

## YIELD RESPONSE OF MAIZE HYBRIDS TO VARYING NITROGEN RATES

Aftab Wajid, Abdul Ghaffar, M. Maqsood, Khalid Hussain and Wajid Nasim  
Department of Agronomy, University of Agriculture, Faisalabad.

A field trial was conducted to evaluate the effect of three nitrogen levels ( $N_1$  @ 150 kg ha<sup>-1</sup>,  $N_2$  @ 200 kg ha<sup>-1</sup>,  $N_3$  @ 250 kg ha<sup>-1</sup>) and three maize cultivars B-202, M-919 and P-31-R-88 on yield and yield components of maize. Nitrogen rates significantly affected harvest index (HI). The maximum HI (41.97%) was achieved in  $N_3$  treatment followed by  $N_2$  (41.20%) and  $N_1$  (38.01%). Maximum grain yield (8.09 t ha<sup>-1</sup>) was produced @ 250 kg N ha<sup>-1</sup> followed by  $N_2$  (7.57 t ha<sup>-1</sup>) and  $N_1$  (6.59 t ha<sup>-1</sup>) treatments. Cultivar P-31-R-88 also showed maximum grain yield (8.33 t ha<sup>-1</sup>) over cv. B-202 (7.77 t ha<sup>-1</sup>) and cv. M-919 (6.16 t ha<sup>-1</sup>).  $N_3$  (250 kg N ha<sup>-1</sup>) treatment increased plant height to 176.00 cm as compared to  $N_2$  (167.17 cm) and  $N_1$  (157.68 cm) treatments. 1000-grain weight was also increased in  $N_3$  treatment over  $N_2$  and  $N_1$  treatments, such as 250.88 g, 262.57 g, and 270.43 g in  $N_1$ ,  $N_2$  and  $N_3$  treatments, respectively. Whereas maximum 1000-grain weight 277.02 g was achieved by cv. P-31-R-88 followed by B-202 (273.18 g) and M-919 (233.68 g). Results suggested that the cultivar P-31-R-88 and nitrogen rate  $N_3$  (250 kg ha<sup>-1</sup>) could be used successfully for improving maize yield.

**Key words:** Nitrogen fertilizers; cultivar; economic yield; yield components; maize.

### INTRODUCTION

Maize (*Zea mays* L) is an important cereal crop. In Pakistan, maize occupies third position after wheat and rice and 98% of which is grown in Punjab and N.W.F.P. In Pakistan, maize is grown on an area of 896 thousand hectares with annual production of 2775 thousand tonnes of grain and average yield of about 3097 kg ha<sup>-1</sup> (GOP, 2005). Its commercial products are corn oil, corn flakes, corn starch, tanning material for leather industry, custard, glucose, jelly, energile, etc. In recent years, increased quantities of corn have been used in the manufacturing of shortening compounds, soaps, varnishes, paints and similar other products (Martin *et al.*, 1975). Maize grain has great nutritional value as it contains 72% Starch, 10% Proteins, 4.8% Oil, 8.5% Fibre, 3% Sugar and 1% ash. (Chaudhry, 1983). It is extensively grown in temperate, sub tropical and tropical regions of the world.

The average yield of maize is low as compared to biological potential of the existing maize cultivars. However, this potential has not been explored fully due to some management constraints. During last decade, crop yield in Pakistan has been declining despite increased inputs of fertilizers and pesticides. This is due to use of synthetic or composite varieties which have less potential as compared to hybrids as reported by Njeru (1983). Nitrogen supply positively enhances grain yield in all hybrids, primarily by increasing kernel number. N supply also impacts the yield protein relationship by stimulating the protein synthesis rather than by inhibiting the starch production (Uribe-larrea *et al.*, 2004). Rasheed (2002) working at Faisalabad, studied nutrient management as hybrid maize and reported that 250:150:100 Kg NPK ha<sup>-1</sup> gave maximum

yield 8.53 t ha<sup>-1</sup>. To overcome this problem modern technology lays emphasis on the selection of suitable cultivars of maize and nitrogen levels to enhance productivity.

This paper reports the effects of nitrogen levels and cultivars on grain yield and components of yield in maize under semi arid conditions.

### MATERIALS AND METHODS

The study was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad (31°26' N, 73°06' E) during 2005. Experiment was laid out in split plot design, cultivars and nitrogen levels were randomized in main and sub plots respectively. There were four replications with net plot size of 4.2 m x 7 m with six rows in each plot. The treatments were three cultivars (B-202, M-919 and P-31-R-88) and three nitrogen levels (150-, 200- and 250 Kg ha<sup>-1</sup>). Cultivars were sown with the help of dibbler. The row to row (R x R) distance was kept 70 cm and plant to plant (P x P) distance was maintained at 20 cm. The plant population was controlled in all treatments by gap filling and thinning after germination. Phosphorus and Potassium both @ 100 Kg ha<sup>-1</sup> were applied. Nitrogen, Phosphorus and Potassium were applied in the form of Urea, SSP and SOP. 1/3 rd of nitrogen, all of the phosphorus and potassium were applied during seed bed preparation and 1/3 rd of remaining nitrogen was applied at knee height and 1/3 rd was applied at tasseling. Ten irrigation were applied including irrigation at sowing till maturity. All other agronomic practices were kept uniform for all the treatments. Crop was harvested at maturity by taking an area of 2.1m x 7m. A sub sample of ten plants at random from

each plot was taken to determine the plant height (cm), number of cobs per plant, number of grains per cob, economic yield ( $\text{t ha}^{-1}$ ) and harvest index (%).

Data recorded on yield and yield components were analyzed statistically by employing the Fisher's analysis of variance technique and significance of treatment means was tested using least significance difference (LSD) test at 5% probability level (Steel and Torrie, 1984).

## RESULTS AND DISCUSSION

### Germination Count

The maximum germination (6.39) was recorded in cv. P-31-R-88 that was statistically at par with the cv. B-202 (6.18). The minimum germination was in cv. M-919 i.e. 5.86 plants  $\text{m}^{-2}$  that was also statistically at par with cv. B-202 i.e. 6.18 plants  $\text{m}^{-2}$ . While the germination trend in last germination count (6 DAS) was from 6.01 to 6.35 plants  $\text{m}^{-2}$  among various nitrogen levels, with an average value of 6.14 plant  $\text{m}^{-2}$ . There was no substantial improvement in the germination count with varying nitrogen levels and the differences were not large enough to reach the level of significance. This indicated that during germination seeds did not depend upon external nutrition much and used their own reserved food material. These results are in accordance with those of Akhtar *et al.* (1996) who reported similar results of germination count per unit area.

### Plant height at Maturity

Maximum plant height (184.57 cm) was recorded in cultivar P-31-R-88 that was statistically at par with cv. B-202 with the height of 170.12 cm. The minimum plant height (146.17 cm) was shown by cultivar M-919. The plots fertilized with 250 Kg N  $\text{ha}^{-1}$  attained maximum plant height i.e. 176 cm, which was statistically different with that of plots fertilized with 200 Kg N  $\text{ha}^{-1}$  (167.17 cm). While minimum plant height of 157.68 cm was recorded in those plots fertilized at 150 Kg N  $\text{ha}^{-1}$ . The increase in plant height might be due to increasing level of nitrogen as it increases cell division, cell elongation and nucleus formation. Interaction between cultivars and nitrogen levels was statistically non-significant. These results are in agreements with those of Akhtar *et al.* (1996) who reported plant height 199 cm.

### Number of Cobs Plant<sup>-1</sup>

Maize cv. P-31-R-88 produced higher number of cobs per plant (1.17) that was statistically at par with cv. B-202 (1.08), whereas the minimum number of cobs per plant (1.05) was produced by M-919 that is also

statistically at par with cv. B-202 (1.08). As regards nitrogen, non-significant differences were observed. On an average the range varies from 1.05-1.14 cobs plant<sup>-1</sup>. The interaction between cultivars and nitrogen levels was non-significant. Many workers presented similar results (Bangrwa *et al.*, 1988 and Khan *et al.*, 1999). They reported that number of cobs plant<sup>-1</sup> did not increase with increase in nitrogen rates.

### Number of Grains Cob<sup>-1</sup>

Number of grains cob<sup>-1</sup> is also vital parameter, which contributes materially towards final yield in maize. The effect of different maize hybrid on number of grains cob<sup>-1</sup> was highly significant. Maize cv. P-31-R-88 produced significantly higher number of grains cob<sup>-1</sup> (566.77) followed by cv. B-202 that produced less number of grains cob<sup>-1</sup> (510.19) and statistically minimum number of grains cob<sup>-1</sup> (447.06) were produced by the cv. M-919. The effect of nitrogen levels on number of grains per cob was found to be non significant. Interaction between cultivars and nitrogen levels was also statistically non-significant. Similar results were reported by Ali *et al.* (1999).

### 1000-Grain Weight

Maximum 1000-grain weight (277.02 g) was attained by cv. P-31-R-88 which was statistically at par with cv. B-202, producing 1000-grain weight (273.18 g). Minimum 1000-grain weight (233.68 g) produced by cv. M-919. Data pertaining to 1000-grain weight also showing significant effect of nitrogen rates. Maximum 1000-grain weight (270.43 g) was attained by 250 Kg N  $\text{ha}^{-1}$  which was statistically at par with treatment 200 Kg N  $\text{ha}^{-1}$ , producing 1000-grain weight (262.57 g). Minimum 1000-grain weight (250.88 g) produced by 150 Kg N  $\text{ha}^{-1}$  was also statistically at par with treatment 200 Kg N  $\text{ha}^{-1}$ , producing 1000-grain weight (262.57 g). The interactive effect between cultivars and nitrogen levels was found to be statistically non-significant. These observations are fully reported by Khan *et al.* (1999) and Sharar *et al.* (2003). They reported 1000 grain weight of 249.3 g in cultivar and 226.5 g @ 210 Kg N  $\text{ha}^{-1}$ .

### Grain yield

Cultivar P-31-R-88 out yielded by producing (8.33 t  $\text{ha}^{-1}$ ) which was statistically at par with cv. B-202 producing (7.77 t  $\text{ha}^{-1}$ ) and lowest per hectare grain yield (7.61 t  $\text{ha}^{-1}$ ) obtained by cv. M-919. Grain yield is a product of a number of sub fractions called yield associated traits and the sub fractions are the number of reproductive plant per unit area, maturity of plant, the number of grain per reproductive unit and average weight per unit. The more grain yield of cv. P-31-R-88 might be

### Yield response of maize to nitrogen rates

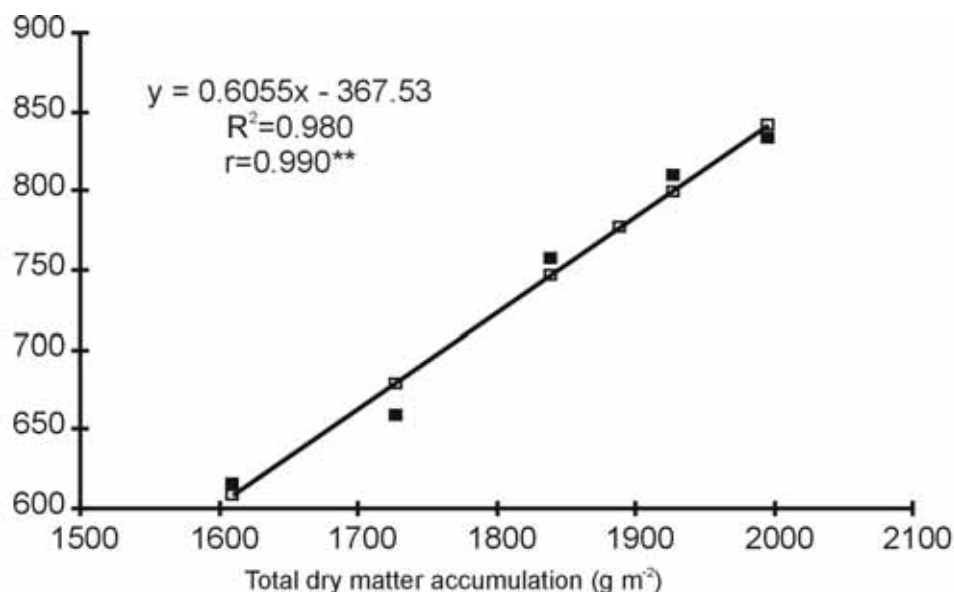


Fig. 1. Relationship between grain yield and total dry matter production

### Effect of different nitrogen levels and cultivar on yield and components of yield of maize. (Average of four replicates)

Treatments	Germination count (Plants m <sup>-2</sup> )	Plant height (Cm)	No. of cobs plant <sup>-1</sup>	No. of grains cob <sup>-1</sup>	1000 grain weight	Grain yield (t ha <sup>-1</sup> )	Harvest index (%)
<b>Cultivars</b>							
V <sub>1</sub> = B-202	6.18 ab	170.12 ab	1.08 ab	510.19 b	273.18 a	7.77 ab	40.92 ab
V <sub>2</sub> = M-919	5.86 b	146.17 b	1.05 b	447.06 c	233.68 b	6.16 b	38.16 b
V <sub>3</sub> = P-31- R-88	6.39 a	184.57 a	1.17 a	566.77 a	277.02 a	8.33 a	42.10 a
LSD	0.40	28.19	0.11	29.95	35.19	1.76	3.05
<b>Nitrogen levels</b>							
N <sub>1</sub> = 150 Kg ha <sup>-1</sup>	6.35 N.S	157.68 c	1.05 NS	491.93 NS	250.88 b	6.59 b	38.01 b
N <sub>2</sub> = 200 Kg ha <sup>-1</sup>	6.07	167.17 b	1.11	511.82	262.57 ab	7.57 a	41.20 a
N <sub>3</sub> = 250 Kg ha <sup>-1</sup>	6.01	176.00 a	1.14	520.27	270.43 a	8.09 a	41.97 a
LSD	0.34	8.40	0.11	37.13	14.62	0.83	2.17
Interaction	NS	NS	NS	NS	NS	NS	NS

Any two means not sharing a letter differ significantly at 5% probability level.

attributed to its genetic make up. The response of nitrogen levels to grain yield was found to be highly significant. Grain yield increased with increase in nitrogen up to N<sub>3</sub> (250 Kg N ha<sup>-1</sup>) treatment. Both N<sub>2</sub> (200 Kg N ha<sup>-1</sup>) and N<sub>3</sub> (250 Kg N ha<sup>-1</sup>) treatments were statistically at par in grain yield. While N<sub>1</sub> (150 Kg N ha<sup>-1</sup>) treatment attained minimum grain yield. The average grain yield was 6.59, 7.57 and 8.09 t ha<sup>-1</sup> in N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub> treatments, respectively. Overall, average grain yield was at 7.42 t ha<sup>-1</sup> in this experiment. There was also a positive correlation between seed yield and total dry matter production.

Increase in grain yield with an increase in nitrogen rates was also observed by others (Luschinger *et al.*, 1999, Sabir *et al.*, 2000, Younas *et al.*, 2002).

### Harvest index

Significant effect among cultivars and highly significant effect among fertilizer levels on harvest index. Maximum harvest index (42.10) was observed in cv. P-31-R-88 that was statistically at par with cv. B-202 producing (40.92) and minimum harvest index (38.16) was recorded in cv. M-919. In case of fertilizer levels, the N<sub>3</sub> (250 Kg N ha<sup>-1</sup>) treatment gave maximum

harvest index (41.97) that was statistically at par with harvest index 41.20 in fertilized with  $N_2$  (200 Kg N ha<sup>-1</sup>). Significantly minimum harvest index (38.01) was produced at minimum fertilizer level  $N_1$  (150 Kg N ha<sup>-1</sup>). Results suggest that an optimum supply of nitrogen is essential for favourable partitioning of dry matter between grain and other parts of maize plant. Higher efficiency of converting dry matter into economic yield, higher the value of harvest index (%). Bangarwa *et al.*, (1988) and Sabir *et al.*, (2000) presented similar results.

## REFERENCES

- Akhtar, M., M. Saeed and S.S. Kaleem. 1996. Maize productivity as affected by varying seed size and nitrogen levels. *Pakistan Journal of Science*, 48(3-4): 72-75.
- Ali, A., M.A. Malik, M.A. Choudhry, M. Khalid and M. Rafique. 1999. Effect of various doses of nitrogen on the growth, yield and protein content of two maize genotypes. *Pakistan Journal of Biological Science*, 2 (3): 889-890.
- Bangarwa, A.S., M.S. Kairon and K.P. Singh. 1988. Effect of plant density and level and proportion of nitrogen fertilization on growth, yield and yield component of winter maize. *Haryana Agric. Univ. Ind. Ind. J. Agric. Sci.*, 58(11): 854-856.
- GOP. 2005. Economic Survey Govt. Of Pakistan 2004-2005, Finance Division, Economic Advisory Wing, Islamabad, Pakistan, PP. 8.
- Chaudhry, A.R. 1983. *Agronomy in "Maize in Pakistan"* Punjab Agriculture Coordination board Univ. Agri. Faisalabad, Pakistan.
- Khan. M.A., N.U. Khan, K. Ahmad, M.S. Baloch and M. Sadiq. 1999. Yield of maize hybrid -3335 as affected by NP levels. *Pakistan Journal of Biological Science*, 2(3):857-859.
- Kumar, B. and U.S. Walia. 2003. Effect of nitrogen and plant population levels on competition of maize (*Zea mays* L.) with weeds. *Ind. J. of Weeds Science*.35 (1/2): 53-36.
- Luchsinger, L.A., A.J.D. Opazo and V.O. Neira. 1999. Response of sweet corn to nitrogen fertilization. *Investigation Agricola*, 19(1/2):9-18 (*Field Crop Absts.* 53(7): 4524: 2000).
- Martin, J., H. Leonard and L. Stamp. 1975. *Principles of field crop production*. (III ed.) Macmillan Pub.Co.Inc., NewYork.
- Njeru, N. 1983. Some physiological studies of different maize varieties at N.A.R.S. Kitale. Rome, Italy. *FAO: 511-517 (Field Crop Absts.*, 37(5):2876; 1984).
- Rasheed, M. 2002. Biological response of Hybrid Maize to plantation methods and nutrient management. Ph.D. Thesis, Deptt. of Agronomy, Univ. Agric. Faisalabad.
- Sabir, M.R., I. Ahmad and M.A. Shahzad. 2000. Effect of nitrogen and phosphorus on yield and quality of two hybrids of maize (*Zea mays* L.). *J. Agric. Res.* 38(4): 339-346.
- Sangoi, L., M. Ender, A.F. Guidolin, M.L. Almeida and V.A. Konflanz. 2001. Nitrogen fertilization impact on Agronomic traits of maize hybrids released at different decades. *Pesq. agropec. bras.*, 36 (5): 757-764.
- Sharar, M., S.M. Ayub, M. Nadeem and N. Ahmad. 2003. Effect of different rates of nitrogen and phosphorus on growth and grain yield of Maize (*Zea mays* L.). *Asian Journal of Plant Science* 2(3): 347-349.
- Uribelarrea, M., F.E. Below and S.P. Moose. 2004. Grain composition and productivity of maize hybrids derived from the Illinois protein strains in response to variable nitrogen supply. *Crop Sci.* 44: 1593-1600.
- Younas, M.H. Rehman and G. Hayder. 2002. Magnitude of variability for yield and yield associated traits in maize hybrids. *Asian J. Plant Sci.* 1 (6): 694-696.