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Productivity and Economics of Hybrid Maize (*Zea mays* L.) under different Fertilizer Doses in the Inner Terai Region of Nepal

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ABSTRACT

Maize (*Zea mays* L.) varieties differ in their response to nutrient supply. Optimum fertilizer dose is necessary to explore the yield potential of a variety. A field experiment was conducted at Rampur, Chitwan, during winter season of 2012/13 and 2013/14 to study the productivity of hybrid maize RML-32 X RML-17 to different level of nitrogen, phosphorus and potash. Treatment factors included two levels of potash (40 and 60 kg K_2O ha^{-1}) and phosphorus (60 and 90 kg P_2O_5 ha^{-1}) and four levels of nitrogen (120, 160, 200 and 240 kg N ha^{-1}). Number of ears m^{-2}, kernel rows ear^{-1}, kernels row^{-1}, grain and stover yield ha^{-1} were increased with increased nitrogen levels. Increased phosphorus doses significantly decreased days to 50% tasselling and silking. Soil analysis results indicated that increased N and P doses had increased available N, P and soil organic matter, but decreased soil pH. The highest mean grain yield of 9.35 t ha^{-1} was obtained when 200 kg N ha^{-1} applied with 60:40 P_2O_5:K_2O kg ha^{-1}. Application of 200:60:40 kg N: P_2O_5.K_2O ha^{-1} gave the highest net returns of Rs 1,34,696 ha^{-1} with the highest benefit cost ratio of 1.9. Farmers of Chitwan are suggested to apply 200:60:40 N:P_2O_5:K_2O kg ha^{-1} for grain production of hybrid maize RML-32 × RML-17.

Keywords: Fertilizers, grain yield, hybrid maize RML-32 × RML-17, net return, phosphorus

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INTRODUCTION

Soil fertility in terai and mid hill is declining day by day due to faulty soil management practices, use of high yielding varieties of maize specially hybrids leading to excessive mining of soil because of exhaustive nature of maize crops (Panday, 2000). A large number of factors are contributing to declining the productivity (Meena *et al.*, 2013). However, a balance application of major plant nutrients for specific variety for specific region is important. Nepalese farmers either due to resources constraint or lack of knowledge have been not practicing of replenishing the harvested nutrients. Therefore, soil has become more and more deficient in plant nutrients (Karki *et al.*, 2004). A number of experiments were carried out in the past in soil fertility management in maize. Bhattarai *et al.*, (2004) reported that mean grain increase response of 12-20 kg grain kg^{-1} N when applied at 45-90 kg N ha^{-1}. The amount of fertilizers to be applied in maize depends largely on genotypic makeup of plants, nutrient supplying capacity of the soil, soil moisture and environmental condition. There is very limited study carried out on this aspect and the national fertilizer recommendation is lacking, only blank recommendation of 120:60:40 kg NPK/ha recommended by NMRP for all season planting. Therefore, for a promising hybrid variety, fertilizer dose is very important to see the production potentiality and economical fertilizer dose. Therefore, a location specific and variety specific fertilizer response was lacking. The present investigation was undertaken to study the response and economics of major nutrient NPK levels on hybrid maize at Chitwan condition.

MATERIALS AND METHODS

The experiment was conducted at the farm land of National Maize Research Program (NMRP), Rampur, Chitwan. NMRP is located in between 27º40' N latitude and 84º19' E longitude and an altitude of 228 m above mean sea level in the inner terai (Siwalik Dun Valley). The experiment was carried out during 2013 and 2014. The experiment was laid out Split-Split plot RCB design. The treatment consist of two level of Potash (40 and 60 kg K_2O/ha), two level of Phosphorus (60 and 90 kg P_2O_5/ha) and four level of Nitrogen (120, 160, 200 and 240 kg N/ha). Hybrid maize RML 32 X RML 17 was planted in six rows of 5 meter long. The row to row distance was 60 cm and plant to plant distance was 25 cm. Outer two rows are used as border line and remaining four rows were harvested for grain yield and other yield attributing parameters. N fertilizer was applied 25% at planting, and remaining 75% in three split at knee height, tasseling, and dough stage. P and K fertilizer applied at planting time. The sources of chemical fertilizer were Urea, Diammonium Phosphate (DAP) and Muriate of potash (MOP). Soil sampling was done before sowing and analyzed for total N, available P, available K, Soil Organic matter and pH. The soil type was *Ustic Psamments* (USDA classification) and was alluvial sandy loam in texture. The initial total N content was low (0.052%), available P was high (65 kg/ha), available K was medium (232 kg/ha), soil organic matter was low (1.87%) and very strongly acidic in pH (5.2). FYM, K and half doses of N were applied during final land

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preparation and remaining doses of N was applied in two split at knee height and before tasseling as per treatment designed. Weeding was done one month after planting. Irrigation was given as need. The growth, yield and yield attributes were measured and analysis of variance (ANOVA) was carried out by using Genstat 13.2.The significance differences among the means were tested using least significance difference (LSD) at 5%.

RESULTS AND DISCUSSION

Effect on growth and yield attributes

N P and K doses and their interaction effect did not significantly influenced on plant height. Days to 50% tasseling and silking days were affected by P and K doses (Table 1). During 2013 increasing P doses had significantly decreased days to tasseling as well as days to silking. K doses had significantly influenced on days to silking only during 2013. There was significant interaction effect of P and K on ear length during 2012 but during 2013 effect was non-significant. Therefore, it was hard to reach in conclusion on the effect of P and K on ear length. The number of ears per plot was significantly influenced by N doses and P K interaction effect during 2012, while during effect was on significant. During 2012, among the four doses of N applied, the highest no. of ears per plot (76) was observed with the application of 200 kg N/ha. Similarly, in the same year the highest no. of ears per plot was observed when 60 kg P_2O_5/ha and 40 kg K_2O/ha application (Table 1). The no. of kernels per row was significantly affected by N doses during 2013. P and K doses did not affect on no. of kernels per row. Increased N doses had increased no. of kernels per row. The highest no. of kernel per row (28.1) was found when 240 kg N/ha applied while lowest no. of kernels per row was found at 120 kg N/ha applied. The no. of kernel rows per ear was significantly affected by N doses during 2013 but not affected in during 2012. P and K doses did not influence on no. of kernel rows per ear during both consecutive year (Table 2). The highest no. of kernel rows per ear was found at 160 kg N/ha which was at par with 200 kg N/ha and 240 kg N/ha applied. The 1000 grains wt. was significantly affected by the interaction effect of NP during 2012 and N, P and K during 2013. The highest 1000 grain wt. was found when 200:90:60 kg $NP_2O_5K_2O$/ha applied.

Grain yield, stover yield and economic returns

Only N doses had significantly influenced on grain and stover yield but increased P and K doses did not influence (Table 2). The highest stover yield was obtained with the application of 200 kg N/ha during 2012 and at 240 kg N/ha during 2013. The results were at par with 160, 200 and 240 kg N/ha applied treatments. The highest mean grain yield of 9.35 t ha^{-1} was obtained when 200 kg N ha^{-1} applied with 60:40 P_2O_5:K_2O kg ha^{-1}(Table 3). Application of 200:60:40 kg N: P_2O_5:K_2O ha^{-1} gave the highest net returns of Rs 1,34,696 ha^{-1} with the highest benefit cost ratio of 1.9. Farmers of Chitwan are suggested to apply 200:60:40 N:P_2O_5:K_2O kg ha^{-1} for grain production of hybrid maize RML-32 × RML-17.

Effect on residual soil nutrient status

There was significant interaction effect on soil available N status with N, P and K application. The soil available N was increased with increased N doses (Table 4). Similarly, increased P and K doses had increased soil available P and K. Soil organic matter was slightly increased with increased N doses (Singh *et al.*, 2013). Soil pH was slightly decreased with increased N doses but no effect of P and K application found.

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Table 1: Effect of N,P and K on maize growth and yield attributes during 2012 and 2013 at Rampur, Chitwan, Nepal

Treatments		Plant ht. (cm)		Ears/plot		DT		DS		Ear length (cm)		No. of kernel/row	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
K level	40	141.8	157.0	73.4	68.3	71.7	69.4	77.0	74.8	14.1	13.4	27.3	27.1
	60	139.0	154.9	71.9	65.9	72.5	70.5	78.2	75.9	14.2	13.5	28.0	26.8
F test/(LSD)		NS	NS	NS	NS	NS	NS	*(1.07)	NS	NS	NS	NS	NS
P level	60	139.9	154.1	73.6	66.5	72.1	72.0	77.6	77.3	14.2	13.5	27.4	26.4
	90	141.0	157.8	71.6	67.7	72.0	68.0	77.6	73.3	14.1	13.4	27.9	27.5
F test/(LSD)		NS	NS	NS	NS	NS	*(3.8)	NS	*(3.9)	NS	NS	NS	NS
N level	120	137.8	155.2	67.2	63.2	72.6	69.1	78.6	74.7	14.0	13.3	27.2	25.8
	160	141.2	156.2	72.1	67.2	71.7	69.7	77.0	75.0	14.4	13.5	28.3	26.6
	200	140.9	155.9	76.0	67.4	71.7	70.5	77.1	76.0	14.4	13.4	28.0	27.3
	240	141.8	156.5	75.2	70.5	72.3	70.5	77.7	75.8	13.9	13.5	27.0	28.1
F-test/(LSD)		NS	NS	*(4.01)	NS	NS	NS	NS	NS	NS	NS	NS	*(1.6)
Interaction													
K × P		NS	NS	*(4.01)	NS	NS	NS	NS	NS	*(0.5)	NS	NS	NS
K × N		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
P × N		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
K × P × N		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%		8.9	4.6	6.6	8.4	2.5	3.7	2.3	3.0	4.7	4.7	7.8	7.0

Table 2: Effect of N,P and K on maize grain yield attributess and grain yield during 2012 and 2013 at Rampur, Chitwan Nepal

Treatments		**Kernels rows/ear**		**1000 grains wt.(g)**		**Stover yield**		**Grain yield**	
		2012	2013	2012	2013	2012	2013	2012	2013
K level	40	12.3	11.5	418.5	412.7	9.02	6.57	9.31	7.99
	60	12.2	11.5	406.5	427.3	9.39	7.54	9.31	8.45
Ftest/(LSD)		NS	NS	NS	NS	NS	NS	NS	NS
P level	60	12.3	11.5	407.2	415.9	9.14	6.75	9.31	7.99
	90	12.2	11.6	418.2	427.0	9.27	7.36	9.30	8.45
Ftest/(LSD)		NS	NS	NS	NS	NS	NS	NS	NS
N level	120	12.3	11.0	403.5	414.4	8.17	5.87	8.17	7.00
	160	12.4	11.8	411.9	415.8	9.28	7.14	9.38	8.36
	200	12.4	11.7	422.1	427.2	9.99	7.42	10.27	8.43
	240	12.0	11.5	413.3	422.5	9.40	7.80	9.40	9.09
F-test/(LSD)		NS	*(0.41)	NS	NS	*(0.83)	*(0.51)	*(0.71)	*(0.58)
K × P		NS	NS	NS	NS	*(041)	NS	NS	NS
K × N		NS	NS	NS	NS	NS	NS	NS	NS
P × N		NS	NS	*(35.9)	NS	NS	NS	NS	NS
K × P × N		NS	NS	NS	*(32.8)	NS	NS	NS	NS
CV%		4.6	4.6	7.4	3.5	10.9	8.6	9.2	8.4

Table 3: Effect of N,P and K on maize mean grain yield, net returns and benefit cost ratio during 2012 and 2013 at Rampur, Chitwan Nepal.

Treatment		Mean grain yield (ton/ha)	Cost of cultivation (Rs/ha)	Returns (Rs/ha)	Net returns (Rs/ha)	Benefit: cost ratio
K (K_2O kg/ha)						
	40	8.65	69632	190300	120668	1.73
	60	8.88	70697	195360	124663	1.76
P (P_2O_5 kg/ha)						
	60	8.65	68888	190300	121412	1.76
	90	8.88	71442	195360	123918	1.73
N (N kg/ha)						
	120	7.59	67646	166980	99334	1.47
	160	8.87	69325	195140	125815	1.81
	200	9.35	71004	205700	134696	1.90
	240	9.25	72683	203500	130817	1.80

Table 4: Effect of N,P and K on soil nutrient status and soil reaction during 2012 and 2013 at Rampur, Chitwan Nepal

	40 kg K_2O/ha		60 kg K_2O/ha		
N doses	60 kg P_2O_5/ha	90 kg P_2O_5/ha	60 kg P_2O_5/ha	90 kg P_2O_5/ha	
120	0.098	0.168	0.229	0.167	
160	0.092	0.107	0.242	0.164	
200	0.179	0.260	0.174	0.099	
240	0.189	0.159	0.173	0.125	N%

120	5.86	5.76	5.93	5.96	
160	6.11	5.80	5.80	5.70	
200	5.63	5.56	5.86	5.90	
240	5.43	5.50	5.53	5.73	pH
120	1.96	1.99	2.20	2.08	
160	2.15	2.01	2.38	2.19	
200	2.47	2.23	2.35	2.39	
240	2.57	2.02	2.41	2.50	OM%
120	51.26	64.00	69.30	80.50	
160	52.25	56.37	62.63	70.67	
200	56.71	115.59	65.59	76.36	
240	61.26	84.40	68.53	79.10	P_2O_5
120	164.4	203.7	205.9	218.4	
160	162.2	164.4	170.3	184.0	
200	181.8	262.7	186.2	279.9	
240	254.0	227.7	179.6	286.2	K_2O

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