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Investigations into Utility of Maize as a Dual Purpose Crop

SHAMSHAD HUSSAIN SHAH, GHULAM MUSTAFA AND SHAHID IBNI ZAMIR
Department of Agronomy, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

Studies to see the possibility of raising a successful maize crop for dual purpose were conducted under irrigated conditions at Faisalabad. Maize crop was grown using three plant densities (88, 888; 1, 77, 776; and 2, 66, 664) and three N, P_2O_5, K_2O levels (O+O+O; 75+75+50; and 150+75+50 kg ha^{-1}). Thinning was done at tasseling stage and subsequently density in all the treatments was kept as 88,888 plants per hectare. The results revealed that fodder yield increased with an increase in N, P and K levels and plant density. Maximum fodder yield (13.61 t ha^{-1}) was obtained when the crop was fertilized @ 150+75+50 kg N, P_2O_5, K_2O ha^{-1} at a density of 1, 77, 776. Thinning of crop at tasselling stage and its use as fodder did not affect the grain yield obtained by sowing crop at any of three densities treated with 150+75+50 kg NPK ha^{-1}. Similarly, a net income of Rs.21,175.65 was obtained in this treatment and it was the highest of all other treatments.

Key Words: Maize; Nitrogen; Phosphorus; Potash Levels; Fodder yield; Grain yield

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereals grown in Pakistan and ranks third in area and production after wheat and rice. Although high yielding varieties are being cultivated in the country, yet the yield is far below that of many agriculturally advanced maize growing countries in the world. Low yields can be attributed to imbalance use of fertilizer and low plant density in the field. Nitrogen is considered as a vital plant nutrient as it is most deficient in our soils and is utilized by maize plants throughout the crop growth period. Increase in the rate of nitrogen fertilizer increases maize grain yield (Khan *et al*., 1994) and improves grain quality by increasing protein concentration (Rending & Broadbent, 1979). According to Wang *et al*. (1987), it was stated that low plant density increased the yield per plant due to higher ear length and more number of grains per ear; whereas, yield ha^{-1} increased with increase in plant density due to more number of cobs per hectare.

The present study was, therefore, planned to examine the possibility of raising a successful dual purpose maize crop through adjustment of plant population and providing soil nutrients without affecting the productivity of crop.

MATERIALS AND METHODS

To see the agro-economic response of maize to added N, P_2O_5, K_2O and removal of extra plants as forage at tasselling the experiment was conducted at the Agronomic Research Area of the University of Agriculture, Faisalabad during 1998 on a sandy clay loam soil having 0.043% nitrogen, 10.54 ppm available phosphorous and 269 ppm available potassium. The pH and EC of the soil were 7.9 and 1.1 dS m^{-1}, respectively. The experiment was laid out in a RCBD with factorial arrangement and replicated thrice. The treatments consisted of three N, P_2O_5, K_2O levels (0-0-0; 75-75-50 and 150-75-50 kg ha^{-1}) and three densities (88, 888; 1, 77, 776 and 2, 66, 664 plants ha^{-1}).

The crop was sown on a well prepared seedbed with the help of hand drill. The whole P, K and 1/3rd of N in the form of SSP, K_2SO_4 and Urea were applied at sowing time respectively; while remaining N was top dressed in two splits i.e. with first irrigation and the second at flowering. The crop was thinned at tasselling for forage purposes and at the end the plant population in all the treatments was kept as 88, 888 per hectare. All other agronomic practices were kept normal and uniform for all the treatments. Data on agro-economic aspects of the crop were recorded and were analysed statistically and differences among treatment means were tested using LSD-test at 5% level of significance.

RESULTS AND DISCUSSION

Interaction between the two factors (Fertilizer and Density) was significant for leaf area per plant, fodder yield, stalk yield and net income computed per hectare (Table I). Fertilizer levels and densities affected significantly the crop characteristics namely plant height, number of grains per cob and 1000-grain weight but significant differences in grain yield were found due to use of different fertilizer levels; whereas, it was statistically similar for all population treatments. Leaf area per plant was maximum (37.38 m^2) in F_3D_1 treatment and it differed significantly from all other combinations. It was followed by that of F_3D_2 treatment where N, P and K were used @ 150-75-50 kg ha^{-1} and

the density was 1, 77, 776. Non-significant difference was found among F_3D_3, F_2D_1, and F_2D_2 treatments but they produced significantly higher leaf area per plant than that of F_1D_3 treatment which was the lowest (18.15 m^2) of all the combinations. The deficiency of nitrogen appeared to cause reduction in leaf area per plant and the suppressive effects of nitrogen deficiency were more clear with increased plant population. These findings are in agreement with those reported by Ahmad (1980) as with increase in nitrogen and reduction in plant population, the leaf area per plant was increased in maize. For recording fodder yield the crop was thinned at tasselling stage in treatments D_2 and D_3 and no thinning was done in D_1 where the minimum plant population was kept as 88, 888 per hectare. Fodder yield in treatments F_3D_2 and F_3D_3 was statistically the same but it was significantly higher than other treatments. The lowest fodder yield of 5.83 t ha^{-1} was recorded in F_1D_3 combination. Increase in fertilizer levels and plant population caused a significant increase in the fodder yield. Increased plant density with low supply of fertilizer might have produced plants of low vigour which caused a decrease in the weight of fodder. Similar results were obtained by Horn (1990) and Lucas (1986).

Stalk yield in F_3D_1 combination was significantly the highest (9.38 t ha^{-1}) of all the treatments except that of F_3D_2, where the fertilizer was added @ 150-75-50 kg NPK/ha and the density was 1, 77, 776. Stalk yield was the minimum (5.28 t ha^{-1}) in F_1D_3 treatment where no fertilizer was added and the plant population was 2, 66, 664. Low plant population with high NPK level when compared with higher plant population and zero fertilizer treatment caused a significant increase in the stalk yield of the crop. These results support the findings of Khalifa *et al*. (1984) and Singh and Srivastava (1991). Plant height showed a significant increase with added NPK as compared to the check and the treatments differed significantly from one another. The plants produced in plots treated with 150-75-50 kg NPK ha^{-1} were 232.46 cm high as compared to 210.02 cm high produced in no fertilizer treatment. Increase in plant height with added fertilizer was also reported by Khalil *et al*. (1988) and Bakht *et al*. (1989). With increase in plant population, plant height decreased significantly from 224.85 to 214.82 cm at 88, 888 and 2, 66, 664 plants/ha,respectively.

Table I. Effect of NPK levels and plant densities on growth, yield and economic analysis of maize subjected to thinning at tasseling for fodder

	Plant Height (cm)				**Leaf area/ plant (m^2)**			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
F_1	215.16	212.48	202.43	210.02c	19.85ef	19.28ef	18.15f	
F_2	223.87	221.48	216.86	220.74b	23.92cd	22.31cde	21.24ef	
F_3	235.53	236.68	225.18	232.46a	37.38a	30.25b	26.07c	
Mean	224.85a	223.55a	214.82b					
	Fodder yield (t ha^{-1})				**Number of grains per cob**			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
F_1	No thinning	7.59d	5.83e		360.52	320.50	318.94	333.32c
F_2	No thinning	11.67b	8.89c		446.35	417.02	405.99	423.12b
F_3	No thinning	13.61a	13.51a		473.77	461.47	433.12	456.12a
Mean					426.88a	399.66b	386.02c	
	1000-grain weight (g)				**Grain yield (t ha^{-1})**			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
F_1	233.40	232.83	230.17	232.13c	1.78	1.75	1.74	1.76c
F_2	262.50	261.50	259.03	261.01b	2.90	2.88	2.81	2.86b
F_3	285.17	283.98	282.83	283.89a	3.73	3.72	3.70	3.72a
Mean	260.36a	259.44a	257.34b		2.80	2.78	2.75ns	
	Stalk yield (t ha^{-1})				**Net income (Rs./ha)**			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
F_1	7.60de	6.34f	5.28g		2050.83g	6753.53e	4494.71f	
F_2	8.89b	7.93d	7.26e		6983.00e	14875.50c	11954.67d	
F_3	9.38a	9.26ab	8.39c		11648.14d	21175.65a	19888.14b	
Mean	224.85a	223.55a	214.82b					

D = Density, F = Fertilizer

F_1=0-0-0; F_2=75-75-50 and F_3=150-75-50 kg ha^{-1}

However, a non-significant difference was found between D_1 and D_2 treatments. The reduced plant height

at closer spacing might be due to limited supply of nutrients, water and light to the crop. The results are in agreement with that reported by Pereira *et al*. (1980). Out of the yield contributing parameters, the number of grains formed per cob showed a significant decrease with zero fertilizer as compared to that of the added fertilizer. The number of grains per cob was 456.12 with the highest fertilizer dose of 150-75-50 kg NPK. Jamil (1996) also reported reduction in the number of grains formed per cob with reduced nitrogen supply.

Weight per 1000-grains was significantly affected both by the fertilizer as well as plant population treatments. All the fertilizer treatments differed significantly from one another and weight per 1000-grains was the maximum (283.99 g) when the crop was treated with 150+75+50 kg NPK ha^{-1}. The grains formed with no fertilizer application were not bold and the weight was the lowest (232.13 g). These findings are in conformity with that of Ahmad *et al*. (1994) who stated that weight per 1000-grains was increased by increased nitrogen application to maize. Increased plant population caused a significant decrease in weight of grains and it was the lowest (257.34 g) when the plant density was 2, 66, 664. Non-significant difference was found between D_1 and D_2 treatments and the average weight per 1000-grains was 259.90 g. Similar results were obtained by Singh and Srivastava (1991) and Akcin *et al*. (1994).

Grain yield recorded in tons per hectare was the highest when the crop was treated with the highest amount of NPK @ 150+75+50 kg/ha. It was followed by that produced in F_2 and F_1 treatments i.e. 2.86 t and 1.76 t ha^{-1} and the two treatments differed significantly from each other. The yields recorded for different plant densities did not differ significantly from one another. The increase in grain yield due to application of fertilizer was attributed to greater leaf area, more number of grains per cob and weight per 1000-grains. These results are in accordance with that obtained by Ahmad (1994). Net income was computed after working out the total expenditure (cost of production ha^{-1}) and the total income from each treatment in the experiment. Income recorded in F_3D_2 combination (1, 77, 776 plants treated with 150+75+50 kg NPK ha^{-1}) was the maximum (Rs.21175.65 ha^{-1}) and it differed significantly from rest of the treatments. It was followed by that obtained from F_3D_3 treatment where 2, 66, 664 plants were treated with 150+75+50 kg NPK ha^{-1}. The increase was the lowest (2050.83 t) when 88, 888 plants were grown per hectare without any fertilizer addition and thinning the plants at tasseling stage.

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