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Full Length Research Paper

Genotypes and fertilization influence on grain yield of winter maize

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In order to investigate the effects of different rates of fertilizers (NPK and farmyard manures) on grain yield and yield attributing traits of different maize cultivars, field experiments were conducted in randomized complete block design with three replications at Rampur, Chitwan, Nepal during winter seasons of 2009/10 and 2010/011. Five levels of fertilization; Control (zero fertilizer), Farm yard manure (FYM) 10 t/ha, 60:30:20 N, P_2O_5 and K_2O plus FYM 10 t/ha, 120: 60: 40 N, P_2O_5 and K_2O plus FYM 10 t/ha, 180: 90: 60 N, P_2O_5 and K_2O kg/ha plus FYM 10 t/ha and 120: 60: 40 N, P_2O_5 and K_2O kg/ha) applied to four maize varieties (Rampur Composite, Manakamana-4, Across9942 x Across 9944 and S99TLYQ-B) in the experiment. Grain yield was non significant for varieties but the fertilization rates were highly significant for grain yield. Rampur Composite produced the highest grain yield (5195 kg/ha), followed by Manakamana-4 (5074 kg/ha) and Across9942 x Across9944 (5052 kg/ha) with application of NPK 180: 90: 60 kg/ha plus FYM 10 t/ha. Similarly, S99TLYQ-B produced the highest grain yield (4789 kg/ha) under the same level of fertilization. This information obtained through this study might be useful in generating suitable fertilization packages for higher grain yield of maize cultivars.

Key words: Fertilizer, manures, maize genotypes, grain yield, yield attributing traits.

INTRODUCTION

Maize (*Zea mays* L.) has the highest productivity per unit area as compared to other cereal crops. It ranked third among the cereal crops in the world after wheat and rice. In Nepal, it is the second most important staple food crop in terms of both area and production after rice but it is the the first staple crop for hills. In Nepal, it is the food for more than 14 million people in the hills and is playing a vital role in the livelihood of rural people in Nepal. It is used for food and feeds, fodder, and fuel. More than 87% maize production is used for direct human consumption; 12% for poultry and animal feeds and 1% is for different purposes. Maize is highly nutritive and its seed contains; starch (78%), protein (10%), oil (4.8%), fibre (8.5%), sugar (3.1%) and ash (1.7%) (Chaudhary,1983).

The productivity of maize in Nepal is very low (2.2 t/ha) as compared to the world average of 4.3 t/ha (NMRP, 2011). And it can be improved or increased through adequate nutrient management practices. Inappropriate crop nutrition management and poor soil fertility are the most important factors responsible for the low yield in Nepal. Soil fertility can be enhanced through the application of mineral fertilizers as well as with the addition of organic matter to the soil. The judicious management of fertilization must attempt to ensure both an enhanced and safeguarded environment. Manures and fertilizers both play important role in the maize cultivation. Hybrids and composite varieties exhibit their full yield potential only when supplied with adequate quantities of nutrients at proper time. Requirement of nutrients by hybrids is higher because of its greater potentiality for grain production. Growing local material at a high nutrient level need not result in higher grain yield. But on the contrary, a high level of nutrients for hybrids and composites proves beneficial. N is usually applied in

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3 equal splits at sowing, knee high stage and tasseling stage. Nitrogen level in the range of 100-120 kg/hais applied with a view to obtain 40-50 quintals/ha of grain yields and likewise, it can be reduced or increased as per its expected yield. Phosphorus (P) is the next most important plant nutrient after N which is found difficult in most soils. It has beneficial effect on root growth and plant health. This nutrient should be applied initially at the early stage because of its low solubility in water. It should be applied in moist zone to be transformed quickly for early absorption by plant. The dose of P should be balanced with the dose of N applied. Potassium is considered to be the 3rd most essential fertilizer element, it is not found deficient in most of the soils. It is essential for vigorous growth of the plant and for so many other metabolic activities. Placement of 30-40 kg K_2O/ha is generally found adequate; however, this can be increased with increased rate of N to balance the nutrient status of soil for better uptake of total essential nutrients (Dayanand, 2002).

K application through fertilizers has been responding satisfactorily (Regmi et al., 2002). Maize being a high nutrient mining crop it needs higher amount of NPK for its economic production. Farmers applying 20-25 t/ha of compost/FYM (manures) are not sufficient to replenish the harvested nutrients and hence need sufficient amount of mineral fertilizers addition with heavy manure application (Joshy, 1997). Adhikary et al. (2001), reported that the highest maize grain yield (4.65 t/ha) could be obtained when the crop is fertilized by 20 t of compost plus 100: 75: 40 kg/ha of N, P_2O_5 and K_2O in the acidic soils of Malepatan, Pokhara. Adhikary and Ranabhat (2004), studied the economics of manures and fertilizer application on maize production and concluded that most economic dose of fertilizer was 100: 75: 40 kg N, P_2O_5 and K_2O/ha from inorganic sources and 20 t/ha of compost that contained 280 kg N, 184 kg P_2O_5 and 216 kg K_2O. Adhikary et al. (2007), studied the effect of fertilizer and agricultural lime on grain yield of different maize genotypes in the Western hills of Nepal and reported that improved maize variety (Manakamana-1) did not differ in grain production with the local variety when supplied with fertilizers at 60: 30: 30 kg N, P_2O_5 and K_2O and 4 t/ha of agri-lime. Adhikary (2008) also studied the effects of nitrogen on maize inbred (NML-1) and reported that increased seed yield (2.85 t/ha) was obtained with this variety when supplied with 180 kg N and crop planted at the density of 66,666 plants/ha and crop fertilized along with the recommended dose of P and K fertilizers. Series of experiments were conducted to evaluate the effects of fertilizers on different maize genotypes during the years 2009 and 2010. The results revealed that the highest grain yield of 6.28 t/ha was produced by the S99TLYQ-B when the crop was fertilized with 120: 60: 40 kg N, P_2O_5 and K_2O/ha and 10 t/ha of compost (Anonymous, 2010). Hence, balanced dose of fertilizers are needed to increase the crop yield of maize in acid soils. The amount of fertilizers to be applied in maize depends largely on genotypic makeup of plants.

The objective of this experiment was to study the response of fertilizer nutrients at different levels on the different maize genotypes in the soil condition of Rampur, Chitwan, Nepal.

MATERIALS AND METHODS

Study Site and Experiment Details

This experiment was conducted at Rampur, (NMRP farmland), Chitwan, Nepal during the winter season of the year 2009/10 and 2010/11.The site was located in central Nepal at 27° 40’ N latitude and 84° 19’ E longitude with an elevation of 228 m above mean sea level and had a sub tropical climate (NMRP, 2010/11).

Maize was planted on sandy silt loam, acidic soil (pH 5.54). Fertilizer was applied in the form of Urea, di-amonium phosphate (DAP), and murate of potash (MoP). Entire dose of DAP and MoP was applied at the time of sowing while half of urea was first top dressed at knee high stage and second top dressed at tasseling stage.

The average data derived from both years on maximum temperature ranged from 21.95 (January) to 36.35 ^{0}C (April), the minimum temperature varied from 9.4 (January) to 24.65 ^{0}C (October). There is no rainfall in Novemebr and January, minimum rainfall (1.1 mm) occurred in January and maximum rainfall occurred in 99.35 mm (April). Similarly, average data on relative humidity showed that minimum humidity (76.8%) occurred in April and maximum relative humidity (99%) was occurred in December. The details of weather data of individual year was shown in Table 2.

The crop was planted in October and harvested in April. Twenty four treatment combinations consisting of six levels of fertilization and four maize genotypes were replicated three times and laid out in a randomized complete block design. The details of the treatment combinations are given in the following Table 1. Row to row spacing 75 x 25 cm was maitained. The net harvested area was 7.2 m^2. The gross plot size was 12 m^2.

At maturity central two rows from each plot were separately harvested and the fresh ear weight was measured in each plot. Grains were shelled from five randomly selected cobs to observe the percent grain moisture at harvest for each plot. Thousand grain weight and grain yield were recorded at 15% moisture level.

Data Collection and Analysis

Observations were taken on plant height, ear height, cob

Table 1. The details of the treatments used in experiment in 2009/10 and 2010/11 winter seasons at Rampur, Chitwan, Nepal.

Genotypes	Fertilizer rates
V1= Rampur Composite	F1=Control (Zero fertilizer)
V2= Manakamana-4	F2= FYM @ 10 t/ha
V3=Across9942 x Across9944	F3= FYM@ 10 t/ha plus 60:30 20 kg NPK/ha
V4= S99TLYQ-B	F4=FYM@ 10 t/ha plus 120: 60: 40 kg NPK/ha
	F5=FYM@ 10 t/ha plus 180: 90: 60 kg NPK/ha
	F6= 120: 60: 40 kg NPK/ha

Table 2. Monthly mean weather condition during crop growing season (October-April) in 2009/10 and 2010/11 winter seasons at Rampur, Chitwan, Nepal.

Month	Maximum temperature (^{0}C)		Minimum temperature (^{0}C)		Rainfall (mm)		Relative humidity (%)	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
October	31.4	31.4	26.5	22.8	101	48.6	97.0	97.5
November	27.1	27.1	21.6	17.0	0.0	0.0	99.0	98.8
December	24.0	24.0	16.0	9.1	2.2	0.0	99.0	99.0
January	20.0	23.9	10.3	8.5	0.0	0.0	94.6	100.5
February	25.4	26.1	11.9	15.1	0.0	34.9	89.5	96.3
March	33.1	31.1	19.1	18.9	0.0	34.4	82.2	83.2
April	38.1	34.6	23.3	19.6	165	33.7	75.4	78.2

(Source: NMRP, 2010-2011).

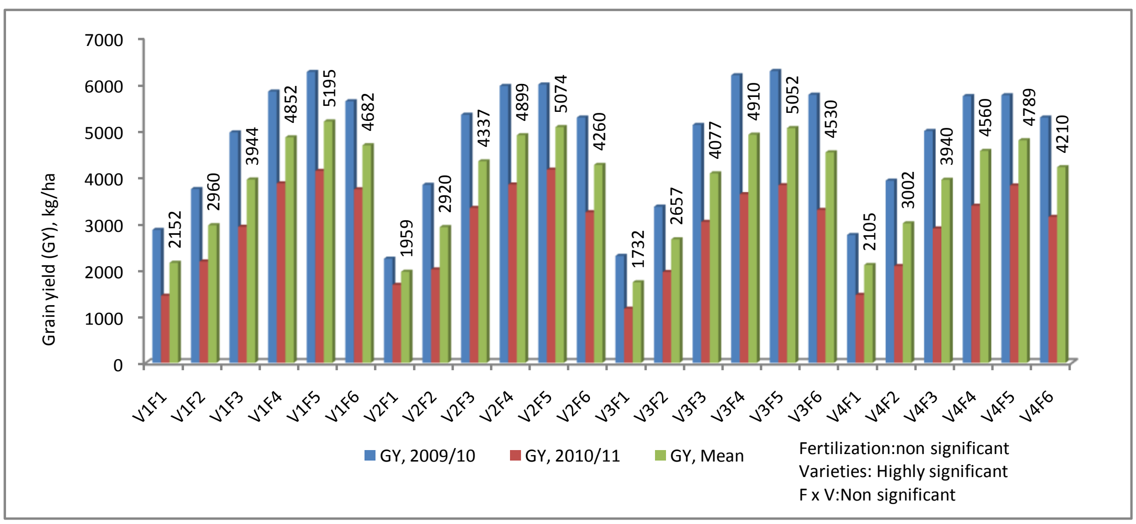

Figure 1. Effect of different level of manures and fertilizers and different maize genotypes on maize grain production in 2009/10 and 2010/11 winter seasons at Rampur, Chitwan, Nepal.

length, no. of Kernel rows per cob, no. of kernels per rows, and grain yield. Plant height and ear height was recorded at just near to harvesting and rest of data were recored after hervesting. All these parameters were statistically analysed. Analysis of variance for all data was analyzed using MSTAT computer program.

RESULTS AND DISCUSSION

The interaction between different fertilizer levels and varieties on grain yield showed that the highest grain yield (5195 kg/ha) was obtained in Rampur Composite followed by Manakamana-4 (5074 kg/ha) and Across9942

Table 3. Effect of different level of manures and fertilizers on different maize genotypes in 2009/10 and 2010/11 winter seasons at Rampur, Chitwan, Nepal.

Treatments	cob length (cm)		kernel rows per cob (No.)		Kernel per kernel row (No.)		Grain yield (kg/ha)	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
V1F1	11.4	9.66	10.7	10.4	22.6	14.86	2860	1443
V1F2	12.2	11.6	12	11.93	24.2	17.53	3740	2180
V1F3	13.8	14.13	12.8	13.6	31.1	28.33	4960	2927
V1F4	14.1	14.46	13	13.86	30.5	30.4	5840	3863
V1F5	14.2	15.13	13.1	14	31.9	30.8	6260	4130
V1F6	13.8	13.86	12.6	13.73	29.1	29.46	5630	3733
V2F1	10.4	9.06	11.5	10	21.1	15.53	2240	1677
V2F2	11.7	11.6	13.3	11.7	25.3	21.86	3830	2010
V2F3	13.8	14.6	15.2	13.4	28.5	30.2	5340	3333
V2F4	14.3	14.73	15.3	13.86	30.2	31	5960	3837
V2F5	14.9	14.86	15.5	14.26	31.7	31.73	5990	4157
V2F6	14.2	13	15.1	12.93	30.7	27.2	5280	3240
V3F1	9.7	8.33	11.7	9.2	19.7	13.8	2300	1163
V3F2	11.6	10.8	13.7	11.53	25.5	21.13	3360	1953
V3F3	12.6	13.2	15.7	12.03	29.3	30.4	5120	3033
V3F4	13.3	13.66	15.7	13.33	28.8	29	6190	3630
V3F5	13.4	13.93	16.3	13.43	30.9	29.53	6280	3823
V3F6	13.2	13.2	15.1	13.16	29.1	28.23	5770	3290
V4F1	9.9	7.2	11.6	9.33	20.7	12.66	2750	1460
V4F2	11.7	10.2	13.5	10.13	25	20.06	3920	2083
V4F3	14.3	13.53	14.9	12.26	28.3	25.4	4990	2890
V4F4	14.9	13.73	15.2	12.13	32.5	29.73	5740	3380
V4F5	13.9	13.13	14.9	12.53	30.5	26.06	5760	3817
V4F6	14.1	13.4	14.9	12.03	29.1	28.6	5280	3140
Grand mean	13	12.54	13.9	12.28	27.8	25.14	4810	2925
CV, %	4.62	9.36	7.52	7.99	6.25	14.63	15.32	17.44
F-test (V)	**	**	**	**	ns	Ns	ns	Ns
(F)	**	**	**	**	**	**	**	**
(V × F)	ns	Ns	ns	Ns	ns	Ns	ns	Ns
$LSD_{0.05}$	0.402	0.788	0.701	0.658	1.428	2.468	605	419

**Highly significant at 0.01 level, *Significant at 0.05 level and ns, non-significant.

x Across9944 (5052 kg/ha) under treatment of application of NPK 180: 90: 60 kg/ha plus FYM 10 t/ha. Similarly, S99TLYQ-B produced the highest grain yield (4789 kg/ha) under the same level of fertilization (Figure 1).

Highest yield attributing traits namely cob length, no. of kernel rows per cob and no. of kernels per kernel rows were found under level of fertilization (180:90:60 kg NPK plus 10 t FYM/ha in Rampur Composite, Manakamana-4, Across9942 × Across9944. In both years, the interaction between genotypes and fertilizers showed that S99TLYQ-B, Manakamana-4, Across9944 and Rampur Composite produced highest grain yield by use of NPK 180:90:60 kg/ha plus FYM 10 t/ha (Table 3).

In 2009/10 and 2010/11, the effect of genotypes was observed to be non-significant where as the effect of fertilizers was found to be highly significant. In 2009/10, grain yield was increased with the increased level of fertilization. The highest grain yield (6068 kg/ha) was obtained at highest level of fertilization (180:90:60 NPK kg/ha plus FYM 10 t/ha). The variety Rampur composite produced highest grain yield (4882 kg/ha) followed by Across9942 x Across 9944 (4837 kg/ha) and Manakamana-4 (4773 kg/ha) Similarly in 2010/11, grain yield was increased with the increased level of fertilization.The highest grain yield (3873 kg/ha) was obtained at highest level of fertilization (180:90:60 NPK kg/ha

Table 4. Grain yield under different fertilizer levels and genotypes in 2009/10 and 2010/11 winter seasons at Rampur, Chitwan, Nepal.

Treatments	**Grain yield (kg/ha)**	
Fertilizer levels	**2009/10**	**2010/11**
F1 (Control)	2538	1436
F2 (FYM 10 t /ha)	3713	2057
F3 (60:30:20 NPK plus FYM 10t/ha)	5103	3046
F4 (120:60:40 NPK plus FYM 10t/ha)	5938	3787
F5 (180:90:60 NPK kg/ha plus FYM 10 t/ha)	6068	3873
F6 (120:60:40 NPK kg/ha)	5490	3351
CV,%	15.32	17.4
F-test	**	**
$LSD_{0.05}$	221.5	419.1
Genotypes		
V1 (Rampur Composite)	4882	3046
V2 (Manakamana-4)	4773	3042
V3 (Across9942 x Across9944)	4837	2816
V4 (S99TLYQ-B)	4740	2795
CV,%	15.32	17.4
F-test	Ns	Ns
$LSD_{0.05}$	605	342.2

plus FYM 10 t/ha). The variety Rampur composite produced highest grain yield (3046 kg/ha) followed by Manakamana-4 (3042 kg/ha) and Across9942 x Across 9944 (2816 kg/ha) (Table 4).

CONCLUSION

On the basis of the results of two years experiment, it can be concluded that maize genotypes namely Rampur Composite, Manakamana-4, Across9942 × Across 9944 produced better grain yield and indirectly enhanced the growth and yield attributing traits when fertilization level at the rate of 180: 90: 60 kg NPK/ha plus FYM 10 t/ha was applied as compared to other level of fertilization at Rampur, Chitwan, Nepal.

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