44.8010 | 2.1945 | AB |
| 27 | 2003 | 2 | 2 | _ | 48.2862 | 2.2204 | A |
| 28 | 2004 | 1 | 1 | _ | 35.7615 | 2.2059 | D |
| 29 | 2004 | 1 | 2 | _ | 37.1094 | 2.2317 | CD |
| 30 | 2004 | 2 | 1 | _ | 46.1445 | 2.2292 | A |
| 31 | 2004 | 2 | 2 | _ | 39.7565 | 2.2301 | BCD |
| 32 | 2005 | 1 | 1 | _ | 44.0205 | 2.1945 | AB |
| 33 | 2005 | 1 | 2 | _ | 46.5242 | 2.2178 | A |
| 34 | 2005 | 2 | 1 | _ | 44.9958 | 2.1945 | AB |
| 35 | 2005 | 2 | 2 | _ | 44.7657 | 2.2059 | AB |

---------------------------- Effect=Date   Method=LSD(P<.05)   Set=8 -------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 36 | _ | _ | _ | 1 | 46.1782 | 0.9083 | A |
| 37 | _ | _ | _ | 2 | 39.4854 | 0.9077 | B |

------------------------- Effect=Year*Date   Method=LSD(P<.05)   Set=9 -----------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 38 | 2003 | _ | _ | 1 | 48.0838 | 1.5712 | A |
| 39 | 2003 | _ | _ | 2 | 39.3681 | 1.5621 | B |
| 40 | 2004 | _ | _ | 1 | 48.8694 | 1.5742 | A |
| 41 | 2004 | _ | _ | 2 | 30.5166 | 1.5919 | C |
| 42 | 2005 | _ | _ | 1 | 41.5816 | 1.5743 | B |
| 43 | 2005 | _ | _ | 2 | 48.5716 | 1.5621 | A |

Mean separation for total

------------------------ Effect=Variety*Date Method=LSD(P<.05) Set=10 ---------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 44 | _ | 1 | _ | 1 | 43.7229 | 1.2759 | B |
| 45 | _ | 1 | _ | 2 | 38.0211 | 1.2720 | C |
| 46 | _ | 2 | _ | 1 | 48.6335 | 1.2764 | A |
| 47 | _ | 2 | _ | 2 | 40.9497 | 1.2784 | BC |

---------------------- Effect=Year*Variety*Date Method=LSD(P<.05) Set=11 ------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 48 | 2003 | 1 | _ | 1 | 42.5638 | 2.1945 | CD |
| 49 | 2003 | 1 | _ | 2 | 39.2527 | 2.1945 | D |
| 50 | 2003 | 2 | _ | 1 | 53.6037 | 2.2204 | A |
| 51 | 2003 | 2 | _ | 2 | 39.4835 | 2.1945 | D |
| 52 | 2004 | 1 | _ | 1 | 44.5064 | 2.2173 | BCD |
| 53 | 2004 | 1 | _ | 2 | 28.3645 | 2.2204 | E |
| 54 | 2004 | 2 | _ | 1 | 53.2324 | 2.2059 | A |
| 55 | 2004 | 2 | _ | 2 | 32.6686 | 2.2531 | E |
| 56 | 2005 | 1 | _ | 1 | 44.0985 | 2.2178 | CD |
| 57 | 2005 | 1 | _ | 2 | 46.4462 | 2.1945 | BC |
| 58 | 2005 | 2 | _ | 1 | 39.0646 | 2.2059 | D |
| 59 | 2005 | 2 | _ | 2 | 50.6970 | 2.1945 | AB |

--------------------------- Effect=K*Date Method=LSD(P<.05) Set=12 ------------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 60 | _ | _ | 1 | 1 | 46.9178 | 1.2714 | A |
| 61 | _ | _ | 1 | 2 | 39.0130 | 1.2715 | B |
| 62 | _ | _ | 2 | 1 | 45.4386 | 1.2808 | A |
| 63 | _ | _ | 2 | 2 | 39.9578 | 1.2789 | B |

------------------------- Effect=Year*K*Date Method=LSD(P<.05) Set=13 ---------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 64 | 2003 | _ | 1 | 1 | 47.9505 | 2.1945 | AB |
| 65 | 2003 | _ | 1 | 2 | 38.9197 | 2.1945 | D |
| 66 | 2003 | _ | 2 | 1 | 48.2170 | 2.2204 | AB |
| 67 | 2003 | _ | 2 | 2 | 39.8165 | 2.1945 | D |
| 68 | 2004 | _ | 1 | 1 | 50.5842 | 2.2173 | A |
| 69 | 2004 | _ | 1 | 2 | 31.3219 | 2.2178 | E |

Mean separation for total

------------------------ Effect=Year*K*Date Method=LSD(P<.05) Set=13 ---------------
(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 70 | 2004 | _ | 2 | 1 | 47.1545 | 2.2059 | ABC |
| 71 | 2004 | _ | 2 | 2 | 29.7113 | 2.2557 | E |
| 72 | 2005 | _ | 1 | 1 | 42.2188 | 2.1945 | BCD |
| 73 | 2005 | _ | 1 | 2 | 46.7975 | 2.1945 | ABC |
| 74 | 2005 | _ | 2 | 1 | 40.9443 | 2.2291 | CD |
| 75 | 2005 | _ | 2 | 2 | 50.3457 | 2.1945 | A |

---------------------- Effect=Variety*K*Date Method=LSD(P<.05) Set=14 --------------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 76 | _ | 1 | 1 | 1 | 42.9118 | 1.7920 | BCD |
| 77 | _ | 1 | 1 | 2 | 38.3223 | 1.7857 | DE |
| 78 | _ | 1 | 2 | 1 | 44.5340 | 1.8047 | BC |
| 79 | _ | 1 | 2 | 2 | 37.7199 | 1.7999 | E |
| 80 | _ | 2 | 1 | 1 | 50.9239 | 1.7920 | A |
| 81 | _ | 2 | 1 | 2 | 39.7037 | 1.7985 | CDE |
| 82 | _ | 2 | 2 | 1 | 46.3432 | 1.8061 | AB |
| 83 | _ | 2 | 2 | 2 | 42.1958 | 1.8053 | BCDE |

-------------------- Effect=Year*Variety*K*Date Method=LSD(P<.05) Set=15 -----------

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 84 | 2003 | 1 | 1 | 1 | 42.2743 | 3.0930 | CDEF |
| 85 | 2003 | 1 | 1 | 2 | 41.8640 | 3.0930 | CDEF |
| 86 | 2003 | 1 | 2 | 1 | 42.8533 | 3.0930 | CDEF |
| 87 | 2003 | 1 | 2 | 2 | 36.6413 | 3.0930 | DEFG |
| 88 | 2003 | 2 | 1 | 1 | 53.6267 | 3.0930 | AB |
| 89 | 2003 | 2 | 1 | 2 | 35.9753 | 3.0930 | EFG |
| 90 | 2003 | 2 | 2 | 1 | 53.5808 | 3.1661 | AB |
| 91 | 2003 | 2 | 2 | 2 | 42.9917 | 3.0930 | CDEF |
| 92 | 2004 | 1 | 1 | 1 | 43.3124 | 3.1254 | CDE |
| 93 | 2004 | 1 | 1 | 2 | 28.2107 | 3.0930 | G |
| 94 | 2004 | 1 | 2 | 1 | 45.7004 | 3.1254 | BC |
| 95 | 2004 | 1 | 2 | 2 | 28.5184 | 3.1661 | G |
| 96 | 2004 | 2 | 1 | 1 | 57.8560 | 3.1254 | A |
| 97 | 2004 | 2 | 1 | 2 | 34.4330 | 3.1589 | FG |
| 98 | 2004 | 2 | 2 | 1 | 48.6087 | 3.0930 | BC |
| 99 | 2004 | 2 | 2 | 2 | 30.9043 | 3.1935 | G |
| 100 | 2005 | 1 | 1 | 1 | 43.1487 | 3.0930 | CDEF |
| 101 | 2005 | 1 | 1 | 2 | 44.8923 | 3.0930 | BCD |

Mean separation for total

--------------------- Effect=Year*Variety*K*Date Method=LSD(P<.05) Set=15 -----------
(continued)

| Obs | Year | Variety | K | Date | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|---|
| 102 | 2005 | 1 | 2 | 1 | 45.0484 | 3.1589 | BCD |
| 103 | 2005 | 1 | 2 | 2 | 48.0000 | 3.0930 | BC |
| 104 | 2005 | 2 | 1 | 1 | 41.2890 | 3.0930 | CDEF |
| 105 | 2005 | 2 | 1 | 2 | 48.7027 | 3.0930 | BC |
| 106 | 2005 | 2 | 2 | 1 | 36.8401 | 3.1254 | DEFG |
| 107 | 2005 | 2 | 2 | 2 | 52.6913 | 3.0930 | AB |

Check on normality for total

The UNIVARIATE Procedure
Variable: Resid (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.991626 | Pr < W | 0.0005 |
| Kolmogorov-Smirnov | D | 0.037184 | Pr > D | 0.0188 |
| Cramer-von Mises | W-Sq | 0.131652 | Pr > W-Sq | 0.0435 |
| Anderson-Darling | A-Sq | 0.876252 | Pr > A-Sq | 0.0246 |

Extreme Observations

| ------Lowest----- | | -----Highest----- | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -29.4235 | 339 | 35.8050 | 227 |
| -28.7923 | 356 | 39.1990 | 681 |
| -28.4457 | 361 | 40.7465 | 285 |
| -28.1357 | 433 | 45.1715 | 386 |
| -27.5195 | 75 | 47.1713 | 463 |

Missing Values

| Missing Value | Count | -----Percent Of----- All Obs | Missing Obs |
|---|---|---|---|
| . | 15 | 2.08 | 100.00 |

```
                Histogram                        #          Boxplot
 45+*                                            3             0
   .*                                            5             0
   .******                                      29             0
   .********************                        96             |
   .*******************************************  214          +--+--+
   .********************************************* 223         *-----*
   .********************                        99             |
-25+********                                    36             |
    ----+----+----+----+----+----+----+----+----+
    * may represent up to 5 counts
```

```
                    The UNIVARIATE Procedure
                  Variable:  Resid  (Residual)

                         Normal Probability Plot
   45+                                                 *
     |                                                ***
     |                                         *******++
     |                                  ********
     |                        **********
     |              **********
     |       ********
  -25+**********
      +----+----+----+----+----+----+----+----+----+----+
           -2        -1         0        +1        +2
```

Check equality of stddev for y= total

| Levene Obs | Year | Variety | K | Date | nobs | rawmean_ y | stddev_y | stderr_y | LeveneF_df | P |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 1 | 1 | 30 | 42.2743 | 9.1364 | 1.66807 | 1.5(23,681) | .08 |
| 2 | 2003 | 1 | 1 | 2 | 30 | 41.8640 | 17.5874 | 3.21100 | | . |
| 3 | 2003 | 1 | 2 | 1 | 30 | 42.8533 | 9.9417 | 1.81509 | | . |
| 4 | 2003 | 1 | 2 | 2 | 30 | 36.6413 | 17.7014 | 3.23182 | | . |
| 5 | 2003 | 2 | 1 | 1 | 30 | 53.6267 | 16.0565 | 2.93150 | | . |
| 6 | 2003 | 2 | 1 | 2 | 30 | 35.9753 | 16.1272 | 2.94442 | | . |
| 7 | 2003 | 2 | 2 | 1 | 28 | 53.7346 | 10.4531 | 1.97546 | | . |
| 8 | 2003 | 2 | 2 | 2 | 30 | 42.9917 | 12.3756 | 2.25946 | | . |
| 9 | 2004 | 1 | 1 | 1 | 29 | 43.3193 | 13.5272 | 2.51194 | | . |
| 10 | 2004 | 1 | 1 | 2 | 30 | 28.2107 | 12.5463 | 2.29064 | | . |
| 11 | 2004 | 1 | 2 | 1 | 29 | 45.8321 | 15.7649 | 2.92747 | | . |
| 12 | 2004 | 1 | 2 | 2 | 28 | 28.4043 | 12.9862 | 2.45416 | | . |
| 13 | 2004 | 2 | 1 | 1 | 29 | 57.8059 | 9.4559 | 1.75592 | | . |
| 14 | 2004 | 2 | 1 | 2 | 28 | 34.2182 | 16.3260 | 3.08532 | | . |
| 15 | 2004 | 2 | 2 | 1 | 30 | 48.6087 | 13.6125 | 2.48529 | | . |
| 16 | 2004 | 2 | 2 | 2 | 27 | 30.8319 | 13.4102 | 2.58079 | | . |
| 17 | 2005 | 1 | 1 | 1 | 30 | 43.1487 | 13.0977 | 2.39131 | | . |
| 18 | 2005 | 1 | 1 | 2 | 30 | 44.8923 | 15.1172 | 2.76000 | | . |
| 19 | 2005 | 1 | 2 | 1 | 28 | 44.9746 | 12.5635 | 2.37427 | | . |
| 20 | 2005 | 1 | 2 | 2 | 30 | 48.0000 | 12.0347 | 2.19723 | | . |
| 21 | 2005 | 2 | 1 | 1 | 30 | 41.2890 | 12.0000 | 2.19089 | | . |
| 22 | 2005 | 2 | 1 | 2 | 30 | 48.7027 | 13.6419 | 2.49065 | | . |
| 23 | 2005 | 2 | 2 | 1 | 29 | 36.9321 | 10.8712 | 2.01873 | | . |
| 24 | 2005 | 2 | 2 | 2 | 30 | 52.6913 | 13.7624 | 2.51267 | | |

N&K Standard Curve Data
-Glucose-

| | |
|---|---|
| Intercept | -0.00313 |
| Net Abs | 0.565566 |

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.99853 |
| R Square | 0.997062 |

| Concentration mg/ml | Net ABS |
|---|---|
| 0.1 | 0.16 |
| 0.1 | 0.16 |
| 0.25 | 0.43 |
| 0.25 | 0.43 |
| 0.5 | 0.87 |

| | |
|---|---|
| 0.5 | 0.89 |
| 0.8 | 1.29 |
| 0.8 | 1.31 |

-Fructose-

| | |
|---|---|
| Intercept | -0.09182 |
| Net Abs | 0.868935 |

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.997946 |
| R Square | 0.995896 |

| Concentration mg/ml | Net ABS |
|---|---|
| 0.1 | 0.22 |
| 0.1 | 0.21 |
| 0.5 | 0.72 |
| 0.5 | 0.68 |
| 0.8 | 1.00 |
| 0.8 | 0.09 |

-Sucrose-

| | |
|---|---|
| Intercept | -0.09477 |
| Net Abs | 0.690577 |

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.998684 |
| R Square | 0.99737 |

| Concentration mg/ml | Net ABS |
|---|---|
| 0.1 | 0.28 |
| 0.1 | 0.27 |
| 0.5 | 0.87 |
| 0.5 | 0.89 |
| 0.8 | 1.26 |
| 0.8 | 1.31 |

N&K Lint yield
SAS Input

**Variety 1= PM1218**
**2= DP555**
**K 1= 60lbs $K_2O$/acre/yr**
**2= 120lbs $K_2O$/acre/yr**
**Date 1= Early Bloom**
**2= Cutout**

```
- Lint yield is in lbs/acre
data lint;
input Plot     Year K  Variety V Rep Lintyield;
cards;
102     2003    60      1       1218    1       1267.3
102     2004    60      2       555     1       1846.7
102     2005    60      1       1218    1       1211.86
108     2003    60      2       555     2       1321.9
108     2004    60      1       1218    1       1722.3
108     2005    60      2       555     1       1630.00
109     2003    120     1       1218    2       1498.5
109     2004    120     2       555     1       2167.0
109     2005    120     1       1218    1       1542.18
111     2003    120     2       555     2       1305.2
```

```
111     2004    120     1       1218    1       2018.9
111     2005    120     2       555     1       1644.89
205     2003    60      2       555     1       1447.2
205     2004    60      1       1218    2       1821.0
205     2005    60      2       555     2       1565.69
206     2003    120     1       1218    1       1599.8
206     2004    120     2       555     2       1954.1
206     2005    120     1       1218    2       1461.20
208     2003    120     2       555     4       1185.26
208     2004    120     1       1218    2       1966.4
208     2005    120     2       555     2       1578.47
211     2003    60      1       1218    2       1261.1
211     2004    60      2       555     2       2070.1
211     2005    60      1       1218    2       1358.33
301     2003    60      1       1218    3       1465.2
301     2004    60      2       555     3       2048.5
301     2005    60      1       1218    3       1396.62
303     2003    120     2       555     1       1348.2
303     2004    120     1       1218    3       1918.4
303     2005    120     2       555     3       1565.50
306     2003    120     1       1218    3       1683.6
306     2004    120     2       555     3       2132.0
306     2005    120     1       1218    3       1532.13
311     2003    60      2       555     4       1531.9
311     2004    60      1       1218    3       1768.2
311     2005    60      2       555     3       1634.02
404     2003    60      2       555     3       1552.2
404     2004    60      1       1218    4       1746.5
404     2005    60      2       555     4       1611.80
405     2003    120     2       555     3       1573.8
405     2004    120     1       1218    4       2030.2
405     2005    120     2       555     4       1761.75
407     2003    120     1       1218    4       1610.6
407     2004    120     2       555     4       2167.2
407     2005    120     1       1218    4       1539.86
412     2003    60      1       1218    4       1224.3
412     2004    60      2       555     4       2160.8
412     2005    60      1       1218    4       1461.50
501     2003    120     2       555     5       1469.1
501     2004    120     1       1218    5       1731.5
501     2005    120     2       555     5       1338.05
505     2003    120     1       1218    5       1427.0
505     2004    120     2       555     5       2103.6
505     2005    120     1       1218    5       1457.19
509     2003    60      1       1218    5       1348.5
509     2004    60      2       555     5       1820.8
509     2005    60      1       1218    5       1461.67
512     2003    60      2       555     5       1216.0
512     2004    60      1       1218    5       1782.2
512     2005    60      2       555     5       1584.04
602     2003    120     2       555     6       1297.2
602     2004    120     1       1218    6       1780.3
602     2005    120     2       555     6       1558.04
603     2003    60      1       1218    6       1427.7
603     2004    60      2       555     6       1968.5
603     2005    60      1       1218    6       1482.09
605     2003    120     1       1218    6       1413.4
605     2004    120     2       555     6       2024.1
605     2005    120     1       1218    6       1449.04
606     2003    60      2       555     6       1578.5
606     2004    60      1       1218    6       1718.4
606     2005    60      2       555     6       1445.22
;
%include"c:\danda.sas";
%mmaov(lint, lintyield, Class=Year Rep Variety K, fixed=Year |Variety |K, random=
Rep(Year) Variety*K*Rep(Year)
   );
N&K Lint Yield
```
SAS Output

Mixed ANOVA for lintyield

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.LINT |
| Dependent Variable | Lintyield |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Prasad-Rao-Jeske-Kackar-Harville |
| Degrees of Freedom Method | Kenward-Roger |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 2003 2004 2005 |
| Rep | 6 | 1 2 3 4 5 6 |
| Variety | 2 | 1 2 |
| K | 2 | 60 120 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 3 |
| Columns in X | 36 |
| Columns in Z | 90 |
| Subjects | 1 |
| Max Obs Per Subject | 72 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 72 |
| Number of Observations Used | 72 |
| Number of Observations Not Used | 0 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 753.72413377 | |
| 1 | 2 | 752.25136384 | 0.00000000 |

Convergence criteria met but final hessian is not positive definite.

Mixed ANOVA for lintyield

The Mixed Procedure

Covariance Parameter Estimates

| Cov Parm | Estimate | Standard Error | Z Value | Pr Z |
|---|---|---|---|---|
| Rep(Year) | 1604.47 | 1596.78 | 1.00 | 0.1575 |
| Rep*Variety*K(Year) | 10077 | 2124.62 | 4.74 | <.0001 |
| Residual | 0.9999 | 0 | . | . |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 752.3 |
| AIC (smaller is better) | 758.3 |
| AICC (smaller is better) | 758.7 |
| BIC (smaller is better) | 760.9 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 15 | 110.72 | <.0001 |
| Variety | 1 | 45 | 18.08 | 0.0001 |
| Year*Variety | 2 | 45 | 8.85 | 0.0006 |
| K | 1 | 45 | 11.39 | 0.0015 |
| Year*K | 2 | 45 | 1.01 | 0.3715 |
| Variety*K | 1 | 45 | 9.29 | 0.0039 |
| Year*Variety*K | 2 | 45 | 2.35 | 0.1070 |

Mean separation for lintyield

---------------------------- Effect=Year Method=LSD(P<.05) Set=1 -------------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 1 | 2003 | _ | _ | 1418.89 | 26.2169 | C |
| 2 | 2004 | _ | _ | 1936.15 | 26.2169 | A |
| 3 | 2005 | _ | _ | 1511.30 | 26.2169 | B |

-------------------------- Effect=Variety Method=LSD(P<.05) Set=2 ------------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 4 | _ | 1 | _ | 1571.80 | 19.2115 | B |
| 5 | _ | 2 | _ | 1672.43 | 19.2115 | A |

------------------------ Effect=Year*Variety Method=LSD(P<.05) Set=3 ---------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 6 | 2003 | 1 | _ | 1435.58 | 33.2752 | D |
| 7 | 2003 | 2 | _ | 1402.21 | 33.2752 | D |
| 8 | 2004 | 1 | _ | 1833.69 | 33.2752 | B |
| 9 | 2004 | 2 | _ | 2038.62 | 33.2752 | A |
| 10 | 2005 | 1 | _ | 1446.14 | 33.2752 | D |
| 11 | 2005 | 2 | _ | 1576.46 | 33.2752 | C |

----------------------------- Effect=K Method=LSD(P<.05) Set=4 ---------------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 12 | _ | _ | 60 | 1582.18 | 19.2115 | B |
| 13 | _ | _ | 120 | 1662.05 | 19.2115 | A |

--------------------------- Effect=Year*K Method=LSD(P<.05) Set=5 ------------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 14 | 2003 | _ | 60 | 1386.82 | 33.2752 | D |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 | 2003 | _ | 120 | 1450.97 | 33.2752 | CD |
| 16 | 2004 | _ | 60 | 1872.83 | 33.2752 | B |
| 17 | 2004 | _ | 120 | 1999.47 | 33.2752 | A |
| 18 | 2005 | _ | 60 | 1486.90 | 33.2752 | C |
| 19 | 2005 | _ | 120 | 1535.69 | 33.2752 | C |

Mean separation for lintyield

------------------------- Effect=Variety*K Method=LSD(P<.05) Set=6 -----------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 20 | _ | 1 | 60 | 1495.82 | 25.4759 | B |
| 21 | _ | 1 | 120 | 1647.79 | 25.4759 | A |
| 22 | _ | 2 | 60 | 1668.55 | 25.4759 | A |
| 23 | _ | 2 | 120 | 1676.30 | 25.4759 | A |

----------------------- Effect=Year*Variety*K Method=LSD(P<.05) Set=7 --------------

| Obs | Year | Variety | K | Estimate | Standard Error | Letter Group |
|---|---|---|---|---|---|---|
| 24 | 2003 | 1 | 60 | 1332.35 | 44.1256 | G |
| 25 | 2003 | 1 | 120 | 1538.82 | 44.1256 | DE |
| 26 | 2003 | 2 | 60 | 1441.28 | 44.1256 | EFG |
| 27 | 2003 | 2 | 120 | 1363.13 | 44.1256 | G |
| 28 | 2004 | 1 | 60 | 1759.77 | 44.1256 | C |
| 29 | 2004 | 1 | 120 | 1907.62 | 44.1256 | B |
| 30 | 2004 | 2 | 60 | 1985.90 | 44.1256 | AB |
| 31 | 2004 | 2 | 120 | 2091.33 | 44.1256 | A |
| 32 | 2005 | 1 | 60 | 1395.34 | 44.1256 | FG |
| 33 | 2005 | 1 | 120 | 1496.93 | 44.1256 | DEF |
| 34 | 2005 | 2 | 60 | 1578.46 | 44.1256 | D |
| 35 | 2005 | 2 | 120 | 1574.45 | 44.1256 | D |

Check on normality for lintyield

The UNIVARIATE Procedure
Variable: Resid (Residual)

Tests for Normality

| Test | --Statistic--- | | -----p Value------ | |
|---|---|---|---|---|
| Shapiro-Wilk | W | 0.96722 | Pr < W | 0.0572 |
| Kolmogorov-Smirnov | D | 0.076994 | Pr > D | >0.1500 |
| Cramer-von Mises | W-Sq | 0.116202 | Pr > W-Sq | 0.0704 |
| Anderson-Darling | A-Sq | 0.726163 | Pr > A-Sq | 0.0574 |

Extreme Observations

| -------Lowest------ | | ------Highest------ | |
|---|---|---|---|
| Value | Obs | Value | Obs |
| -0.0214839 | 51 | 0.0125890 | 49 |
| -0.0202773 | 58 | 0.0132164 | 70 |
| -0.0180479 | 3 | 0.0138781 | 47 |
| -0.0164554 | 19 | 0.0151197 | 40 |
| -0.0145158 | 50 | 0.0154014 | 42 |

```
Stem Leaf                     #             Boxplot
   1 55                       2                |
   1 001334                   6                |
   0 555555556777889999      18             +-----+
   0 011113333444            12             *--+--*
  -0 44443332221111000       17             +-----+
  -0 99765                    5                |
  -1 4433200                  7                |
```

```
-1 865                    3                |
-2 10                     2                0
   ----+----+----+----+
Multiply Stem.Leaf by 10**-2


                 Normal Probability Plot
 0.0175+                                          ++*++ *
       |                                    +****+*
       |                            **********
       |                       ******+
-0.0025+                 *******
       |             +***++
       |       ++******
       |  ++++* *
-0.0225++*+  *
        +----+----+----+----+----+----+----+----+----+----+
            -2        -1         0        +1        +2
```

Check equality of stddev for y= lintyield

| Obs | Year | Variety | K | nobs | rawmean_ y | stddev_y | stderr_y | LeveneF_df | P |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2003 | 1 | 60 | 6 | 1332.35 | 97.964 | 39.9935 | 1.28(11,60) | 0.2580 |
| 2 | 2003 | 1 | 120 | 6 | 1538.82 | 109.263 | 44.6063 | | |
| 3 | 2003 | 2 | 60 | 6 | 1441.28 | 144.487 | 58.9865 | | . |
| 4 | 2003 | 2 | 120 | 6 | 1363.13 | 137.967 | 56.3249 | | . |
| 5 | 2004 | 1 | 60 | 6 | 1759.77 | 39.025 | 15.9320 | | . |
| 6 | 2004 | 1 | 120 | 6 | 1907.62 | 125.067 | 51.0585 | | . |
| 7 | 2004 | 2 | 60 | 6 | 1985.90 | 133.068 | 54.3249 | | . |
| 8 | 2004 | 2 | 120 | 6 | 2091.33 | 85.602 | 34.9470 | | . |
| 9 | 2005 | 1 | 60 | 6 | 1395.35 | 101.330 | 41.3677 | | . |
| 10 | 2005 | 1 | 120 | 6 | 1496.93 | 45.341 | 18.5103 | | . |
| 11 | 2005 | 2 | 60 | 6 | 1578.46 | 70.430 | 28.7529 | | . |
| 12 | 2005 | 2 | 120 | 6 | 1574.45 | 138.776 | 56.6550 | | . |

## Appendix E: Ultra Narrow Row- Pix (UNR-Pix) Study SAS data

```
UNR-Pix
Starch input

MPTrt 1= 40inch rows
      2= 20inch rows
      3= 10inch rows
SPTrt 1= No Pix
      2= Application of Pix


Data UNRP959697s;
input Year Rep MPTrt SPTrt Stem starch;
cards;
1995    1       1       1       6       51.54
1995    1       1       4       6       50.12
1995    1       2       4       6       49.99
1995    1       2       1       6       48.69
1995    1       4       4       6       50.70
1995    1       4       1       6       49.63
1995    2       4       1       6       50.28
1995    2       4       4       6       51.34
1995    2       1       1       6       48.05
1995    2       1       4       6       51.54
1995    2       2       1       6       50.89
1995    2       2       4       6       52.15
1995    3       1       4       6       50.70
1995    3       1       1       6       50.79
1995    3       4       4       6       50.83
1995    3       4       1       6       51.63
1995    3       2       4       6       50.18
1995    3       2       1       6       47.95
1995    4       1       4       6       16.23
1995    4       1       1       6       51.18
1995    4       4       1       6       48.89
1995    4       4       4       6       45.27
1995    4       2       1       6       45.08
1995    4       2       4       6       51.05
1995    1       1       1       7       32.58
1995    1       1       4       7       49.95
1995    1       2       4       7       33.19
1995    1       2       1       7       41.72
1995    1       4       4       7       50.02
1995    1       4       1       7       48.92
1995    2       4       1       7       50.08
1995    2       4       4       7       51.25
1995    2       1       1       7       50.24
1995    2       1       4       7       30.80
1995    2       2       1       7       50.21
1995    2       2       4       7       50.41
1995    3       1       4       7       25.99
1995    3       1       1       7       50.18
1995    3       4       4       7       51.08
1995    3       4       1       7       51.41
1995    3       2       4       7       38.84
1995    3       2       1       7       50.76
1995    4       1       4       7       17.23
1995    4       1       1       7       45.17
1995    4       4       1       7       49.79
1995    4       4       4       7       49.82
1995    4       2       1       7       47.92
1995    4       2       4       7       50.63
1995    1       1       1       8       27.76
1995    1       1       4       8       39.88
1995    1       2       4       8       47.66
1995    1       2       1       8       47.44
```

| | | | | | |
|---|---|---|---|---|---|
| 1995 | 1 | 4 | 4 | 8 | 7.41 |
| 1995 | 1 | 4 | 1 | 8 | 46.11 |
| 1995 | 2 | 4 | 1 | 8 | 40.33 |
| 1995 | 2 | 4 | 4 | 8 | 48.24 |
| 1995 | 2 | 1 | 1 | 8 | 48.47 |
| 1995 | 2 | 1 | 4 | 8 | 48.44 |
| 1995 | 2 | 2 | 1 | 8 | 48.18 |
| 1995 | 2 | 2 | 4 | 8 | 34.81 |
| 1995 | 3 | 1 | 4 | 8 | 48.54 |
| 1995 | 3 | 1 | 1 | 8 | 47.44 |
| 1995 | 3 | 4 | 4 | 8 | 47.44 |
| 1995 | 3 | 4 | 1 | 8 | 47.34 |
| 1995 | 3 | 2 | 4 | 8 | 8.48 |
| 1995 | 3 | 2 | 1 | 8 | 47.21 |
| 1995 | 4 | 1 | 4 | 8 | 46.95 |
| 1995 | 4 | 1 | 1 | 8 | 41.49 |
| 1995 | 4 | 4 | 1 | 8 | 47.53 |
| 1995 | 4 | 4 | 4 | 8 | 46.60 |
| 1995 | 4 | 2 | 1 | 8 | 49.44 |
| 1995 | 4 | 2 | 4 | 8 | 49.60 |
| 1995 | 1 | 1 | 1 | 9 | 39.72 |
| 1995 | 1 | 1 | 4 | 9 | 29.67 |
| 1995 | 1 | 2 | 4 | 9 | 26.50 |
| 1995 | 1 | 2 | 1 | 9 | 33.87 |
| 1995 | 1 | 4 | 4 | 9 | 31.03 |
| 1995 | 1 | 4 | 1 | 9 | 49.63 |
| 1995 | 2 | 4 | 1 | 9 | 2.92 |
| 1995 | 2 | 4 | 4 | 9 | 48.92 |
| 1995 | 2 | 1 | 1 | 9 | 48.18 |
| 1995 | 2 | 1 | 4 | 9 | 23.73 |
| 1995 | 2 | 2 | 1 | 9 | 50.22 |
| 1995 | 2 | 2 | 4 | 9 | 49.41 |
| 1995 | 3 | 1 | 4 | 9 | 16.85 |
| 1995 | 3 | 1 | 1 | 9 | 49.57 |
| 1995 | 3 | 4 | 4 | 9 | 17.62 |
| 1995 | 3 | 4 | 1 | 9 | 50.28 |
| 1995 | 3 | 2 | 4 | 9 | 67.17 |
| 1995 | 3 | 2 | 1 | 9 | 49.08 |
| 1995 | 4 | 1 | 4 | 9 | 43.56 |
| 1995 | 4 | 1 | 1 | 9 | 27.34 |
| 1995 | 4 | 4 | 1 | 9 | 33.22 |
| 1995 | 4 | 4 | 4 | 9 | 31.09 |
| 1995 | 4 | 2 | 1 | 9 | 49.47 |
| 1995 | 4 | 2 | 4 | 9 | 50.41 |
| 1995 | 1 | 1 | 1 | 10 | 43.56 |
| 1995 | 1 | 1 | 4 | 10 | 47.98 |
| 1995 | 1 | 2 | 4 | 10 | 45.72 |
| 1995 | 1 | 2 | 1 | 10 | . |
| 1995 | 1 | 4 | 4 | 10 | 48.60 |
| 1995 | 1 | 4 | 1 | 10 | 47.95 |
| 1995 | 2 | 4 | 1 | 10 | 49.76 |
| 1995 | 2 | 4 | 4 | 10 | 33.38 |
| 1995 | 2 | 1 | 1 | 10 | 49.57 |
| 1995 | 2 | 1 | 4 | 10 | 34.32 |
| 1995 | 2 | 2 | 1 | 10 | 49.11 |
| 1995 | 2 | 2 | 4 | 10 | 50.57 |
| 1995 | 3 | 1 | 4 | 10 | 50.50 |
| 1995 | 3 | 1 | 1 | 10 | 45.66 |
| 1995 | 3 | 4 | 4 | 10 | 34.09 |
| 1995 | 3 | 4 | 1 | 10 | 43.23 |
| 1995 | 3 | 2 | 4 | 10 | 27.73 |
| 1995 | 3 | 2 | 1 | 10 | 6.22 |
| 1995 | 4 | 1 | 4 | 10 | 36.84 |
| 1995 | 4 | 1 | 1 | 10 | 47.98 |
| 1995 | 4 | 4 | 1 | 10 | 49.92 |
| 1995 | 4 | 4 | 4 | 10 | 21.14 |
| 1995 | 4 | 2 | 1 | 10 | 46.72 |
| 1995 | 4 | 2 | 4 | 10 | 49.18 |
| 1996 | 1 | 1 | 1 | 6 | 46.27 |

| | | | | | |
|---|---|---|---|---|---|
| 1996 | 1 | 1 | 4 | 6 | 35.32 |
| 1996 | 1 | 2 | 4 | 6 | 45.69 |
| 1996 | 1 | 2 | 1 | 6 | 47.92 |
| 1996 | 1 | 4 | 4 | 6 | 29.93 |
| 1996 | 1 | 4 | 1 | 6 | 48.21 |
| 1996 | 2 | 4 | 1 | 6 | 44.59 |
| 1996 | 2 | 4 | 4 | 6 | 45.21 |
| 1996 | 2 | 1 | 1 | 6 | 48.08 |
| 1996 | 2 | 1 | 4 | 6 | 44.46 |
| 1996 | 2 | 2 | 1 | 6 | 45.56 |
| 1996 | 2 | 2 | 4 | 6 | 49.57 |
| 1996 | 3 | 1 | 4 | 6 | 44.49 |
| 1996 | 3 | 1 | 1 | 6 | 47.53 |
| 1996 | 3 | 4 | 4 | 6 | 48.53 |
| 1996 | 3 | 4 | 1 | 6 | 42.56 |
| 1996 | 3 | 2 | 4 | 6 | 47.85 |
| 1996 | 3 | 2 | 1 | 6 | 20.75 |
| 1996 | 4 | 1 | 4 | 6 | 25.79 |
| 1996 | 4 | 1 | 1 | 6 | 50.53 |
| 1996 | 4 | 4 | 1 | 6 | 48.76 |
| 1996 | 4 | 4 | 4 | 6 | 46.40 |
| 1996 | 4 | 2 | 1 | 6 | 37.19 |
| 1996 | 4 | 2 | 4 | 6 | 21.24 |
| 1996 | 1 | 1 | 1 | 7 | 49.41 |
| 1996 | 1 | 1 | 4 | 7 | 11.97 |
| 1996 | 1 | 2 | 4 | 7 | 30.41 |
| 1996 | 1 | 2 | 1 | 7 | 50.34 |
| 1996 | 1 | 4 | 4 | 7 | 49.60 |
| 1996 | 1 | 4 | 1 | 7 | 49.05 |
| 1996 | 2 | 4 | 1 | 7 | 49.31 |
| 1996 | 2 | 4 | 4 | 7 | 50.02 |
| 1996 | 2 | 1 | 1 | 7 | 32.19 |
| 1996 | 2 | 1 | 4 | 7 | 50.44 |
| 1996 | 2 | 2 | 1 | 7 | 48.57 |
| 1996 | 2 | 2 | 4 | 7 | 50.57 |
| 1996 | 3 | 1 | 4 | 7 | 49.50 |
| 1996 | 3 | 1 | 1 | 7 | 45.82 |
| 1996 | 3 | 4 | 4 | 7 | 49.57 |
| 1996 | 3 | 4 | 1 | 7 | 48.86 |
| 1996 | 3 | 2 | 4 | 7 | 47.57 |
| 1996 | 3 | 2 | 1 | 7 | 50.28 |
| 1996 | 4 | 1 | 4 | 7 | 48.31 |
| 1996 | 4 | 1 | 1 | 7 | 50.34 |
| 1996 | 4 | 4 | 1 | 7 | 49.83 |
| 1996 | 4 | 4 | 4 | 7 | 48.05 |
| 1996 | 4 | 2 | 1 | 7 | 30.41 |
| 1996 | 4 | 2 | 4 | 7 | 50.76 |
| 1996 | 1 | 1 | 1 | 8 | 34.61 |
| 1996 | 1 | 1 | 4 | 8 | 18.69 |
| 1996 | 1 | 2 | 4 | 8 | 49.96 |
| 1996 | 1 | 2 | 1 | 8 | 43.50 |
| 1996 | 1 | 4 | 4 | 8 | 50.25 |
| 1996 | 1 | 4 | 1 | 8 | 41.78 |
| 1996 | 2 | 4 | 1 | 8 | 48.02 |
| 1996 | 2 | 4 | 4 | 8 | 66.85 |
| 1996 | 2 | 1 | 1 | 8 | 29.77 |
| 1996 | 2 | 1 | 4 | 8 | 28.80 |
| 1996 | 2 | 2 | 1 | 8 | 50.80 |
| 1996 | 2 | 2 | 4 | 8 | 38.97 |
| 1996 | 3 | 1 | 4 | 8 | 10.58 |
| 1996 | 3 | 1 | 1 | 8 | 37.81 |
| 1996 | 3 | 4 | 4 | 8 | 50.18 |
| 1996 | 3 | 4 | 1 | 8 | 38.91 |
| 1996 | 3 | 2 | 4 | 8 | 35.39 |
| 1996 | 3 | 2 | 1 | 8 | 50.51 |
| 1996 | 4 | 1 | 4 | 8 | 24.57 |
| 1996 | 4 | 1 | 1 | 8 | 49.44 |
| 1996 | 4 | 4 | 1 | 8 | 50.12 |
| 1996 | 4 | 4 | 4 | 8 | 50.47 |

| | | | | | |
|---|---|---|---|---|---|
| 1996 | 4 | 2 | 1 | 8 | 50.28 |
| 1996 | 4 | 2 | 4 | 8 | 49.99 |
| 1996 | 1 | 1 | 1 | 9 | 37.58 |
| 1996 | 1 | 1 | 4 | 9 | 46.05 |
| 1996 | 1 | 2 | 4 | 9 | 46.66 |
| 1996 | 1 | 2 | 1 | 9 | 33.55 |
| 1996 | 1 | 4 | 4 | 9 | 44.24 |
| 1996 | 1 | 4 | 1 | 9 | 43.53 |
| 1996 | 2 | 4 | 1 | 9 | 47.02 |
| 1996 | 2 | 4 | 4 | 9 | 47.31 |
| 1996 | 2 | 1 | 1 | 9 | 29.64 |
| 1996 | 2 | 1 | 4 | 9 | 47.05 |
| 1996 | 2 | 2 | 1 | 9 | 45.34 |
| 1996 | 2 | 2 | 4 | 9 | 45.73 |
| 1996 | 3 | 1 | 4 | 9 | 19.79 |
| 1996 | 3 | 1 | 1 | 9 | 28.60 |
| 1996 | 3 | 4 | 4 | 9 | 28.25 |
| 1996 | 3 | 4 | 1 | 9 | 45.14 |
| 1996 | 3 | 2 | 4 | 9 | 21.47 |
| 1996 | 3 | 2 | 1 | 9 | 48.34 |
| 1996 | 4 | 1 | 4 | 9 | 40.62 |
| 1996 | 4 | 1 | 1 | 9 | 33.13 |
| 1996 | 4 | 4 | 1 | 9 | 36.55 |
| 1996 | 4 | 4 | 4 | 9 | 39.78 |
| 1996 | 4 | 2 | 1 | 9 | 47.28 |
| 1996 | 4 | 2 | 4 | 9 | 33.39 |
| 1996 | 1 | 1 | 1 | 10 | 47.05 |
| 1996 | 1 | 1 | 4 | 10 | 46.05 |
| 1996 | 1 | 2 | 4 | 10 | 15.72 |
| 1996 | 1 | 2 | 1 | 10 | 47.24 |
| 1996 | 1 | 4 | 4 | 10 | 48.08 |
| 1996 | 1 | 4 | 1 | 10 | 47.44 |
| 1996 | 2 | 4 | 1 | 10 | 70.89 |
| 1996 | 2 | 4 | 4 | 10 | 47.05 |
| 1996 | 2 | 1 | 1 | 10 | 45.92 |
| 1996 | 2 | 1 | 4 | 10 | 46.66 |
| 1996 | 2 | 2 | 1 | 10 | 47.08 |
| 1996 | 2 | 2 | 4 | 10 | 46.98 |
| 1996 | 3 | 1 | 4 | 10 | 43.08 |
| 1996 | 3 | 1 | 1 | 10 | 42.27 |
| 1996 | 3 | 4 | 4 | 10 | 47.44 |
| 1996 | 3 | 4 | 1 | 10 | 47.47 |
| 1996 | 3 | 2 | 4 | 10 | 44.17 |
| 1996 | 3 | 2 | 1 | 10 | 47.40 |
| 1996 | 4 | 1 | 4 | 10 | 40.14 |
| 1996 | 4 | 1 | 1 | 10 | 42.95 |
| 1996 | 4 | 4 | 1 | 10 | 46.34 |
| 1996 | 4 | 4 | 4 | 10 | 34.48 |
| 1996 | 4 | 2 | 1 | 10 | 16.07 |
| 1996 | 4 | 2 | 4 | 10 | 47.60 |
| 1997 | 1 | 1 | 1 | 6 | 46.66 |
| 1997 | 1 | 1 | 4 | 6 | 32.13 |
| 1997 | 1 | 2 | 4 | 6 | 46.79 |
| 1997 | 1 | 2 | 1 | 6 | 46.92 |
| 1997 | 1 | 4 | 4 | 6 | 47.82 |
| 1997 | 1 | 4 | 1 | 6 | 47.37 |
| 1997 | 2 | 4 | 1 | 6 | 48.60 |
| 1997 | 2 | 4 | 4 | 6 | 48.24 |
| 1997 | 2 | 1 | 4 | 6 | . |
| 1997 | 2 | 1 | 1 | 6 | 48.31 |
| 1997 | 2 | 2 | 4 | 6 | 48.15 |
| 1997 | 2 | 2 | 1 | 6 | 48.08 |
| 1997 | 3 | 1 | 1 | 6 | 40.20 |
| 1997 | 3 | 1 | 4 | 6 | 48.28 |
| 1997 | 3 | 4 | 1 | 6 | 30.25 |
| 1997 | 3 | 4 | 4 | 6 | 47.86 |
| 1997 | 3 | 2 | 1 | 6 | 48.31 |
| 1997 | 3 | 2 | 4 | 6 | 49.21 |
| 1997 | 4 | 1 | 4 | 6 | 48.18 |

| | | | | | |
|---|---|---|---|---|---|
| 1997 | 4 | 1 | 1 | 6 | 48.18 |
| 1997 | 4 | 4 | 4 | 6 | 45.18 |
| 1997 | 4 | 4 | 1 | 6 | 44.63 |
| 1997 | 4 | 2 | 1 | 6 | 47.86 |
| 1997 | 4 | 2 | 4 | 6 | 43.59 |
| 1997 | 1 | 1 | 1 | 7 | 29.06 |
| 1997 | 1 | 1 | 4 | 7 | 48.47 |
| 1997 | 1 | 2 | 4 | 7 | 47.70 |
| 1997 | 1 | 2 | 1 | 7 | 47.53 |
| 1997 | 1 | 4 | 4 | 7 | 47.02 |
| 1997 | 1 | 4 | 1 | 7 | 46.63 |
| 1997 | 2 | 4 | 1 | 7 | 47.34 |
| 1997 | 2 | 4 | 4 | 7 | 47.18 |
| 1997 | 2 | 1 | 4 | 7 | 45.05 |
| 1997 | 2 | 1 | 1 | 7 | 30.48 |
| 1997 | 2 | 2 | 4 | 7 | 47.53 |
| 1997 | 2 | 2 | 1 | 7 | 46.02 |
| 1997 | 3 | 1 | 1 | 7 | 48.73 |
| 1997 | 3 | 1 | 4 | 7 | 47.86 |
| 1997 | 3 | 4 | 1 | 7 | 46.08 |
| 1997 | 3 | 4 | 4 | 7 | 47.76 |
| 1997 | 3 | 2 | 1 | 7 | 45.79 |
| 1997 | 3 | 2 | 4 | 7 | 23.18 |
| 1997 | 4 | 1 | 4 | 7 | 46.08 |
| 1997 | 4 | 1 | 1 | 7 | 44.85 |
| 1997 | 4 | 4 | 4 | 7 | 46.79 |
| 1997 | 4 | 4 | 1 | 7 | 41.65 |
| 1997 | 4 | 2 | 1 | 7 | 41.88 |
| 1997 | 4 | 2 | 4 | 7 | 34.58 |
| 1997 | 1 | 1 | 1 | 8 | 48.84 |
| 1997 | 1 | 1 | 4 | 8 | 47.59 |
| 1997 | 1 | 2 | 4 | 8 | 47.18 |
| 1997 | 1 | 2 | 1 | 8 | 31.05 |
| 1997 | 1 | 4 | 4 | 8 | 49.31 |
| 1997 | 1 | 4 | 1 | 8 | 48.23 |
| 1997 | 2 | 4 | 1 | 8 | 48.03 |
| 1997 | 2 | 4 | 4 | 8 | 44.35 |
| 1997 | 2 | 1 | 4 | 8 | 48.84 |
| 1997 | 2 | 1 | 1 | 8 | 49.65 |
| 1997 | 2 | 2 | 4 | 8 | 45.70 |
| 1997 | 2 | 2 | 1 | 8 | 46.88 |
| 1997 | 3 | 1 | 1 | 8 | 46.91 |
| 1997 | 3 | 1 | 4 | 8 | 12.05 |
| 1997 | 3 | 4 | 1 | 8 | 46.47 |
| 1997 | 3 | 4 | 4 | 8 | 48.60 |
| 1997 | 3 | 2 | 1 | 8 | 49.24 |
| 1997 | 3 | 2 | 4 | 8 | 49.17 |
| 1997 | 4 | 1 | 4 | 8 | 47.28 |
| 1997 | 4 | 1 | 1 | 8 | 49.41 |
| 1997 | 4 | 4 | 4 | 8 | 48.70 |
| 1997 | 4 | 4 | 1 | 8 | 48.74 |
| 1997 | 4 | 2 | 1 | 8 | 49.65 |
| 1997 | 4 | 2 | 4 | 8 | 48.63 |
| 1997 | 1 | 1 | 1 | 9 | 26.36 |
| 1997 | 1 | 1 | 4 | 9 | 47.01 |
| 1997 | 1 | 2 | 4 | 9 | 48.60 |
| 1997 | 1 | 2 | 1 | 9 | 47.72 |
| 1997 | 1 | 4 | 4 | 9 | 49.21 |
| 1997 | 1 | 4 | 1 | 9 | 48.53 |
| 1997 | 2 | 4 | 1 | 9 | 40.50 |
| 1997 | 2 | 4 | 4 | 9 | 46.91 |
| 1997 | 2 | 1 | 4 | 9 | 24.37 |
| 1997 | 2 | 1 | 1 | 9 | 48.57 |
| 1997 | 2 | 2 | 4 | 9 | 48.74 |
| 1997 | 2 | 2 | 1 | 9 | 48.47 |
| 1997 | 3 | 1 | 1 | 9 | 46.58 |
| 1997 | 3 | 1 | 4 | 9 | 18.77 |
| 1997 | 3 | 4 | 1 | 9 | 47.96 |
| 1997 | 3 | 4 | 4 | 9 | 48.50 |

```
1997    3       2       1       9       44.11
1997    3       2       4       9       49.07
1997    4       1       4       9       48.03
1997    4       1       1       9       11.81
1997    4       4       4       9       29.67
1997    4       4       1       9       48.23
1997    4       2       1       9       49.75
1997    4       2       4       9       49.01
1997    1       1       1       10      37.19
1997    1       1       4       10      26.36
1997    1       2       4       10      48.36
1997    1       2       1       10      46.14
1997    1       4       4       10      46.58
1997    1       4       1       10      48.13
1997    2       4       1       10      47.99
1997    2       4       4       10      46.85
1997    2       1       4       10      46.27
1997    2       1       1       10      44.85
1997    2       2       4       10      46.17
1997    2       2       1       10      46.85
1997    3       1       1       10      47.12
1997    3       1       4       10      47.55
1997    3       4       1       10      46.47
1997    3       4       4       10      47.35
1997    3       2       1       10      50.46
1997    3       2       4       10      50.96
1997    4       1       4       10      50.15
1997    4       1       1       10      50.12
1997    4       4       4       10      49.44
1997    4       4       1       10      49.78
1997    4       2       1       10      51.20
1997    4       2       4       10      37.90
;
run;
Proc   glm   data =UNRP9598;
Class  Year Rep MPTrt SPTrt Stem;
Model  Starch=Year Rep(Year) MPTrt Year*MPTrt MPTrt*Rep(Year) SPTrt Year*SPTrt
MPTrt*SPTrt Year*MPTrt*SPTrt;
Test   h=MPTrt e=MPTrt*Rep(Year);
Lsmeans  MPTrt SPTrt MPTrt*SPTrt/ pdiff ;
Run ;
```

UNR Starch
SAS Output

```
                                        The Mixed Procedure

                                        Model Information

                      Data Set                      WORK.UNRP9598
                      Dependent Variable            starch
                      Covariance Structure          Diagonal
                      Estimation Method             REML
                      Residual Variance Method      Profile
                      Fixed Effects SE Method       Model-Based
                      Degrees of Freedom Method     Residual


                                      Class Level Information

                         Class     Levels    Values

                         Year           3    1995 1996 1997
                         Rep            4    1 2 3 4
                         MPTrt          3    1 2 4
                         SPTrt          2    1 4


                                            Dimensions
```

| | |
|---|---|
| Covariance Parameters | 1 |
| Columns in X | 96 |
| Columns in Z | 0 |
| Subjects | 1 |
| Max Obs Per Subject | 360 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 360 |
| Number of Observations Used | 358 |
| Number of Observations Not Used | 2 |

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Residual | 95.2062 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 2417.6 |
| AIC (smaller is better) | 2419.6 |
| AICC (smaller is better) | 2419.7 |
| BIC (smaller is better) | 2423.4 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 313 | 1.70 | 0.1837 |
| Rep(Year) | 9 | 313 | 0.90 | 0.5243 |
| MPTrt | 2 | 313 | 7.74 | 0.0005 |
| Year*MPTrt | 4 | 313 | 1.42 | 0.2278 |
| Rep*MPTrt(Year) | 18 | 313 | 0.74 | 0.7704 |
| SPTrt | 1 | 313 | 5.86 | 0.0161 |
| Year*SPTrt | 2 | 313 | 1.02 | 0.3602 |
| MPTrt*SPTrt | 2 | 313 | 0.87 | 0.4214 |
| Year*MPTrt*SPTrt | 4 | 313 | 0.34 | 0.8527 |

Least Squares Means

| Effect | MPTrt | SPTrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| MPTrt | 1 | | 40.6178 | 0.8950 | 313 | 45.39 | <.0001 |
| MPTrt | 2 | | 44.2354 | 0.8950 | 313 | 49.43 | <.0001 |
| MPTrt | 4 | | 45.3810 | 0.8907 | 313 | 50.95 | <.0001 |
| SPTrt | | 1 | 44.6599 | 0.7296 | 313 | 61.21 | <.0001 |
| SPTrt | | 4 | 42.1628 | 0.7296 | 313 | 57.79 | <.0001 |
| MPTrt*SPTrt | 1 | 1 | 42.8215 | 1.2597 | 313 | 33.99 | <.0001 |
| MPTrt*SPTrt | 1 | 4 | 38.4140 | 1.2716 | 313 | 30.21 | <.0001 |
| MPTrt*SPTrt | 2 | 1 | 44.9110 | 1.2716 | 313 | 35.32 | <.0001 |
| MPTrt*SPTrt | 2 | 4 | 43.5598 | 1.2597 | 313 | 34.58 | <.0001 |
| MPTrt*SPTrt | 4 | 1 | 46.2473 | 1.2597 | 313 | 36.71 | <.0001 |
| MPTrt*SPTrt | 4 | 4 | 44.5147 | 1.2597 | 313 | 35.34 | <.0001 |

Differences of Least Squares Means

| Effect | MPTrt | SPTrt | _MPTrt | _SPTrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPTrt | 1 | | 2 | | -3.6176 | 1.2657 | 313 | -2.86 | 0.0045 |
| MPTrt | 1 | | 4 | | -4.7632 | 1.2627 | 313 | -3.77 | 0.0002 |
| MPTrt | 2 | | 4 | | -1.1456 | 1.2627 | 313 | -0.91 | 0.3650 |
| SPTrt | | 1 | | 4 | 2.4971 | 1.0318 | 313 | 2.42 | 0.0161 |
| MPTrt*SPTrt | 1 | 1 | 1 | 4 | 4.4075 | 1.7899 | 313 | 2.46 | 0.0143 |
| MPTrt*SPTrt | 1 | 1 | 2 | 1 | -2.0895 | 1.7899 | 313 | -1.17 | 0.2439 |
| MPTrt*SPTrt | 1 | 1 | 2 | 4 | -0.7383 | 1.7814 | 313 | -0.41 | 0.678 |
| MPTrt*SPTrt | 1 | 1 | 4 | 1 | -3.4258 | 1.7814 | 313 | -1.92 | 0.0554 |
| MPTrt*SPTrt | 1 | 1 | 4 | 4 | -1.6932 | 1.7814 | 313 | -0.95 | 0.3426 |
| MPTrt*SPTrt | 1 | 4 | 2 | 1 | -6.4970 | 1.7983 | 313 | -3.61 | 0.0004 |
| MPTrt*SPTrt | 1 | 4 | 2 | 4 | -5.1458 | 1.7899 | 313 | -2.87 | 0.0043 |
| MPTrt*SPTrt | 1 | 4 | 4 | 1 | -7.8333 | 1.7899 | 313 | -4.38 | <.0001 |

Differences of Least Squares Means

| Effect | MPTrt | SPTrt | MPTrt | SPTrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPTrt*SPTrt | 1 | 4 | 4 | 4 | -6.1006 | 1.7899 | 313 | -3.41 | 0.0007 |
| MPTrt*SPTrt | 2 | 1 | 2 | 4 | 1.3512 | 1.7899 | 313 | 0.75 | 0.4509 |
| MPTrt*SPTrt | 2 | 1 | 4 | 1 | -1.3363 | 1.7899 | 313 | -0.75 | 0.4559 |
| MPTrt*SPTrt | 2 | 1 | 4 | 4 | 0.3963 | 1.7899 | 313 | 0.22 | 0.8249 |
| MPTrt*SPTrt | 2 | 4 | 4 | 1 | -2.6875 | 1.7814 | 313 | -1.51 | 0.1324 |
| MPTrt*SPTrt | 2 | 4 | 4 | 4 | -0.9548 | 1.7814 | 313 | -0.54 | 0.5923 |
| MPTrt*SPTrt | 4 | 1 | 4 | 4 | 1.7327 | 1.7814 | 313 | 0.97 | 0.3315 |

Glucose Standard Curve

| | |
|---|---|
| Intercept | -0.00805 |
| Abs | 0.538385 |

*Regression Statistics*

| | |
|---|---|
| Multiple R | 0.986878 |
| R Square | 0.973929 |

UNR- Pix Soluble Sugar-
Glucose, Fructose, Sucrose and the sum of all three
SAS Input

MPTrt 1= 40inch rows
2= 20inch rows
3= 10inch rows
SPTrt 1= No Pix
2= Application of Pix
Sugars are in mg/g dry weight

```
Data UNR959697;
input Batch    Year Plot  Rep  MPtrt  SPtrt  Glu  Fru Suc TSS;
cards;
1      1995   101    1      1      1      8.37    9.98    25.85   43.87
1      1995   104    1      1      4      6.23    9.83    29.15   46.09
1      1995   105    1      2      4      7.56    8.44    61.61   78.37
1      1995   106    1      2      1      14.37   13.84   39.07   69.28
1      1995   110    1      4      4      8.08    12.60   34.86   56.36
1      1995   112    1      4      1      7.61    12.10   28.25   49.20
1      1995   205    2      4      1      13.37   13.27   44.18   70.99
1      1995   208    2      4      4      8.56    10.62   27.05   46.72
1      1995   210    2      1      1      18.47   15.22   23.74   57.51
1      1995   211    2      1      4      6.84    11.18   9.62    28.10
1      1995   215    2      2      1      13.13   13.90   25.25   53.44
1      1995   216    2      2      4      5.42    8.82    9.32    24.10
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1995 | 302 | 3 | 1 | 4 | 11.37 | 13.24 | 28.55 | 53.06 |
| 1 | 1995 | 303 | 3 | 1 | 1 | 8.94 | 12.42 | 20.14 | 44.66 |
| 1 | 1995 | 309 | 3 | 4 | 4 | 10.51 | 12.98 | 17.73 | 42.73 |
| 1 | 1995 | 311 | 3 | 4 | 1 | 22.18 | 18.03 | 21.64 | 62.09 |
| 1 | 1995 | 315 | 3 | 2 | 4 | 14.32 | 11.03 | 33.96 | 59.83 |
| 1 | 1995 | 316 | 3 | 2 | 1 | 16.09 | 13.65 | 30.66 | 59.48 |
| 1 | 1995 | 401 | 4 | 1 | 4 | 9.04 | 10.90 | 27.05 | 48.34 |
| 1 | 1995 | 404 | 4 | 1 | 1 | 9.32 | 12.48 | 24.95 | 47.75 |
| 1 | 1995 | 406 | 4 | 4 | 1 | 13.23 | 13.27 | . | . |
| 1 | 1995 | 407 | 4 | 4 | 4 | 12.32 | 11.56 | 0.00 | 17.72 |
| 1 | 1995 | 409 | 4 | 2 | 1 | 19.23 | 11.59 | 12.62 | 33.61 |
| 1 | 1995 | 410 | 4 | 2 | 4 | 7.23 | 12.48 | 24.34 | 44.69 |
| 1 | 1995 | 101 | 1 | 1 | 1 | 7.70 | 11.31 | 17.13 | 36.83 |
| 1 | 1995 | 104 | 1 | 1 | 4 | 7.75 | 8.94 | 20.44 | 37.34 |
| 1 | 1995 | 105 | 1 | 2 | 4 | 9.56 | 12.19 | 24.04 | 47.04 |
| 1 | 1995 | 106 | 1 | 2 | 1 | 11.27 | 11.69 | 27.05 | 48.61 |
| 1 | 1995 | 110 | 1 | 4 | 4 | 6.08 | 12.57 | 32.46 | 51.45 |
| 1 | 1995 | 112 | 1 | 4 | 1 | 8.80 | 10.65 | 32.76 | 53.06 |
| 1 | 1995 | 205 | 2 | 4 | 1 | 11.99 | 14.69 | 41.18 | 67.54 |
| 1 | 1995 | 208 | 2 | 4 | 4 | 11.56 | 12.89 | 30.66 | 55.39 |
| 1 | 1995 | 210 | 2 | 1 | 1 | 9.70 | 12.86 | 10.52 | 33.05 |
| 1 | 1995 | 211 | 2 | 1 | 4 | 11.66 | 13.84 | 11.72 | 38.62 |
| 1 | 1995 | 215 | 2 | 2 | 1 | 13.04 | 15.89 | 33.36 | 64.62 |
| 1 | 1995 | 216 | 2 | 2 | 4 | 7.27 | 11.25 | 9.92 | 30.18 |
| 1 | 1995 | 302 | 3 | 1 | 4 | 3.22 | 10.36 | 38.17 | 52.59 |
| 1 | 1995 | 303 | 3 | 1 | 1 | 8.32 | 11.34 | 32.16 | 50.58 |
| 1 | 1995 | 309 | 3 | 4 | 4 | 3.99 | 9.67 | 18.93 | 33.80 |
| 1 | 1995 | 311 | 3 | 4 | 1 | 18.85 | 17.25 | 25.25 | 64.48 |
| 1 | 1995 | 315 | 3 | 2 | 4 | 4.65 | 9.64 | . | . |
| 1 | 1995 | 316 | 3 | 2 | 1 | 8.37 | 10.71 | 39.37 | 58.88 |
| 1 | 1995 | 401 | 4 | 1 | 4 | 10.27 | 15.54 | 10.22 | 38.20 |
| 1 | 1995 | 404 | 4 | 1 | 1 | 8.32 | 11.75 | 33.06 | 54.63 |
| 1 | 1995 | 406 | 4 | 4 | 1 | 5.89 | 10.39 | 51.09 | 70.64 |
| 1 | 1995 | 407 | 4 | 4 | 4 | 5.75 | 11.63 | 40.27 | 59.89 |
| 1 | 1995 | 409 | 4 | 2 | 1 | 4.08 | 10.84 | 36.97 | 54.86 |
| 1 | 1995 | 410 | 4 | 2 | 4 | 10.56 | 13.20 | 45.08 | 68.51 |
| 2 | 1995 | 101 | 1 | 1 | 1 | 18.18 | 16.30 | 39.37 | 74.73 |
| 2 | 1995 | 104 | 1 | 1 | 4 | 9.70 | 14.25 | . | . |
| 2 | 1995 | 105 | 1 | 2 | 4 | 6.84 | 12.16 | 3.01 | 22.75 |
| 2 | 1995 | 106 | 1 | 2 | 1 | 11.04 | 12.89 | 8.42 | 33.01 |
| 2 | 1995 | 110 | 1 | 4 | 4 | 13.51 | 11.91 | 32.76 | 57.83 |
| 2 | 1995 | 112 | 1 | 4 | 1 | 12.37 | 11.85 | 34.56 | 58.14 |
| 2 | 1995 | 205 | 2 | 4 | 1 | 11.94 | 13.99 | 21.34 | 47.54 |
| 2 | 1995 | 208 | 2 | 4 | 4 | 9.46 | 11.75 | 28.85 | 50.85 |
| 2 | 1995 | 210 | 2 | 1 | 1 | 6.75 | 9.51 | 20.14 | 36.02 |
| 2 | 1995 | 211 | 2 | 1 | 4 | 9.99 | 14.44 | 20.74 | 45.57 |
| 2 | 1995 | 215 | 2 | 2 | 1 | 13.51 | 14.85 | 27.35 | 56.64 |
| 2 | 1995 | 216 | 2 | 2 | 4 | 8.46 | 13.65 | 6.91 | 28.86 |
| 2 | 1995 | 302 | 3 | 1 | 4 | 7.51 | 10.39 | 24.04 | 43.24 |
| 2 | 1995 | 303 | 3 | 1 | 1 | 10.32 | 12.95 | 32.46 | 57.23 |
| 2 | 1995 | 309 | 3 | 4 | 4 | 15.85 | 19.46 | 40.27 | 74.27 |
| 2 | 1995 | 311 | 3 | 4 | 1 | 13.27 | 15.98 | 23.44 | 53.96 |
| 2 | 1995 | 315 | 3 | 2 | 4 | 8.99 | 14.85 | 18.63 | 43.33 |
| 2 | 1995 | 316 | 3 | 2 | 1 | 12.04 | 15.10 | 22.54 | 49.08 |
| 2 | 1995 | 401 | 4 | 1 | 4 | 6.75 | 12.32 | . | . |
| 2 | 1995 | 404 | 4 | 1 | 1 | 16.56 | 16.68 | 18.93 | 53.39 |
| 2 | 1995 | 406 | 4 | 4 | 1 | 13.94 | 16.27 | 29.15 | 60.67 |
| 2 | 1995 | 407 | 4 | 4 | 4 | 13.75 | 11.97 | 28.85 | 54.39 |
| 2 | 1995 | 409 | 4 | 2 | 1 | 4.89 | 9.26 | 11.12 | 25.60 |
| 2 | 1995 | 410 | 4 | 2 | 4 | 13.18 | 12.89 | 31.56 | 58.70 |
| 2 | 1995 | 101 | 1 | 1 | 1 | 6.13 | 7.08 | 70.33 | 83.49 |
| 2 | 1995 | 104 | 1 | 1 | 4 | 6.56 | 7.90 | 33.06 | 47.88 |
| 2 | 1995 | 105 | 1 | 2 | 4 | 5.56 | 8.82 | 30.06 | 44.57 |
| 2 | 1995 | 106 | 1 | 2 | 1 | 12.51 | 12.64 | 73.33 | 98.51 |
| 2 | 1995 | 110 | 1 | 4 | 4 | 5.84 | 8.66 | 18.93 | 33.41 |
| 2 | 1995 | 112 | 1 | 4 | 1 | 21.28 | 12.57 | 141.26 | 178.13 |
| 2 | 1995 | 205 | 2 | 4 | 1 | 11.80 | 8.69 | 70.33 | 90.39 |
| 2 | 1995 | 208 | 2 | 4 | 4 | 7.89 | 7.33 | 62.81 | 78.71 |
| 2 | 1995 | 210 | 2 | 1 | 1 | 9.32 | 11.53 | 55.60 | 75.79 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 1995 | 211 | 2 | 1 | 4 | 5.89 | 9.95 | 26.45 | 43.36 |
| 2 | 1995 | 215 | 2 | 2 | 1 | 7.89 | 12.45 | 7.51 | 29.42 |
| 2 | 1995 | 216 | 2 | 2 | 4 | 12.42 | 10.84 | 57.71 | 80.36 |
| 2 | 1995 | 302 | 3 | 1 | 4 | 7.61 | 10.93 | 40.87 | 59.84 |
| 2 | 1995 | 303 | 3 | 1 | 1 | 13.04 | 17.78 | 35.77 | 67.39 |
| 2 | 1995 | 309 | 3 | 4 | 4 | 3.89 | 10.84 | 27.05 | 43.40 |
| 2 | 1995 | 311 | 3 | 4 | 1 | 15.23 | 15.41 | 27.65 | 58.72 |
| 2 | 1995 | 315 | 3 | 2 | 4 | 7.80 | 9.32 | 23.74 | 41.50 |
| 2 | 1995 | 316 | 3 | 2 | 1 | 7.65 | 10.65 | 14.73 | 33.77 |
| 2 | 1995 | 401 | 4 | 1 | 4 | 9.70 | 12.73 | 14.43 | 38.36 |
| 2 | 1995 | 404 | 4 | 1 | 1 | 12.89 | 15.38 | 9.92 | 40.96 |
| 2 | 1995 | 406 | 4 | 4 | 1 | 15.80 | 17.15 | 50.79 | 86.03 |
| 2 | 1995 | 407 | 4 | 4 | 4 | 7.37 | 11.59 | 22.84 | 43.73 |
| 2 | 1995 | 409 | 4 | 2 | 1 | 15.23 | 17.66 | 54.10 | 88.51 |
| 2 | 1995 | 410 | 4 | 2 | 4 | 6.13 | 11.56 | 32.16 | 52.19 |
| 3 | 1995 | 101 | 1 | 1 | 1 | 12.94 | 17.59 | 41.18 | 71.30 |
| 3 | 1995 | 104 | 1 | 1 | 4 | 9.85 | 12.98 | 14.73 | 38.03 |
| 3 | 1995 | 105 | 1 | 2 | 4 | 7.99 | 12.32 | 24.95 | 45.66 |
| 3 | 1995 | 106 | 1 | 2 | 1 | 5.75 | 9.07 | 9.92 | 24.85 |
| 3 | 1995 | 110 | 1 | 4 | 4 | 6.99 | 10.36 | 30.96 | 46.73 |
| 3 | 1995 | 112 | 1 | 4 | 1 | 14.18 | 14.72 | 41.18 | 70.72 |
| 3 | 1995 | 205 | 2 | 4 | 1 | 9.85 | 12.51 | 21.94 | 43.96 |
| 3 | 1995 | 208 | 2 | 4 | 4 | 8.46 | 10.71 | 33.96 | 53.97 |
| 3 | 1995 | 210 | 2 | 1 | 1 | 3.56 | 9.04 | 14.73 | 27.75 |
| 3 | 1995 | 211 | 2 | 1 | 4 | 9.08 | 10.58 | 48.39 | 69.01 |
| 3 | 1995 | 215 | 2 | 2 | 1 | 8.18 | 11.63 | 15.93 | 36.26 |
| 3 | 1995 | 216 | 2 | 2 | 4 | 8.56 | 11.06 | 4.51 | 23.67 |
| 3 | 1995 | 302 | 3 | 1 | 4 | 6.46 | 10.05 | 45.98 | 63.59 |
| 3 | 1995 | 303 | 3 | 1 | 1 | 8.18 | 12.19 | 18.33 | 40.25 |
| 3 | 1995 | 309 | 3 | 4 | 4 | 5.99 | 11.09 | 18.93 | 36.84 |
| 3 | 1995 | 311 | 3 | 4 | 1 | 18.75 | 17.47 | 49.59 | 85.86 |
| 3 | 1995 | 315 | 3 | 2 | 4 | 9.61 | 10.77 | 23.74 | 45.53 |
| 3 | 1995 | 316 | 3 | 2 | 1 | 16.32 | 12.95 | 9.92 | 38.41 |
| 3 | 1995 | 401 | 4 | 1 | 4 | 18.56 | 13.24 | 17.73 | 48.39 |
| 3 | 1995 | 404 | 4 | 1 | 1 | 9.08 | 11.56 | 2.70 | 24.21 |
| 3 | 1995 | 406 | 4 | 4 | 1 | 6.51 | 12.89 | 18.93 | 41.41 |
| 3 | 1995 | 407 | 4 | 4 | 4 | 12.08 | 8.85 | 9.32 | 28.51 |
| 3 | 1995 | 409 | 4 | 2 | 1 | 13.51 | 13.39 | 24.95 | 51.19 |
| 3 | 1995 | 410 | 4 | 2 | 4 | 9.27 | 11.75 | 25.55 | 45.93 |
| 3 | 1996 | 101 | 1 | 1 | 1 | 4.51 | 8.88 | 31.56 | 45.28 |
| 3 | 1996 | 104 | 1 | 1 | 4 | 4.80 | 8.69 | 13.52 | 27.18 |
| 3 | 1996 | 105 | 1 | 2 | 4 | 6.46 | 8.75 | 9.92 | 25.99 |
| 3 | 1996 | 106 | 1 | 2 | 1 | 7.99 | 10.62 | . | . |
| 3 | 1996 | 110 | 1 | 4 | 4 | 5.13 | 7.68 | 12.32 | 26.13 |
| 3 | 1996 | 112 | 1 | 4 | 1 | 5.75 | 5.69 | 22.84 | 33.90 |
| 3 | 1996 | 205 | 2 | 4 | 1 | 6.65 | 8.34 | 15.03 | 30.05 |
| 3 | 1996 | 208 | 2 | 4 | 4 | 5.46 | 7.46 | 25.85 | 39.10 |
| 3 | 1996 | 210 | 2 | 1 | 1 | 4.22 | 9.07 | 14.43 | 28.55 |
| 3 | 1996 | 211 | 2 | 1 | 4 | 4.32 | 8.37 | 4.81 | 18.03 |
| 3 | 1996 | 215 | 2 | 2 | 1 | 4.22 | 7.96 | 11.42 | 23.58 |
| 3 | 1996 | 216 | 2 | 2 | 4 | 4.89 | 8.22 | 7.51 | 21.10 |
| 3 | 1996 | 302 | 3 | 1 | 4 | 5.32 | 8.41 | 19.84 | 33.56 |
| 3 | 1996 | 303 | 3 | 1 | 1 | 5.08 | 8.44 | 7.21 | 20.92 |
| 3 | 1996 | 309 | 3 | 4 | 4 | 4.65 | 7.77 | 11.12 | 23.62 |
| 3 | 1996 | 311 | 3 | 4 | 1 | 3.80 | 8.91 | 9.02 | 23.03 |
| 3 | 1996 | 315 | 3 | 2 | 4 | 4.65 | 8.25 | 14.43 | 27.64 |
| 3 | 1996 | 316 | 3 | 2 | 1 | 5.18 | 9.67 | 10.22 | 25.37 |
| 3 | 1996 | 401 | 4 | 1 | 4 | 6.56 | 10.30 | 12.02 | 28.93 |
| 3 | 1996 | 404 | 4 | 1 | 1 | 4.18 | 8.72 | 18.63 | 32.06 |
| 3 | 1996 | 406 | 4 | 4 | 1 | 5.08 | 7.46 | 29.45 | 42.68 |
| 3 | 1996 | 407 | 4 | 4 | 4 | 4.65 | 7.62 | 13.52 | 26.22 |
| 3 | 1996 | 409 | 4 | 2 | 1 | 3.51 | 8.97 | 17.13 | 30.71 |
| 3 | 1996 | 410 | 4 | 2 | 4 | 4.32 | 10.36 | 4.81 | 19.97 |
| 4 | 1996 | 101 | 1 | 1 | 1 | 7.51 | 10.52 | 15.03 | 33.13 |
| 4 | 1996 | 104 | 1 | 1 | 4 | 9.04 | 12.67 | 16.23 | 37.72 |
| 4 | 1996 | 105 | 1 | 2 | 4 | 3.75 | 9.89 | 10.82 | 25.31 |
| 4 | 1996 | 106 | 1 | 2 | 1 | 6.32 | 10.02 | 16.23 | 33.40 |
| 4 | 1996 | 110 | 1 | 4 | 4 | 5.51 | 8.18 | 16.53 | 30.34 |
| 4 | 1996 | 112 | 1 | 4 | 1 | 9.08 | 10.27 | 19.24 | 38.68 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 1996 | 205 | 2 | 4 | 1 | 6.70 | 9.48 | 16.23 | 32.84 |
| 4 | 1996 | 208 | 2 | 4 | 4 | 6.27 | 8.25 | 9.62 | 24.21 |
| 4 | 1996 | 210 | 2 | 1 | 1 | 4.18 | 8.66 | 13.52 | 26.67 |
| 4 | 1996 | 211 | 2 | 1 | 4 | 4.80 | 9.54 | 13.22 | 27.85 |
| 4 | 1996 | 215 | 2 | 2 | 1 | 4.51 | 8.50 | 15.63 | 29.19 |
| 4 | 1996 | 216 | 2 | 2 | 4 | 5.65 | 8.41 | 9.92 | 22.02 |
| 4 | 1996 | 302 | 3 | 1 | 4 | 7.23 | 11.78 | . | . |
| 4 | 1996 | 303 | 3 | 1 | 1 | 6.46 | 10.68 | 2.70 | 20.01 |
| 4 | 1996 | 309 | 3 | 4 | 4 | 4.51 | 8.75 | 6.61 | 20.07 |
| 4 | 1996 | 311 | 3 | 4 | 1 | 5.51 | 8.03 | 15.33 | 29.03 |
| 4 | 1996 | 315 | 3 | 2 | 4 | 4.99 | 10.27 | 9.62 | 24.85 |
| 4 | 1996 | 316 | 3 | 2 | 1 | 2.22 | 8.50 | 11.42 | 24.69 |
| 4 | 1996 | 401 | 4 | 1 | 4 | 4.70 | 9.70 | 8.72 | 23.21 |
| 4 | 1996 | 404 | 4 | 1 | 1 | 4.80 | 7.93 | 12.92 | 26.20 |
| 4 | 1996 | 406 | 4 | 4 | 1 | 6.23 | 9.70 | 0.90 | 17.42 |
| 4 | 1996 | 407 | 4 | 4 | 4 | 3.51 | 7.11 | 3.91 | 14.53 |
| 4 | 1996 | 409 | 4 | 2 | 1 | 6.32 | 9.86 | 6.61 | 22.96 |
| 4 | 1996 | 410 | 4 | 2 | 4 | 6.37 | 10.08 | 9.02 | 25.25 |
| 4 | 1996 | 101 | 1 | 1 | 1 | 5.37 | 8.22 | 6.31 | 18.13 |
| 4 | 1996 | 104 | 1 | 1 | 4 | 7.13 | 10.27 | 11.12 | 28.26 |
| 4 | 1996 | 105 | 1 | 2 | 4 | 5.75 | 9.23 | 10.82 | 26.44 |
| 4 | 1996 | 106 | 1 | 2 | 1 | 5.37 | 9.35 | 13.22 | 28.97 |
| 4 | 1996 | 110 | 1 | 4 | 4 | 8.18 | 8.66 | 3.61 | 19.87 |
| 4 | 1996 | 112 | 1 | 4 | 1 | 4.61 | 7.52 | 12.62 | 25.39 |
| 4 | 1996 | 205 | 2 | 4 | 1 | 8.23 | 9.92 | 9.92 | 27.76 |
| 4 | 1996 | 208 | 2 | 4 | 4 | 7.32 | 9.13 | 10.82 | 27.53 |
| 4 | 1996 | 210 | 2 | 1 | 1 | 5.94 | 9.01 | 18.93 | 33.24 |
| 4 | 1996 | 211 | 2 | 1 | 4 | 6.13 | 8.28 | 15.63 | 30.13 |
| 4 | 1996 | 215 | 2 | 2 | 1 | 4.75 | 7.08 | 26.45 | 38.63 |
| 4 | 1996 | 216 | 2 | 2 | 4 | 4.22 | 8.25 | 15.93 | 28.78 |
| 4 | 1996 | 302 | 3 | 1 | 4 | 5.89 | 8.94 | . | . |
| 4 | 1996 | 303 | 3 | 1 | 1 | 5.03 | 8.78 | . | . |
| 4 | 1996 | 309 | 3 | 4 | 4 | 4.65 | 7.93 | 12.02 | 24.85 |
| 4 | 1996 | 311 | 3 | 4 | 1 | 6.42 | 7.30 | 36.67 | 51.00 |
| 4 | 1996 | 315 | 3 | 2 | 4 | 4.99 | 9.04 | 10.52 | 25.09 |
| 4 | 1996 | 316 | 3 | 2 | 1 | 3.03 | 9.23 | 8.11 | 21.61 |
| 4 | 1996 | 401 | 4 | 1 | 4 | 3.41 | 9.35 | 1.50 | 15.01 |
| 4 | 1996 | 404 | 4 | 1 | 1 | 3.99 | 9.16 | 12.62 | 26.56 |
| 4 | 1996 | 406 | 4 | 4 | 1 | 5.56 | 10.87 | . | . |
| 4 | 1996 | 407 | 4 | 4 | 4 | 5.61 | 10.43 | . | . |
| 4 | 1996 | 409 | 4 | 2 | 1 | 9.37 | 11.66 | 1.20 | 21.73 |
| 4 | 1996 | 410 | 4 | 2 | 4 | 9.23 | 12.32 | 11.12 | 32.50 |
| 5 | 1996 | 101 | 1 | 1 | 1 | 7.80 | 9.70 | 21.34 | 38.60 |
| 5 | 1996 | 104 | 1 | 1 | 4 | 7.13 | 8.72 | 13.83 | 30.08 |
| 5 | 1996 | 105 | 1 | 2 | 4 | 7.70 | 10.05 | 22.24 | 40.49 |
| 5 | 1996 | 106 | 1 | 2 | 1 | 6.18 | 9.35 | 21.94 | 37.95 |
| 5 | 1996 | 110 | 1 | 4 | 4 | 6.08 | 7.81 | 39.07 | 53.03 |
| 5 | 1996 | 112 | 1 | 4 | 1 | 6.99 | 9.29 | 26.75 | 44.74 |
| 5 | 1996 | 205 | 2 | 4 | 1 | 3.18 | 7.17 | 15.33 | 25.65 |
| 5 | 1996 | 208 | 2 | 4 | 4 | 3.89 | 7.71 | 18.63 | 30.38 |
| 5 | 1996 | 210 | 2 | 1 | 1 | 6.13 | 9.23 | 16.53 | 31.93 |
| 5 | 1996 | 211 | 2 | 1 | 4 | 4.70 | 8.88 | 17.13 | 31.88 |
| 5 | 1996 | 215 | 2 | 2 | 1 | 8.61 | 8.44 | 22.54 | 39.92 |
| 5 | 1996 | 216 | 2 | 2 | 4 | 4.51 | 8.85 | 11.42 | 25.11 |
| 5 | 1996 | 302 | 3 | 1 | 4 | 6.32 | 9.32 | 21.34 | 36.72 |
| 5 | 1996 | 303 | 3 | 1 | 1 | 7.70 | 10.52 | 18.93 | 37.40 |
| 5 | 1996 | 309 | 3 | 4 | 4 | 8.84 | 4.74 | 16.53 | 27.95 |
| 5 | 1996 | 311 | 3 | 4 | 1 | 5.27 | 7.96 | 17.73 | 31.28 |
| 5 | 1996 | 315 | 3 | 2 | 4 | 4.75 | 8.82 | 15.63 | 29.72 |
| 5 | 1996 | 316 | 3 | 2 | 1 | 3.65 | 8.09 | 18.63 | 31.52 |
| 5 | 1996 | 401 | 4 | 1 | 4 | 3.80 | 8.72 | 12.62 | 25.66 |
| 5 | 1996 | 404 | 4 | 1 | 1 | 6.08 | 8.94 | 16.83 | 32.19 |
| 5 | 1996 | 406 | 4 | 4 | 1 | 4.18 | 8.44 | 26.45 | 39.56 |
| 5 | 1996 | 407 | 4 | 4 | 4 | 3.89 | 7.96 | 22.24 | 34.17 |
| 5 | 1996 | 409 | 4 | 2 | 1 | 7.46 | 8.94 | 17.13 | 32.23 |
| 5 | 1996 | 410 | 4 | 2 | 4 | 3.51 | 8.03 | 9.02 | 21.05 |
| 5 | 1996 | 101 | 1 | 1 | 1 | 8.65 | 10.58 | 21.64 | 41.35 |
| 5 | 1996 | 104 | 1 | 1 | 4 | 6.94 | 9.07 | 18.03 | 34.14 |
| 5 | 1996 | 105 | 1 | 2 | 4 | 5.13 | 9.26 | 11.12 | 25.13 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5 | 1996 | 106 | 1 | 2 | 1 | 7.37 | 9.48 | 25.55 | 43.20 |
| 5 | 1996 | 110 | 1 | 4 | 4 | 3.89 | 8.03 | 24.65 | 36.97 |
| 5 | 1996 | 112 | 1 | 4 | 1 | 11.56 | 10.08 | 33.36 | 55.45 |
| 5 | 1996 | 205 | 2 | 4 | 1 | 10.04 | 10.52 | 37.27 | 58.21 |
| 5 | 1996 | 208 | 2 | 4 | 4 | 5.13 | 7.30 | 22.54 | 35.02 |
| 5 | 1996 | 210 | 2 | 1 | 1 | 4.84 | 10.30 | 12.32 | 28.30 |
| 5 | 1996 | 211 | 2 | 1 | 4 | 4.03 | 8.03 | 15.63 | 28.02 |
| 5 | 1996 | 215 | 2 | 2 | 1 | 7.70 | 8.59 | 26.15 | 42.49 |
| 5 | 1996 | 216 | 2 | 2 | 4 | 7.03 | 9.01 | 21.34 | 37.36 |
| 5 | 1996 | 302 | 3 | 1 | 4 | 5.70 | 10.62 | 26.15 | 45.18 |
| 5 | 1996 | 303 | 3 | 1 | 1 | 5.94 | 9.67 | 18.33 | 33.56 |
| 5 | 1996 | 309 | 3 | 4 | 4 | 5.94 | 8.53 | 16.23 | 31.39 |
| 5 | 1996 | 311 | 3 | 4 | 1 | 4.37 | 7.52 | 14.73 | 26.78 |
| 5 | 1996 | 315 | 3 | 2 | 4 | 7.61 | 10.21 | 13.83 | 31.30 |
| 5 | 1996 | 316 | 3 | 2 | 1 | 4.99 | 8.97 | 11.42 | 25.12 |
| 5 | 1996 | 401 | 4 | 1 | 4 | 4.46 | 8.85 | 9.62 | 23.00 |
| 5 | 1996 | 404 | 4 | 1 | 1 | 4.94 | 9.38 | 17.13 | 31.81 |
| 5 | 1996 | 406 | 4 | 4 | 1 | 5.18 | 8.31 | 27.95 | 41.51 |
| 5 | 1996 | 407 | 4 | 4 | 4 | 7.32 | 10.36 | 29.15 | 48.89 |
| 5 | 1996 | 409 | 4 | 2 | 1 | 4.89 | 8.94 | 29.75 | 44.40 |
| 5 | 1996 | 410 | 4 | 2 | 4 | 8.27 | 11.18 | 16.23 | 37.09 |
| 6 | 1997 | 101 | 1 | 1 | 1 | 3.70 | 8.09 | 9.32 | 21.04 |
| 6 | 1997 | 104 | 1 | 1 | 4 | 7.37 | 8.31 | 11.72 | 27.35 |
| 6 | 1997 | 105 | 1 | 2 | 4 | 4.32 | 9.10 | 9.02 | 22.01 |
| 6 | 1997 | 108 | 1 | 2 | 1 | 4.41 | 6.67 | 8.42 | 19.74 |
| 6 | 1997 | 110 | 1 | 4 | 4 | 5.75 | 7.55 | 20.14 | 33.20 |
| 6 | 1997 | 111 | 1 | 4 | 1 | 5.70 | 9.26 | 17.73 | 32.74 |
| 6 | 1997 | 206 | 2 | 4 | 1 | 5.13 | 6.67 | 14.43 | 25.15 |
| 6 | 1997 | 208 | 2 | 4 | 4 | 4.80 | 6.64 | 11.72 | 23.11 |
| 6 | 1997 | 209 | 2 | 1 | 4 | 5.56 | 8.31 | 9.62 | 23.25 |
| 6 | 1997 | 211 | 2 | 1 | 1 | 4.32 | 7.68 | 12.32 | 25.54 |
| 6 | 1997 | 214 | 2 | 2 | 4 | 5.80 | 7.33 | 17.73 | 31.19 |
| 6 | 1997 | 215 | 2 | 2 | 1 | 5.42 | 7.30 | 24.04 | 37.00 |
| 6 | 1997 | 302 | 3 | 1 | 1 | 5.42 | 6.29 | 13.52 | 24.71 |
| 6 | 1997 | 303 | 3 | 1 | 4 | 5.51 | 7.52 | 15.03 | 28.77 |
| 6 | 1997 | 309 | 3 | 4 | 1 | 7.42 | 7.02 | 29.15 | 44.01 |
| 6 | 1997 | 311 | 3 | 4 | 4 | 4.94 | 4.81 | 16.83 | 27.46 |
| 6 | 1997 | 313 | 3 | 2 | 1 | 8.84 | 8.59 | 49.89 | 68.05 |
| 6 | 1997 | 315 | 3 | 2 | 4 | 7.65 | 7.74 | 27.95 | 43.97 |
| 6 | 1997 | 402 | 4 | 1 | 4 | 6.13 | 5.72 | 31.26 | 43.11 |
| 6 | 1997 | 404 | 4 | 1 | 1 | 5.89 | 6.89 | 26.15 | 39.52 |
| 6 | 1997 | 405 | 4 | 4 | 4 | 4.65 | 6.26 | 34.56 | 45.71 |
| 6 | 1997 | 408 | 4 | 4 | 1 | 7.51 | 6.35 | 38.47 | 52.57 |
| 6 | 1997 | 410 | 4 | 2 | 1 | 7.18 | 6.48 | 28.85 | 42.27 |
| 6 | 1997 | 412 | 4 | 2 | 4 | 4.51 | 6.32 | 24.95 | 35.56 |
| 6 | 1997 | 101 | 1 | 1 | 1 | 6.08 | 6.95 | 27.05 | 39.75 |
| 6 | 1997 | 104 | 1 | 1 | 4 | 4.80 | 6.70 | 11.72 | 23.12 |
| 6 | 1997 | 105 | 1 | 2 | 4 | 4.51 | 6.54 | 24.65 | 36.13 |
| 6 | 1997 | 108 | 1 | 2 | 1 | 5.70 | 6.64 | 22.54 | 35.12 |
| 6 | 1997 | 110 | 1 | 4 | 4 | 4.61 | 5.50 | 29.75 | 39.67 |
| 6 | 1997 | 111 | 1 | 4 | 1 | 4.75 | 5.28 | 26.75 | 36.21 |
| 6 | 1997 | 206 | 2 | 4 | 1 | 5.80 | 5.41 | 28.85 | 39.94 |
| 6 | 1997 | 208 | 2 | 4 | 4 | 5.61 | 6.51 | 24.95 | 37.23 |
| 6 | 1997 | 209 | 2 | 1 | 4 | 3.89 | 6.29 | 13.83 | 24.15 |
| 6 | 1997 | 211 | 2 | 1 | 1 | 7.56 | 8.28 | 26.15 | 42.06 |
| 6 | 1997 | 214 | 2 | 2 | 4 | 5.56 | 7.14 | 30.06 | 42.99 |
| 6 | 1997 | 215 | 2 | 2 | 1 | 6.37 | 7.21 | 29.75 | 43.73 |
| 6 | 1997 | 302 | 3 | 1 | 1 | 5.13 | 6.10 | 34.56 | 46.01 |
| 6 | 1997 | 303 | 3 | 1 | 4 | 4.41 | 6.10 | 19.84 | 30.52 |
| 6 | 1997 | 309 | 3 | 4 | 1 | 6.99 | 5.34 | 40.87 | 53.66 |
| 6 | 1997 | 311 | 3 | 4 | 4 | 4.94 | 5.79 | 29.45 | 40.32 |
| 6 | 1997 | 313 | 3 | 2 | 1 | 5.75 | 6.92 | 31.56 | 45.06 |
| 6 | 1997 | 315 | 3 | 2 | 4 | 5.46 | 7.21 | 72.13 | 84.63 |
| 6 | 1997 | 402 | 4 | 1 | 4 | 5.89 | 6.73 | 31.26 | 44.33 |
| 6 | 1997 | 404 | 4 | 1 | 1 | 7.61 | 8.53 | 33.66 | 50.70 |
| 6 | 1997 | 405 | 4 | 4 | 4 | 5.27 | 6.45 | 39.67 | 51.73 |
| 6 | 1997 | 408 | 4 | 4 | 1 | 6.03 | 7.84 | 26.15 | 40.61 |
| 6 | 1997 | 410 | 4 | 2 | 1 | 10.08 | 7.93 | 55.00 | 72.09 |
| 6 | 1997 | 412 | 4 | 2 | 4 | 6.65 | 4.52 | 16.83 | 28.13 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 1997 | 101 | 1 | 1 | 1 | 9.03 | 10.92 | 57.89 | 77.87 |
| 7 | 1997 | 104 | 1 | 1 | 4 | 7.06 | 10.78 | 50.92 | 69.04 |
| 7 | 1997 | 105 | 1 | 2 | 4 | 6.78 | 9.64 | 51.96 | 68.15 |
| 7 | 1997 | 108 | 1 | 2 | 1 | 8.92 | 11.30 | 56.99 | 77.74 |
| 7 | 1997 | 110 | 1 | 4 | 4 | 5.99 | 10.36 | 43.33 | 59.86 |
| 7 | 1997 | 111 | 1 | 4 | 1 | 4.92 | 9.01 | 52.16 | 65.87 |
| 7 | 1997 | 206 | 2 | 4 | 1 | 6.50 | 9.53 | 56.79 | 73.13 |
| 7 | 1997 | 208 | 2 | 4 | 4 | 9.14 | 9.98 | 62.45 | 81.91 |
| 7 | 1997 | 209 | 2 | 1 | 4 | 6.38 | 9.67 | 44.99 | 61.30 |
| 7 | 1997 | 211 | 2 | 1 | 1 | 6.22 | 9.71 | 51.41 | 67.75 |
| 7 | 1997 | 214 | 2 | 2 | 4 | 4.98 | 8.70 | 48.02 | 61.62 |
| 7 | 1997 | 215 | 2 | 2 | 1 | 4.87 | 8.49 | 50.16 | 63.30 |
| 7 | 1997 | 302 | 3 | 1 | 1 | 8.92 | 10.02 | 62.58 | 81.24 |
| 7 | 1997 | 303 | 3 | 1 | 4 | 3.40 | 9.15 | 31.33 | 44.05 |
| 7 | 1997 | 309 | 3 | 4 | 1 | 5.15 | 8.39 | 54.99 | 68.70 |
| 7 | 1997 | 311 | 3 | 4 | 4 | 6.72 | 9.22 | 55.75 | 72.20 |
| 7 | 1997 | 313 | 3 | 2 | 1 | 7.17 | 9.19 | 47.96 | 64.54 |
| 7 | 1997 | 315 | 3 | 2 | 4 | 6.05 | 9.29 | 47.68 | 63.41 |
| 7 | 1997 | 402 | 4 | 1 | 4 | 5.82 | 9.29 | 46.44 | 61.80 |
| 7 | 1997 | 404 | 4 | 1 | 1 | 5.65 | 9.29 | 65.76 | 81.46 |
| 7 | 1997 | 405 | 4 | 4 | 4 | 7.23 | 9.36 | 74.45 | 92.28 |
| 7 | 1997 | 408 | 4 | 4 | 1 | 11.11 | 12.24 | 48.85 | 70.90 |
| 7 | 1997 | 410 | 4 | 2 | 1 | 5.82 | 10.54 | 46.78 | 62.86 |
| 7 | 1997 | 412 | 4 | 2 | 4 | 5.54 | 10.54 | 38.92 | 54.80 |
| 7 | 1997 | 101 | 1 | 1 | 1 | 6.67 | 9.81 | 52.16 | 68.44 |
| 7 | 1997 | 104 | 1 | 1 | 4 | 5.43 | 9.50 | 41.47 | 55.83 |
| 7 | 1997 | 105 | 1 | 2 | 4 | 3.85 | 8.46 | 41.95 | 54.46 |
| 7 | 1997 | 108 | 1 | 2 | 1 | 3.46 | 8.60 | 46.58 | 58.35 |
| 7 | 1997 | 110 | 1 | 4 | 4 | 5.77 | 8.60 | 63.62 | 78.15 |
| 7 | 1997 | 111 | 1 | 4 | 1 | 4.92 | 8.94 | 53.54 | 67.75 |
| 7 | 1997 | 206 | 2 | 4 | 1 | 4.92 | 8.53 | 44.71 | 58.58 |
| 7 | 1997 | 208 | 2 | 4 | 4 | 3.63 | 8.42 | 50.78 | 62.84 |
| 7 | 1997 | 209 | 2 | 1 | 4 | 4.64 | 8.87 | 44.51 | 58.47 |
| 7 | 1997 | 211 | 2 | 1 | 1 | 4.75 | 8.98 | 60.03 | 73.85 |
| 7 | 1997 | 214 | 2 | 2 | 4 | 4.30 | 9.08 | 46.02 | 59.49 |
| 7 | 1997 | 215 | 2 | 2 | 1 | 6.38 | 9.39 | 35.67 | 51.14 |
| 7 | 1997 | 302 | 3 | 1 | 1 | 6.50 | 9.19 | 90.46 | 106.99 |
| 7 | 1997 | 303 | 3 | 1 | 4 | 3.80 | 8.70 | 39.12 | 51.28 |
| 7 | 1997 | 309 | 3 | 4 | 1 | 3.97 | 7.56 | 58.31 | 69.77 |
| 7 | 1997 | 311 | 3 | 4 | 4 | 5.48 | 8.74 | 61.89 | 76.34 |
| 7 | 1997 | 313 | 3 | 2 | 1 | 3.46 | 8.22 | 51.47 | 65.60 |
| 7 | 1997 | 315 | 3 | 2 | 4 | 1.38 | 7.90 | 34.29 | 45.29 |
| 7 | 1997 | 402 | 4 | 1 | 4 | 2.17 | 8.80 | 40.78 | 53.80 |
| 7 | 1997 | 404 | 4 | 1 | 1 | 4.81 | 9.98 | 44.99 | 60.46 |
| 7 | 1997 | 405 | 4 | 4 | 4 | 4.36 | 9.05 | 47.27 | 62.28 |
| 7 | 1997 | 408 | 4 | 4 | 1 | 3.80 | 8.18 | 46.71 | 59.76 |
| 7 | 1997 | 410 | 4 | 2 | 1 | 7.12 | 9.78 | 43.95 | 61.83 |
| 7 | 1997 | 412 | 4 | 2 | 4 | 3.80 | 8.15 | 54.79 | 66.84 |
| 8 | 1997 | 101 | 1 | 1 | 1 | 4.91 | 9.60 | 7.59 | 22.78 |
| 8 | 1997 | 104 | 1 | 1 | 4 | 6.37 | 11.47 | 20.63 | 38.59 |
| 8 | 1997 | 105 | 1 | 2 | 4 | 3.90 | 11.34 | 10.35 | 25.42 |
| 8 | 1997 | 108 | 1 | 2 | 1 | 7.67 | 10.82 | 37.47 | 56.65 |
| 8 | 1997 | 110 | 1 | 4 | 4 | 2.66 | 8.56 | 24.43 | 35.31 |
| 8 | 1997 | 111 | 1 | 4 | 1 | 5.08 | 9.88 | 24.63 | 39.90 |
| 8 | 1997 | 206 | 2 | 4 | 1 | 5.98 | 10.05 | 37.12 | 52.71 |
| 8 | 1997 | 208 | 2 | 4 | 4 | 5.42 | 6.10 | 31.05 | 41.98 |
| 8 | 1997 | 209 | 2 | 1 | 4 | 5.08 | 11.06 | 11.25 | 27.13 |
| 8 | 1997 | 211 | 2 | 1 | 1 | 4.63 | 8.60 | 24.98 | 38.37 |
| 8 | 1997 | 214 | 2 | 2 | 4 | 4.18 | 9.84 | 32.22 | 45.88 |
| 8 | 1997 | 215 | 2 | 2 | 1 | 4.46 | 9.46 | 28.57 | 42.15 |
| 8 | 1997 | 302 | 3 | 1 | 1 | 7.27 | 11.58 | 22.84 | 41.64 |
| 8 | 1997 | 303 | 3 | 1 | 4 | 4.07 | 12.62 | 21.25 | 37.94 |
| 8 | 1997 | 309 | 3 | 4 | 1 | 6.21 | 9.53 | 35.05 | 51.47 |
| 8 | 1997 | 311 | 3 | 4 | 4 | 6.94 | 11.09 | 33.81 | 52.51 |
| 8 | 1997 | 313 | 3 | 2 | 1 | 9.19 | 12.13 | 34.22 | 56.02 |
| 8 | 1997 | 315 | 3 | 2 | 4 | 4.01 | 9.22 | 19.18 | 32.98 |
| 8 | 1997 | 402 | 4 | 1 | 4 | 6.54 | 12.13 | 24.91 | 43.47 |
| 8 | 1997 | 404 | 4 | 1 | 1 | 4.29 | 10.23 | 31.88 | 47.07 |
| 8 | 1997 | 405 | 4 | 4 | 4 | 2.72 | 13.42 | 12.70 | 28.94 |

```
8       1997    408     4       4       1       5.87    10.40   30.02   46.40
8       1997    410     4       2       1       5.08    10.36   30.50   46.14
8       1997    412     4       2       4       6.21    9.88    38.64   54.92

;
Proc mixed data=UNR959697;
Class Year Rep MPTrt SPTrt;
Model Glu= Year Rep(Year) MPTrt Year*MPTrt MPTrt*Rep(Year) SPTrt Year*SPTrt MPTrt*SPTrt
Year*MPTrt*SPTrt;
Lsmeans  MPTrt SPTrt MPTrt*SPTrt/pdiff;
Run;
Proc mixed data=UNR959697;
Class Year Rep MPTrt SPTrt;
Model Fru= Year Rep(Year) MPTrt Year*MPTrt MPTrt*Rep(Year) SPTrt Year*SPTrt MPTrt*SPTrt
Year*MPTrt*SPTrt;
Lsmeans MPTrt SPTrt MPTrt*SPTrt/pdiff;
Proc mixed data=UNR959697;
Class Year Rep MPTrt SPTrt;
Model Suc= Year Rep(Year) MPTrt Year*MPTrt MPTrt*Rep(Year) SPTrt Year*SPTrt MPTrt*SPTrt
Year*MPTrt*SPTrt;
Lsmeans  MPTrt SPTrt MPTrt*SPTrt/pdiff;
Run;
Proc mixed data=UNR959697;
Class Year Rep MPTrt SPTrt;
Model TSS= Year Rep(Year) MPTrt Year*MPTrt MPTrt*Rep(Year) SPTrt Year*SPTrt MPTrt*SPTrt
Year*MPTrt*SPTrt;
Lsmeans MPTrt SPTrt MPTrt*SPTrt/pdiff;
Run;
```

UNR-Pix Soluble Sugar

SAS Output

Model Information

| | |
|---|---|
| Data Set | WORK.UNR959697 |
| Dependent Variable | Glu |
| Covariance Structure | Diagonal |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Residual |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1995 1996 1997 |
| Rep | 4 | 1 2 3 4 |
| MPtrt | 3 | 1 2 4 |
| SPtrt | 2 | 1 4 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 1 |
| Columns in X | 96 |
| Columns in Z | 0 |
| Subjects | 1 |
| Max Obs Per Subject | 360 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 360 |
| Number of Observations Used | 360 |
| Number of Observations Not Used | 0 |

Covariance Parameter
Estimates

| Cov Parm | Estimate |
|---|---|
| Residual | 6.2067 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 1572.6 |
| AIC (smaller is better) | 1574.6 |
| AICC (smaller is better) | 1574.6 |
| BIC (smaller is better) | 1578.4 |

The Mixed Procedure

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 315 | 131.99 | <.0001 |
| Rep(Year) | 9 | 315 | 1.07 | 0.3856 |
| MPtrt | 2 | 315 | 1.94 | 0.1461 |
| Year*MPtrt | 4 | 315 | 1.30 | 0.2694 |
| Rep*MPtrt(Year) | 18 | 315 | 0.97 | 0.4955 |
| SPtrt | 1 | 315 | 27.20 | <.0001 |
| Year*SPtrt | 2 | 315 | 9.70 | <.0001 |
| MPtrt*SPtrt | 2 | 315 | 1.47 | 0.2324 |
| Year*MPtrt*SPtrt | 4 | 315 | 1.18 | 0.3180 |

Least Squares Means

| Effect | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 6.9131 | 0.2274 | 315 | 30.40 | <.0001 |
| MPtrt | 2 | | 7.1141 | 0.2274 | 315 | 31.28 | <.0001 |
| MPtrt | 4 | | 7.5332 | 0.2274 | 315 | 33.12 | <.0001 |
| SPtrt | | 1 | 7.8716 | 0.1857 | 315 | 42.39 | <.0001 |
| SPtrt | | 4 | 6.5020 | 0.1857 | 315 | 35.01 | <.0001 |
| MPtrt*SPtrt | 1 | 1 | 7.3133 | 0.3216 | 315 | 22.74 | <.0001 |
| MPtrt*SPtrt | 1 | 4 | 6.5128 | 0.3216 | 315 | 20.25 | <.0001 |
| MPtrt*SPtrt | 2 | 1 | 7.8182 | 0.3216 | 315 | 24.31 | <.0001 |
| MPtrt*SPtrt | 2 | 4 | 6.4100 | 0.3216 | 315 | 19.93 | <.0001 |
| MPtrt*SPtrt | 4 | 1 | 8.4832 | 0.3216 | 315 | 26.38 | <.0001 |
| MPtrt*SPtrt | 4 | 4 | 6.5832 | 0.3216 | 315 | 20.47 | <.0001 |

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr>\|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 2 | | -0.2010 | 0.3216 | 315 | -0.62 | 0.5325 |
| MPtrt | 1 | | 4 | | -0.6201 | 0.3216 | 315 | -1.93 | 0.0548 |
| MPtrt | 2 | | 4 | | -0.4191 | 0.3216 | 315 | -1.30 | 0.1935 |
| SPtrt | | 1 | 4 | | 1.3696 | 0.2626 | 315 | 5.22 | <.0001 |
| MPtrt*SPtrt | 1 | 1 | 1 | 4 | 0.8005 | 0.4549 | 315 | 1.76 | 0.0794 |
| MPtrt*SPtrt | 1 | 1 | 2 | 1 | -0.5048 | 0.4549 | 315 | - 1.11 | 0.2679 |
| MPtrt*SPtrt | 1 | 1 | 2 | 4 | 0.9033 | 0.4549 | 315 | 1.99 | 0.0479 |
| MPtrt*SPtrt | 1 | 1 | 4 | 1 | -1.1698 | 0.4549 | 315 | - 2.57 | 0.0106 |
| MPtrt*SPtrt | 1 | 1 | 4 | 4 | 0.7302 | 0.4549 | 315 | 1.61 | 0.1094 |
| MPtrt*SPtrt | 1 | 4 | 2 | 1 | -1.3053 | 0.4549 | 315 | - 2.80 | 0.0044 |
| MPtrt*SPtrt | 1 | 4 | 2 | 4 | 0.1028 | 0.4549 | 315 | 0.23 | 0.8213 |
| MPtrt*SPtrt | 1 | 4 | 4 | 1 | -1.9703 | 0.4549 | 315 | - 4.33 | <.0001 |

The Mixed Procedure

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | _MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt*SPtrt | 1 | 4 | 4 | 4 | -0.07033 | 0.4549 | 315 | -0.15 | 0.8772 |
| MPtrt*SPtrt | 2 | 1 | 2 | 4 | 1.4082 | 0.4549 | 315 | 3.10 | 0.0021 |
| MPtrt*SPtrt | 2 | 1 | 4 | 1 | -0.6650 | 0.4549 | 315 | -1.46 | 0.1447 |
| MPtrt*SPtrt | 2 | 1 | 4 | 4 | 1.2350 | 0.4549 | 315 | 2.72 | 0.0070 |
| MPtrt*SPtrt | 2 | 4 | 4 | 1 | -2.0732 | 0.4549 | 315 | -4.56 | <.0001 |
| MPtrt*SPtrt | 2 | 4 | 4 | 4 | -0.1732 | 0.4549 | 315 | -0.38 | 0.7037 |
| MPtrt*SPtrt | 4 | 1 | 4 | 4 | 1.9000 | 0.4549 | 315 | 4.18 | <.0001 |

The Mixed Procedure
Model Information

| | |
|---|---|
| Data Set | WORK.UNR959697 |
| Dependent Variable | Fru |
| Covariance Structure | Diagonal |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Residual |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1995 1996 1997 |
| Rep | 4 | 1 2 3 4 |
| MPtrt | 3 | 1 2 4 |
| SPtrt | 2 | 1 4 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 1 |
| Columns in X | 96 |
| Columns in Z | 0 |
| Subjects | 1 |
| Max Obs Per Subject | 360 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 360 |
| Number of Observations Used | 360 |
| Number of Observations Not Used | 0 |

Covariance Parameter
Estimates

| Cov Parm | Estimate |
|---|---|
| Residual | 3.2259 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 1366.5 |
| AIC (smaller is better) | 1368.5 |
| AICC (smaller is better) | 1368.5 |
| BIC (smaller is better) | 1372.2 |

The Mixed Procedure

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 315 | 157.69 | <.0001 |
| Rep(Year) | 9 | 315 | 1.80 | 0.0674 |
| MPtrt | 2 | 315 | 1.47 | 0.2309 |
| Year*MPtrt | 4 | 315 | 2.64 | 0.0341 |
| Rep*MPtrt(Year) | 18 | 315 | 1.31 | 0.1798 |
| SPtrt | 1 | 315 | 10.83 | 0.0011 |
| Year*SPtrt | 2 | 315 | 7.41 | 0.0007 |
| MPtrt*SPtrt | 2 | 315 | 1.50 | 0.2240 |
| Year*MPtrt*SPtrt | 4 | 315 | 0.54 | 0.7037 |

Least Squares Means

| Effect | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 10.1490 | 0.1640 | 315 | 61.90 | <.0001 |
| MPtrt | 2 | | 9.9696 | 0.1640 | 315 | 60.81 | <.0001 |
| MPtrt | 4 | | 9.7517 | 0.1640 | 315 | 59.48 | <.0001 |
| SPtrt | | 1 | 10.2683 | 0.1339 | 315 | 76.70 | <.0001 |
| SPtrt | | 4 | 9.6452 | 0.1339 | 315 | 72.05 | <.0001 |
| MPtrt*SPtrt | 1 | 1 | 10.3010 | 0.2319 | 315 | 44.43 | <.0001 |
| MPtrt*SPtrt | 1 | 4 | 9.9970 | 0.2319 | 315 | 43.11 | <.0001 |
| MPtrt*SPtrt | 2 | 1 | 10.2148 | 0.2319 | 315 | 44.05 | <.0001 |
| MPtrt*SPtrt | 2 | 4 | 9.7243 | 0.2319 | 315 | 41.94 | <.0001 |
| MPtrt*SPtrt | 4 | 1 | 10.2890 | 0.2319 | 315 | 44.37 | <.0001 |
| MPtrt*SPtrt | 4 | | 9.2143 | 0.2319 | 315 | 39.74 | <.0001 |

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | _MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 2 | | 0.1794 | 0.2319 | 315 | 0.77 | 0.4396 |
| MPtrt | 1 | | 4 | | 0.3973 | 0.2319 | 315 | 1.71 | 0.0876 |
| MPtrt | 2 | | 4 | | 0.2179 | 0.2319 | 315 | 0.94 | 0.3480 |
| SPtrt | | 1 | | 4 | 0.6231 | 0.1893 | 315 | 3.29 | 0.0011 |
| MPtrt*SPtrt | 1 | 1 | 1 | 4 | 0.3040 | 0.3279 | 315 | 0.93 | 0.3546 |
| MPtrt*SPtrt | 1 | 1 | 2 | 1 | 0.08617 | 0.3279 | 315 | 0.26 | 0.7929 |
| MPtrt*SPtrt | 1 | 1 | 2 | 4 | 0.5767 | 0.3279 | 315 | 1.76 | 0.0796 |
| MPtrt*SPtrt | 1 | 1 | 4 | 1 | 0.01200 | 0.3279 | 315 | 0.04 | 0.9708 |
| MPtrt*SPtrt | 1 | 1 | 4 | 4 | 1.0867 | 0.3279 | 315 | 3.31 | 0.0010 |
| MPtrt*SPtrt | 1 | 4 | 2 | 1 | -0.2178 | 0.3279 | 315 | -0.66 | 0.5070 |
| MPtrt*SPtrt | 1 | 4 | 2 | 4 | 0.2727 | 0.3279 | 315 | 0.83 | 0.4063 |
| MPtrt*SPtrt | 1 | 4 | 4 | 1 | -0.2920 | 0.3279 | 315 | -0.89 | 0.3739 |

The Mixed Procedure

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt*SPtrt | 1 | 4 | 4 | 4 | 0.7827 | 0.3279 | 315 | 2.39 | 0.0176 |
| MPtrt*SPtrt | 2 | 1 | 2 | 4 | 0.4905 | 0.3279 | 315 | 1.50 | 0.1357 |
| MPtrt*SPtrt | 2 | 1 | 4 | 1 | -0.07417 | 0.3279 | 315 | -0.23 | 0.8212 |
| MPtrt*SPtrt | 2 | 1 | 4 | 4 | 1.0005 | 0.3279 | 315 | 3.05 | 0.0025 |
| MPtrt*SPtrt | 2 | 4 | 4 | 1 | -0.5647 | 0.3279 | 315 | -1.72 | 0.0861 |
| MPtrt*SPtrt | 2 | 4 | 4 | 4 | 0.5100 | 0.3279 | 315 | 1.56 | 0.1209 |
| MPtrt*SPtrt | 4 | 1 | 4 | 4 | 1.0747 | 0.3279 | 315 | 3.28 | 0.0012 |

Model Information

| | |
|---|---|
| Data Set | WORK.UNR959697 |
| Dependent Variable | Suc |
| Covariance Structure | Diagonal |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Residual |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1995 1996 1997 |
| Rep | 4 | 1 2 3 4 |
| MPtrt | 3 | 1 2 4 |
| SPtrt | 2 | 1 4 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 1 |
| Columns in X | 96 |
| Columns in Z | 0 |
| Subjects | 1 |
| Max Obs Per Subject | 360 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 360 |
| Number of Observations Used | 350 |
| Number of Observations Not Used | 10 |

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Residual | 215.53 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 2606.6 |
| AIC (smaller is better) | 2608.6 |
| AICC (smaller is better) | 2608.6 |
| BIC (smaller is better) | 2612.3 |

The Mixed Procedure

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 305 | 54.64 | <.0001 |
| Rep(Year) | 9 | 305 | 1.56 | 0.1266 |
| MPtrt | 2 | 305 | 4.96 | 0.0076 |
| Year*MPtrt | 4 | 305 | 0.56 | 0.6935 |
| Rep*MPtrt(Year) | 18 | 305 | 0.67 | 0.8402 |
| SPtrt | 1 | 305 | 7.10 | 0.0081 |
| Year*SPtrt | 2 | 305 | 0.11 | 0.8947 |
| MPtrt*SPtrt | 2 | 305 | 0.24 | 0.7863 |
| Year*MPtrt*SPtrt | 4 | 305 | 1.48 | 0.2073 |

Least Squares Means

| Effect | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 24.7438 | 1.3770 | 305 | 17.97 | <.0001 |
| MPtrt | 2 | | 25.5055 | 1.3529 | 305 | 18.85 | <.0001 |
| MPtrt | 4 | | 30.3415 | 1.3604 | 305 | 22.30 | <.0001 |
| SPtrt | | 1 | 28.9569 | 1.1081 | 305 | 26.13 | <.0001 |
| SPtrt | | 4 | 24.7702 | 1.1164 | 305 | 22.19 | <.0001 |
| MPtrt*SPtrt | 1 | 1 | 26.9378 | 1.9136 | 305 | 14.08 | <.0001 |
| MPtrt*SPtrt | 1 | 4 | 22.5498 | 1.9737 | 305 | 11.43 | <.0001 |
| MPtrt*SPtrt | 2 | 1 | 26.8896 | 1.9133 | 305 | 14.05 | <.0001 |
| MPtrt*SPtrt | 2 | 4 | 24.1215 | 1.9133 | 305 | 12.61 | <.0001 |
| MPtrt*SPtrt | 4 | 1 | 33.0435 | 1.9312 | 305 | 17.11 | <.0001 |
| MPtrt*SPtrt | 4 | 4 | 27.6394 | 1.9134 | 305 | 14.45 | <.0001 |

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | _MPtrt | _SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 2 | | -0.7617 | 1.9304 | 305 | -0.39 | 0.6934 |
| MPtrt | 1 | | 4 | | -5.5977 | 1.9357 | 305 | -2.89 | 0.0041 |
| MPtrt | 2 | | 4 | | -4.8359 | 1.9186 | 305 | -2.52 | 0.0122 |
| SPtrt | | 1 | | 4 | 4.1867 | 1.5716 | 305 | 2.66 | 0.0081 |
| MPtrt*SPtrt | 1 | 1 | 1 | 4 | 4.3880 | 2.7440 | 305 | 1.60 | 0.1108 |
| MPtrt*SPtrt | 1 | 1 | 2 | 1 | 0.04820 | 2.7060 | 305 | 0.02 | 0.9858 |
| MPtrt*SPtrt | 1 | 1 | 2 | 4 | 2.8163 | 2.7060 | 305 | 1.04 | 0.2988 |
| MPtrt*SPtrt | 1 | 1 | 4 | 1 | -6.1058 | 2.7187 | 305 | -2.25 | 0.0254 |
| MPtrt*SPtrt | 1 | 1 | 4 | 4 | -0.7017 | 2.7061 | 305 | -0.26 | 0.7956 |
| MPtrt*SPtrt | 1 | 4 | 2 | 1 | -4.3398 | 2.7488 | 305 | -1.58 | 0.1154 |
| MPtrt*SPtrt | 1 | 4 | 2 | 4 | -1.5717 | 2.7488 | 305 | -0.57 | 0.5679 |
| MPtrt*SPtrt | 1 | 4 | 4 | 1 | -10.4937 | 2.7613 | 305 | -3.80 | 0.0002 |

The Mixed Procedure

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt*SPtrt | 1 | 4 | 4 | 4 | -5.0896 | 2.7489 | 305 | -1.85 | 0.0651 |
| MPtrt*SPtrt | 2 | 1 | 2 | 4 | 2.7681 | 2.7057 | 305 | 1.02 | 0.3071 |
| MPtrt*SPtrt | 2 | 1 | 4 | 1 | -6.1540 | 2.7185 | 305 | -2.26 | 0.0243 |
| MPtrt*SPtrt | 2 | 1 | 4 | 4 | -0.7499 | 2.7058 | 305 | -0.28 | 0.7819 |
| MPtrt*SPtrt | 2 | 4 | 4 | 1 | -8.9220 | 2.7185 | 305 | -3.28 | 0.0012 |
| MPtrt*SPtrt | 2 | 4 | 4 | 4 | -3.5179 | 2.7058 | 305 | -1.30 | 0.1945 |
| MPtrt*SPtrt | 4 | 1 | 4 | 4 | 5.4041 | 2.7164 | 305 | 1.99 | 0.0475 |

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.UNR959697 |
| Dependent Variable | TSS |
| Covariance Structure | Diagonal |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Residual |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1995 1996 1997 |
| Rep | 4 | 1 2 3 4 |
| MPtrt | 3 | 1 2 4 |
| SPtrt | 2 | 1 4 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 1 |
| Columns in X | 96 |
| Columns in Z | 0 |
| Subjects | 1 |
| Max Obs Per Subject | 360 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 360 |
| Number of Observations Used | 350 |
| Number of Observations Not Used | 10 |

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Residual | 254.78 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 2657.6 |
| AIC (smaller is better) | 2659.6 |
| AICC (smaller is better) | 2659.6 |
| BIC (smaller is better) | 2663.3 |

The Mixed Procedure

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 305 | 61.23 | <.0001 |
| Rep(Year) | 9 | 305 | 1.24 | 0.2726 |
| MPtrt | 2 | 305 | 4.43 | 0.0127 |
| Year*MPtrt | 4 | 305 | 0.95 | 0.4371 |
| Rep*MPtrt(Year) | 18 | 305 | 0.38 | 0.9900 |
| SPtrt | 1 | 305 | 13.29 | 0.0003 |
| Year*SPtrt | 2 | 305 | 1.06 | 0.3481 |
| MPtrt*SPtrt | 2 | 305 | 0.56 | 0.5712 |
| Year*MPtrt*SPtrt | 4 | 305 | 2.00 | 0.0949 |

Least Squares Means

| Effect | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 42.2035 | 1.4972 | 305 | 28.19 | <.0001 |
| MPtrt | 2 | | 42.9219 | 1.4709 | 305 | 29.18 | <.0001 |
| MPtrt | 4 | | 47.9282 | 1.4791 | 305 | 32.40 | <.0001 |
| SPtrt | | 1 | 47.4653 | 1.2048 | 305 | 39.40 | <.0001 |
| SPtrt | | 4 | 41.2371 | 1.2138 | 305 | 33.97 | <.0001 |
| MPtrt*SPtrt | 1 | 1 | 44.9613 | 2.0805 | 305 | 21.61 | <.0001 |
| MPtrt*SPtrt | 1 | 4 | 39.4457 | 2.1459 | 305 | 18.38 | <.0001 |
| MPtrt*SPtrt | 2 | 1 | 45.1528 | 2.0802 | 305 | 21.71 | <.0001 |
| MPtrt*SPtrt | 2 | 4 | 40.6910 | 2.0802 | 305 | 19.56 | <.0001 |
| MPtrt*SPtrt | 4 | 1 | 52.2819 | 2.0997 | 305 | 24.90 | <.0001 |
| MPtrt*SPtrt | 4 | 4 | 43.5745 | 2.0803 | 305 | 20.95 | <.0001 |

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | MPtrt | SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt | 1 | | 2 | | -0.7183 | 2.0988 | 305 | -0.34 | 0.7324 |
| MPtrt | 1 | | 4 | | -5.7247 | 2.1046 | 305 | -2.72 | 0.0069 |
| MPtrt | 2 | | 4 | | -5.0064 | 2.0859 | 305 | -2.40 | 0.0170 |
| SPtrt | | 1 | | 4 | 6.2283 | 1.7087 | 305 | 3.64 | 0.0003 |
| MPtrt*SPtrt | 1 | 1 | 1 | 4 | 5.5156 | 2.9834 | 305 | 1.85 | 0.0655 |
| MPtrt*SPtrt | 1 | 1 | 2 | 1 | -0.1914 | 2.9421 | 305 | -0.07 | 0.9482 |
| MPtrt*SPtrt | 1 | 1 | 2 | 4 | 4.2704 | 2.9421 | 305 | 1.45 | 0.1477 |
| MPtrt*SPtrt | 1 | 1 | 4 | 1 | -7.3206 | 2.9559 | 305 | -2.48 | 0.0138 |
| MPtrt*SPtrt | 1 | 1 | 4 | 4 | 1.3868 | 2.9422 | 305 | 0.47 | 0.6377 |
| MPtrt*SPtrt | 1 | 4 | 2 | 1 | -5.7070 | 2.9886 | 305 | -1.91 | 0.0571 |
| MPtrt*SPtrt | 1 | 4 | 2 | 4 | -1.2452 | 2.9886 | 305 | -0.42 | 0.6772 |
| MPtrt*SPtrt | 1 | 4 | 4 | 1 | -12.8362 | 3.0022 | 305 | -4.28 | <.0001 |

The Mixed Procedure

Differences of Least Squares Means

| Effect | MPtrt | SPtrt | MPtrt | _SPtrt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|---|---|
| MPtrt*SPtrt | 1 | 4 | 4 | 4 | -4.1288 | 2.9887 | 305 | -1.38 | 0.1682 |
| MPtrt*SPtrt | 2 | 1 | 2 | 4 | 4.4618 | 2.9418 | 305 | 1.52 | 0.1304 |
| MPtrt*SPtrt | 2 | 1 | 4 | 1 | -7.1292 | 2.9556 | 305 | -2.41 | 0.0165 |
| MPtrt*SPtrt | 2 | 1 | 4 | 4 | 1.5782 | 2.9419 | 305 | 0.54 | 0.5920 |
| MPtrt*SPtrt | 2 | 4 | 4 | 1 | -11.5909 | 2.9556 | 305 | -3.92 | 0.0001 |
| MPtrt*SPtrt | 2 | 4 | 4 | 4 | -2.8836 | 2.9419 | 305 | -0.98 | 0.3278 |
| MPtrt*SPtrt | 4 | 1 | 4 | 4 | 8.7074 | 2.9534 | 305 | 2.95 | 0.0034 |

Standard Curves for UNR- Pix Soluble Sugars

Glucose-
Intercept -0.01347
Net Abs 0.5326

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.99827 |
| R Square | 0.997052 |

Fructose-
Intercept 0.0121
Net Abs 0.5271

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.997946 |
| R Square | 0.996894 |

Sucrose-
Intercept -0.0084
Net Abs 0.05145

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.99763 |
| R Square | 0.99777 |

## Appendix F: Plant Population Density (PPD) Study SAS data

PPD Starch
SAS input

Treatment 1= 18,900-30,710 plants/plot
2= 33,323-46,391 plants/plot
3= 66,647-84,289 plants/plot
4= 99,970-128,720 plants/plot
5= 133,294- 194,713 plants/plot

```
Starch concentrations are mg/g dry weight
Data PPD;
input Year Trt Rep Plot Starch;
cards;

1998    1       1       101     49.95
1998    4       1       102     50.51
1998    3       1       103     46.20
1998    2       1       104     47.54
1998    2       2       201     51.67
1998    3       2       202     51.12
1998    4       2       203     50.93
1998    1       2       205     44.84
1998    1       3       301     35.83
1998    2       3       302     51.61
1998    3       3       303     51.25
1998    4       3       305     30.04
1998    3       4       401     27.83
1998    1       4       402     51.15
1998    2       4       404     51.32
1998    4       4       405     9.15
1998    2       5       501     29.80
1998    1       5       502     50.91
1998    4       5       503     51.66
1998    3       5       504     51.20
1998    1       1       101     51.20
1998    4       1       102     85.50
1998    3       1       103     57.13
1998    2       1       104     44.09
1998    2       2       201     82.63
1998    3       2       202     14.33
1998    4       2       203     47.92
1998    1       2       205     46.11
1998    1       3       301     68.93
1998    2       3       302     60.27
1998    3       3       303     62.47
1998    4       3       305     59.66
1998    3       4       401     21.66
1998    1       4       402     95.19
1998    2       4       404     75.48
1998    4       4       405     56.58
1998    2       5       501     20.15
1998    1       5       502     35.39
1998    4       5       503     88.21
1998    3       5       504     105.24
1998    1       1       101     75.05
1998    4       1       102     31.02
1998    3       1       103     45.45
1998    2       1       104     36.63
1998    2       2       201     93.47
1998    3       2       202     23.96
1998    4       2       203     104.09
1998    1       2       205     46.23
1998    1       3       301     53.84
1998    2       3       302     39.44
1998    3       3       303     44.63
```

| | | | | |
|---|---|---|---|---|
| 1998 | 4 | 3 | 305 | 19.52 |
| 1998 | 3 | 4 | 401 | 29.36 |
| 1998 | 1 | 4 | 402 | 11.85 |
| 1998 | 2 | 4 | 404 | 89.39 |
| 1998 | 4 | 4 | 405 | 20.70 |
| 1998 | 2 | 5 | 501 | 31.56 |
| 1998 | 1 | 5 | 502 | 56.95 |
| 1998 | 4 | 5 | 503 | 38.05 |
| 1998 | 3 | 5 | 504 | 102.31 |
| 1998 | 1 | 1 | 101 | 45.17 |
| 1998 | 4 | 1 | 102 | 33.89 |
| 1998 | 3 | 1 | 103 | 44.72 |
| 1998 | 2 | 1 | 104 | 20.57 |
| 1998 | 2 | 2 | 201 | 60.63 |
| 1998 | 3 | 2 | 202 | 49.76 |
| 1998 | 4 | 2 | 203 | 86.65 |
| 1998 | 1 | 2 | 205 | 94.61 |
| 1998 | 1 | 3 | 301 | 63.53 |
| 1998 | 2 | 3 | 302 | 81.63 |
| 1998 | 3 | 3 | 303 | 56.19 |
| 1998 | 4 | 3 | 305 | 61.02 |
| 1998 | 3 | 4 | 401 | 28.00 |
| 1998 | 1 | 4 | 402 | 28.15 |
| 1998 | 2 | 4 | 404 | 28.51 |
| 1998 | 4 | 4 | 405 | 28.27 |
| 1998 | 2 | 5 | 501 | 24.95 |
| 1998 | 1 | 5 | 502 | 26.25 |
| 1998 | 4 | 5 | 503 | 51.57 |
| 1998 | 3 | 5 | 504 | 28.57 |
| 1998 | 1 | 1 | 101 | 54.05 |
| 1998 | 4 | 1 | 102 | 77.47 |
| 1998 | 3 | 1 | 103 | 50.34 |
| 1998 | 2 | 1 | 104 | 81.66 |
| 1998 | 2 | 2 | 201 | 45.54 |
| 1998 | 3 | 2 | 202 | 25.31 |
| 1998 | 4 | 2 | 203 | 9.74 |
| 1998 | 1 | 2 | 205 | 60.54 |
| 1998 | 1 | 3 | 301 | 44.78 |
| 1998 | 2 | 3 | 302 | 64.07 |
| 1998 | 3 | 3 | 303 | 53.41 |
| 1998 | 4 | 3 | 305 | 90.57 |
| 1998 | 3 | 4 | 401 | 62.05 |
| 1998 | 1 | 4 | 402 | 54.77 |
| 1998 | 2 | 4 | 404 | 42.40 |
| 1998 | 4 | 4 | 405 | 35.97 |
| 1998 | 2 | 5 | 501 | 53.53 |
| 1998 | 1 | 5 | 502 | 37.90 |
| 1998 | 4 | 5 | 503 | 6.36 |
| 1998 | 3 | 5 | 504 | 79.01 |
| 1999 | 4 | 1 | 601 | 35.67 |
| 1999 | 3 | 1 | 602 | 63.95 |
| 1999 | 2 | 1 | 603 | 103.76 |
| 1999 | 5 | 1 | 604 | 77.05 |
| 1999 | 1 | 1 | 605 | 87.22 |
| 1999 | 2 | 2 | 701 | 103.34 |
| 1999 | 4 | 2 | 702 | 30.29 |
| 1999 | 1 | 2 | 703 | 103.97 |
| 1999 | 3 | 2 | 704 | 92.95 |
| 1999 | 5 | 2 | 705 | 100.86 |
| 1999 | 3 | 3 | 801 | 81.30 |
| 1999 | 1 | 3 | 802 | 102.01 |
| 1999 | 2 | 3 | 803 | 24.56 |
| 1999 | 4 | 3 | 804 | 92.44 |
| 1999 | 5 | 3 | 805 | 103.46 |
| 1999 | 1 | 4 | 901 | 99.08 |
| 1999 | 2 | 4 | 902 | 103.64 |
| 1999 | 4 | 4 | 903 | 70.98 |
| 1999 | 5 | 4 | 904 | 80.16 |
| 1999 | 3 | 4 | 905 | 105.66 |

| | | | | |
|---|---|---|---|---|
| 1999 | 2 | 5 | 1001 | 47.26 |
| 1999 | 3 | 5 | 1002 | 32.07 |
| 1999 | 5 | 5 | 1003 | 78.07 |
| 1999 | 1 | 5 | 1004 | 105.33 |
| 1999 | 4 | 5 | 1005 | 101.62 |
| 1999 | 4 | 1 | 601 | 104.15 |
| 1999 | 3 | 1 | 602 | 54.29 |
| 1999 | 2 | 1 | 603 | 105.60 |
| 1999 | 5 | 1 | 604 | 83.17 |
| 1999 | 1 | 1 | 605 | 105.15 |
| 1999 | 2 | 2 | 701 | 104.91 |
| 1999 | 4 | 2 | 702 | 106.84 |
| 1999 | 1 | 2 | 703 | 75.05 |
| 1999 | 3 | 2 | 704 | 101.25 |
| 1999 | 5 | 2 | 705 | 85.47 |
| 1999 | 3 | 3 | 801 | 36.15 |
| 1999 | 1 | 3 | 802 | 85.89 |
| 1999 | 2 | 3 | 803 | 90.39 |
| 1999 | 4 | 3 | 804 | 76.68 |
| 1999 | 5 | 3 | 805 | 84.35 |
| 1999 | 1 | 4 | 901 | 92.05 |
| 1999 | 2 | 4 | 902 | 60.48 |
| 1999 | 4 | 4 | 903 | 102.91 |
| 1999 | 5 | 4 | 904 | 104.63 |
| 1999 | 3 | 4 | 905 | 69.56 |
| 1999 | 2 | 5 | 1001 | 96.51 |
| 1999 | 3 | 5 | 1002 | 87.34 |
| 1999 | 5 | 5 | 1003 | 97.99 |
| 1999 | 1 | 5 | 1004 | 97.39 |
| 1999 | 4 | 5 | 1005 | 98.11 |
| 1999 | 4 | 1 | 601 | 60.52 |
| 1999 | 3 | 1 | 602 | 91.39 |
| 1999 | 2 | 1 | 603 | 33.50 |
| 1999 | 5 | 1 | 604 | 99.96 |
| 1999 | 1 | 1 | 605 | 71.57 |
| 1999 | 2 | 2 | 701 | 29.65 |
| 1999 | 4 | 2 | 702 | 98.14 |
| 1999 | 1 | 2 | 703 | 50.80 |
| 1999 | 3 | 2 | 704 | 86.85 |
| 1999 | 5 | 2 | 705 | 67.65 |
| 1999 | 3 | 3 | 801 | 106.67 |
| 1999 | 1 | 3 | 802 | 87.83 |
| 1999 | 2 | 3 | 803 | 31.78 |
| 1999 | 4 | 3 | 804 | 97.27 |
| 1999 | 5 | 3 | 805 | 60.00 |
| 1999 | 1 | 4 | 901 | 106.50 |
| 1999 | 2 | 4 | 902 | 36.08 |
| 1999 | 4 | 4 | 903 | 106.81 |
| 1999 | 5 | 4 | 904 | 47.34 |
| 1999 | 3 | 4 | 905 | 74.23 |
| 1999 | 2 | 5 | 1001 | 112.83 |
| 1999 | 3 | 5 | 1002 | 33.99 |
| 1999 | 5 | 5 | 1003 | 56.08 |
| 1999 | 1 | 5 | 1004 | 109.82 |
| 1999 | 4 | 5 | 1005 | 108.88 |
| 1999 | 4 | 1 | 601 | 89.09 |
| 1999 | 3 | 1 | 602 | 88.42 |
| 1999 | 2 | 1 | 603 | 109.96 |
| 1999 | 5 | 1 | 604 | 71.29 |
| 1999 | 1 | 1 | 605 | 58.21 |
| 1999 | 2 | 2 | 701 | 8.01 |
| 1999 | 4 | 2 | 702 | 75.56 |
| 1999 | 1 | 2 | 703 | 29.89 |
| 1999 | 3 | 2 | 704 | 109.40 |
| 1999 | 5 | 2 | 705 | 89.68 |
| 1999 | 3 | 3 | 801 | . |
| 1999 | 1 | 3 | 802 | 95.24 |
| 1999 | 2 | 3 | 803 | 58.25 |
| 1999 | 4 | 3 | 804 | 93.74 |

| | | | | |
|---|---|---|---|---|
| 1999 | 5 | 3 | 805 | 112.02 |
| 1999 | 1 | 4 | 901 | 49.33 |
| 1999 | 2 | 4 | 902 | 48.18 |
| 1999 | 4 | 4 | 903 | 61.54 |
| 1999 | 5 | 4 | 904 | 84.05 |
| 1999 | 3 | 4 | 905 | 99.05 |
| 1999 | 2 | 5 | 1001 | 73.18 |
| 1999 | 3 | 5 | 1002 | 112.65 |
| 1999 | 5 | 5 | 1003 | 33.95 |
| 1999 | 1 | 5 | 1004 | 103.49 |
| 1999 | 4 | 5 | 1005 | 100.94 |
| 1999 | 4 | 1 | 601 | 30.91 |
| 1999 | 3 | 1 | 602 | 104.33 |
| 1999 | 2 | 1 | 603 | 74.61 |
| 1999 | 5 | 1 | 604 | 51.47 |
| 1999 | 1 | 1 | 605 | 101.18 |
| 1999 | 2 | 2 | 701 | 100.97 |
| 1999 | 4 | 2 | 702 | 15.11 |
| 1999 | 1 | 2 | 703 | 95.45 |
| 1999 | 3 | 2 | 704 | 98.04 |
| 1999 | 5 | 2 | 705 | 41.08 |
| 1999 | 3 | 3 | 801 | 26.85 |
| 1999 | 1 | 3 | 802 | 104.05 |
| 1999 | 2 | 3 | 803 | 74.30 |
| 1999 | 4 | 3 | 804 | 104.26 |
| 1999 | 5 | 3 | 805 | 77.20 |
| 1999 | 1 | 4 | 901 | 82.62 |
| 1999 | 2 | 4 | 902 | 96.74 |
| 1999 | 4 | 4 | 903 | 43.50 |
| 1999 | 5 | 4 | 904 | 108.70 |
| 1999 | 3 | 4 | 905 | 104.75 |
| 1999 | 2 | 5 | 1001 | 106.22 |
| 1999 | 3 | 5 | 1002 | 52.27 |
| 1999 | 5 | 5 | 1003 | 107.06 |
| 1999 | 1 | 5 | 1004 | 79.16 |
| 1999 | 4 | 5 | 1005 | 106.04 |
| 2000 | 2 | 1 | 601 | 36.57 |
| 2000 | 4 | 1 | 602 | 44.51 |
| 2000 | 3 | 1 | 603 | 74.51 |
| 2000 | 5 | 1 | 604 | 92.20 |
| 2000 | 1 | 1 | 605 | 55.94 |
| 2000 | 2 | 2 | 701 | 95.31 |
| 2000 | 3 | 2 | 702 | 29.55 |
| 2000 | 5 | 2 | 703 | 38.92 |
| 2000 | 1 | 2 | 704 | 47.97 |
| 2000 | 4 | 2 | 705 | 35.07 |
| 2000 | 1 | 3 | 801 | 35.73 |
| 2000 | 5 | 3 | 802 | 65.98 |
| 2000 | 2 | 3 | 803 | 94.40 |
| 2000 | 4 | 3 | 804 | 20.98 |
| 2000 | 3 | 3 | 805 | 55.94 |
| 2000 | 5 | 4 | 901 | 42.69 |
| 2000 | 1 | 4 | 902 | 59.33 |
| 2000 | 3 | 4 | 903 | 48.81 |
| 2000 | 4 | 4 | 904 | 28.88 |
| 2000 | 2 | 4 | 905 | 21.43 |
| 2000 | 4 | 5 | 1001 | 45.87 |
| 2000 | 3 | 5 | 1002 | 67.09 |
| 2000 | 2 | 5 | 1003 | 56.89 |
| 2000 | 5 | 5 | 1004 | 50.28 |
| 2000 | 1 | 5 | 1005 | 57.03 |
| 2000 | 2 | 1 | 601 | 68.49 |
| 2000 | 4 | 1 | 602 | 43.53 |
| 2000 | 3 | 1 | 603 | 62.37 |
| 2000 | 5 | 1 | 604 | 94.75 |
| 2000 | 1 | 1 | 605 | 105.62 |
| 2000 | 2 | 2 | 701 | 104.30 |
| 2000 | 3 | 2 | 702 | 103.25 |
| 2000 | 5 | 2 | 703 | 31.12 |

| | | | | |
|---|---|---|---|---|
| 2000 | 1 | 2 | 704 | 92.76 |
| 2000 | 4 | 2 | 705 | 63.60 |
| 2000 | 1 | 3 | 801 | 95.38 |
| 2000 | 5 | 3 | 802 | 54.26 |
| 2000 | 2 | 3 | 803 | 44.12 |
| 2000 | 4 | 3 | 804 | 49.54 |
| 2000 | 3 | 3 | 805 | 104.47 |
| 2000 | 5 | 4 | 901 | 41.26 |
| 2000 | 1 | 4 | 902 | 78.28 |
| 2000 | 3 | 4 | 903 | 73.18 |
| 2000 | 4 | 4 | 904 | 28.92 |
| 2000 | 2 | 4 | 905 | 96.36 |
| 2000 | 4 | 5 | 1001 | 57.93 |
| 2000 | 3 | 5 | 1002 | 37.31 |
| 2000 | 2 | 5 | 1003 | 58.91 |
| 2000 | 5 | 5 | 1004 | 106.81 |
| 2000 | 1 | 5 | 1005 | 80.35 |
| 2000 | 2 | 1 | 601 | 81.36 |
| 2000 | 4 | 1 | 602 | 93.81 |
| 2000 | 3 | 1 | 603 | 101.22 |
| 2000 | 5 | 1 | 604 | 48.39 |
| 2000 | 1 | 1 | 605 | 106.60 |
| 2000 | 2 | 2 | 701 | 71.81 |
| 2000 | 3 | 2 | 702 | 54.40 |
| 2000 | 5 | 2 | 703 | 48.98 |
| 2000 | 1 | 2 | 704 | 77.62 |
| 2000 | 4 | 2 | 705 | 46.71 |
| 2000 | 1 | 3 | 801 | 103.18 |
| 2000 | 5 | 3 | 802 | 108.70 |
| 2000 | 2 | 3 | 803 | 48.29 |
| 2000 | 4 | 3 | 804 | 58.14 |
| 2000 | 3 | 3 | 805 | 93.77 |
| 2000 | 5 | 4 | 901 | 31.26 |
| 2000 | 1 | 4 | 902 | 85.76 |
| 2000 | 3 | 4 | 903 | 98.21 |
| 2000 | 4 | 4 | 904 | 87.58 |
| 2000 | 2 | 4 | 905 | 57.24 |
| 2000 | 4 | 5 | 1001 | 39.82 |
| 2000 | 3 | 5 | 1002 | 48.04 |
| 2000 | 2 | 5 | 1003 | 97.93 |
| 2000 | 5 | 5 | 1004 | 48.11 |
| 2000 | 1 | 5 | 1005 | 93.42 |
| 2000 | 2 | 1 | 601 | 53.91 |
| 2000 | 4 | 1 | 602 | 86.85 |
| 2000 | 3 | 1 | 603 | 96.36 |
| 2000 | 5 | 1 | 604 | 49.72 |
| 2000 | 1 | 1 | 605 | 56.54 |
| 2000 | 2 | 2 | 701 | 66.61 |
| 2000 | 3 | 2 | 702 | 58.21 |
| 2000 | 5 | 2 | 703 | 78.95 |
| 2000 | 1 | 2 | 704 | 85.00 |
| 2000 | 4 | 2 | 705 | 47.48 |
| 2000 | 1 | 3 | 801 | 71.19 |
| 2000 | 5 | 3 | 802 | 106.95 |
| 2000 | 2 | 3 | 803 | 89.54 |
| 2000 | 4 | 3 | 804 | 72.93 |
| 2000 | 3 | 3 | 805 | 88.84 |
| 2000 | 5 | 4 | 901 | 19.48 |
| 2000 | 1 | 4 | 902 | 96.85 |
| 2000 | 3 | 4 | 903 | 90.52 |
| 2000 | 4 | 4 | 904 | 57.72 |
| 2000 | 2 | 4 | 905 | 32.73 |
| 2000 | 4 | 5 | 1001 | 32.17 |
| 2000 | 3 | 5 | 1002 | 47.13 |
| 2000 | 2 | 5 | 1003 | 56.57 |
| 2000 | 5 | 5 | 1004 | 42.69 |
| 2000 | 1 | 5 | 1005 | 101.92 |
| 2000 | 2 | 1 | 601 | 47.38 |
| 2000 | 4 | 1 | 602 | 48.53 |

| | | | | |
|---|---|---|---|---|
| 2000 | 3 | 1 | 603 | 29.37 |
| 2000 | 5 | 1 | 604 | 78.67 |
| 2000 | 1 | 1 | 605 | 78.11 |
| 2000 | 2 | 2 | 701 | 85.28 |
| 2000 | 3 | 2 | 702 | 26.19 |
| 2000 | 5 | 2 | 703 | 74.19 |
| 2000 | 1 | 2 | 704 | 81.53 |
| 2000 | 4 | 2 | 705 | 84.51 |
| 2000 | 1 | 3 | 801 | 99.12 |
| 2000 | 5 | 3 | 802 | 62.55 |
| 2000 | 2 | 3 | 803 | 81.15 |
| 2000 | 4 | 3 | 804 | 59.33 |
| 2000 | 3 | 3 | 805 | 75.35 |
| 2000 | 5 | 4 | 901 | 48.15 |
| 2000 | 1 | 4 | 902 | 84.37 |
| 2000 | 3 | 4 | 903 | 25.80 |
| 2000 | 4 | 4 | 904 | 90.73 |
| 2000 | 2 | 4 | 905 | 64.96 |
| 2000 | 4 | 5 | 1001 | 97.55 |
| 2000 | 3 | 5 | 1002 | 64.05 |
| 2000 | 2 | 5 | 1003 | 61.82 |
| 2000 | 5 | 5 | 1004 | 39.89 |
| 2000 | 1 | 5 | 1005 | 94.58 |

```
;

Proc mixed data=PPD;
Class Year Rep Trt;
Model Starch=Year Trt Year*Trt Rep(Year);
Random Year Rep(Year);
Lsmeans Trt/pdiff;
Run;
```

PPD Starch
SAS Output

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.PPD |
| Dependent Variable | Starch |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1998 1999 2000 |
| Rep | 5 | 1 2 3 4 5 |
| Trt | 5 | 1 2 3 4 5 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 3 |
| Columns in X | 38 |
| Columns in Z | 18 |
| Subjects | 1 |
| Max Obs Per Subject | 350 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 350 |
| Number of Observations Used | 349 |
| Number of Observations Not Used | 1 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 3062.83099824 | |
| 1 | 1 | 3608.70577745 | 0.00000000 |

Convergence criteria met but final hessian is not positive definite.

The Mixed Procedure

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Year | 1.262E16 |
| Rep(Year) | 8.349E15 |
| Residual | 603.90 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 3608.7 |
| AIC (smaller is better) | 3614.7 |
| AICC (smaller is better) | 3614.8 |
| BIC (smaller is better) | 3612.0 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 0 | 40.78 | . |
| Trt | 4 | 323 | 2.43 | 0.0474 |
| Year*Trt | 7 | 323 | 1.25 | 0.2761 |
| Rep(Year) | 12 | 0 | 0.87 | . |

Least Squares Means

| Effect | Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Trt | 1 | 73.1417 | 2.8376 | 323 | 25.78 | <.0001 |
| Trt | 2 | 64.2215 | 2.8376 | 323 | 22.63 | <.0001 |
| Trt | 3 | 64.7708 | 2.8579 | 323 | 22.66 | <.0001 |
| Trt | 4 | 62.1299 | 2.8376 | 323 | 21.90 | <.0001 |
| Trt | 5 | Non-est | . | . | . | . |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 1 | 2 | 8.9203 | 4.0130 | 323 | 2.22 | 0.0269 |
| Trt | 1 | 3 | 8.3709 | 4.0274 | 323 | 2.08 | 0.0385 |
| Trt | 1 | 4 | 11.0119 | 4.0130 | 323 | 2.74 | 0.0064 |
| Trt | 1 | 5 | Non-est | . | . | . | . |
| Trt | 2 | 3 | -0.5493 | 4.0274 | 323 | -0.14 | 0.8916 |

The Mixed Procedure

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > |t| |
|---|---|---|---|---|---|---|---|
| Trt | 2 | 4 | 2.0916 | 4.0130 | 323 | 0.52 | 0.6026 |
| Trt | 2 | 5 | Non-est | . | . | . | . |
| Trt | 3 | 4 | 2.6409 | 4.0274 | 323 | 0.66 | 0.5125 |
| Trt | 3 | 5 | Non-est | . | . | . | . |
| Trt | 4 | 5 | Non-est | . | . | . | . |

Glucose Standard Curve for PPD Starch

| | |
|---|---|
| Intercept | 0.02809 |
| Net Abs | 0.503046 |
| *Regression Statistics* | |
| Multiple R | 0.995556 |
| R Square | 0.991132 |

PPD Soluble Sugar-
Glucose, Fructose, Sucrose and the sum of all three
SAS Input

Treatment 1= 18,900-30,710 plants/plot
2= 33,323-46,391 plants/plot
3= 66,647-84,289 plants/plot
4= 99,970-128,720 plants/plot
5= 133,294- 194,713 plants/plot
Sugars are in mg/g dry weight

```
Data PPD;
input Year Trt Stem Rep Glu Fru Suc Totsug;
cards;
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1998 | 1 | 6 | 1 | 5.6 | 14.1 | 14.5 | 34.2 |
| 1998 | 4 | 6 | 1 | 5.4 | 12.1 | 19.7 | 37.2 |
| 1998 | 3 | 6 | 1 | 7.0 | 13.7 | 23.2 | 43.9 |
| 1998 | 2 | 6 | 1 | 5.2 | 12.0 | 18.8 | 36.0 |
| 1998 | 2 | 6 | 2 | 6.8 | 14.4 | 24.6 | 45.8 |
| 1998 | 3 | 6 | 2 | 4.8 | 13.3 | 18.1 | 36.2 |
| 1998 | 4 | 6 | 2 | 6.9 | 14.1 | 33.6 | 54.6 |
| 1998 | 1 | 6 | 2 | 9.9 | 16.2 | 33.7 | 59.8 |
| 1998 | 1 | 6 | 3 | 6.6 | 13.5 | 15.1 | 35.2 |
| 1998 | 2 | 6 | 3 | 5.4 | 13.3 | 14.0 | 32.7 |
| 1998 | 3 | 6 | 3 | 3.3 | 10.7 | 12.4 | 26.4 |
| 1998 | 4 | 6 | 3 | 5.8 | 13.0 | 16.7 | 35.6 |
| 1998 | 3 | 6 | 4 | 7.4 | 15.1 | 25.6 | 48.0 |
| 1998 | 1 | 6 | 4 | 8.9 | 6.0 | 46.5 | 61.4 |
| 1998 | 2 | 6 | 4 | 5.3 | 5.8 | 33.3 | 44.3 |
| 1998 | 4 | 6 | 4 | 7.5 | 14.0 | 25.7 | 47.2 |
| 1998 | 2 | 6 | 5 | 8.6 | 16.3 | 20.5 | 45.4 |
| 1998 | 1 | 6 | 5 | 4.4 | 12.0 | 13.1 | 29.4 |
| 1998 | 4 | 6 | 5 | 3.6 | 10.0 | 30.4 | 43.9 |
| 1998 | 3 | 6 | 5 | 5.1 | 8.4 | 32.2 | 45.7 |
| 1998 | 1 | 7 | 1 | 7.8 | 14.0 | 32.0 | 53.7 |
| 1998 | 4 | 7 | 1 | 6.5 | 8.8 | 17.7 | 33.0 |
| 1998 | 3 | 7 | 1 | 1.9 | 7.1 | 2.0 | 10.9 |
| 1998 | 2 | 7 | 1 | 2.9 | 5.8 | 5.4 | 14.1 |
| 1998 | 2 | 7 | 2 | 1.5 | 3.4 | 4.4 | 9.4 |
| 1998 | 3 | 7 | 2 | 1.7 | 6.7 | 0.3 | 8.8 |
| 1998 | 4 | 7 | 2 | 3.1 | 7.4 | 3.8 | 14.3 |
| 1998 | 1 | 7 | 2 | 3.3 | 6.3 | 3.2 | 12.7 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1998 | 1 | 7 | 3 | 4.8 | 10.0 | 8.9 | | 23.8 | |
| 1998 | 2 | 7 | 3 | 3.0 | 4.8 | | 5.1 | | 12.8 |
| 1998 | 3 | 7 | 3 | 1.8 | 3.8 | | . | . | |
| 1998 | 4 | 7 | 3 | 1.7 | 4.1 | 2.7 | 8.6 | | |
| 1998 | 3 | 7 | 4 | 2.3 | 3.9 | 1.1 | 7.3 | | |
| 1998 | 1 | 7 | 4 | 3.9 | 5.3 | 6.7 | 15.9 | | |
| 1998 | 2 | 7 | 4 | 1.0 | 3.0 | 5.2 | 9.3 | | |
| 1998 | 4 | 7 | 4 | 2.6 | 6.3 | 10.3 | 19.2 | | |
| 1998 | 2 | 7 | 5 | 3.7 | 7.1 | 1.8 | 12.6 | | |
| 1998 | 1 | 7 | 5 | 2.6 | 4.5 | 1.7 | 8.7 | | |
| 1998 | 4 | 7 | 5 | 1.8 | 6.3 | 5.0 | 13.2 | | |
| 1998 | 3 | 7 | 5 | 3.4 | 4.7 | 3.1 | 11.3 | | |
| 1998 | 1 | 8 | 1 | 1.6 | 4.0 | 0.0 | 5.6 | | |
| 1998 | 4 | 8 | 1 | 4.1 | 5.3 | 2.5 | 11.9 | | |
| 1998 | 3 | 8 | 1 | 3.1 | 5.1 | 3.7 | 11.9 | | |
| 1998 | 2 | 8 | 1 | 5.0 | 5.8 | 6.1 | 16.9 | | |
| 1998 | 2 | 8 | 2 | 2.9 | 5.0 | 4.5 | 12.3 | | |
| 1998 | 3 | 8 | 2 | 2.2 | 6.5 | . | . | | |
| 1998 | 4 | 8 | 2 | 1.5 | 3.1 | 4.8 | 9.4 | | |
| 1998 | 1 | 8 | 2 | 5.8 | 9.8 | 8.4 | 24.0 | | |
| 1998 | 1 | 8 | 3 | 2.8 | 4.2 | 0.6 | 7.7 | | |
| 1998 | 2 | 8 | 3 | 2.1 | 6.3 | 0.5 | 8.9 | | |
| 1998 | 3 | 8 | 3 | 1.9 | 4.5 | 0.1 | 6.4 | | |
| 1998 | 4 | 8 | 3 | 3.1 | 4.7 | . | . | | |
| 1998 | 3 | 8 | 4 | 0.7 | 3.0 | 1.7 | 5.4 | | |
| 1998 | 1 | 8 | 4 | 3.5 | 5.3 | 3.3 | 12.1 | | |
| 1998 | 2 | 8 | 4 | 3.9 | 6.2 | 6.0 | 16.1 | | |
| 1998 | 4 | 8 | 4 | 6.4 | 8.0 | 10.4 | 24.7 | | |
| 1998 | 2 | 8 | 5 | 3.7 | 6.1 | 2.7 | 12.5 | | |
| 1998 | 1 | 8 | 5 | 7.9 | 11.5 | 12.8 | 32.1 | | |
| 1998 | 4 | 8 | 5 | 2.9 | 6.2 | 5.3 | 14.3 | | |
| 1998 | 3 | 8 | 5 | 5.6 | 8.9 | 15.9 | 30.4 | | |
| 1998 | 1 | 9 | 1 | 4.4 | 5.5 | 13.7 | 23.6 | | |
| 1998 | 4 | 9 | 1 | 8.2 | 10.8 | 9.4 | 28.4 | | |
| 1998 | 3 | 9 | 1 | 5.9 | 8.5 | 6.9 | 21.4 | | |
| 1998 | 2 | 9 | 1 | 5.7 | 7.4 | 2.9 | 16.0 | | |
| 1998 | 2 | 9 | 2 | 6.1 | 7.8 | 6.8 | 20.8 | | |
| 1998 | 3 | 9 | 2 | 7.1 | 8.6 | 12.8 | 28.5 | | |
| 1998 | 4 | 9 | 2 | 6.0 | 7.0 | 7.4 | 20.4 | | |
| 1998 | 1 | 9 | 2 | 4.8 | 5.7 | 3.8 | 14.3 | | |
| 1998 | 1 | 9 | 3 | 8.4 | 10.5 | 8.5 | 27.4 | | |
| 1998 | 2 | 9 | 3 | 5.9 | 7.8 | 6.0 | 19.7 | | |
| 1998 | 3 | 9 | 3 | 4.0 | 5.6 | 4.1 | 13.7 | | |
| 1998 | 4 | 9 | 3 | 5.3 | 6.2 | 11.1 | 22.7 | | |
| 1998 | 3 | 9 | 4 | 6.8 | 9.8 | 6.2 | 22.8 | | |
| 1998 | 1 | 9 | 4 | 9.0 | 11.7 | 13.1 | 33.8 | | |
| 1998 | 2 | 9 | 4 | 8.8 | 12.0 | 9.0 | 29.7 | | |
| 1998 | 4 | 9 | 4 | 5.6 | 8.2 | 7.2 | 20.9 | | |
| 1998 | 2 | 9 | 5 | 8.4 | 10.3 | 17.5 | 36.3 | | |
| 1998 | 1 | 9 | 5 | 5.2 | 6.3 | 6.1 | 17.6 | | |
| 1998 | 4 | 9 | 5 | 5.4 | 7.7 | 5.0 | 18.1 | | |
| 1998 | 3 | 9 | 5 | 5.1 | 6.0 | 6.0 | 17.2 | | |
| 1998 | 1 | 10 | 1 | 6.6 | 8.3 | 14.0 | 29.0 | | |
| 1998 | 4 | 10 | 1 | 7.2 | 6.8 | 12.3 | 26.3 | | |
| 1998 | 3 | 10 | 1 | 4.6 | 7.2 | 4.7 | 16.5 | | |
| 1998 | 2 | 10 | 1 | 5.5 | 8.5 | 6.9 | 20.9 | | |
| 1998 | 2 | 10 | 2 | 6.9 | 9.5 | 9.8 | 26.2 | | |
| 1998 | 3 | 10 | 2 | 6.4 | 10.2 | 8.0 | 24.5 | | |
| 1998 | 4 | 10 | 2 | 3.3 | 8.8 | 1.3 | 13.4 | | |
| 1998 | 1 | 10 | 2 | 2.7 | 8.8 | 7.0 | 18.4 | | |
| 1998 | 1 | 10 | 3 | 7.4 | 10.4 | 7.9 | 25.8 | | |
| 1998 | 2 | 10 | 3 | 7.1 | 9.7 | 10.1 | 26.8 | | |
| 1998 | 3 | 10 | 3 | 3.2 | 5.3 | . | . | | |
| 1998 | 4 | 10 | 3 | 4.9 | 6.3 | 16.4 | 27.6 | | |
| 1998 | 3 | 10 | 4 | 4.2 | 9.6 | 7.6 | 21.4 | | |
| 1998 | 1 | 10 | 4 | 4.9 | 7.6 | 7.6 | 20.1 | | |
| 1998 | 2 | 10 | 4 | 3.8 | 7.5 | 5.2 | 16.5 | | |
| 1998 | 4 | 10 | 4 | 4.0 | 7.5 | 4.3 | 15.9 | | |
| 1998 | 2 | 10 | 5 | 7.1 | 8.3 | 10.4 | 25.9 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1998 | 1 | 10 | 5 | 4.7 | 6.6 | 7.2 | 18.6 |
| 1998 | 4 | 10 | 5 | 4.1 | 5.7 | 0.3 | 10.1 |
| 1998 | 3 | 10 | 5 | 4.8 | 5.4 | 5.4 | 15.5 |
| 1999 | 4 | 6 | 1 | 3.0 | 5.9 | 21.6 | 30.6 |
| 1999 | 3 | 6 | 1 | 4.6 | 4.8 | 30.4 | 39.8 |
| 1999 | 2 | 6 | 1 | 2.3 | 3.0 | 20.8 | 26.1 |
| 1999 | 5 | 6 | 1 | 6.0 | 6.5 | 29.7 | 42.3 |
| 1999 | 1 | 6 | 1 | 5.7 | 3.9 | 34.2 | 43.8 |
| 1999 | 2 | 6 | 2 | 4.4 | 4.3 | 27.9 | 36.6 |
| 1999 | 4 | 6 | 2 | 6.9 | 8.6 | 39.8 | 55.3 |
| 1999 | 1 | 6 | 2 | 5.6 | 4.7 | 41.4 | 51.8 |
| 1999 | 3 | 6 | 2 | 4.4 | 6.4 | 21.7 | 32.4 |
| 1999 | 5 | 6 | 2 | 5.4 | 6.1 | 25.5 | 37.0 |
| 1999 | 3 | 6 | 3 | 3.2 | 8.5 | 22.0 | 33.7 |
| 1999 | 1 | 6 | 3 | 5.5 | 6.6 | 33.8 | 46.0 |
| 1999 | 2 | 6 | 3 | 1.5 | 1.8 | 0.4 | 3.7 |
| 1999 | 4 | 6 | 3 | 3.7 | 10.3 | 22.0 | 36.0 |
| 1999 | 5 | 6 | 3 | 3.4 | 7.1 | 15.4 | 25.8 |
| 1999 | 1 | 6 | 4 | 4.8 | 7.9 | 26.0 | 38.7 |
| 1999 | 2 | 6 | 4 | 5.1 | 4.6 | 25.1 | 34.9 |
| 1999 | 4 | 6 | 4 | 5.9 | 8.3 | 27.3 | 41.5 |
| 1999 | 5 | 6 | 4 | 3.4 | 9.0 | 21.4 | 33.9 |
| 1999 | 3 | 6 | 4 | 2.8 | 9.8 | 16.1 | 28.8 |
| 1999 | 2 | 6 | 5 | 4.2 | 9.0 | 19.9 | 33.0 |
| 1999 | 3 | 6 | 5 | 4.5 | 9.7 | 19.0 | 33.2 |
| 1999 | 5 | 6 | 5 | 4.5 | 9.6 | 19.7 | 33.8 |
| 1999 | 1 | 6 | 5 | 4.2 | 6.9 | 26.6 | 37.7 |
| 1999 | 4 | 6 | 5 | 7.0 | 10.5 | 34.2 | 51.8 |
| 1999 | 4 | 7 | 1 | 3.7 | 4.4 | 20.1 | 28.2 |
| 1999 | 3 | 7 | 1 | 3.8 | 5.5 | 20.4 | 29.6 |
| 1999 | 2 | 7 | 1 | 3.3 | 8.0 | 18.2 | 29.5 |
| 1999 | 5 | 7 | 1 | 6.0 | 9.6 | 24.6 | 40.2 |
| 1999 | 1 | 7 | 1 | 3.5 | 3.9 | 23.3 | 30.6 |
| 1999 | 2 | 7 | 2 | 4.9 | 5.8 | 25.3 | 36.1 |
| 1999 | 4 | 7 | 2 | 4.4 | 6.2 | 20.7 | 31.4 |
| 1999 | 1 | 7 | 2 | 3.1 | 3.5 | 19.2 | 25.8 |
| 1999 | 3 | 7 | 2 | 2.2 | 2.9 | 19.6 | 24.7 |
| 1999 | 5 | 7 | 2 | 3.6 | 5.0 | 15.4 | 24.0 |
| 1999 | 3 | 7 | 3 | 4.0 | 9.4 | 17.0 | 30.4 |
| 1999 | 1 | 7 | 3 | 5.4 | 3.0 | 27.2 | 35.7 |
| 1999 | 2 | 7 | 3 | 3.7 | 3.7 | 18.8 | 26.3 |
| 1999 | 4 | 7 | 3 | 5.6 | 6.0 | 18.2 | 29.9 |
| 1999 | 5 | 7 | 3 | 3.7 | 9.3 | 17.1 | 30.0 |
| 1999 | 1 | 7 | 4 | 6.4 | 6.7 | 35.7 | 48.8 |
| 1999 | 2 | 7 | 4 | 8.1 | 5.8 | 31.2 | 45.1 |
| 1999 | 4 | 7 | 4 | 6.4 | 7.8 | 28.8 | 42.9 |
| 1999 | 5 | 7 | 4 | 5.7 | 6.6 | 27.9 | 40.2 |
| 1999 | 3 | 7 | 4 | 6.5 | 7.6 | 20.0 | 34.1 |
| 1999 | 2 | 7 | 5 | 5.1 | 2.6 | 24.6 | 32.3 |
| 1999 | 3 | 7 | 5 | 4.9 | 8.2 | 22.2 | 35.3 |
| 1999 | 5 | 7 | 5 | 7.4 | 5.2 | 44.7 | 57.2 |
| 1999 | 1 | 7 | 5 | 4.1 | 4.8 | 30.8 | 39.7 |
| 1999 | 4 | 7 | 5 | 6.9 | 7.1 | 35.0 | 49.0 |
| 1999 | 4 | 8 | 1 | 4.4 | 8.7 | 22.8 | 35.9 |
| 1999 | 3 | 8 | 1 | 7.6 | 9.3 | 40.4 | 57.4 |
| 1999 | 2 | 8 | 1 | 4.5 | 7.1 | 25.0 | 36.7 |
| 1999 | 5 | 8 | 1 | 2.2 | 2.4 | 17.5 | 22.0 |
| 1999 | 1 | 8 | 1 | 4.1 | 4.2 | 41.4 | 49.8 |
| 1999 | 2 | 8 | 2 | 5.8 | 3.6 | 32.4 | 41.8 |
| 1999 | 4 | 8 | 2 | 2.6 | 4.4 | 18.5 | 25.5 |
| 1999 | 1 | 8 | 2 | 5.4 | 5.5 | 40.5 | 51.4 |
| 1999 | 3 | 8 | 2 | 4.5 | 6.8 | 27.6 | 38.9 |
| 1999 | 5 | 8 | 2 | 6.1 | 6.8 | 28.8 | 41.6 |
| 1999 | 3 | 8 | 3 | 3.6 | 6.8 | 25.5 | 35.8 |
| 1999 | 1 | 8 | 3 | 3.5 | 7.2 | 21.5 | 32.2 |
| 1999 | 2 | 8 | 3 | 6.7 | 5.2 | 35.9 | 47.9 |
| 1999 | 4 | 8 | 3 | 7.1 | 6.4 | 30.8 | 44.2 |
| 1999 | 5 | 8 | 3 | 5.7 | 8.2 | 25.3 | 39.2 |
| 1999 | 1 | 8 | 4 | 3.2 | 6.1 | 17.8 | 27.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1999 | 2 | 8 | 4 | 4.2 | 7.3 | 24.1 | 35.6 |
| 1999 | 4 | 8 | 4 | 5.1 | 6.4 | 26.4 | 37.9 |
| 1999 | 5 | 8 | 4 | 4.7 | 9.5 | 21.5 | 35.7 |
| 1999 | 3 | 8 | 4 | 6.1 | 4.4 | 27.2 | 37.7 |
| 1999 | 2 | 8 | 5 | 6.3 | 7.4 | 23.8 | 37.6 |
| 1999 | 3 | 8 | 5 | 4.9 | 10.6 | 21.7 | 37.2 |
| 1999 | 5 | 8 | 5 | 5.3 | 11.2 | 21.0 | 37.5 |
| 1999 | 1 | 8 | 5 | 4.4 | 7.2 | 13.4 | 25.0 |
| 1999 | 4 | 8 | 5 | 4.3 | 9.5 | 25.5 | 39.3 |
| 1999 | 4 | 9 | 1 | 3.9 | 6.7 | 26.8 | 37.4 |
| 1999 | 3 | 9 | 1 | 5.4 | 6.2 | 31.5 | 43.1 |
| 1999 | 2 | 9 | 1 | 4.7 | 5.0 | 28.4 | 38.0 |
| 1999 | 5 | 9 | 1 | 5.8 | 3.0 | 27.9 | 36.7 |
| 1999 | 1 | 9 | 1 | 5.1 | 3.1 | 30.3 | 38.4 |
| 1999 | 2 | 9 | 2 | 4.5 | 8.0 | 21.7 | 34.2 |
| 1999 | 4 | 9 | 2 | 3.4 | 8.5 | 17.3 | 29.1 |
| 1999 | 1 | 9 | 2 | 4.3 | 4.8 | 32.2 | 41.3 |
| 1999 | 3 | 9 | 2 | 5.0 | 7.4 | 24.7 | 37.1 |
| 1999 | 5 | 9 | 2 | 3.9 | 6.4 | 18.5 | 28.9 |
| 1999 | 3 | 9 | 3 | 3.6 | 9.9 | 18.9 | 32.5 |
| 1999 | 1 | 9 | 3 | 6.8 | 10.5 | 0.4 | 17.6 |
| 1999 | 2 | 9 | 3 | 6.4 | 5.1 | 27.8 | 39.2 |
| 1999 | 4 | 9 | 3 | 7.2 | 6.1 | 23.3 | 36.5 |
| 1999 | 5 | 9 | 3 | 7.8 | 5.6 | 29.8 | 43.2 |
| 1999 | 1 | 9 | 4 | 7.6 | 5.9 | 28.3 | 41.8 |
| 1999 | 2 | 9 | 4 | 5.1 | 8.1 | 22.1 | 35.3 |
| 1999 | 4 | 9 | 4 | 7.2 | 1.8 | 33.0 | 42.0 |
| 1999 | 5 | 9 | 4 | 5.5 | 6.4 | 19.3 | 31.1 |
| 1999 | 3 | 9 | 4 | 7.0 | 6.9 | 22.6 | 36.6 |
| 1999 | 2 | 9 | 5 | 5.5 | 7.7 | 21.7 | 34.9 |
| 1999 | 3 | 9 | 5 | 5.8 | 6.3 | 24.0 | 36.1 |
| 1999 | 5 | 9 | 5 | 5.0 | 8.7 | 22.4 | 36.1 |
| 1999 | 1 | 9 | 5 | 6.2 | 7.8 | 37.1 | 51.1 |
| 1999 | 4 | 9 | 5 | 6.6 | 8.9 | 34.5 | 50.1 |
| 1999 | 4 | 10 | 1 | 3.4 | 2.8 | 25.6 | 31.8 |
| 1999 | 3 | 10 | 1 | 3.1 | 6.2 | 31.1 | 40.4 |
| 1999 | 2 | 10 | 1 | 4.7 | 1.9 | 21.2 | 27.7 |
| 1999 | 5 | 10 | 1 | 3.6 | 5.2 | 15.3 | 24.2 |
| 1999 | 1 | 10 | 1 | 4.9 | 0.9 | 18.7 | 24.4 |
| 1999 | 2 | 10 | 2 | 4.6 | 1.5 | 15.3 | 21.4 |
| 1999 | 4 | 10 | 2 | 2.4 | 4.8 | 14.9 | 22.0 |
| 1999 | 1 | 10 | 2 | 4.6 | 3.5 | 26.0 | 34.1 |
| 1999 | 3 | 10 | 2 | 5.9 | . | . | . |
| 1999 | 5 | 10 | 2 | 5.9 | 1.1 | 19.1 | 26.1 |
| 1999 | 3 | 10 | 3 | 3.1 | 3.0 | 18.2 | 24.4 |
| 1999 | 1 | 10 | 3 | 4.0 | 5.0 | 31.0 | 40.0 |
| 1999 | 2 | 10 | 3 | 4.4 | 4.2 | 22.9 | 31.5 |
| 1999 | 4 | 10 | 3 | 1.7 | 5.5 | 11.0 | 18.2 |
| 1999 | 5 | 10 | 3 | 3.4 | 4.0 | 8.5 | 15.9 |
| 1999 | 1 | 10 | 4 | 4.2 | 2.7 | 17.6 | 24.5 |
| 1999 | 2 | 10 | 4 | 4.9 | 1.4 | 15.9 | 22.3 |
| 1999 | 4 | 10 | 4 | 4.8 | 4.5 | 19.2 | 28.6 |
| 1999 | 5 | 10 | 4 | 1.1 | 5.1 | 11.6 | 17.8 |
| 1999 | 3 | 10 | 4 | 2.4 | 4.2 | 10.8 | 17.5 |
| 1999 | 2 | 10 | 5 | 3.2 | 3.9 | 16.9 | 24.0 |
| 1999 | 3 | 10 | 5 | 3.3 | 6.8 | 25.8 | 35.9 |
| 1999 | 5 | 10 | 5 | 2.5 | 6.7 | 17.0 | 26.3 |
| 1999 | 1 | 10 | 5 | 3.4 | 6.7 | 24.4 | 34.5 |
| 1999 | 4 | 10 | 5 | 4.0 | 2.4 | 10.9 | 17.3 |
| 2000 | 2 | 6 | 1 | 2.1 | 5.5 | 10.3 | 17.8 |
| 2000 | 4 | 6 | 1 | 2.3 | 3.9 | 14.1 | 20.3 |
| 2000 | 3 | 6 | 1 | 2.0 | 3.9 | 11.3 | 17.2 |
| 2000 | 5 | 6 | 1 | 4.2 | 1.7 | 13.5 | 19.4 |
| 2000 | 1 | 6 | 1 | 3.1 | 1.9 | 13.4 | 18.5 |
| 2000 | 2 | 6 | 2 | 3.8 | 2.4 | 18.0 | 24.3 |
| 2000 | 3 | 6 | 2 | 3.4 | 5.5 | 18.8 | 27.7 |
| 2000 | 5 | 6 | 2 | 3.9 | 2.0 | 14.7 | 20.6 |
| 2000 | 1 | 6 | 2 | 4.2 | 1.7 | 15.2 | 21.0 |
| 2000 | 4 | 6 | 2 | 2.1 | 6.2 | 12.0 | 20.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2000 | 1 | 6 | 3 | 3.2 | 3.4 | 12.0 | 18.5 |
| 2000 | 5 | 6 | 3 | 3.9 | 5.2 | 23.7 | 32.9 |
| 2000 | 2 | 6 | 3 | 1.6 | 4.7 | 11.8 | 18.1 |
| 2000 | 4 | 6 | 3 | 2.3 | 4.4 | 14.8 | 21.5 |
| 2000 | 3 | 6 | 3 | 4.8 | 2.0 | 15.6 | 22.4 |
| 2000 | 5 | 6 | 4 | 5.3 | 0.5 | 14.0 | 19.8 |
| 2000 | 1 | 6 | 4 | 4.2 | 3.2 | 13.3 | 20.8 |
| 2000 | 3 | 6 | 4 | 3.8 | 5.3 | 17.5 | 26.6 |
| 2000 | 4 | 6 | 4 | 2.8 | 4.8 | 9.8 | 17.4 |
| 2000 | 2 | 6 | 4 | 4.7 | 2.6 | 14.6 | 21.9 |
| 2000 | 4 | 6 | 5 | 3.1 | 3.2 | 13.0 | 19.3 |
| 2000 | 3 | 6 | 5 | 3.6 | 3.6 | 23.0 | 30.2 |
| 2000 | 2 | 6 | 5 | 4.3 | 5.7 | 19.9 | 30.0 |
| 2000 | 5 | 6 | 5 | 2.6 | 3.4 | 17.6 | 23.5 |
| 2000 | 1 | 6 | 5 | 5.0 | 5.1 | 33.1 | 43.2 |
| 2000 | 2 | 7 | 1 | 3.4 | 4.9 | 16.0 | 24.2 |
| 2000 | 4 | 7 | 1 | 5.7 | 4.3 | 12.5 | 22.6 |
| 2000 | 3 | 7 | 1 | 3.7 | 7.8 | 15.3 | 26.8 |
| 2000 | 5 | 7 | 1 | 4.2 | 5.8 | 15.3 | 25.2 |
| 2000 | 1 | 7 | 1 | 3.6 | 4.4 | 17.4 | 25.5 |
| 2000 | 2 | 7 | 2 | 2.8 | 7.1 | 15.6 | 25.5 |
| 2000 | 3 | 7 | 2 | 3.8 | 5.3 | 8.9 | 17.9 |
| 2000 | 5 | 7 | 2 | 4.5 | 4.5 | 21.8 | 30.8 |
| 2000 | 1 | 7 | 2 | 1.9 | 9.2 | 17.7 | 28.8 |
| 2000 | 4 | 7 | 2 | 3.3 | 5.3 | 13.2 | 21.9 |
| 2000 | 1 | 7 | 3 | 4.4 | 5.4 | 10.6 | 20.3 |
| 2000 | 5 | 7 | 3 | 6.5 | 4.2 | 17.7 | 28.3 |
| 2000 | 2 | 7 | 3 | 2.9 | 8.1 | 9.5 | 20.5 |
| 2000 | 4 | 7 | 3 | 3.6 | 0.6 | 8.7 | 13.0 |
| 2000 | 3 | 7 | 3 | 3.4 | 6.1 | 13.2 | 22.7 |
| 2000 | 5 | 7 | 4 | 3.5 | 6.7 | 22.2 | 32.4 |
| 2000 | 1 | 7 | 4 | 3.9 | 7.4 | 14.5 | 25.8 |
| 2000 | 3 | 7 | 4 | 5.6 | 2.2 | 14.4 | 22.2 |
| 2000 | 4 | 7 | 4 | 3.7 | . | . | . |
| 2000 | 2 | 7 | 4 | 3.0 | 2.8 | 10.4 | 16.2 |
| 2000 | 4 | 7 | 5 | 3.5 | 3.2 | 10.9 | 17.5 |
| 2000 | 3 | 7 | 5 | 6.5 | 0.4 | 11.5 | 18.3 |
| 2000 | 2 | 7 | 5 | 5.1 | 0.8 | 13.6 | 19.5 |
| 2000 | 5 | 7 | 5 | 6.0 | 0.1 | 16.7 | 22.8 |
| 2000 | 1 | 7 | 5 | 3.4 | 7.8 | 10.7 | 21.9 |
| 2000 | 2 | 8 | 1 | 2.6 | 2.1 | 9.8 | 14.5 |
| 2000 | 4 | 8 | 1 | 3.2 | 2.0 | 9.4 | 14.5 |
| 2000 | 3 | 8 | 1 | 2.4 | 2.9 | 11.4 | 16.8 |
| 2000 | 5 | 8 | 1 | 2.6 | 6.6 | 13.3 | 22.5 |
| 2000 | 1 | 8 | 1 | 2.5 | 4.7 | 11.4 | 18.6 |
| 2000 | 2 | 8 | 2 | 3.5 | 4.1 | 13.1 | 20.6 |
| 2000 | 3 | 8 | 2 | 4.3 | 3.4 | 15.1 | 22.8 |
| 2000 | 5 | 8 | 2 | 3.6 | 2.9 | 18.4 | 24.9 |
| 2000 | 1 | 8 | 2 | 3.6 | 7.0 | 14.9 | 25.5 |
| 2000 | 4 | 8 | 2 | 4.3 | 0.1 | 11.5 | 15.9 |
| 2000 | 1 | 8 | 3 | 3.8 | 2.8 | 9.3 | 15.9 |
| 2000 | 5 | 8 | 3 | 6.0 | 1.3 | 17.9 | 25.2 |
| 2000 | 2 | 8 | 3 | 2.9 | 1.3 | 4.2 | 8.4 |
| 2000 | 4 | 8 | 3 | 3.2 | 1.8 | 8.3 | 13.3 |
| 2000 | 3 | 8 | 3 | 3.5 | 3.0 | 13.9 | 20.4 |
| 2000 | 5 | 8 | 4 | 3.8 | 15.3 | 19.2 | 38.3 |
| 2000 | 1 | 8 | 4 | 4.5 | 4.9 | 13.6 | 23.0 |
| 2000 | 3 | 8 | 4 | 5.8 | 1.4 | 16.4 | 23.6 |
| 2000 | 4 | 8 | 4 | 4.3 | 1.8 | 9.5 | 15.5 |
| 2000 | 2 | 8 | 4 | 4.5 | 4.6 | 15.1 | 24.2 |
| 2000 | 4 | 8 | 5 | 2.8 | 3.8 | 10.7 | 17.3 |
| 2000 | 3 | 8 | 5 | 3.3 | 5.6 | 11.3 | 20.1 |
| 2000 | 2 | 8 | 5 | 4.5 | 2.7 | 16.3 | 23.5 |
| 2000 | 5 | 8 | 5 | 4.9 | 3.4 | 22.1 | 30.4 |
| 2000 | 1 | 8 | 5 | 6.8 | 6.0 | 22.0 | 34.8 |
| 2000 | 2 | 9 | 1 | 4.4 | 4.6 | 21.4 | 30.4 |
| 2000 | 4 | 9 | 1 | 7.6 | . | . | . |
| 2000 | 3 | 9 | 1 | 4.5 | 7.2 | 23.4 | 35.1 |
| 2000 | 5 | 9 | 1 | 2.2 | 7.6 | 32.8 | 42.5 |

```
2000    1       9       1       4.1     3.0     17.3    24.5
2000    2       9       2       5.8     4.2     18.4    28.4
2000    3       9       2       2.6     6.8     28.3    37.7
2000    5       9       2       5.4     8.3     26.0    39.7
2000    1       9       2       4.5     3.9     20.7    29.2
2000    4       9       2       6.1     1.2     22.1    29.3
2000    1       9       3       3.6     6.2     20.3    30.0
2000    5       9       3       3.5     8.4     24.0    36.0
2000    2       9       3       6.7     4.5     17.1    28.3
2000    4       9       3       7.1     2.3     14.9    24.3
2000    3       9       3       5.7     8.7     25.9    40.3
2000    5       9       4       3.2     5.8     21.9    30.9
2000    1       9       4       4.2     8.2     11.2    23.7
2000    3       9       4       5.1     7.1     18.8    31.0
2000    4       9       4       4.7     7.6     12.4    24.7
2000    2       9       4       6.1     4.4     17.5    28.1
2000    4       9       5       6.3     3.9     31.4    41.6
2000    3       9       5       4.9     1.9     22.7    29.5
2000    2       9       5       5.3     6.9     20.1    32.3
2000    5       9       5       4.4     7.7     25.4    37.5
2000    1       9       5       4.3     4.6     15.9    24.8
2000    2       10      1       3.9     5.7     17.8    27.4
2000    4       10      1       5.4     2.2     22.7    30.3
2000    3       10      1       4.7     1.5     29.5    35.7
2000    5       10      1       5.8     2.1     23.1    31.0
2000    1       10      1       5.1     1.3     15.0    21.3
2000    2       10      2       4.5     3.7     18.7    26.9
2000    3       10      2       3.4     6.3     16.0    25.6
2000    5       10      2       4.3     3.8     20.8    28.9
2000    1       10      2       5.0     4.4     17.3    26.8
2000    4       10      2       3.9     5.3     13.2    22.4
2000    1       10      3       3.6     5.4     19.7    28.7
2000    5       10      3       6.8     4.3     1.5     12.5
2000    2       10      3       6.4     3.8     23.3    33.4
2000    4       10      3       7.2     .       .       .
2000    3       10      3       7.8     5.5     23.6    36.9
2000    5       10      4       7.6     3.4     18.9    29.9
2000    1       10      4       5.1     7.8     23.4    36.3
2000    3       10      4       7.2     0.1     22.1    29.4
2000    4       10      4       5.5     4.4     18.4    28.2
2000    2       10      4       7.0     0.9     18.5    26.5
2000    4       10      5       5.5     3.5     18.9    27.8
2000    3       10      5       5.8     2.1     21.1    29.0
2000    2       10      5       5.0     4.5     14.5    24.0
2000    5       10      5       6.2     2.9     13.2    22.3
2000    1       10      5       6.6     0.4     11.3    18.4
;
Proc mixed data=PPD;
Class Year Rep Trt;
Model Glu=Year Trt Year*Trt Rep(Year) ;
Random Year Rep(Year);
Lsmeans Trt/pdiff;
Run;
Proc mixed data=PPD;
Class Year Rep Trt;
Model Fru=Year Trt Year*Trt Rep(Year);
Random Year Rep(Year);
Lsmeans Trt/pdiff;
Proc mixed data=PPD;
Class Year Rep Trt;
Model Suc=Year Trt Year*Trt Rep(Year);
Random Year Rep(Year);
Lsmeans Trt/pdiff;
Run;
Proc mixed data=PPD;
Class Year Rep Trt;
Model TotSug=Year Trt Year*Trt Rep(Year);
Random Year Rep(Year);
Lsmeans Trt/pdiff;
```

**Run**;

PPD Soluble Sugars
SAS Output - Glucose, Fructose, Sucrose and the Total
Sugars are in mg/g dry weight

Model Information

| | |
|---|---|
| Data Set | WORK.PPD |
| Dependent Variable | Glu |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1998 1999 2000 |
| Rep | 5 | 1 2 3 4 5 |
| Trt | 5 | 1 2 3 4 5 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 3 |
| Columns in X | 38 |
| Columns in Z | 18 |
| Subjects | 1 |
| Max Obs Per Subject | 350 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 350 |
| Number of Observations Used | 350 |
| Number of Observations Not Used | 0 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 1320.41547493 | |
| 1 | 1 | 1536.48603032 | 0.00000000 |

Convergence criteria met but final hessian is not positive definite.

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Year | 5.156E31 |
| Rep(Year) | 0 |
| Residual | 2.7097 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 1536.5 |
| AIC (smaller is better) | 1540.5 |
| AICC (smaller is better) | 1540.5 |

| | |
|---|---|
| BIC (smaller is better) | 1538.7 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 0 | 2.67 | . |
| Trt | 4 | 324 | 0.79 | 0.5322 |
| Year*Trt | 7 | 324 | 1.06 | 0.3911 |
| Rep(Year) | 12 | 0 | 1.19 | . |

Least Squares Means

| Effect | Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Trt | 1 | 4.8227 | 0.1901 | 324 | 25.37 | <.0001 |
| Trt | 2 | 4.6827 | 0.1901 | 324 | 24.64 | <.0001 |
| Trt | 3 | 4.3747 | 0.1901 | 324 | 23.02 | <.0001 |
| Trt | 4 | 4.6400 | 0.1901 | 324 | 24.41 | <.0001 |
| Trt | 5 | Non-est | . | . | . | . |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 1 | 2 | 0.1400 | 0.2688 | 324 | 0.52 | 0.6029 |
| Trt | 1 | 3 | 0.4480 | 0.2688 | 324 | 1.67 | 0.0966 |
| Trt | 1 | 4 | 0.1827 | 0.2688 | 324 | 0.68 | 0.4973 |
| Trt | 1 | 5 | Non-est | . | . | . | . |
| Trt | 2 | 3 | 0.3080 | 0.2688 | 324 | 1.15 | 0.2527 |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 2 | 4 | 0.04267 | 0.2688 | 324 | 0.16 | 0.8740 |
| Trt | 2 | 5 | Non-est | . | . | . | . |
| Trt | 3 | 4 | -0.2653 | 0.2688 | 324 | -0.99 | 0.3243 |
| Trt | 3 | 5 | Non-est | . | . | . | . |
| Trt | 4 | 5 | Non-est | . | . | . | . |

Model Information

| | |
|---|---|
| Data Set | WORK.PPD |
| Dependent Variable | Fru |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1998 1999 2000 |
| Rep | 5 | 1 2 3 4 5 |
| Trt | 5 | 1 2 3 4 5 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 3 |
| Columns in X | 38 |
| Columns in Z | 18 |
| Subjects | 1 |
| Max Obs Per Subject | 350 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 350 |
| Number of Observations Used | 346 |
| Number of Observations Not Used | 4 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 1604.85590316 | |
| 1 | 1 | 1604.85590316 | 0.00000000 |

Convergence criteria met but final hessian is not positive definite.

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Year | 162388 |
| Rep(Year) | 0 |
| Residual | 6.9212 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 1604.9 |
| AIC (smaller is better) | 1608.9 |
| AICC (smaller is better) | 1608.9 |
| BIC (smaller is better) | 1607.1 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 0 | 0.00 | . |
| Trt | 4 | 320 | 1.02 | 0.3967 |
| Year*Trt | 7 | 320 | 1.76 | 0.0941 |
| Rep(Year) | 12 | 0 | 1.36 | . |

Least Squares Means

| Effect | Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Trt | 1 | 6.2827 | 232.66 | 320 | 0.03 | 0.9785 |
| Trt | 2 | 5.7693 | 232.66 | 320 | 0.02 | 0.9802 |
| Trt | 3 | 6.2798 | 232.66 | 320 | 0.03 | 0.9785 |
| Trt | 4 | 5.9637 | 232.66 | 320 | 0.03 | 0.9796 |
| Trt | 5 | Non-est | . | . | . | . |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 1 | 2 | 0.5133 | 0.4296 | 320 | 1.19 | 0.2330 |
| Trt | 1 | 3 | 0.002851 | 0.4312 | 320 | 0.01 | 0.9947 |
| Trt | 1 | 4 | 0.3190 | 0.4346 | 320 | 0.73 | 0.4634 |
| Trt | 1 | 5 | Non-est | . | . | . | . |
| Trt | 2 | 3 | -0.5105 | 0.4312 | 320 | -1.18 | 0.2373 |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 2 | 4 | -0.1943 | 0.4346 | 320 | -0.45 | 0.6551 |
| Trt | 2 | 5 | Non-est | . | . | . | . |
| Trt | 3 | 4 | 0.3162 | 0.4361 | 320 | 0.73 | 0.4690 |
| Trt | 3 | 5 | Non-est | . | . | . | . |
| Trt | 4 | 5 | Non-est | . | . | . | . |

The Mixed Procedure

Model Information

| | |
|---|---|
| Data Set | WORK.PPD |
| Dependent Variable | Suc |
| Covariance Structure | Variance Components |
| Estimation Method | REML |
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1998 1999 2000 |
| Rep | 5 | 1 2 3 4 5 |
| Trt | 5 | 1 2 3 4 5 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 3 |
| Columns in X | 38 |
| Columns in Z | 18 |
| Subjects | 1 |
| Max Obs Per Subject | 350 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 350 |
| Number of Observations Used | 342 |
| Number of Observations Not Used | 8 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 2242.93966964 | |
| 1 | 1 | 2242.93966964 | 0.00000000 |

Convergence criteria met but final hessian is not positive definite.

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Year | 0 |
| Rep(Year) | 0 |
| Residual | 55.4427 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 2242.9 |
| AIC (smaller is better) | 2244.9 |
| AICC (smaller is better) | 2245.0 |
| BIC (smaller is better) | 2244.0 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 0 | 86.95 | . |
| Trt | 4 | 316 | 1.07 | 0.3730 |
| Year*Trt | 7 | 316 | 1.73 | 0.1022 |
| Rep(Year) | 12 | 0 | 0.94 | . |

Least Squares Means

| Effect | Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|
| Trt | 1 | 18.2587 | 0.8598 | 316 | 21.24 | <.0001 |
| Trt | 2 | 15.8707 | 0.8598 | 316 | 18.46 | <.0001 |
| Trt | 3 | 16.7385 | 0.8864 | 316 | 18.88 | <.0001 |
| Trt | 4 | 16.4392 | 0.8856 | 316 | 18.56 | <.0001 |
| Trt | 5 | Non-est | . | . | . | . |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 1 | 2 | 2.3880 | 1.2159 | 316 | 1.96 | 0.0504 |
| Trt | 1 | 3 | 1.5202 | 1.2349 | 316 | 1.23 | 0.2192 |
| Trt | 1 | 4 | 1.8194 | 1.2343 | 316 | 1.47 | 0.1415 |
| Trt | 1 | 5 | Non-est | . | . | . | . |
| Trt | 2 | 3 | -0.8678 | 1.2349 | 316 | -0.70 | 0.4827 |

Differences of Least Squares Means

| Effect | Trt | _Trt | Estimate | Standard Error | DF | t Value | Pr > \|t\| |
|---|---|---|---|---|---|---|---|
| Trt | 2 | 4 | -0.5686 | 1.2343 | 316 | -0.46 | 0.6454 |
| Trt | 2 | 5 | Non-est | . | . | . | . |
| Trt | 3 | 4 | 0.2992 | 1.2522 | 316 | 0.24 | 0.8113 |
| Trt | 3 | 5 | Non-est | . | . | . | . |
| Trt | 4 | 5 | Non-est | . | . | . | . |

Model Information

| | |
|---|---|
| Data Set | WORK.PPD |
| Dependent Variable | Totsug |
| Covariance Structure | Variance Components |
| Estimation Method | REML |

| | |
|---|---|
| Residual Variance Method | Profile |
| Fixed Effects SE Method | Model-Based |
| Degrees of Freedom Method | Containment |

Class Level Information

| Class | Levels | Values |
|---|---|---|
| Year | 3 | 1998 1999 2000 |
| Rep | 5 | 1 2 3 4 5 |
| Trt | 5 | 1 2 3 4 5 |

Dimensions

| | |
|---|---|
| Covariance Parameters | 3 |
| Columns in X | 38 |
| Columns in Z | 18 |
| Subjects | 1 |
| Max Obs Per Subject | 350 |

Number of Observations

| | |
|---|---|
| Number of Observations Read | 350 |
| Number of Observations Used | 342 |
| Number of Observations Not Used | 8 |

Iteration History

| Iteration | Evaluations | -2 Res Log Like | Criterion |
|---|---|---|---|
| 0 | 1 | 2414.19926023 | |
| 1 | 1 | 2414.19926023 | 0.00000000 |

Convergence criteria met but final hessian is not positive definite.

Covariance Parameter Estimates

| Cov Parm | Estimate |
|---|---|
| Year | 0 |
| Rep(Year) | 0 |
| Residual | 95.3268 |

Fit Statistics

| | |
|---|---|
| -2 Res Log Likelihood | 2414.2 |
| AIC (smaller is better) | 2416.2 |
| AICC (smaller is better) | 2416.2 |
| BIC (smaller is better) | 2415.3 |

Type 3 Tests of Fixed Effects

| Effect | Num DF | Den DF | F Value | Pr > F |
|---|---|---|---|---|
| Year | 2 | 0 | 42.77 | . |
| Trt | 4 | 316 | 1.11 | 0.3538 |
| Year*Trt | 7 | 316 | 1.25 | 0.2727 |
| Rep(Year) | 12 | 0 | 0.56 | . |

Least Squares Means

<table>
<tr><th>Effect</th><th>Trt</th><th>Estimate</th><th>Standard Error</th><th>DF</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Trt</td><td>1</td><td>29.3667</td><td>1.1274</td><td>316</td><td>26.05</td><td><.0001</td></tr>
<tr><td>Trt</td><td>2</td><td>26.3267</td><td>1.1274</td><td>316</td><td>23.35</td><td><.0001</td></tr>
<tr><td>Trt</td><td>3</td><td>27.5596</td><td>1.1623</td><td>316</td><td>23.71</td><td><.0001</td></tr>
<tr><td>Trt</td><td>4</td><td>27.0209</td><td>1.1612</td><td>316</td><td>23.27</td><td><.0001</td></tr>
<tr><td>Trt</td><td>5</td><td>Non-est</td><td>.</td><td>.</td><td>.</td><td>.</td></tr>
</table>

Differences of Least Squares Means

<table>
<tr><th>Effect</th><th>Trt</th><th>_Trt</th><th>Estimate</th><th>Standard Error</th><th>DF</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Trt</td><td>1</td><td>2</td><td>3.0400</td><td>1.5944</td><td>316</td><td>1.91</td><td>0.0575</td></tr>
<tr><td>Trt</td><td>1</td><td>3</td><td>1.8071</td><td>1.6193</td><td>316</td><td>1.12</td><td>0.2653</td></tr>
<tr><td>Trt</td><td>1</td><td>4</td><td>2.3458</td><td>1.6185</td><td>316</td><td>1.45</td><td>0.1482</td></tr>
<tr><td>Trt</td><td>1</td><td>5</td><td>Non-est</td><td>.</td><td>.</td><td>.</td><td>.</td></tr>
<tr><td>Trt</td><td>2</td><td>3</td><td>-1.2329</td><td>1.6193</td><td>316</td><td>-0.76</td><td>0.4470</td></tr>
</table>

Differences of Least Squares Means

<table>
<tr><th>Effect</th><th>Trt</th><th>_Trt</th><th>Estimate</th><th>Standard Error</th><th>DF</th><th>t Value</th><th>Pr > |t|</th></tr>
<tr><td>Trt</td><td>2</td><td>4</td><td>-0.6942</td><td>1.6185</td><td>316</td><td>-0.43</td><td>0.6683</td></tr>
<tr><td>Trt</td><td>2</td><td>5</td><td>Non-est</td><td>.</td><td>.</td><td>.</td><td>.</td></tr>
<tr><td>Trt</td><td>3</td><td>4</td><td>0.5387</td><td>1.6420</td><td>316</td><td>0.33</td><td>0.7431</td></tr>
<tr><td>Trt</td><td>3</td><td>5</td><td>Non-est</td><td>.</td><td>.</td><td>.</td><td>.</td></tr>
<tr><td>Trt</td><td>4</td><td>5</td><td>Non-est</td><td>.</td><td>.</td><td>.</td><td>.</td></tr>
</table>

Standard Curves for PPD Soluble Sugars

Glucose-

| | |
|---|---|
| Intercept | 0.011775 |
| Net Abs | 0.482578 |

*Regression Statistics*

| | |
|---|---|
| Multiple R | 0.995556 |
| R Square | 0.991132 |

Fructose-

| | |
|---|---|
| Intercept | -0.02998 |
| Net Abs | 0.5169 |

*Regression Statistics*

| | |
|---|---|
| Multiple R | 0.994019 |
| R Square | 0.988075 |

Sucrose-

| | |
|---|---|
| Intercept | -0.05703 |
| Net Abs | 0.518444 |

*Regression Statistics*

| | |
|---|---|
| Multiple R | 0.997947 |
| R Square | 0.995898 |

# VITA

Jenny Dale Clement was born in Jackson, TN on April 8, 1980. She was the oldest of five girls in a very close family. She attended Trinity Christian Academy where she received her high school diploma in 1998. She received her Associate of Science from Jackson State Community College in 2000. She then attended the University of Tennessee at Chattanooga where she received her Bachelor of Science specializing in general biology and minored in chemistry in 2002. She is currently at the University of Tennessee where she is pursuing her Masters of Science with emphasis in crop physiology.