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Response of Three Cultivars of Bell Pepper (*Capsicum Annuum* L.) to Mulching & Irrigation

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1988

RESPONSE OF THREE CULTIVARS OF BELL PEPPER
(CAPSICUM ANNUUM L.) TO MULCHING AND IRRIGATION

A Thesis
Presented to
the Faculty of the Department of Agriculture
Western Kentucky University
Bowling Green, Kentucky

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
César Omar González F.

June 1988

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RESPONSE OF THREE CULTIVARS OF BELL PEPPER
(CAPSICUM ANNUUM L.) TO MULCHING AND IRRIGATION

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RESPONSE OF THREE CULTIVARS OF BELL PEPPER
(CAPSICUM ANNUUM L.) TO MULCHING AND IRRIGATION

César Omar González F. June 1988 22 pages

Directed by: Dr. James Martin, Dr. Ray E. Johnson,
Dr. James Worthington

Department of Agriculture Western Kentucky University

The effect of black polyethylene mulching and drip irrigation on the yield and quality of three cultivars of bell pepper was studied during the 1987 growing season. This study was conducted on a Pembroke silt loam soil on the Western Kentucky University Farm in Bowling Green, Kentucky. The experimental design was a split-plot arranged in randomized complete blocks in four replications with treatment as the main plot and cultivars as the sub-plot.

'California Wonder,' 'Lady Bell F₁ Hybrid,' and 'Keystone Resistant Giant' cultivars of bell pepper were established in the field during the last week of May. The cultivars were grown using black polyethylene, with application of irrigation (no mulch) and without irrigation or mulch (check). Irrigation was initiated in early August and continued throughout the remainder of the growing season; the amount per application was 158.8 m³/ha.

At harvest, mature green fruit were removed from the plant, weighed, and classified as grade I or II. There were significant differences at the 5% level in the yield of the cultivars. There were significant differences at the 5% levels among the yields of the treatments. the higher yield

was obtained with irrigation, followed by the use of mulch. The better yield under each of the three treatments was obtained with the cultivar Lady Bell.

The production of grade II peppers was higher than the production of grade I peppers, the average yield was 48.82 MT/ha, and 21.99 MT/ha, respectively. The yield of bell pepper grade II was higher in all three treatments.

INTRODUCTION

Based on acreage and economic value (14), bell pepper is one of the principal vegetable crops grown in Kentucky. It is grown for fresh market and processing. Processed pepper production fits many Kentucky farm operations (10). Many farmers use them as an alternative crop, taking advantage of the fact that the same equipment can be used for peppers that is used for tobacco (8).

In bell pepper production, quality is a major concern, especially when the rainfall is inadequate in amount or unevenly distributed during the growing season. Peppers are known to be sensitive to moisture stress at flowering and fruit set (13). If the moisture conditions of the soil is inadequate, there will be a reduction in yield and quality of the product.

A good way to maintain proper moisture level in the soil is to use mulch; moreover, it assures steady growth and helps to control weeds and soil erosion. Another method is to use drip irrigation, thereby eliminating the wide fluctuation in soil moisture levels (3).

The object of this study was to compare the yields of three cultivars of bell pepper using black polyethylene mulch or drip irrigation.

REVIEW OF LITERATURE

Bell pepper (Capsicum annum L.) belongs to the Solanaceae or nightshade family (10). Peppers are classed as a hot-weather vegetable, but their temperature requirements are not as high as generally supposed. The fruit set occurs in a rather limited range of night temperatures. The blossoms drop when night temperatures fall much below 16° C or rise above 24° C. Peppers thrive best in areas with day temperatures of 23° C and night temperatures of 16° C. Day temperatures above 32° C will cause blossoms to drop excessively. However, fruit setting will resume when temperatures are favorable. The best soil temperatures for peppers range between 18° and 21° C (11, 19).

Mulching

Mulch is an artificial modification of the soil surface. Covering of straw, leaves, refuse, paper, polyethylene film, or even a loose layer of soil produced by cultivation, are examples of mulches (11).

Oebker (12) found that mulched bell pepper plots produce significantly higher yields than non-mulched plots. Porter (14) found that pepper plants grown under a silver reflection polyethylene mulch will produce greater yields than plants grown with a black polyethylene or bare ground because of light reflection. However, black polyethylene

produces higher temperatures in the root zone and thus can be used for planting early in the season when the soil is cooler. Its use can also increase yields and shorten ripening period of melons, eggplant, peppers, and summer squash. In areas where early seasons temperatures are less than ideal for these warm-weather crops, this film has increased the yield of muskmelons in experimental plots up to 4 times that of non-mulched plants (19).

It is the increase in soil temperature that speeds up the growth so remarkably. However, this increase is only in the 2 to 6 degree range (19).

Mulching with polyethylene film, usually $1\frac{1}{2}$ mil thickness, offers these advantages: (1) weed control, (2) elimination of root damage from cultivation, (3) moisture conservation, (4) increase soil temperature, (5) and reduced leaching (11, 16, 18).

Irrigation

The primary objective of irrigation is to provide plants with sufficient water to prevent stress that may cause reduced yield. Potentially, irrigation is one of the most important means of increasing yield and quality (11).

Irrigated peppers produce more fruit per plant and thicker-walled fruit (1, 6, 13). Higher yields may be due to an improved soil environment, where growth is encouraged by a uniform moisture content in the root zone obtained with frequent irrigation (2). Batal (1) found that yield response to irrigation was significant only if water stress

was severe enough to affect normal plant growth. The trickle irrigation system is a very convenient method because it offers excellent control of moisture levels (4).

In Israel Goldberg and Shueli (5) doubled vegetable yields with trickle rather than furrow and sprinkler irrigation with saline water on a sandy loam soil.

The primary explanations given for improved crop response with drip irrigation have been increased irrigation frequency and proper water placement. This system can eliminate the wide fluctuations in soil moisture content, so typical of other applications methods (3). This system also has the capacity to apply small quantities of water at frequent intervals in contrast to the larger, infrequent applications of conventional irrigation methods (2).

Some manufactures of the trickle irrigation system have suggested a possible 50 to 90% saving in irrigation water requirements with the trickle method over other methods. Reasons given for this reduced water usage include irrigation of small portions of the soil volume, decreased surface evaporation, and reduction of water movement below the root zone. When 378.5 liters of water are applied down a furrow in a conventional irrigation system, only half reaches the plants' root zone. Sprinklers rate slightly better, delivering about 283.88 out of every 378.5 liters. A properly installed drip system, however, can direct 340.65 to 360.05 of the 378.5 to precisely the right place (16).

A drip system is not merely a means of irrigation. It can also be utilized to provide the plants with supplementary soluble materials such as fertilizer (nitrogen, phosphoric acid, ammonium and potassium nitrate, calcium nitrate), fumigants, insecticides-nematicides (Vydate, Nematicur), and fungicides (Ridomil) (7, 20). Drip irrigation also works well on hilly terrain by preventing water runoff and can be used successfully on fields with marginal soil that cannot be otherwise farmed. Finally, drip irrigation can be used with mulch film to maximize the benefits of both systems (7).

MATERIALS AND METHODS

This study was conducted on a Pembroke silt loam soil (typic Paleudalf) on the Western Kentucky University Farm, Bowling Green, Kentucky, from May to October 1987. Soil in the plots had a pH of 6.5 and was very high in available phosphorus and potassium, 434.8 Kg/ha and 1153.9 Kg/ha respectively.

Peppers were established in the field during the last week of May. According to practices recommended by the Cooperative Extension Service of Kentucky, plants were spaced 0.45 m. apart, in rows 0.90 m. apart. Subplots were 7.5 m. long by four rows wide. Yields were recorded from the two center rows.

'California Wonder,' 'Lady Bell F₁ Hybrid,' and 'Keystone Resistant Giant' cultivars of bell pepper were grown using black polyethylene mulch, with application of irrigation (no mulch) and without irrigation or mulch (check). The experimental design was a split-plot, arranged in randomized complete blocks in four replications with treatments as the main-plots and cultivars as the subplots.

Ammonium nitrate was applied in March (41Kg/ha) as a top dressing to wheat, which was used as a cover crop. According to recommendations of the Cooperative Extension Service, an application of 56 Kg/ha of P₂O₅ and 56 Kg/ha of K₂O was

made prior to secondary tillage for seed bed preparation. A preplanting treatment with Napropamide [n,n-diethyl-2-(-1-naphthalenyloxy)propionamide], at 1.12 Kg/ha was used for weed control. Chemical weed control methods were used when needed.

Irrigation was applied after the first week of harvest in the middle of August. It was applied once a week during three consecutive weeks. The amount of irrigation per application was 158.8 m³/ha. The tubing used to apply water was double-wall; the system had a water flow rate of 0.95 liter/minute/m. of tubing (8). The source of water was from a municipal water supply.

In the first week of June, Carbaril 80 S (1-naphthylmethylcarbamate) was applied to control flea beetles and aphids, at a rate of 1.12 Kg/ha. A rate of 2.24 Kg/ha of Carbaril 80 S was used to control European Corn Borer. To prevent damage by antracnose, alternaria fruit rot, Maneb 80% (manganous ethylenebisdithiocarbamate) at a rate of 4 Kg/ha was used.

At harvest, mature green fruit were removed from the plants, weighed, and classified. To meet the U.S. No. I Pepper Grade, the fruit must be firm, well shaped, pods must be free from defects caused by sunscald, decay, scars, hail, sunburn, disease, insect, mechanical. The size should be at least 6.4 cm. in diameter and not less than 6.4 cm. in length. The size for U.S.No. II Pepper Grade should be at least 5 cm. in diameter and not less than 5 cm. in length. Also the

fruit must be free of defects caused by sunscald, disease, insect, mechanical or other means (1, 14). Fruit not meeting Grade I or II standards was discarded and not include in any yield data. The data were subjected to analysis of variance and means compared, using Duncan's Multiple Range Test (17).

RESULTS AND DISCUSSION

Figure 1 shows the average yield of four plots of bell pepper by treatment. Lady Bell had a better yield response under the treatments than the other cultivars. All three cultivars produced the highest yield under irrigation, followed by mulch and then the check.

Figure 2 reveals commercial yields (MT/ha) of bell pepper. The lower yield was obtained with Keystone Resistant Giant (19.59 MT/ha), California Wonder produced 21.21 MT/ha and Lady Bell 31.03 MT/ha.

Under the conditions of this study, the results indicated a significant interaction between treatments and cultivars (appendix Table 3), and highly significant differences between treatments and cultivars.

The best yield was obtained with irrigation followed by the use of black polyethylene. There were no significant differences at the 5% level between the irrigation and mulch treatments; however, both were significantly higher than the check (Table 1). These results show that plastic mulching and irrigation significantly increased pepper yields when compared to non-mulching or nonirrigated plots; it was also found by Goyal in 1985 (6) and Batal in 1981 (1).

To maximize the benefits of both systems, drip irrigation can be used with mulch film (7). Peppers can be grown early

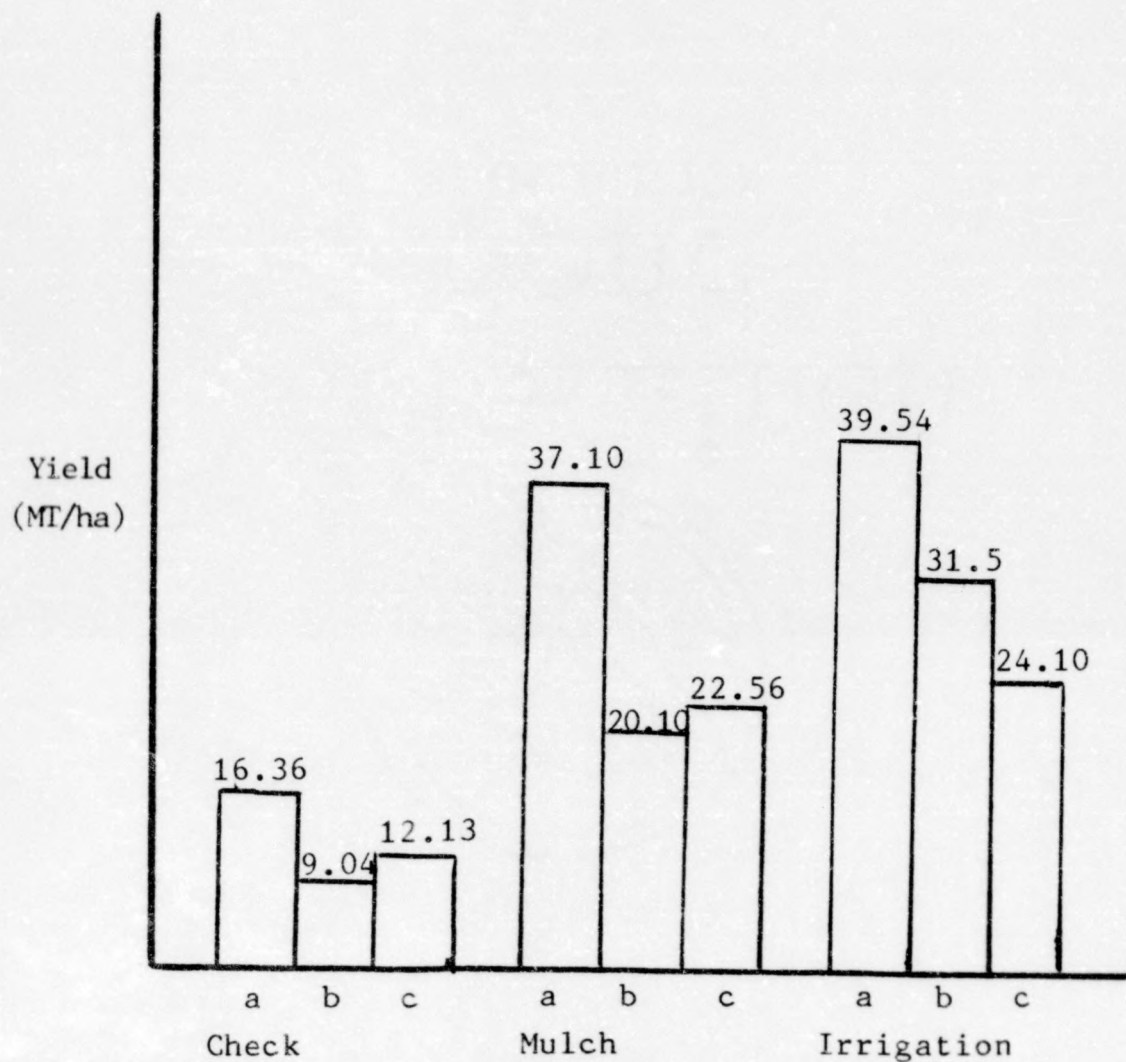


Figure 1. Yield of pepper cultivars by treatment:
(a) Lady Bell, (b) California Wonder,
(c) Keystone Resistant Giant.

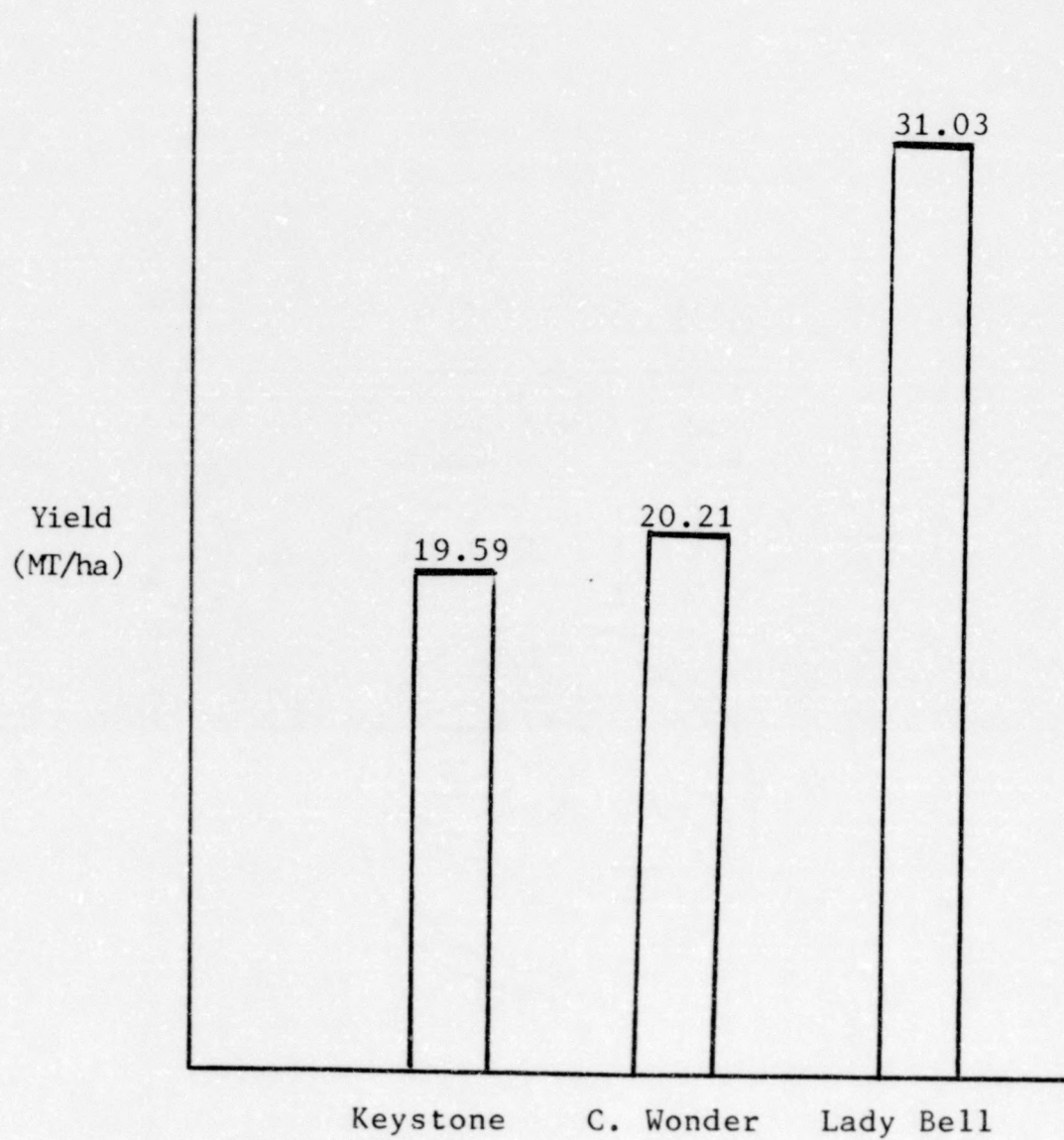


Figure 2. Average total of the yield of bell pepper by cultivar.

Table 1. Effect of black polyethylene and irrigation on weight of marketable peppers.

Treatment	Yield MT/ha
Check	12.50 b*
Black polyethylene	26.59 a
Irrigation	31.74 a

* Means followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 2. Yield of three cultivars of bell pepper

Cultivars	Yield MT/ha
Keystone Resistant Giant	19.59 a*
California Wonder	20.21 a
Lady Bell	31.03 b

* Means followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

in the season with the benefits of drip irrigation that will reduce water runoff, save water, and reduce water loss by wind drift; and the use of black plastic mulch to warm up the soil, help to control weeds, and conserve moisture.

Table 2 shows that the differences between cultivars were significant; there were no significant differences between Keystone Resistant Giant and California Wonder, however both were significantly lower in yield than the cultivar Lady Bell. The differences in yield can be attributed to differences in vigor: Keystone Resistant Giant and California Wonder are partially cross-pollinated plants; Lady Bell is hybrid and will outyield other non-hybrid varieties (11).

Under irrigation or mulch Lady Bell had a better response than the other cultivars. One possible explanation was less sunscald damage. Under Kentucky growing conditions Lady Bell had a good response; however, more research will be necessary for a final recommendation of this cultivar for Kentucky conditions.

The production of grade I peppers was lower than the production of grade II peppers (Figure 3). Difference have been attributable to the dry weather conditions especially during flowering and fruit set in mid-June. Also the deficit in rainfall, produced poor fruit size and fruit set.

Temperature could have influenced plant yield. During blossom time (around mid-June through July), the average temperature was high (appendix Table 2), possibly causing blossom drop and also production of small fruit. To avoid

high temperatures, pepper should be planted as early in May as possible.

In his 1978 study O'Sullivan (13) found that on Caledon sandy loam soil pepper fruit set is affected by lack of moisture and high rates of nitrogen, while other factors such as high day temperatures and low night temperatures at flowering affect fruit set. Growers could obtain more consistent fruit and higher yields by supplementing rainfall with irrigation when rainfall is low and by using rates of nitrogen of no more than 70 Kg/ha (13).

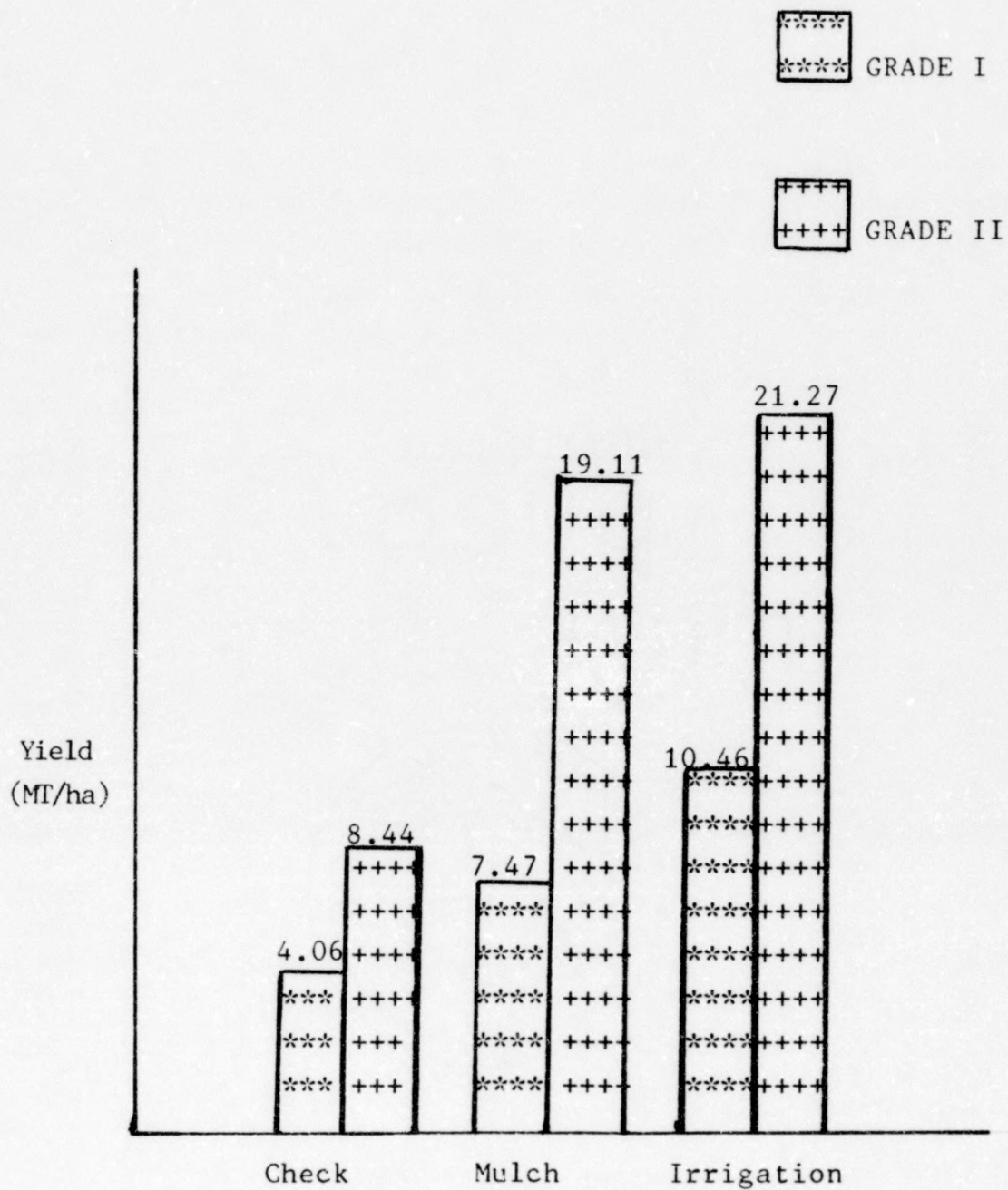


Figure 3. Yield of bell pepper by grade.

APPENDIX

Table 1. Precipitation for 1987 in milimeters.*

Month	Normal	Amount	Total	Month	Departure
		this	this	departure	this
		month	year	from normal	year
January	125.73 (125.48)	44.70	44.70	-80.77	-80.77
February	105.66 (104.14)	127.25	171.96	+ 23.11	- 57.66
March	133.60 (133.60)	60.20	232.16	- 73.41	-131.06
April	110.74 (109.73)	74.93	307.09	- 34.80	-165.86
May	105.92 (107.19)	184.40	491.49	+ 77.22	- 88.65
June	104.65 (105.92)	83.82	575.31	- 22.10	-110.74
July	107.19 (108.81)	170.69	746.00	+ 61.98	- 48.77
August	91.69 (91.95)	47.24	793.24	- 44.70	- 93.47
September	78.74 (81.13)	76.20	869.44	- 4.83	- 98.30
October	67.56 (68.07)	9.40	878.84	- 58.67	-156.97
November	93.22 (94.49)	113.03	991.87	+ 18.54	-138.43
December	107.44 (110.74)	176.02	1269.49	+ 65.28	- 73.15
Total	1234.44 (1241.04)	1169.89	-----	-----	- 73.15

* College Heights Station

Normal based on years 1883-1971

(Normal based on years 1883-1980)

Table 2. Temperature for 1987 (°C).*

Month	Average Monthly	Highest	Lowest
January	1.44	16.66	-12.77
February	4.77	16.66	-12.77
March	10.11	25.55	- 3.33
April	14.38	30.00	- 2.77
May	23.11	32.77	10.55
June	25.55	33.88	15.00
July	26.83	35.55	15.55
August	27.16	37.77	16.66
September	21.77	33.33	9.44
October	12.38	26.66	-2.77
November	12.00	27.77	2.77
December	5.88	17.77	-6.66

* College Heights Station.

Table 3. Analysis of variance for treatment and cultivars of bell pepper yield.

Source of variation	df	SS	MS	F
Total	35	4248.69		
Replications	3	61.44	20.48	1.124 ^{ns}
Treatments	3	2379.46	793.15	43.08**
Error (a)	9	165.725	18.41	
Cultivars	2	994.34	497.17	39.93**
Treatments x cultivars	6	273.93	45.65	2.93*
Error (b)	24	373.795	15.57	

ns Not significant

* Significant at the level 5%

** Significant at the level 1%

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