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Response of Hybrid Maize (*Zea mays*, L.) to Nitrogen, Phosphorus and Potassium Fertilization

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ABSTRACT

Field experiment was conducted on a red calcareous clay-loam soil, testing low, medium and high for available N, P and K respectively. Four levels each of N, P and K @ 0, 60, 120, and 180 Kg N/ha, 0, 15, 30 and 45 kg P/ha and 0, 30, 60 and 90 Kg K/ha were tried. Hybrid maize (Variety-Deccan) was grown as test crop. The crop responded significantly to N fertilization alone. The quadratic equation showed 193 Kg N/ha as physical optimum and 182 Kg N/ha as economic optimum. P and K did not increase the maize grain yield. Nitrogen fertilization progressively increased the straw yield. Straw yield decreased with increase in P level and the influence of added K on the straw yield was not significant. The results of the investigation revealed further that it is not economical to apply phosphatic and potassic fertilizers to the maize crop when the inherent availability of these nutrients in the soil is either under medium or high status according to Soil Test Classification.

INTRODUCTION

Crop varieties differ among themselves in nutrient requirements for producing maximum yields. Hybrid varieties of a particular crop need higher quantities of nutrient elements than the ordinary varieties. Balanced nutrition of the crop is one of the main factors that decide the yield potential since the ratios in which the major plant nutrients of N, P and K are needed for crop production vary for different crops. Over-fertilization as well as under-fertilization of the crops with plant nutrients will not result in profitable yields since the former will be uneconomical besides the deleterious side-effects and the latter will not meet the normal requirements of the crops. An economic fertilizer schedule is very essential for important crops like hybrid maize which are grown extensively so that the use of fertilizers can be rationalised for maximum crop production. Usually, the fertilizer recommendations made, are based on the concept that the value of the marginal yield increase should be higher than the value of the last increment of fertilizer input. The objective of the study reported below was to assess the optimum as well as economic fertilizer schedule for hybrid maize crop.

MATERIALS AND METHODS

Field experiment was conducted in a red calcareous clay-loam soil of a farmer's holding in Coimbatore District.

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Basic characteristics of the experimental field were as follows: EC = 0.2 m mhos/cm; pH = 8.0; available N (Subbiah and Asija, 1956) 240 Kg N/ha; available P (Olsen *et al.*, 1954) = 13.7 Kg P/ha; available K (Stanford and English, 1949) = 761 Kg K/ha. Four levels of N @ 0, 60, 120 and 180 Kg N/ha, four levels of P @ 0, 15, 30 and 45 Kg P/ha and four levels K @ 0, 30, 60 and 90 Kg K/ha were tried with two replications of each treatment combination. Strip plot design was followed to conduct the trial. The experimental plots were of 7 × 3 m size. N (in two split doses, one at the time of sowing as basal dressing and the other on the 35th day after sowing), P (as basal dressing at the time of sowing) and K (as basal dressing at the time of sowing) were applied in the form of urea, superphosphate and muriate of potash respectively. Deccan variety of hybrid maize crop was grown as test crop following a spacing of 60 cm between rows and 25 cm between plants within the row. The crop was grown to maturity with usual irrigation and plant protection measures. At maturity the crop was harvested and the yields of grain and straw were recorded. The yield data were statistically scrutinized.

RESULTS AND DISCUSSION

The results on grain yield revealed that the crop responded significantly to N fertilization alone. Grain yield increased progressively with increase in N application upto 180 Kg N/ha the maximum level tried (Table 1). Orthogonal polynomial was used to fit up the response equation. It was found that cubic and biquadratic terms were insignificant. Hence the second degree equation was fit in ($Y = 26.91 + 249\ X - 0.000646\ X^2$). From the response equation, the physical

TABLE 1. Yield of maize grain (quintal/ha) as influenced by NPK fertilization

	K_0	K_{30}	K_{60}	K_{90}	Mean
N_0P_0	33.3	38.1	23.9	26.2	30.3
N_0P_{15}	28.6	29.8	20.3	21.5	25.0
N_0P_{30}	29.8	23.8	19.1	23.9	24.1
N_0P_{45}	29.8	32.2	22.7	32.2	29.2
Mean	30.3	30.9	21.5	25.9	27.2
$N_{60}P_0$	44.1	38.1	44.1	36.9	40.8
$N_{60}P_{15}$	41.7	34.5	31.0	34.6	35.4
$N_{60}P_{30}$	39.3	34.6	38.1	27.4	34.8
$N_{60}P_{45}$	46.5	44.1	38.1	46.4	43.7
Mean	42.9	37.8	37.8	36.3	38.7

TABLE 1 *(Contd.)*

		K_0	K_{30}	K_{60}	K_{90}	Mean
$N_{120}P_0$		51.2	42.9	46.4	50.0	47.6
$N_{120}P_{15}$		60.7	48.8	40.5	40.5	47.6
$N_{120}P_{30}$		50.0	51.2	48.9	46.5	49.1
$N_{120}P_{45}$		51.2	59.6	41.7	45.3	49.4
	Mean	53.2	50.6	44.3	45.5	48.4
$N_{180}P_0$		57.2	58.3	54.8	39.3	52.4
$N_{180}P_{15}$		61.9	50.0	44.1	46.5	50.6
$N_{180}P_{30}$		57.2	51.2	51.2	44.1	50.9
$N_{180}P_{45}$		58.4	51.2	42.9	41.7	48.5
	Mean	58.6	52.6	48.2	42.9	50.6
P_0		46.4	44.4	42.3	38.1	42.8
P_{15}		48.2	40.8	33.9	35.7	39.6
P_{30}		44.1	40.2	39.3	35.4	39.7
P_{45}		46.4	46.7	36.3	41.4	42.7
	Mean	46.2	43.0	37.9	37.6	41.2

	S. E.	C. D.
Nitrogen	1.64	4.94
Phosphorus		NS
Nitrogen × Phosphorus		NS
Potassium		NS
Nitrogen × Potassium		NS
Phosphorus × Potassium		NS
Nitrogen × Phosphorus × Potassium		NS

optimum was obtained by equating the first derivative to zero and the level of physical optimum was found to be 193 Kg N/ha. Again the economic optimum was worked out by equating the first derivative to price ratio of input of fertilizer and output of grain yield. The economic optimum was found to be 182 Kg N/ha. The equation of the parabola reveals that the curve is very flat due to the large value in latus rectum which reveals that both the increase and decrease will be slow and steady. Tewary *et al.* (1970)

reported that N application upto 180 Kg/ha could give an economical return under Ranchi Plateau conditions. Sinha and Umar (1972) reported that maize grain yield increased with N application upto 165 Kg N/ha but decreased at 220 Kg N/ha for Ganga-Safed, Ganga-101 varieties.

The results of grain yield in the present study further revealed that P and K applications to the crop through fertilizer did not increase the grain yield. Kaushik and Gupta (1970), Tewary *et al.* (1970) and Sumbali and Parakash (1971) reported that P and K did not show any significant effect on grain yields of maize crop.

In case of straw, the yield increased progressively with increase in N levels (Table 2). Application of P reduced the straw yield. Significantly higher straw yield was recorded under no P treatment and the yield gradually decreased with increasing doses of P

TABLE 2. Yield of maize straw (quintal / ha) as influenced by NPK fertilization

	K_0	K_{30}	K_{60}	K_{90}	Mean
N_0P_0	135.8	145.2	138.1	161.9	145.2
N_0P_{15}	119.1	133.4	131.0	138.1	130.4
N_0P_{30}	123.8	123.8	123.7	147.7	129.7
N_0P_{45}	100.0	130.8	123.8	131.0	121.4
Mean	119.6	133.3	129.1	144.6	131.7
$N_{60}P_0$	164.3	169.1	204.4	190.5	181.5
$N_{60}P_{15}$	161.9	181.0	169.1	173.9	171.4
$N_{60}P_{30}$	150.0	161.9	147.6	166.7	156.5
$N_{60}P_{45}$	154.8	178.6	150.6	188.1	167.8
Mean	157.7	172.6	167.2	179.8	169.8
$N_{120}P_0$	171.4	183.4	164.3	209.6	182.2
$N_{120}P_{15}$	192.9	183.4	169.1	202.4	186.9
$N_{120}P_{30}$	169.1	178.6	176.2	178.6	175.6
$N_{120}P_{45}$	178.6	181.0	171.5	176.2	176.8
Mean	178.1	181.6	170.2	191.7	180.4
$N_{180}P_0$	178.6	211.9	211.9	191.0	198.3
$N_{180}P_{15}$	202.4	185.7	185.8	200.0	193.5
$N_{180}P_{30}$	178.6	204.8	181.0	176.2	185.1
$N_{180}P_{45}$	161.9	200.0	166.7	211.9	185.1
Mean	180.4	200.6	186.4	194.8	190.5

TABLE 2 (Contd.)

	K_0	K_{30}	K_{60}	K_{90}	Mean
P_0	162.5	177.4	179.2	188.1	176.8
P_{15}	169.0	170.8	163.7	178.6	170.5
P_{30}	145.4	167.3	157.1	167.3	161.8
P_{45}	148.8	160.1	153.0	176.8	159.7
Mean	158.9	168.9	163.3	177.7	167.2

	S. E.	C. D.
Nitrogen	3.05	9.18
Phosphorus	3.05	9.18
Nitrogen × Phosphorus		NS
Potassium		NS
Nitrogen × Potassium		NS
Phosphorus × Potassium		NS
Nitrogen × Phosphorus × Potassium		NS

though the variations in straw yield was not statistically significant among the P levels tried. Potassium did not influence the straw yield positively or negatively. In the present study, the experimental field analysed for low available N, medium available P and high available K levels according to soil test classifications. Generally, Indian soils are very poor in nitrogen status besides their low organic matter content. They are under tropical conditions and hence they need a good deal of N manuring for high production of crops. In many regions, low limits of productivity have reached owing to very little manuring of the soil. The N content of Indian soils is about 0.03 to 0.07 per cent as compared to 0.1 to 0.17 per cent in soils of Europe and United States of America. Further, the residual effect of nitrogen is very low, as compared to P and K. That too, under tropical climate it is very difficult to build up the N status of the soil. So, each crop needs greater amounts of N for successful growth and production.

Of late, it is widely felt that fertilization of crops with P red K is uneconomical and unnecessary when the inherent available status of these nutrients in soil is under medium or high range of soil test classification. The soil available resource, when present under these ranges, will be sufficient to meet the requirements of the crop. In the present studies also the hybrid maize crop did not respond to fertilization of P and K since the soil available status of these nutrients was under medium and high ranges respectively.

The results discussed above clearly reveal that the hybrid maize crop will economically respond to 182 kg. N/ha when the soil available status of this nutrient is low and the application of P and K will not be profitable when the soil available status of these nutrients is under medium or high range. Under such conditions P and K may safely be deleted from the fertilizer schedule and may profitably be used to bring more unfertile area under cropping. Such an economy in fertilizer use will certainly place the farming on an advantageous footing in causing reduction in fertilizer bills to a considerable extent. Hence, to make an efficient schedule for any crop, the soil of the field under question should be analysed for available status of N, P and K and based on these values alone, the recommendations should be made. Otherwise, under-fertilizing or over-fertilizing the crop, will not result in profitable yields.

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