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Nutrient Efficiency and Economics of Hybrid Maize Under Different Planting Methods and Nutrient Levels

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ABSTRACT

An experiment to study the comparative productivity, nutrient efficiency and economics of maize hybrids was conducted at the University of Agriculture, Faisalabad during 1997 and 1998. The experiment comprised three planting methods 70 cm spaced single rows, 105 cm spaced double-row strips and 70 cm spaced ridges with seven nutrient levels (kg ha^{-1}) viz., 250 N, 250 N + 150 P, 250 N + 150 P + 100 K, 250 N + 150 P + 100 K + 15 S, 250 N + 150 P + 100 K + 15 Mg and 250 N + 150 P + 100 K + 15 S + 15 Mg. Results revealed that the crop sown on ridges increased significantly the grain yield (7.50 t ha^{-1}), stover yield (11-39 t ha^{-1}) and nutrient efficiency (NE) over rest of the two methods which were also statistically different from each other. The crop fertilized @250-150-100-15 Kg NPKS ha^{-1} produced significantly more grain yield (8.52 t ha^{-1}), stover yield (12.08 t ha^{-1}) and NE (10.46) than rest of the treatments. Ridge planting gave the maximum net income and BCR. Among the fertilizer levels, the crop fertilized @250-150-100-15 Kg NPKS ha^{-1} gave the maximum net income of Rs.48690.5 ha^{-1} with a benefit cost ratio of 2.98.

Key Words: Nutrient efficiency; Economics; Planting methods; Nutrient levels; Hybrid maize

INTRODUCTION

There is stagnation in crop yields especially in intensive cropping systems. Due to imbalanced use of fertilizers and continuous growing of crops (exhaustive), several nutrients have become deficient (Mahmood *et al*., 1999; Sakal *et al*., 2000). Overall fertilizer use in Pakistan is quite low and it needs to be increased manifold to reach the level of developed countries. A number of soil fertility surveys have revealed that among the essential nutrient elements like N, P, K, S, Mg etc., our soils are deficient 100% in N and upto 90% in P. Therefore, the proper management of these two elements is very important for good crop production.

N is the motor of plant growth and makes up 1 to 4% of dry matter of the plant (Anonymous, 2000). It imparts dark green colour and guarantees optimal chlorophyll activity (Mahmood *et al*., 2001). Similarly, phosphorus plays a key role in energy transfer and is thus essential for photosynthesis and other chemico-physiological processes in plants (Wasiullah *et al*., 1995; Anonymous, 2000). It is indispensable for cell differentiation and development of tissue as well as for the growing points of the plants (Anonymous, 2000).

K plays a vital role in carbohydrate and protein synthesis as it activates more than 60 enzymes (Tisdale *et al*., 1990; Anonymous, 2000), while sulphur impart dark green colouring and guarantees optimal chlorophyll activity (Belger *et al*., 1978; Mahmood *et al*., 2001) as well as renders in fulfilling the yield potential of the crop (Tandon, 1989). Likewise magnesium, being a metallic constituent of chlorophyll increases photosynthesis in plants and increases the oil content of several crops Marshchner, 1986; Sahai, 1992; Aitken *et al*., 1999).

The previous research has shown that the selection of a suitable planting method as well as the proper combination of fertilizer nutrients leads to increased productivity, nutrient efficiency and net-income per unit area. Consequently, an attempt was made in this study to explore the productive potential, nutrient efficiency and economic benefits of hybrid maize at different planting methods and nutrient levels under the agro-ecological conditions of Faisalabad.

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 + 50 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}. 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 and using three replications. The net plot size was 4.20×7.0m.

The crop in each subplot was harvested manually at maturity. Grain yield was recorded on subplot basis and then converted into t ha^{-1}. Ears were removed from all plants but sheath of the ears was counted/weighed with the stover. After removal of ears, stalks were air dried and stover yield of each subplot was recorded and then transformed into t ha^{-1}. Agronomically, nutrient/fertilizer efficiency is the amount of increase in yield of the harvested crop per unit of fertilizer nutrient applied. It is also referred as grain nutrient ratio (Barber, 1976) and is calculated as:

$$Nutrient\ efficiency\ (Kg\,Kg^{-1})\ \frac{Grain\ yield\ F - Grain\ yeild\ C}{Fertilizer\ nutrients\ applied}$$

Where

Grain yield F = Grain yield of fertilized plots

Grain yield C = Grain yield of control or check plots

For economical analysis, the benefit cost ratio (BCR) was calculated by dividing the gross income by total expenditure as:

$$Benefit\ \cos t\ ratio = \frac{Gross\ \ income}{Total\ \ \exp\ enditure}\ (Rs\ \ ha^{-1})$$

The data collected were subjected to Freed and Eisen Smith (1986) analysis of variance technique and Least Significant Difference (LSD) test at P≤0.05 was used to compare the treatment means (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

The data on grain yield (Table I) indicated that the crop grown on 70 cm spaced ridges produced significantly higher grain yield (7.50 t ha^{-1}) than rest of the two methods which were also statistically different from each other and produced grain yield of 7.11 and 6.27 t ha^{-1}, respectively. These results are not in agreement with those of Nazir *et al*. (1985) and Jaffar *et al*. (1988) who reported the overall superiority of 90 cm spaced double-row strips plantation to 60 cm spaced single-row planting. But corroborate with the findings of Khokhar *et al*. (1986), Bhagwan and Bhatia (1990), Mahal *et al*. (2000) and Arif *et al*. (2001) who concluded that the maize planted on ridges gave higher grain yield than flat planting.

Crop fertilized @250-150-100-15 kg NPKS ha^{-1} (F4) although produced significantly higher grain yield (8.52 t ha^{-1}) than most of the treatments under study but was on a par with F6 (250-150-100-15-15 kg NPKS Mg ha^{-1}) indicating that the addition of S to NPK increased the grain yield to a significant level, however, addition of Mg to NPK did not increase the grain yield over NPK. These results are in agreement with those of Kabesh *et al*. (1989) and Aulakh and Chhibba (1994) who also reported significant increase in grain yield of maize with the application of S in addition to NPK increased GYH significantly.

The stover yield was significantly higher (11.39 t ha^{-1}) for the crop planted on 70 cm spaced ridges (M3) than M2 (11.11 t ha^{-1}) and M1 (10.06 t ha^{-1}) (Table I). Higher stover yield in M3 was probably attributed to proper orientation of the plants and resultantly better growth. These results are in consonance with those of Bhagwan and Bhatia (1990) and Arif *et al*. (2001).

The crop fertilized @ 250-150-100-15 kg NKPS ha^{-1} although produced significantly higher stover yield than F3, F2, F1 and F0 but was at par with F5 and F6 treatments. This shows the promotive effect of S or Mg or S+Mg in addition to NPK alone. These results are in line with those of Hussain *et al*. (1999), Ali *et al*. (2000) and Sakal *et al*. (2000).

The crop planted on 70 cm spaced ridges (M3) gave significantly higher nutrient efficiency (9.74) than M2 and M1 which also differed significantly from each other and exhibited nutrient efficiency of 8.58 and 7.28, respectively. These results are supported by the findings of Khokhar (1986) and Esechie *et al*. (1996).

Although the highest nutrient efficiency (10.46) was recorded in F4 but it was statistically on a par with F6 and F5. However, F4 and F6 differed statistically from F3 indicating thereby the significant role of S in improving the nutrient efficiency. These results are in consonance with those of Sharif *et al*. (1993) and Sakal *et al*. (2000) who reported that NE was increased to a significant level under the different fertilizer levels.

As regard economic benefits, significantly greater net income (Rs. 48137.0 ha^{-1}) and BCR (3.90) was obtained from the crop planted on ridges than that grown either in 105 cm spaced double-row strips (Rs.45491.5 ha^{-1}) and BCR (3.85) or in 70 cm spaced single rows (Rs. 38299.5 ha^{-1} and BCR 3.40). These results corroborate the findings of Ahmad *et al*. (2000) who recorded higher BCR for the crop sown on ridges than other sowing methods. Similar results were reported by Khan (1992) and Agha (1989) who recorded higher BCR for the crop sown in 90 cm spaced double row strips than that grown in 60 cm spaced single rows.

The crop fertilized @ 250-150-100-15 kg NPKS ha^{-1} (F4) gave significantly the maximum net income (Rs. 48690.5 ha^{-1} with BCR of 2.98) and was followed by F6 (Rs. 47288.5 ha^{-1} with BCR of 2.81) and F3 (Rs. 39586.7 with BCR of 2.73) which was significantly different from each other. These results are supported by the findings of Mahmood (1994) and Singh and Singh (2000) who reported that application of S in addition to NPK gave higher BCR than NPK alone.

Table I. Grain and stover yield and nutrient efficiency of hybrid maize as affected by different planting methods and nutrient levels

Treatments						Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Nutrient efficiency (kg kg^{-1})
A. Plantation methods								
M_1 = 70 cm spaced single rows						6.27 c	10.06 c	7.28 c
M_2 = 105 cm spaced double-row strips						7.11 b	11.11 b	8.58 b
M_3 = 70 cm spaced ridges						7.50 a	11.39 a	9.24 a
$S_{\bar{X}}$						0.04	0.02	0.03
LSD 5%						0.11	0.06	0.11
B. Nutrient levels (kg ha^{-1})								
	N	P	K	S	Mg			
F_0 =	0	0	0	0	0	3.10 f	7.48 e	0.00 e
F_1 =	250	0	0	0	0	5.02 e	9.15 d	7.44 d
F_2 =	250	150	0	0	0	7.15 d	11.18 c	10.11 bc
F_3 =	250	150	100	0	0	8.11 c	11.83 b	10.02 c
F_4 =	250	150	100	15	0	8.52 a	12.08 a	10.46 a
F_5 =	250	150	100	0	15	8.27 b	12.09 a	10.11 bc
F_6 =	250	150	100	15	15	8.53 a	12.14 a	10.43 ab
$S_{\bar{X}}$						0.04	0.07	0.12
LSD 5%						0.12	0.18	0.33

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

Table II. Net income and benefit cost ratio of hybrid maize as affected by different planting methods and nutrient levels

Treatments	Grain yield (GYH) t ha^{-1}	Stover yield (SYH) t ha^{-1}	Income (Rs. ha^{-1}) from Grain yield	Stover yield	Gross income (Rs. ha^{-1})	Total expenditure (Rs ha^{-1})	Net income (Rs ha^{-1})	Benefit cost ratio (BCR)
Planting methods								
M1:70 cm spaced single rows	6.27	10.06	51727.5	2515.0	54242.5	15943.0	38299.5	3.40
M2: 105 cm spaced double-row strips	7.11	11.11	58657.5	2777.5	61434.5	15943.0	45491.5	3.85
M3: 70 cm spaced ridges	7.50	11.39	61875.0	2847.5	64722.5	16585.0	48137.0	3.90
Nutrient levels (kg ha^{-1})								
N P K S Mg	3.10	7.48	22575.0	1870.0	24445.0	15943.0	8502.0	1.53
F0: 0 0 0 0 0	5.02	9.15	41415.0	2287.5	43702.5	19470.0	24232.5	2.24
F1: 250 0 0 0 0	7.15	11.18	58987.5	2795.0	61782.5	22610.3	39172.2	2.73
F2: 250 150 100 0 0	8.11	11.83	66907.5	2957.5	69865.0	24393.0	39586.7	2.86
F3: 250 150 100 0 0	8.52	12.08	70290.0	3020.0	73310.0	24619.5	48690.5	2.98
F4: 250 150 100 15 0	8.27	12.09	68227.5	3022.0	71250.0	25893.3	45356.7	2.75
F5: 250 150 100 0 15	8.53	12.14	70372.5	3035.0	73407.5	26119.5	47288.5	2.81
F6: 250 150 100 15 15								

Where, Price of maize grain = Rs. 8.25 /kg, Price of maize stover = 10/40 kg

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