Agronomy Notes

Plant and Soil Sciences

2-1993

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COOPERATIVE EXTENSION SERVICE

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Volume 26, No. 1 February 1993

Hybrid Variation for Yield, Crude Protein, Feed Value and Percent Lysine of Corn Grown in the 1991 Kentucky Hybrid Corn Performance Test

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These data are the results from the second year of protein analyses of corn hybrids grown at three locations in the Kentucky Hybrid Corn Performance Test. These analyses were supported by a grant from the Kentucky Corn Growers Association.

The value of corn as a feed grain depends on the yield per acre, the protein content of the grain, and for some livestock, the lysine level of the protein. Most farmers are aware of yield differences among corn hybrids but may not realize that protein content can also vary significantly. Grain protein level should be accounted for to determine how much protein supplementation will be needed to balance an appropriate animal diet. However, since corn protein is deficient in the amino acid lysine, which is essential for non-ruminant animals, lysine content as well as crude protein content should be considered in diet formulations for these animals.

Comparative yield performance of corn hybridss sold in Kentucky are available in Ky Agric. Exp. Sta. Prog. Rep. No. 336, Kentucky Hybrid Corn Performance Test - 1991. Crude protein contents of these same hybrids are available in this report. To make these data useful as a hybrid selection aid, the relative amount and cost of production of a 16% protein base diet was calculated. Lysine levels are also presented and a final decision about feed value of the corn hybrid for swine or poultry diets will be aided by use of the lysine analyses. This information will provide comparative data from which to choose a corn hybrid(s) for most economical feed production.

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MATERIALS AND METHODS

In 1991, commercially available corn hybrids were evaluated at three locations in Kentucky: Benton, Lexington, and Shelbyville. Benton and Shelbyville were planted no-till into a soybean residue while Lexington was planted in a seedbed prepared by conventional tillage. Nitrogen fertilization was 150 lb/AC at Benton and Lexington and 200 lb/AC at Shelbyville. All areas were treated with recommended herbicides and insecticides. The hybrids were planted on April 17 (Shelbyville), April 25 (Benton), and May 3 (Lexington) in 11 X 12 rectangular lattice designs with three replications at each location. Final stands were between 20,000 and 22,000 plants per acre. Additional details of crop management can be obtained in Ky. Agric. Exp. Sta. Progress Report 336 (Poneleit and Evans, 1991).

At harvest, about 250 grams of grain from each plot were collected for protein analysis. Protein content was determined by duplicate micro Kjeldahl analyses (Bradstreet, 1965). Protein content was calculated as percent total N multiplied by 6.25. All protein and yield data were adjusted to reflect grain at 15.5% harvest moisture. Lysine content was determined by a dye binding method. Both protein and lysine analyses were done by Chemical Service Laboratory of Louisville, KY.

Feed value was evaluated by calculation of the quantity of a 16% protein base diet (BD) produced per acre (T/AC) and cost per ton ($/T) of the base diet considering per acre corn yield and production cost as well as protein supplement cost. A 16% base diet was chosen since this protein level is commonly used for swine and dairy cattle. It is to be used only as a reference since other categories of livestock may require different levels of protein in their diets.

Amount (T/AC) and cost of the 16% protein base diet per ton ($/T) were calculated using the acre yield of corn grain, corn production costs of $200.00 per acre, and cost of 40% protein supplement as $230.00 per ton. The amount of BD per acre was calculated as the tons of corn grain per acre plus the amount of 40% soybean protein supplement needed to make 16% BD (i.e. 100 BU/AC corn with 9.0% protein will require 0.813 tons of 40% soybean protein supplement to make 3.6 tons of BD per acre at a cost of $107.49 per ton). The necessary formulae for these calculations are:

BD(T/AC)=
(BU/ACX56/2000)/(24/40-CP%),
BD($/T)=(200/BDT/AC) +
{[(16-CP%)/(40-CP%)]X230}

where
- BD = Base Diet
- BU/AC=Bushels of corn per acre obtained from "Kentucky Hybrid Corn Performance Test - 1991", Prog. Rep. 336 (Poneleit and Evans, 1991).
- pounds of corn per bushel = 56,
- pounds per ton = 2000,
- corn grain protein percent = CP%,
- corn grain needed per ton BD=24/ 40-CP%,
- dollars per acre for corn production = $200.00,
- protein supplement needed per ton BD = 16-CP% / 40-CP%, and
- dollars per ton of protein supplement = $230.00.

Livestock producers should be most interested in the cost/ton of Base Diet. Comparisons of $/T estimates among hybrids provides an evaluation of the relative feed costs as influenced both by grain yield and protein content. Tons of base diet are important in calculating the number of acres required to produce a given quantity of feed or to estimate the number of tons of feed which could be manufactured from a given number of acres.

The cost per ton of base diet, of course, will vary with corn production cost per acre and cost of protein supplement per ton. Producers may wish to recalculate the cost per ton of base diet for selected varieties using their own corn production and protein supplement costs.

RESULTS AND DISCUSSION

Grain Yield and Crude Protein Content

Significant differences were found among the corn hybrids for both grain yield and grain crude protein percent at each location (data not shown) and for the combined data (Table 1). For the average of three locations, grain yield ranged from 98.5 to 150.2 BU/AC. Crude protein content ranged from 7.2 to 9.2%. The wide ranges of grain yield (51.7 BU/AC) as well as the wide differences in crude protein content (2.0%) suggest that choice of corn hybrid can have a significant effect on feed value of the hybrid. Statistically significant variations among corn hybrids (differences greater than the LSD), indicate that there are real genetic differences among hybrids for crude protein content. Significant tests for environments and the hybrid X environment interaction were found and indicate that some corn hybrids perform differently at one site than another although hybrids with high or low grain yield or protein content usually tended to be either high or low at each location. An extensive analysis of hybrid X environment interaction will be presented in a later publication.

The correlation between protein content and grain yield was statistically significant but low (r = - 0.26). Therefore it should be possible to choose a hybrid with both high grain yield and high protein content.

Lysine content

Lysine analyses were done on a single sample from each location. The sample was a composite of the three replications. Since, replications were not analyzed, statistical analyses could not be done. However, for the three location average, the range of lysine percent was from 2.2% to 3.2%, which is almost a 50% increase from one hybrid extreme to the opposite extreme value. Percent lysine was significantly correlated with percent protein (r=0.73) and, at that level of association, should increase or decrease very similarly to increases or decreases in protein content. Percent lysine was correlated significantly with yield (r=-0.26), to the same magnitude as percent protein. These data suggest that percent protein and percent lysine vary in the same manner and magnitude.

Tons Per Acre and Cost of Base Diet

Significant differences for both 16% protein base diet produced per acre (T/AC) and cost of 16% protein base diet per ton ($/T) were also found among corn hybrids at each location and for the combined data (Table 1). Amount of BD for the three location average ranged from 3.6 to 5.5 T/A. Cost per ton ranged from 91.1 to 134.9 $/T. There also were significant interactions of hybrids X environments for T/AC and $/T.

Both T/AC and $/T result from the combined effects of grain yield and grain protein percent of the corn hybrids. T/AC will increase as grain yield increases, with fixed protein content, whereas $/T would be reduced.

Both T/AC and $/T would be slightly reduced as protein percent increases assuming that grain yield remained constant. Since both quantity of feed produced and cost per unit of feed are important economic considerations, the choice of hybrid to use for feed production should be made using both yield and percent protein data.

CONCLUSIONS

Large and statistically significant variations were found among corn hybrids for grain yield and crude protein percent. Although the data and analyses are not shown, hybrids responded differently to the environmental effects of test locations for both grain yield and protein percent. Expanded evaluations of the hybrid x environment interactions will be presented in a later publication. The correlation between grain yield and protein was near zero and indicated that high grain yield and high protein percent can occur together. Variation of as much as 50% was observed among hybrids for percent lysine.

Variations of grain yield and crude protein content resulted in significantly different BD production (T/AC) and cost ($/T) for different corn hybrids. The large differences of BD amount and cost among corn hybrids indicate that the choice of hybrid corn seed for feed grain production may influence economic returns in an animal feeding operation. Our results indicate that increasing grain yield would increase BD quantity and decrease BD unit cost while increasing protein content would decrease both BD quantity and cost. However, in some cases, a lower yielding hybrid with high protein content may be the best selection.

Although these data include evaluations from hybrids grown at three distinct locations in Kentucky, additional location and year environments would provide increased assurance that the observed hybrid differences are valid. Similar measures of grain yield, crude protein content, and lysine content with computation of BD amount and cost were made in 1989 and 1990 and will be made for 1992 samples. Following the completed analysis of 1992 data, a combined analyses of data from all three years will be presented.

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Table 1. Average Grain Yield(BU/AC), Grain Protein Content(P%), 16% Protein Base Diet(T/AC), Cost of Base Diet($/T), and Percent Lysine (LYS%) for 132 Corn Hybrids Grown at Three Locations, Benton, Lexington, and Shelbyville, of the Kentucky Hybrid Corn Performance Test-1991. All values are adjusted to 15.5% moisture.

NAME	P%	BU/AC	T/A	$/T	LYS%
ADLERS 6130	8.6	121.3	4.5	102.6	0.30
ADLERS 7905	8.0	132.7	5.0	102.1	0.27
AGRATECH 6610	8.5	111.4	4.1	105.1	0.28
AGRATECH 6640	8.2	106.4	4.0	113.8	0.26
AGRATECH 6902	8.8	114.2	4.2	134.9	0.32
AGRATECH 757	8.6	99.7	3.7	125.8	0.30
AGRATECH 787	8.9	114.3	4.2	116.5	0.32
AGRATECH 825	8.7	115.8	4.2	104.8	0.32
AGRI GOLD A-6715	8.5	116.7	4.4	117.9	0.28
AGRIGOLD A-6690	8.2	130.3	4.9	105.2	0.27
AGRIGOLD A-6720	8.5	115.8	4.3	106.8	0.30
AGRIGOLD A-6796W	9.2	107.9	3.9	115.5	0.32
ASGROW RX811	8.8	126.7	4.6	99.7	0.29
ASGROW RX899	8.6	109.1	4.0	122.8	0.28
ASGROW RX908	8.7	133.6	4.9	97.5	0.27
ASGROW RX919	7.7	134.6	5.1	101.5	0.24
ASGROW RX947	8.2	131.5	4.9	101.5	0.29
ASGROW RX956W	9.1	100.3	3.7	119.1	0.30
BALDRIDGE BH-575	8.8	107.8	4.0	117.9	0.30
BECK'S 68X	8.9	128.1	4.6	98.6	0.30
BECK'S 72X	7.9	136.1	5.1	100.9	0.27
BECK'S 81X	8.4	111.2	4.1	113.6	0.28
BO-JAC 6295	8.4	129.5	4.8	103.6	0.28
BO-JAC 905	8.3	119.7	4.4	106.0	0.25
BO-JAC 9250	8.6	146.3	5.4	93.9	0.28
CALLAHAN C775	8.6	108.1	4.0	114.5	0.26
CALLAHAN C776	8.3	121.9	4.5	104.4	0.26
CALLAHAN C783	8.0	116.3	4.4	119.1	0.28
CARGILL 7997	7.9	145.3	5.5	96.7	0.26
CARGILL 8427	8.2	134.2	5.0	98.6	0.27
CARGILL 9027	7.8	116.0	4.4	108.0	0.26
CARGILL 9400W	9.2	106.0	3.8	110.1	0.28
CAVERNDALE FM. CF925	8.6	110.2	4.0	106.2	0.30
CAVERNDALE FM. CF950	8.8	117.0	4.3	108.9	0.29
CAVERNDALE FM. CF975	8.9	116.4	4.3	104.5	0.28
COLBERT 230	8.2	115.2	4.3	107.4	0.27
COLBERT 318	8.4	107.8	4.0	112.5	0.27
COLBERT 324	8.4	124.7	4.6	104.6	0.27
COLBERT 326	8.4	132.0	4.9	103.0	0.26
CROW'S 669	8.7	115.8	4.2	106.6	0.27
CROW'S 670	9.1	123.2	4.5	103.8	0.28
CROW'S 682	8.0	130.1	4.9	103.2	0.26
CROW'S 688	8.5	120.7	4.4	100.8	0.27
DEKALB DK643	8.5	135.8	5.0	100.7	0.28

Table 1. Continued

NAME	P%	BU/AC	T/A	$/T	LYS%
DEKALB DK677	8.2	126.8	4.7	104.4	0.29
DEKALB DK689	8.4	122.6	4.5	106.2	0.27
DEKALB DK703W	8.5	101.0	3.7	113.9	0.28
DEKALB DK715	8.7	125.4	4.7	114.7	0.31
DEKALB DK743	8.5	150.2	5.5	93.3	0.26
FR27 X LH38	8.6	99.5	3.7	123.1	0.30
FR27 X MO17	8.4	112.4	4.2	111.4	0.26
FR27 X PA91	8.5	119.1	4.4	103.3	0.29
FUNK'S G-4631	8.5	124.5	4.6	100.5	0.29
FUNK'S G-4651	8.4	127.0	4.7	100.0	0.28
FUNK'S G-4666	8.3	113.3	4.2	116.6	0.28
FUNK'S G-4671	8.5	126.2	4.7	103.0	0.30
GARST SEED 8105	8.2	116.4	4.4	120.7	0.27
GARST SEED 8250	8.5	139.3	5.1	97.0	0.27
GARST SEED 8315	8.3	127.0	4.8	116.0	0.28
GARST SEED 8316	9.2	124.8	4.5	101.8	0.32
GARST SEED SC-W700	9.2	98.5	3.6	121.8	0.31
GARST SEED SC-W707	8.6	119.2	4.4	113.7	0.26
GLICK SEED GH760	8.8	110.0	4.0	108.9	0.32
GLICK SEED GH796	8.8	116.5	4.3	103.4	0.31
GLICK SEED GH801	8.4	120.9	4.5	110.3	0.28
GLICK SEED GH82X	8.4	118.4	4.4	107.4	0.27
HUBNER SEED H3318	8.6	121.4	4.5	133.1	0.28
HUBNER SEED H3715	8.6	128.9	4.7	97.6	0.28
HUBNER SEED H3717	8.2	124.6	4.6	101.3	0.26
HUBNER SEED H8819W	9.1	119.3	4.3	100.7	0.29
HYPERFORMER HS 9704	8.7	105.3	3.9	112.8	0.27
HYPERFORMER HS97	8.6	105.0	3.9	112.6	0.29
HYPERFORMER HS9773	8.4	123.5	4.6	101.4	0.26
JACQUES 7970	9.1	122.2	4.4	103.4	0.31
JACQUES 8210	8.3	132.0	4.9	97.4	0.26
JACQUES 8410	8.9	105.3	3.9	131.6	0.30
MCCURDY 7400	9.0	145.2	5.3	91.1	0.29
MCCURDY 7477	8.4	119.3	4.4	102.9	0.27
MCCURDY 7777	8.0	138.3	5.2	98.7	0.23
NOBLE BEAR NB 739W	8.1	120.8	4.5	103.6	0.26
NOBLE BEAR NB 747W	8.9	121.6	4.4	100.7	0.31
NOBLEBEAR NBX720W	8.8	114.1	4.2	109.6	0.28
NORTHRUP-KING N7816	8.3	125.3	4.7	107.8	0.26
NORTHRUP-KING N8318	7.8	114.9	4.4	130.7	0.26
NORTHRUP-KING N8565W	8.8	111.2	4.1	126.0	0.30
NORTHRUP-KING N8727	8.7	132.5	4.9	102.1	0.30
NORTHRUP-KING PX9540	8.3	123.1	4.6	101.4	0.28
NORTHRUP-KING S8505	8.9	136.3	5.0	95.1	0.28
PIONEER BRAND 3140	7.5	132.7	5.0	102.7	0.24
PIONEER BRAND 3142	8.2	114.5	4.3	113.2	0.24
PIONEER BRAND 3144W	8.8	112.6	4.1	109.7	0.29
PIONEER BRAND 3154	7.8	138.4	5.2	102.9	0.25

Table 1. Continued

NAME	P%	BU/AC	T/A	$/T	LYS%
PIONEER BRAND 3165	7.2	126.3	4.9	108.1	0.22
PIONEER BRAND 3180	8.1	128.2	4.8	105.0	0.25
PIONEER BRAND 3245	8.4	123.0	4.5	102.1	0.27
PIONEER BRAND 3281W	8.7	126.2	4.6	104.0	0.27
PIONEER BRAND 3295	8.3	126.1	4.7	102.3	0.26
PIONEER BRAND 3394	8.0	124.1	4.6	106.3	0.25
PRAIRIE STREAM SX565	7.9	115.0	4.3	108.6	0.26
PRAIRIE STREAM SX702	8.2	127.6	4.8	102.7	0.27
SCOTT SEED LR 3347	8.2	115.0	4.3	107.2	0.28
SCOTT SEED LR 3359	8.4	126.1	4.7	102.2	0.28
SCOTT SEED LR3350	8.2	107.7	4.0	109.8	0.27
SCOTT SEED LR5241	8.4	122.0	4.5	103.3	0.28
SO. CROSS 411	8.3	107.0	4.0	109.7	0.26
SO. CROSS 511	8.9	111.0	4.0	106.9	0.28
SO. CROSS 611	8.3	117.6	4.4	103.7	0.27
SO. CROSS 711	9.0	121.6	4.4	100.9	0.31
SO. STATES SS790	8.6	109.4	4.0	106.4	0.29
SO. STATES SS793	8.3	127.4	4.7	102.3	0.28
SO. STATES SS812	8.4	111.0	4.2	112.6	0.26
SO. STATES SS917W	9.2	112.7	4.1	119.6	0.28
STEWART HYBRIDS S-8815	8.5	121.5	4.5	111.8	0.28
STEWART HYBRIDS S-9212	8.1	116.4	4.3	105.3	0.25
STEWART HYBRIDS S-9213	8.4	130.5	4.9	110.0	0.26
STINE 1091	8.1	123.0	4.6	104.4	0.26
STINE 1161	8.6	110.6	4.1	118.1	0.29
STINE 1181	8.5	101.9	3.8	122.2	0.27
STINE 1225	8.3	108.2	4.0	125.6	0.27
TERRA SEEDS TR1170	8.6	113.8	4.2	106.3	0.30
TERRA SEEDS TR1180	8.3	118.6	4.4	104.8	0.27
TERRA SEEDS TR1190	8.4	122.9	4.6	107.3	0.26
TERRA SEEDS TR3400	8.0	114.8	4.3	107.8	0.28
UAP DYNA-GRO 5561	8.4	123.1	4.6	105.6	0.26
UAP DYNA-GRO 5655	8.6	123.0	4.5	107.8	0.29
UAP DYNA-GRO 5671	8.5	116.4	4.3	104.0	0.28
VINEYARD SEED V-58W	8.5	111.2	4.1	117.3	0.25
VINEYARD SEED V-68W	8.9	123.8	4.5	102.5	0.30
ZIMMERMAN Z16W	8.5	103.8	3.8	118.1	0.28
ZIMMERMAN Z27	8.3	132.5	4.9	100.9	0.30
ZIMMERMAN Z61W	8.6	118.8	4.4	114.8	0.28
ZIMMERMAN Z63W	8.4	126.7	4.7	107.6	0.26
Average	8.5	120.2	4.4	107.9	0.28
LSD (0.10)	0.4	16.2	0.7	14.8	--