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Maize (*Zea mays* L.) Response to Split application of Nitrogen

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ABSTRACT

A field study was conducted to determine the effect of split application of nitrogen in maize (*Zea mays* L.). NPK @ 150 - 100 – 100 kg ha^{-1} was used in all treatments. P_2O_5 and K_2O were applied at sowing whereas, N was applied through different application methods at different times. Maximum plant height (165.93 cm) was recorded with the application of nitrogen in three splits, *viz*., at sowing, first irrigation and knee height. The highest grain yield of 4.35 t ha^{-1} was obtained from plots where equal amount of nitrogen was side dressed in three splits, i.e. at sowing, at first irrigation and at knee height as against the lowest grain yield (2.8 t ha^{-1}) obtained in control.

Key Words: *Zea mays* L.; Nitrogen; Split application; Grain yield

INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice and known as "King of grain crops". Approximately 8 to 10% of the corn crop is used as food for human consumption. It is not only a source of food, fodder and feed but also many by-products likes glucose, starch and corn oil, etc are prepared from it. In recent years, increased quantities of corn have been used in the manufacture of shortening components, soaps, varnishes, paints and similar other products. Maize is extensively grown in temperate, subtropical and tropical regions of the world. Maize grains have greater nutritional value as it contains 72% starch, 10% protein, 4.8% oil, 8.5% fibre, 3.0% sugar and 1.7 % ash (Chaudhary, 1983). In Pakistan, it is cultivated on an area of 880.8 thousands hectares with an annual production of 1731 thousand tonnes, giving an average grain yield of 1718 kg per hectare (Government of Pakistan, 2001).

Nitrogen has numerous functions in the plant. It is an essential element of amino acids, the building blocks of proteins and part of the nucleic acids; DNA and RNA (Bould *et al.*, 1984). Nitrogen is a constituent of plant compounds including nucleotides, amides and amines. Many enzymes are proteinaceous; hence, N plays a key role in many metabolic reactions. Because N is contained in the chlorophyll molecule, a deficiency of N will result in a chlorotic condition of the plant. Nitrogen is also a structural constituent of cell walls (Schrader, 1984). Maize (*zea mays* L.) is nitropositive and needs ample quantity of nitrogen for its better production. It is therefore, imperative to use an optimum amount of fertilizer through a suitable application technique at a time when it is most efficiently and effectively utilised.

These studies were carried out to determine effective method and time of application of nitrogen for obtaining good crop harvest of maize under Faisalabad conditions.

MATERIALS AND METHODS

The experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 1997. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Net plot size was 3.0 x 5.0 m. A recommended dose of NPK (150 - 100 - 100 kg ha^{-1}) was used. Whole of the P_2O_5 and K_2O was applied at sowing but nitrogen was applied through different application methods at different growth stages. The following treatments were included in the experiments.

T_1 :control(no fertilizer); T_2: 2/3 of nitrogen broadcast at sowing + 1/3 of N broadcast at 1st irrigation; T_3: equal amounts of N applied through broadcast method in three splits *viz*; at sowing, at 1st irrigation , at knee height; T_4: 2/3 of N broadcast at sowing + 1/3 of N side dressed at first irrigation; T_5: 2/3 of N side dressed at sowing + 1/3 side dressed at first irrigation; T_6: 1/3 of N side dressed at sowing + 1/3 side dressed at first irrigation + 1/3 side dressing at knee height; T_7: whole N side dressed at sowing.

Maize cultivar "Golden - 95" was sown during the second week of August, 1997 in 60 cm apart rows with a single row hand drill using seed rate of 30 kg ha^{-1}. Plant to plant distance of 30 cm. was maintained by thinning at four leave stage. Basudin was applied @ 20 kg ha^{-1} before first irrigation to control insects specially the maize borer (*Chillo partellus Swin).* Six irrigations were applied during the whole season according to the requirement of the crop. Hoeing was done manually to control weeds. All other agronomic and plant protection practices were kept normal for all the treatments. Crop was harvested in second week of November 1997. Data on yield and yield components were recorded using standard procedures and analysed statistically using the Fishers analysis of variance techniques and treatment means were compared by using the LSD test at 5% level of probability (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Plant height at maturity. The height of a plant at maturity is a function of the combined effect of both the genetic and environmental factors. Data presented in Table I revealed that application of nitrogen either at different growth stages or through different methods did not affect plant height significantly. However, average plant height at maturity ranged from 165.93 to 152.38 cm. Non significant differences among treatment means of plant height at maturity may partly be due to the genetic characteristics of the variety and partly to the fact that there was no nutrient competition among plants. These results are in agreement with those of Jones (1973) who reported that time of application of N had no significant effect on maize plant characters e.g. grain and stalk yield. But these results are contrary to those of Jamil (1996) who reported that yield and its components increased with increasing levels of N over control.

Number of grains per cob. The data regarding the number of grains per cob showed the differences among treatments could not reach the level of significance. However, average number of grains per cob ranged between 396.15 and 256.85. Non significant differences among the treatments for number of grains per cob may partly be due to the genetic characteristics of the variety and partly to the fact that there was no nutritional stress in any treatment where it could result in differences in number of grains per cob. These results are inline with those of Jones (1973) but are not supported by Sabir *et al.* (2000) and Mehmood *et al*. (2001) who observed that number of grains per cob increased significantly with increasing nitrogen rates.

Grain weight per cob (g). Grain weight per cob indicates the extent to which the photoassimilates have been accumulated in the grains of a cultivar compared to its vegetative organs. The data showed highly significant effects of fertilizer use methods and timing on grain weight per cob. The highest grain weight per cob (96.25 g) was obtained where nitrogen was side dressed in three splits *viz.*, at sowing, after first irrigation and at knee height. Application of N through broadcasting 2/3 at sowing and 1/3 with first irrigation did not bring any change in grain weight per cob as against control. Nitrogen applied through broadcast method in three splits, *viz.* at sowing, first irrigation and at knee height, side dressing whole at sowing and side dressing in two splits as 2/3 at sowing + 1/3 at first irrigation produced statistically similar grain weights per cob of 88.38, 90.01 and 91.83 g respectively. These findings are in conformity with those of Sharma (1980), Gairadin *et al.* (1992) and Pearson (1994).

1000-grain weight. The plumpness of the grain is positively correlated with the grain yield. A perusal of the data presented in the Table revealed that the treatments were significantly different from one another showing the influence of different times and methods of fertilizer application on 1000-grain weight. All the treatments where N was applied either by side dressing or broadcast method resulted in higher 1000- grain weight compared to control. The treatment means comparison showed that T_7 (whole nitrogen side dressed at sowing) and T_6 (N ,1/3 side dressed at sowing + 1/3 side dressed at Ist irrigation + 1/3 side dressed at knee height) remained superior in producing heavy grains (219.16 g and 212.56 g, respectively) but were statistically at par with each other. The control gave the minimum thousand grain weight of 190.84 g. This behaviour may be attributed to the fact that side dressing at first irrigation increases the N use efficiency. These results are quite in line with the finding of Miller *et al.* (1975) and Sharma (1980), who concluded that application time of fertilizer at different growth stages of Maize crop significantly affected the 1000- grain weight. Thakur and Malhotra (1991) found that 1000 grain weight increased significantly by the application of different rates of nitrogen over control.

Grain yield. The efficiency and effectiveness of times and methods of N application is ultimately determined by the

Table I. Effect of split application of nitrogen on yield and yield component of maize

Treatments		Plant height (cm)	Number of grains per cob	Grain weight cob^{-1}(g)	1000-grain weight (g)	Grain yield (t ha^{-1})	Grain pith ratio	Harvest index (%)
T_1	N P K 0 – 0 – 0 Control	152.38 N.S.	256.85 N.S.	76.37 d	190.84 d	2.80 d	1.98 d	31.84 N.S.
T_2	2/3 N broadcast at sowing + 1/3 at 1st irrigation	164.80	331.71	77.94 d	198.21 c	3.60 c	2.29 c	33.89
T_3	1/3 N broadcast at sowing + 1/3 at 1st irrigation + 1/3 at knee height	165.93	358.81	88.38 b	208.14 b	3.99 b	2.49 b	34.66
T_4	2/3 N broadcast at sowing + 1/3 side dressing at 1st irrigation	156.43	343.61	82.70 c	202.86 c	3.68 c	2.17 c	28.90
T_5	2/3 N side dressing at sowing + 1/3 at 1st irrigation	156.43	357.88	91.83 b	210.28 b	3.90 b	2.56 b	35.43
T_6	1/3 N side dressing at sowing + 1/3 at 1st irrigation + 1/3 at knee height	159.05	396.15	96.25 a	212.56 a	4.35 a	2.81 a	41.44
T_7	All N side dressed at sowing	162.96	371.79	90.01 b	219.16 a	3.89 b	2.54 b	27.09
	LSD value.	-	-	4.13	7.32	0.297	0.225	-

Any two means not sharing a letter in common differ significantly at 5 percent probability level

level of grain yield per unit areas which is cumulative behaviour of the yield components. The data showed that side dressing of nitrogen in three splits *viz.*, 1/3 at sowing, 1/3 at first irrigation and 1/3 at knee height produced the highest grain yield (4.35 t/ha) and it was followed by T_7 (whole of the N side dressed at sowing), T_5 (2/3 N side dressed at sowing and 1/3 at knee height) and T_3 (N applied through broadcast in three equal splits *viz.*, at sowing, first irrigation and knee height). These results are in agreement with those of Jamil (1996), Thakur and Malhotra (1991) and Sharma (1980). The minimum grain yield 2.80 t/ha was recorded in plots where no fertilizer was applied.

Grain-pith ratio. The grain pith ratio is an indicator of the productive efficiency of the cob. It shows the relative quantity of assimilates divided into grain and pith in the cob. The nitrogen application methods had significant effect on grain pith ratio. Data presented in the Table I indicated that all the treatments produced greater grain pith ratio than control, however, T6 (side dressing of N, 1/3 at sowing + 1/3 at first irrigation + 1/3 at knee height) gave the highest grain pith ratio (2.81) as compared to rest of the treatments. It seems that there is more accumulation of photoassimilates in T_6 than rest of the treatments. T_5 was statistically at part with T_3 and T_7 but however T_4 was statistically at par with T_2. These results are supported by El – Sharkawy *et al.* (1976) and Singh *et al.* (1986)

Harvest index. Harvest index of a crop is an interaction of its physiological efficiency and its ability of converting the photosynthetic material into economic yield. Data presented in the Table clearly indicated that the harvest index was not affected significantly by split application of N fertilizer. Among the treatments however, more harvest index value was recorded in treatment T_6 (1/3 of N side dressing at sowing + 1/3 side dressing at first irrigation + 1/3 side dressing at knee height). The non significant values of harvest index may probably be due to the reason that the differences in grain yield and stalk yield were not large enough to cause significance in the harvest index.

REFERENCES

Anonymous, 2001. Economics survey, Govt. of Pakistan. p. 15. Economics Advisor's wing, Islamabad.

Bould, C., E.J. Hewitt, and P. Needham, 1984. *Diagnosis of Mineral Disorders in Plants*. Vol. 1: Principles. Chemical Publishing, New York.

Chaudhry, A.R., 1983. *Maize in Pakistan.* Punjab Agri. Co-ordination Board, University of Agri., Faisalabad.

El – Sharkawy, M.A., K. Sgair, F.A. Sorour and M.E. Yousaf, 1976. Effect of nitrogen level and time of application on growth and yield of maize (*Zea mays* L.). *Libyan J. Agric*., 5: 9–15.

Gairadin, P.H., R. Trendel, J. Mayer, M. Birgantzle and P. Freyss, 1992. Effect of conventional multiple N application by fertilisation on maize grain yield of NO3 – N residues. Devel. in Plant Sci. (*Field Crop Absts.*, 47(11): 7016; 1994).

Jamil, M., 1996. Determination of optimum level of nitrogen and its effect on maize (*Zea mays* L.) yield. *M.Sc. (Hons) Agri thesis.*, Dept. Agron., Uni. of Agri., Faisalabad.

Jones, M.J., 1973. Time of application of Nitrogen fertilizer to maize at Somara, Nigeria. *Exp. Agric.*, 9: 113–20.

Mehmood, M.T., M. Maqsood, T.H. Awan, R. Sarwar and M.I. Hussain, 2001. Effect of different level of nitrogen and intra – row plant spacing on yield and yield components of maize. *Pakistan J. Agri. Sci*., 38: 48.

Miller, H.F., J. Kawanaugh and G.W. Thomus, 1975. Time of application and yield of corn in wet alluvial soils. *Agron. J*., 67: 401–4.

Pearson, C.H., 1994. Plant response to the management of fluid and solid N fertilizers applied to furrow irrigated corn. *Fert. Res.,* 37: 51 {*Field Crop Absts.,* 47: 7019; 1994}.

Sabir, M.R., I. Ahmad, 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: 339.

Schrader, L.E., 1984. Functions and transformation of nitrogen in higher plants. *In: Nitrogen in Crop Production.* R.D. Hauck (ed.), pp: 55–6. ASA, CSSA and SSA, Madison, WI.

Sharma, R.N., 1980. Effect of planting techniques and time and method of fertilizer application on Maize (Ganga - 3). *Indian J. Agron*., 25 : 555 {*Field Crop Absts.*,359 :2075; 1982}.

Singh, R.P., K.P.P. Nair and P.P. Singh, 1986. Biological yield and Nitrogen uptake in Maize. *Ann. Agric. Res*., 7: 275–81 {*Field Crop Absts.*, 41:169; 1988}.

Steel, R.J.D. and J.H. Torrie, 1984. *Principles and Procedures of Statistics.* pp: 172–7. Mc Graw Hill Book Co., INC; Singapur.

Thakur, D. R. and V.V. Malhotra, 1991. Response of pop corn to row spacing and nitrogen. *Indian J. Agric. Sci*., 61: 586.

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