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Growth Analysis of Hybrid Maize as Influenced by Planting Techniques and Nutrient Management

MUHAMMAD RASHEED, ABID HUSSAIN AND TARIQ MAHMOOD
Department of Agronomy, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

A two year field study was conducted to evaluate the growth behaviour of hybrid maize under different planting technique and nutrient levels. The planting methods comprised 70 cm spaced single rows, 105 cm spaced double-row strips and 70 cm spaced ridges. While the nutrient levels were 250 kg N, 250 kg N + 150 kg P, 250 kg N + 150 kg P + 100 kg K, 250 kg N + 150 kg P + 100 kg K + 15 kg S, 250 kg N + 150 kg P + 100 kg K + 15 kg Mg and 250 kg N + 150 kg P + 100 kg K + 15 kg S + 15 kg Mg ha^{-1}. Crop sown on ridges produced significantly higher leaf area index (LAI) 5.22, dry matter (DM) 1478.62 g m^{-2}, crop growth rate (CGR) 31.12 g m^{-2} day^{-1} and net assimilation rate (NAR) 8.09 g m^{-2} day^{-1} than the crop sown flat either in 105 cm spaced double row strips or 70 cm spaced single rows. Application of 15 kg S alongwith 250 -150 kg NP produced significantly higher LAI, DM, CGR and NAR than NP alone. Similarly, application of S or Mg or both S + Mg to NPK 250-150-100 kg ha^{-1}) gave significantly higher LAI, DM, CGR or NAR than NPK alone but statistically same to each other.

Key Words: Planting methods; Nutrient management; Hybrid maize

INTRODUCTION

Among cereals, maize (*Zea mays* L.) is an important food and feed crop which ranks third after wheat and rice in the world. Because of its expanded use in the agro-industries it is recognized as a leading commercial crop of great agro-economic value. Pakistan grows about 0.97 mha of maize with total annual production of 1.73 million tone of grain giving an average yield of 1790 kg ha^{-1} (Govt. of Pakistan, 2001) which is tremendously lower than other many maize growing countries of the world. There are many reasons of low productivity. Among them mismanagement of plant nutrition and agronomic practices are considered to be the major ones. Hence, there is a need to improve these two major components of the production technology for getting higher maize production of better quality.

Of the agronomic practices, planting technique is of considerable importance as proper adjustment of plants in the field not only ensures optimum plant population but also enables the plants to utilize the land and other input resources more efficiently and resolutely towards growth and development (Ali *et al.*, 1998). According to Khaliq *et al.* (1988) and Ahmad *et al.* (2000) maize planted on paired ridges performed better than that grown in single-rows.

Balanced nutrition is an essential component of nutrient management and plays a significant role in increasing crop production and its quality. For the major processes of plant development and yield formation the presence of nutrient elements like N, P, K, S, Mg etc. in balanced form is essential (Mahmood *et al*., 1999; Colomb *et al.*, 2000; Randhawa & Arora, 2000). Thus, there is a need to carry out a systematic research on these lines in order to develop comprehensive information in this regard. The present study was, therefore, planned to determine the effect of different planting techniques and nutrient management on various agronomic traits of hybrid maize under the agro-ecological condition of Faisalabad, Punjab.

MATERIALS AND METHODS

The experiment was conducted at the research area of Agronomy department, University of Agriculture, Faisalabad during the autumn of 1997 and 1998 on a sandy clay loam soil having 0.043% total N, 1 ppm available P and 125 ppm available K. The treatments comprised three planting methods (70 cm spaced single rows, 105 cm spaced double-row strips (35/105 cm) and 70 cm spaced ridges) and seven nutrient levels i.e. 250 kg N, 250 kg N + 150 kg P, 250 kg N + 150 kg P + 100 kg K, 250 kg N + 150 P + 100 kg K + 15 kg S, 250 kg N + 150 kg P + 100 kg K + 15 kg Mg and 250 kg N + 150 kg P + 100 kg K + 15 kg S + 15 kg Mg. The experiment was laid out in a Randomized Complete Block Design (RCBD) with a split plot arrangement keeping plantation methods in main plots and nutrient levels in subplots using three replications. The net plot size measured 4.20 x 7.5 m.

Plant growth analysis. Leaf area index (LAI) was calculated as the ratio of total leaf area to land area as:

$$\text{LAI} = \frac{\text{Leaf area (m}^2\text{)}}{\text{Land area (m}^2\text{)}} \times 100$$

For calculating dry matter accumulation, five plants were taken for dry weight per plant at 30, 45, 60, 75 and 90 days after sowing. Each plant was chaffed mixed thoroughly and then sun dried. Thereafter the samples were placed in an oven at 70°C±5°C to dry the plant material to their constant dry weight. The dry weight per plant was calculated and converted into dry matter per unit land area (m^2). The following growth parameters were studied.

Crop growth rate. Crop growth rate (CGR) was calculated by the formula given by Beadle (1987).

$$CGR = \frac{W_2 - W_1}{t_2 - t_1}$$

Where W_2 = dry weight land area at second harvest
W_1 = DW m^{-2} land area at first harvest
t_2 = time corresponding to second harvest
t_1 = time corresponding to first harvest

Net assimilation rate. Net assimilation rate (NAR) was determined by the formula given by Beadle (1987).

$$NAR = \frac{TDM}{LAD}$$

where
TDM = Total dry matter
LAD = Leaf area duration

Leaf Area Duration (LAD) was calculated by the formula of Beadle (1987).

$$LAD = (LAI_1 + LAI_2) \times (t_2 - t_1)/_2$$

where
LAI_1 = Leaf area Index at t_1
LAI_2 = Leaf area index at t_2
t_1 = time of first observation
t_2 = time of second observation

RESULTS AND DISCUSSION

The leaf area index (LAI) of the crop at a particular growth stage indicates its photosynthetic potential or the level of its dry matter accumulation. The more the LAI, the higher the dry mater accumulation potential of the crop and vice versa. The two year average data indicates that LAI of crop (Table I) was very low in the beginning (30 DAS) but with significant variation both among the different plantation methods and the fertilizer treatments in both years. It increased progressively with the advancement of the growth period and reached the maximum at 75 DAS and thereafter declined at 90 DAS.

The average LAI recorded at 75 DAS indicated that significantly higher LAI (5.15) was recorded in the crop planted on 70 cm spaced ridges (M_3) than that recorded in M_2 and M_1 which were also statistically different from each other and gave LAI of 5.12 and 4.99 respectively. These results corroborate the findings of Irshad (1987) and Khaliq *et al.* (1988) who also reported that higher LAI in the crop sown on ridges was probably due to more availability of nutrients and moisture in ridge plantation.

The different nutrient levels also affected significantly the LAI (Table I). The non-significant differences among F_4, F_5 and F_6 suggest that S or Mg or both S + Mg alongwith NPK had no effect on LAI. The results are supported by those of Keerio and Singh (1985) and Colomb *et al.* (2000).

Maximum DM production recorded at 75 DAS revealed that the crop planted on 70 cm spaced ridges produced significantly more DM (1512.73 g m^{-2}) than that planted either in 105 cm spaced double-row strips (M_2) or 70 cm spaced single-rows (M_1) which produced dry matter of 1470.43 and 1357.64 g m^{-2}, respectively and also differed significantly from each other. Higher DM accumulation in M_3 was probably attributed to more interception of solar radiation because of better orientation of the crop plants as compared to M_2 and M_1. These results corroborate the findings of Khaliq *et al.* (1988) and Anonymous (1995).

Differences in DM production among F_4, F_5 and F_6 treatments were non-significant indicating that application of Mg alongwith NPK over NPKS did not affect the DM production. However, K and S application increased the DM significantly over NP and NPK, respectively. Increase in

Table I. Growth analysis of maize as influenced by planting techniques and nutrient management

	Treatments						Leaf area index (LAI) at 75 DAS	Dry matter accumulation at 75 DAS (g m^{-2})	Crop growth rate (CGR) g m^{-2} day^{-1} (30-75) DAS	Net assimilation rate (NAR) gm^{-2} day^{-1} at (30-75) DAS
A	**Plantation methods**									
	M_1 = 70 cm spaced single rows						5.03 c	1333.75 c	27.97 c	7.58 c
	M_2 = 105 cm spaced double row strips						5.20 b	1433.03 b	30.15 b	7.89 b
	M_3 = 70 cm spaced ridges						5.22 a	1478.62 a	31.12 a	8.09 a
	LSD 5%						0.01	2.82	0.06	0.02
B	**Nutrient levels (kg ha^{-1})**									
		N	**P**	**K**	**S**	**Mg**				
	F_0	0	0	0	0	0	3.48 e	817.24 f	16.95 f	6.74 f
	F_1	250	0	0	0	0	4.80 d	1300.64 e	27.21 e	7.69 e
	F_2	250	150	0	0	0	5.33 c	1462.22 d	30.75 d	7.92 d
	F_3	250	150	100	0	0	5.57 b	1553.98 c	32.78 c	8.07 c
	F4	250	150	100	15	0	5.62 a	1591.43 ab	33.55 ab	8.19 ab
	F_5	250	150	100	0	15	5.62 a	1580.43 a	33.29 a	8.13 bc
	F_6	250	150	100	15	15	5.63 a	1600.00 a	33.70 a	8.24 a
	LSD (0.05 p)						0.02	14.49		0.07

Means in a column not sharing a letter differ significantly at 0.05 P; NS = Non-significant

DM with the application of N alone (Ahmed, 1989; Maman, 1999), NP (Randhawa & Arora, 2000), NPK and NPKS has also been reported. Crop growth rate at (30-75) DAS was significantly higher in the crop planted on 70 cm spaced ridges (M_3) than that grown either in 105 cm spaced double-row strips (M_2) or in 70 cm spaced single-rows (M_1) (Table I). The findings of Jafar *et al.* (1988), Agha (1989), Khan (1992) and Khan *et al.* (1994) are contradictory to these results. Who reported that CGR of maize crop grown in 105 cm spaced double row strips was significantly higher than that grown on ridges.

Among the fertilizer treatments although the CGR was significantly the highest in the crop fertilized @ 250-150-100-15-15 kg NPKSMg ha^{-1} (F_6) but it was statistically on a par with F_4(250-150-100-15 kg NPKS ha^{-1}). Overall, CGR was significantly higher in the fertilized crop than the unfertilized crop. This type of variation in growth rate was also reported by Bennett *et al.* (1989), Ahmad *et al.* (1993) and Mohsan (1999) who reported an increase in CGR of maize crop with the application of N over control. Similarly, Biagovestra (1981) and Tariq *et al.* (1999) reported an increase of CGR by addition of P to N alone. These results also corroborate the finding of Mahmood *et al.* (1999). The assimilation rate (NAR) recorded at 30-75 DAS revealed that significantly the highest NAR (8.18 g m^{-2} day^{-1}) was recorded in the crop planted on 70 cm spaced ridges (M_3) against 7.98 and 7.61 in M_2 and M_1, respectively.

As regards fertilizer treatments, the NAR increased significantly upto F4 and reached the maximum at F_6 (8.32). However, the difference between F_6 and F_4 was non-significant. It indicated that application of S or Mg did not show any effect on NAR of the crop. Variation in NAR as a result of different levels of fertilizers has also been reported by Ahmed (1989), Moussa and Bersoum (1995) and Mohsan (1999).

The results suggested that crop growth analysis is a valuable tool to analyse crop performance in response to agronomic treatments.

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