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EFFECT OF ORGANIC MANURES ON GROWTH, YIELD AND NUTRIENT UPTAKE IN MAIZE

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Abstract

An experiment was conducted to evaluate the effects of different sources of organic nitrogen *viz.* urea, household wastes, poultry manure and cowdung on growth, yield and nutrient uptake by maize. The experiment was laid out in a RCBD taking eight treatments with three replications. Growth parameters, yield attributes and yield of maize were the best with substitution of 25% of the recommended dose of fertilizers applied through poultry manure. The highest grain yield of maize (7.70 t/ha) was recorded in treatment receiving 75% N from urea and 25% N from poultry manure. The same treatment produced 121.15% higher grain yield over control. Combined application of organic manures along with chemical fertilizers showed positive effects on N, P, K and S contents and their uptake by grain and stover of maize. The highest uptake of N (173.30 kg/ha), P (33.08 kg/ha), K (164.18 kg/ha) and S (20.36 kg/ha) by maize were observed in treatment receiving 75% N applied through urea in combination with 25% N applied through poultry manure. The effect of poultry manure was most pronounced than that of the cowdung and household wastes.

Key words: Organic manures, growth, yield, nutrient uptake, maize

Introduction

Maize is recognized as relatively an important food crop recently in Bangladesh and has gained an increasing attention of the government. It is the third most important cereal crop in Bangladesh. At present maize is cultivated in 151 thousand hectares of land with a total production of approximately 0.9 million tons (BBS 2008). As food, it can be consumed directly as green cob, roasted cob or popped grain. This crop has much higher grain protein content than our staple food rice. It is one of the most efficient cereal crops which can give high biological yield as well as grain yield in a relatively short period of time. The crop has got enough potentiality in recent years especially due to rapid extension of poultry industries in our country. The agro-climatic condition of Bangladesh is favorable for its cultivation round the year. Production of maize in

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Bangladesh is limited because of many constraints. Maize needs ample nutrients which might come from both the organic and inorganic sources. Integrated nutrient supply leads to soil and crop sustainability by balanced application of nutrients, as these supply micronutrients to meet the crop need which is also pre-requisite to increase fertilizer use efficacy (Singh *et al.* 1999). To get optimum maize yield, a suitable combination of organic and inorganic fertilizer is best option (Babhulkar *et al.* 2000). Therefore, keeping these views in mind the present study was undertaken to assess the effect of combined application of inorganic fertilizers and organic manures on the growth, yield and nutrient uptake by maize.

Materials and Methods

The experiment was carried out at Bangabandhu Sheikh Mujibur Rahman Agricultural University Reasearch Farm, Gazipur, Bangladesh during Rabi season of 2008-2009. The experimental soil belongs to the Salna Series of AEZ 28 and (Madhupur Tract) classified as Inceptisols. The experimental soil was silty clay loam having soil pH 6.12, organic carbon 0.854%, total nitrogen 0.077%, available P 9.42 ppm, exchangeable K 0.18% and available S 10.31 ppm. The experiment was laid out in RCBD taking eight treatments. Treatments, sources and doses of the nutrients for the experiment are shown in Table 1. The total number of plots was 8 x 3= 24; each plot size was 4 m x 3m

Table 1. Treatments, sources and doses of the nutrients used for the experiment.

Treatment	N (kg/ha)	Household wastes (t/ha)	Poultry manure (t/ha)	Cowdung (t/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)
T_0 = control	-	-	-		-	-	-
T_1= RD	248	-	-	-	56	90	40
T_2= $Urea_{75}$+$HW_{25}\Psi$	186	12.30	-	-	27	36	20
T_3 = $Urea_{50}$+HW_{50}	124	24.60	-	-	-	-	-
T_4 = $Urea_{75}$+PM_{25}	186	-	10.30	-	11	34	20
T_5 = $Urea_{50}$+PM_{50}	124	-	20.60	-	-	-	-
T_6 = $Urea_{75}$+CD_{25}	186	-	-	11.30	28	55	20
T_7 = $Urea_{50}$+CD_{50}	124	-	-	22.60	-	-	-

Each treatment received 5.0 kg Zn/ha except control. TSP, MoP and gypsum were adjusted where manures were applied. RD = Recommended dose, HW= Household wastes, PM= Poultry manure, CD = Cow-dung. Ψ Figures shown as subscript represent per cent nitrogen from different sources.

accommodating 35 plants with a row to row and plant to plant spacing of 75 cm x 45 cm, respectively. The test crop was maize (*Zea mays*) variety (BARI Hybrid maize - 5). The nutrient contents in different organic manures are shown in Table 2.

Table 2. Nutrient contents in household wastes, poultry manure and cowdung.

Organic sources	Nutrient (%)			
	N	P	K	S
Household waste	1.01	0.340	0.630	0.187
Poultry manure	1.20	0.625	0.780	0.221
Cow-dung	1.10	0.355	0.695	0.198

Well decomposed household wastes (HW), poultry manure (PM) and cow-dung (CD) were applied as per treatments one week before final land preparation and thoroughly mixed with the soil. Phosphorus from triple super phosphate (TSP), potassium from murate of potash (MoP), sulphur from gypsum and zinc from zinc oxide and 1/3 nitrogen from urea were applied two days before final land preparation. Rest of the nitrogen from urea was top dressed in two equal splits at 35 and 65 days after seed sowing. Seeds were sown maintaining line to line distances of 75 cm and seed to seed distances of 45 cm. Two seeds were sown per hill at a depth of 2.5 cm. The intercultural operations were done as and when necessary. Harvesting was done plot wise after full ripening of the crop. Harvesting was completed within April 2009. From each plot 10 plants were randomly selected to keep records on yield and yield contributing characters. The selected plants were collected before the crop was harvested and the necessary information was recorded accordingly. The grain and stover samples were also kept for chemical analyses. The initial and post harvest soil samples of 0 - 15 cm depth were collected from each plot. Soil pH was determined by a glass electrode pH meter; organic carbon by wet oxidation method; total nitrogen by Microjeldahl method; available P, exchangeable K and available S by standard methods. The analysis of variance for the crop character and also the nutrient content of the plant samples were done following the ANOVA and the mean values were adjusted by DMRT.

Results and Discussion

Yield contributing characters

Plant height, cob length, cob/plant, grains/cob and 1000-grain weight of maize were significantly influenced by the application of N applied as urea along with household wastes, poultry manure and cowdung (Table 3). All the parameters were the best in T_4 treatment receiving 75% N from urea in combination with 25% N from poultry manure. The tallest plant (227.3 cm) was recorded in T_4 treatment. The effect of this treatment was

statistically similar to treatments T_2, T_5, T_6 and T_7 but superior to the rest of the treatments. All the treatments recorded higher plant height over T_0 (control) treatment where no fertilizer was applied. The maximum cob length (20.46 cm) was observed in treatment T_4 whose effect was statistically identical to all the treatments except T_1 (recommended dose) and T_0 (control) treatments. The maximum number of cob (1.867/ plant) was found in T_4 treatment. The effect of this treatment was statistically identical to all the treatments except T_1 and T_0 treatments. There was a significant effect of the different treatments on number of grains/cob. The maximum number of grains (513.2/cob) was recorded in treatment T_4 receiving 75% N from urea and 25% N from poultry manure. The effect of this treatment was statistically identical with all the treatments except T_1 and T_0 treatments. The lowest number of grains per cob (425.6/cob) was produced by the control treatment. Different treatments exerted significant variation in respect of 1000- grain weight. The maximum weight of 1000-grains (310.49 g) was recorded in T_4 treatment which was statistically similar to all the treatments except T_1 and T_0 treatments. It was reported that the plant height and number of maize grains/cob were increased by the application of poultry manure applied at the rate of 7.5 t/ha in combination with 25% recommended chemical fertilizer.

Table 3. Effects of urea nitrogen, household wastes, poultry manure and cow-dung on plant height, cob length, number of cob/ plant, grains/cob and 1000-grain weight of maize.

Ttreatment	Plant height (cm)	Cob length (cm)	Cob/plant (No.)	Grains/ cob (N.)	1000- grain weight (g)
T_0 = control	191.9 ^{c} *	17.82 ^{c}	1.133 ^{c}	425.6 ^{c}	272.3 ^{c}
T_1= RD	216.^{4b}	18.70 ^{b}	1.667 ^{b}	494.3 ^{b}	295.8 ^{b}
T_2= $Urea_{75}$+HW_{25} Ψ	221.3 ^{ab}	20.20 ^{a}	1.833 ^{a}	507 .6 ^{ab}	305.7 ^{ab}
T_3 = $Urea_{50}$+HW_{50}	217.^{4b}	19.88 ^{ab}	1.733 ^{ab}	497.8 ^{ab}	298.1 ^{ab}
T_4 = $Urea_{75}$+PM_{25}	227.3 ^{a}	20.46 ^{a}	1.867 ^{a}	513.2 ^{a}	310.4 ^{a}
T_5 = $Urea_{50}$+PM_{50}	219.9 ^{ab}	20. 07 ^{a}	1.767 ^{ab}	500.9 ^{ab}	303.8 ^{ab}
T_6 = $Urea_{75}$+CD_{25}	225.7 ^{a}	20.03 ^{a}	1.867 ^{a}	505.9 ^{ab}	306.3 ^{ab}
T_7 = $Urea_{50}$+CD_{50}	219.0 ^{ab}	19.92 ^{ab}	1.733 ^{ab}	498.7 ^{ab}	298.2 ^{ab}
CV (%)	5.14	3.13	4.33	3.98	2.66

*Means in a column followed by same letter(s) are not significantly different at 5% level of significance by DMRT.

Ψ Figures shown as subscript represent percent nitrogen from different sources.

Grain and stover yield of maize

The influence of the different treatments was found significant in recording grain and stover yields of maize (Table 4). The highest grain and stover yields of maize were

recorded in treatment T_4 receiving 75% N from urea and 25% N from poultry manure. The maximum grain yield (7.70 t/ha) was obtained from treatment T_4 whose effect was

Table 4. Effects of urea nitrogen, household wastes, poultry manure and cow-dung on grain and stover yields of maize.

Treatment	Grain yield (t/ha)	Stover yield (t/ha)
T_0 = control	3.48^{c*}	4.37^{f}
T_1= RD	7.19^{b}	8.11^{e}
T_2= $Urea_{75}$ + HW_{25} Ψ	7.49^{ab}	9.02^{abc}
T_3 = $Urea_{50}$ + HW_{50}	7.25^{b}	8.42^{de}
T_4 = $Urea_{75}$ + PM_{25}	7.70^{a}	9.31^{a}
T_5 = $Urea_{50}$ + PM_{50}	7.39^{ab}	8.72^{bcd}
T_6 = $Urea_{75}$ + CD_{25}	7.55^{ab}	9.11^{ab}
T_7 = $Urea_{50}$ + CD_{50}	7.34^{ab}	8.52^{cde}
CV (%)	3.11	3.45

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Ψ Figures shown as subscript represent percent nitrogen from different sources.

statistically identical to T_2, T_5, T_6 and T_7 treatments but superior to the rest of the treatments. Treatment T_4 produced 121.15% higher grain yield over control treatment (Figure 1). The lowest grain yield (3.48 t/ha) was noted in T_0 (control) treatment. The

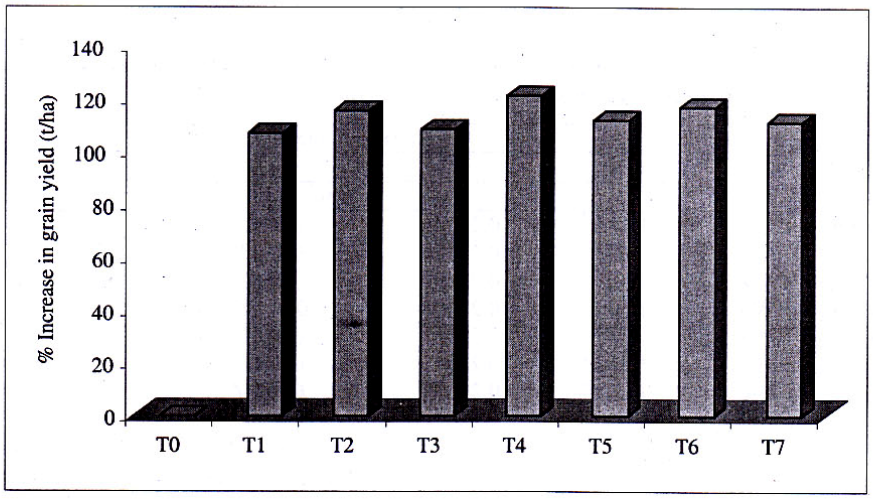

Figure 1. Effects of urea nitrogen, household wastes, poultry manure and cowdung on per cent increase in grain yield of maize.

higher grain yield obtained with the use of organic manures especially poultry manure might have the consequence of continuous supply of nutrients at a rate sufficient to support growth and reproduction. Mehta *et al.* (2008) found that the higher photosynthetic efficiency of plants estimated in terms of biomass accumulation seemed to be one of the potential factors for improving various yield components and yield. Verma *et al.* (2006) found that the application of FYM alone or with chemical fertilizer produced the maximum grain yield of maize. The maximum stover yield (9.31 t/ha) was recorded in T_4 treatment. The effect of this treatment was statistically similar to T_2 and T_6 treatments but superior to the rest of the treatments. The lowest stover yield (4.37 t/ha) was noted in T_0 treatment. It was found that maximum stover yield of maize was obtained when poultry manure at the rate of 7.5 t/ha along with the recommended chemical fertilizers were applied.

Nitrogen, phosphorus, potassium and sulphur content in maize grain

A significant difference was observed on N, P, K and S contents in maize grain due to application of different levels of N applied through urea in combination with household wastes, poultry manure and cowdung (Table 5). The highest contents of N, P, K and S in maize grain were recorded in treatment T_4 receiving 75% N from urea and 25% N from poultry manure. All the treatments receiving N from urea in association with household wastes, poultry manure and cowdung performed better in recording N, P, K and S contents in maize grain over that contained only chemical fertilizer treatment and control. The maximum N content in grain (1.577%) was recorded in T_4 treatment which

Table 5. Effects of urea nitrogen, household wastes, poultry manure and cow-dung on nitrogen, phosphors, potassium and sulphur contents in maize grain.

Treatment	Nutrient content (%)			
	N	P	K	S
	Grain			
T_0 = control	1.120^{c*}	0.2067^{b}	0.3000^{c}	0.0960^{c}
T_1= RD	1.530^{b}	0.2667^{a}	0.4333^{b}	0.1120^{bc}
T_2= $Urea_{75}$ + HW_{25} Ψ	1.557^{ab}	0.2766^{a}	0.4568^{a}	0.1213^{ab}
T_3 = $Urea_{50}$ + HW_{50}	1.540^{ab}	0.2700^{a}	0.4400^{ab}	0.1223^{ab}
T_4 = $Urea_{75}$ + PM_{25}	1.577^{a}	0.2916^{a}	0.4800^{a}	0.1340^{a}
T_5 = $Urea_{50}$ + PM_{50}	1.550^{ab}	0.2890^{a}	0.4600^{a}	0.1293^{ab}
T_6 = $Urea_{75}$ + CD_{25}	1.563^{ab}	0.2900^{a}	0.4700^{a}	0.1330^{a}
T_7 = $Urea_{50}$ + CD_{50}	1.543^{ab}	0.2887^{a}	0.4567^{a}	0.1260^{ab}
CV (%)	5.17	8.36	5.47	3.99

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Ψ Figures shown as subscript represent percent nitrogen from different sources.

was statistically similar to all the treatments except T_1 (recommended dose) and T_0 (control). The lowest N content in grain (1.12%) was obtained in T_0 treatment. The maximum P content in grain (0.2916%) was found in T_4 treatment whose effect was however, statistically identical with all the treatments except T_0 treatment. The lowest P content in grain (0.2067%) was recorded in T_0 treatment. The maximum K content in grain (0.480%) was recorded in T_4 treatment which was statistically similar with all the treatments except T_1 and T_0 treatments. The lowest K content in grain (0.300%) was found in T_0 treatment. Maximum S content in grain (0.134%) was found in T_4 treatment which was statistically identical with all the treatments but superior to the rest of the treatments. The lowest S content in grain (0.096%) was noted in T_0 treatment. Sukanya and Meli (2009) found significant increase in N, P, K and S contents in maize due to application of different sources of organic manures.

Nitrogen, phosphorus, potassium and sulphur content in maize stover

The concentration of N, P, K and S in maize stover was significantly influenced due to the application of different levels of N applied through urea in combination with household wastes, poultry manure and cowdung (Table 6). The maximum N, P, K and S contents were obtained in treatment T_4 receiving 75% N from urea and 25% N from poultry manure. The maximum N content in stover (0.5567%) was recorded in T_4 treatment whose effect was statistically similar to T_2 and T_6 treatments but superior to the rest of the treatments. The lowest value of N content (0.3433%) was found in T_0 (control) treatment. The maximum P content (0.1143%) in maize stover was obtained in T_4 treatment. The effect of this treatment was statistically identical with all the treatments

Table 6. Effects of urea nitrogen, household wastes, poultry manure and cow-dung on nitrogen, phosphors, potassium and sulphur contents in maize stover.

Treatment	Nutrient content (%)			
	N	P	K	S
	stover			
T_0 = control	0.3433^{e*}	0.0823^{c}	1.090^{e}	0.0720^{c}
T_1= RD	0.5200^{d}	0.0940^{bc}	1.323^{d}	0.0840^{bc}
T_2= $Urea_{75}$ + HW_{25} Ψ	0.5400^{abc}	0.1090^{ab}	1.343^{bc}	0.1017^{ab}
T_3 = $Urea_{50}$ + HW_{50}	0.5233^{cd}	0.1067^{ab}	1.330^{cd}	0.1010^{ab}
T_4 = $Urea_{75}$ + PM_{25}	0.5567^{a}	0.1143^{a}	1.367^{a}	0.1080^{a}
T_5 = $Urea_{50}$ + PM_{50}	0.5367^{bcd}	0.1103^{ab}	1.340^{bcd}	0.1060^{a}
T_6 = $Urea_{75}$ + CD_{25}	0.5500^{ab}	0.1110^{ab}	1.350^{ab}	0.1077^{a}
T_7 = $Urea_{50}$ + CD_{50}	0.5267^{cd}	0.1080^{ab}	1.333^{bcd}	0.1053^{a}
CV (%)	4.68	5.27	5.25	3.62

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Ψ Figures shown as subscript represent percent nitrogen from different sources.

except T_1 (recommended dose) and T_0 (control) treatments. The lowest P content (0.0823%) was recorded in T_0 treatment. The highest K content in stover (1.367 %) was noted in T_4 treatment whose effect was statistically similar to T_6 treatment but superior to the rest of other treatments. The lowest K content (1.090%) in stover was found in T_0 treatment. Treatment T_4 recorded the maximum S content (0.108%) in stover which was statistically identical to all the treatments except T_1 and T_0 treatments. The lowest S content in stover (0.0720%) was found in T_0 treatment. Application of N from urea in association with household wastes, poultry manure and cowdung increased N, P, K and S contents in stover as compared to only chemical fertilizer and control treatment. Tamanna and Chowdhury (2006) found that application of different organic manures significantly increased N, P and K contents in maize.

Nitrogen, phosphorus, potassium and sulphur uptake by maize grain

A marked difference was observed in N, P, K and S uptake by maize grain due to application of different levels of nitrogen applied along with organic manures (Table 7). The highest uptake of N, P, K and S by maize stover was observed in treatment T_4 receiving 75% N from urea and 25% N from poultry manure. The maximum N uptake by grain (121.5 kg/ha) was recorded in T_4 treatment whose effect was statistically similar to treatments T_2, T_5 and T_6 but superior to the rest of the treatments. The maximum P uptake by grain (22.47 kg/ha) was observed in T_4 treatment. The effect of this treatment was statistically identical to treatments T_5, T_6 and T_7 but superior to the rest of the treatments. The maximum K uptake by grain (36.98 kg/ha) was recorded in treatment T_4 which was statistically similar to T_6 treatment but superior to the rest of the treatments.

Table 7. Effects of urea nitrogen, household wastes, poultry manure and cowdung on nitrogen, phosphors, potassium and sulphur uptake by maize grain.

Treatment	Nutrient uptake (kg/ha)			
	N	P	K	S
	Grain			
T_0 = control	38.31^{d*}	7.21^{d}	10.45^{e}	3.34^{e}
T_1= RD	110.0^{c}	19.13^{c}	31.16^{d}	8.05^{d}
T_2= $Urea_{75}$ + HW_{25} Ψ	116.5^{abc}	20.52^{bc}	34.19^{bc}	9.08^{bc}
T_3 = $Urea_{50}$ + HW_{50}	111.4^{bc}	19.53^{c}	$31.90c^{d}$	8.87^{c}
T_4 = $Urea_{75}$ + PM_{25}	121.5^{a}	22.47^{a}	36.98^{a}	10.32^{a}
T_5 = $Urea_{50}$ + PM_{50}	114.2^{abc}	21.34^{ab}	33.97^{bc}	9.55^{abc}
T_6 = $Urea_{75}$ + CD_{25}	118.3^{ab}	21.91^{ab}	35.49^{ab}	9.82^{ab}
T_7 = $Urea_{50}$ + CD_{50}	113.3^{bc}	21.22^{ab}	32.81^{cd}	9.25^{bc}
CV (%)	3.76	4.16	4.07	5.16

*Means in a column followed by same letter(s) are not significantly different at 5% level of significance by DMRT.

Ψ Figures shown as subscript represent percent nitrogen from different sources.

The maximum S uptake by grain (10.32 kg/ha) was found in T_4 treatment which was statistically identical to treatments T_5 and T_6 but superior to the rest of the treatments. Higher biomass production may be the most pertinent reasoning for higher uptake of nutrients. Saha and Mondal (2006) observed that the maximum uptake of N, P and K/ha was recorded under the treatment receiving 75% recommended dose of fertilizer +25% pelleted form of organic manure in maize production.

Nitrogen, Phosphorus, Potassium and Sulphur uptake by maize stover

A significant variation was found among the treatments on N, P, K and S uptake by stover (Table 8). The maximum N, P, K and S uptake by maize stover was found in treatment T_4 receiving 75% N from urea along with 25% N from poultry manure. The highest N uptake by stover (51.80 kg/ha) was recorded in T_4 treatment whose effect was statistically identical to treatments T_2 and T_6 but superior to the rest of the treatments. Pathak *et al.* (2005) found that combined application of inorganic fertilizers and FYM (75:25) significantly increased N uptake by maize stover. The maximum P uptake (10.61 kg/ha) was noted in T_4 treatment. The effect of this treatment was statistically superior to the rest of the treatments. This might be due to the application of chemical nitrogen fertilizer along with poultry manure and might have increased efficacy of phosphorus accumulation resulting higher P uptake by stover. Treatment T_4 recorded the highest K uptake (127.2 kg/ha) which was statistically similar to treatments T_2 and T_6 but superior to the rest of the treatments. The maximum S uptake by stover (10.04 kg/ha) was recorded in T_4 treatment which was statistically identical to T_6 treatment but superior to the rest of the treatments.

Table 8. Effects of urea nitrogen, household wastes, poultry manure and cowdung on nitrogen, phosphors, potassium and sulphur uptake by maize stover.

Treatment	Nutrient uptake (kg/ha)			
	N	P	K	S
	stover			
T_0 = control	15.01^{f*}	3.60^{f}	45.44^{e}	3.14^{f}
T_1= RD	41.91^{e}	7.63^{e}	107.4^{d}	7.22^{e}
T_2= $Urea_{75}$ + HW_{25} Ψ	48.75^{abc}	9.84^{b}	121.3^{ab}	9.17^{bc}
T_3 = $Urea_{50}$ + HW_{50}	44.08^{de}	8.99^{d}	112.0^{cd}	8.50^{d}
T_4 = $Urea_{75}$ + PM_{25}	51.80^{a}	10.61^{a}	127.2^{a}	10.04^{a}
T_5 = $Urea_{50}$ + PM_{50}	46.81^{bcd}	9.62^{bc}	116.9^{bc}	9.24^{bc}
T_6 = $Urea_{75}$ + CD_{25}	50.12^{ab}	10.11^{b}	123.0^{ab}	9.81^{ab}
T_7 = $Urea_{50}$ + CD_{50}	44.85^{cde}	9.20^{cd}	113.6^{cd}	8.97^{cd}
CV (%)	5.03	3.11	3.25	4.25

*Means in a column followed by same letter(s) are not significantly different at 5% level of significance by DMRT.

Ψ Figures shown as subscript represent percent nitrogen from different sources.

Conclusions

It may be concluded that the application of organic and inorganic sources of nutrients with urea fertilizer had a positive impact on the yield and yield contributing characters of maize.

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