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Effect of nitrogen and poultry manure on yield and nutrients uptake by maize (*Zea mays*)

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Maize (*Zea mays* L.) is cultivated in India over 8.67 million ha with 22.26 million tonnes production having an average productivity of 2566 kg/ha (DACNET 2014). India Rank 4th in maize area in the world. Maize grain is mainly used for feed (63%), food (23%) and industrial purpose (13%) in the country (Yadav *et al*. 2014). Application of farmyard manure (FYM) is common in India but availability is declining because of increase in cropping intensity and area, and other competitive uses of cow dung. The poultry manure (PM) is relatively a cheap source of both macro nutrients (N, P, K, Ca, Mg, S) and micronutrients (Cu, Fe, Mn, B) and can increase soil carbon and N content, soil porosity and enhance soil microbial activity. As poultry waste contains a high concentration of nutrients, addition of small quantity of it in an integrated nutrient management system could meet the shortage of FYM to some extent. Results of a long term experiment indicated that substitution of inorganic fertilizers by FYM, either 50 or 25% of RDF increased grain yield and uptake of NPK. A significant increase in N content both in seeds and stalk were recorded with the application of FYM (Singh *et al*. 2005). Gondek and Filipek-Mazur (2005) carried a pot experiment to determine the influence of different soil amendment, i.e. FYM, pig slurry and liquid organo-mineral fertilizer on soil properties and observed a decrease in soil *p*H and an increase in hydrolytic conductivity. Keeping above observation in mind a greenhouse pot culture experiment was conducted to evaluate the effect of poultry manure and nitrogen on maize yield and soil properties.

A nethouse pot experiment was conducted (2014) to assess the effect of nitrogen (N) and poultry manure (PM) on yield, quality and uptake of nutrients by maize (*Zea mays* L.) crop. The study has included 16 combinations, comprising of four levels of nitrogen (N), i.e. 0, 100, 125 and 150 kg/ha and four doses of poultry manure (PM), i.e. 0, 10, 20 and 30 t/ha. The highest grain yield (g/plant) was recorded in treatment 125 kg/ha N + 10 t/ha PM. The lower bulk density value 1.12 g/cm^3 was noticed in treatment 0 kg/ha N + 10 t/ha PM and maximum was observed in treatment 150 kg/ha N + 30 t/ha PM which was 1.29 g/cm^3.

The maximum nitrogen (N) and phosphorus (P) content was observed in treatment 0.99% per plant, 0.88% per plant and maximum potash (K) content in 0.88% per plant, respectively. Use of PM @10 tonnes/ha with 125 kg N improved the physical and chemical status particularly N of the soil. A nethouse pot experiment was conducted 2014–15 to assess effect of poultry manure on yield, and uptake of nutrients by maize crop. Surface (0–15 cm) soil was collected from the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi and air dried, grinded properly and passed through 2 mm sieve and 10 kg of soil was filled in polythene lined earthen pot. Required quantities of fertilizers for 10 kg soil were calculated and applied in solution form using urea, DAP and MOP as source of N, P and K applied, respectively. The pots were irrigated to field capacity and 5 seeds of maize cv. DHM 117 were sown in each pot. This experiment having 16 treatments with four levels of N, i.e. 0, 100, 125 and 150 kg/ha and four levels of PM, i.e. 10, 20 and 30 t/ha. PM contained 1.0–1.8% N, 0.8–1.2% P and 0.5–0.7% K besides other micronutrients. Soil and plant samples were collected after harvesting and stored in polythene bags and were analyzed by using standards protocols for their physico-chemical properties.

The maximum number of grains/cob was found in treatment T_{10} and highest weight per 100 seed of maize was observed highest in T_{10} (26.92 g) and lowest in T_1 (22.05 g) compared to other treatments (Table 1). Same trend was also found in stover yield, fresh weight and dry weight of plant. Similar observations have been made by Kumar and Dhar (2010). N uptake was highest in treatment T_{10} and minimum in T_1. The application of N, PM and combination levels did not have significant influence on P and K content in plant stover and in grain. Observation

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Table 1 Effect of different treatments on fresh weight, dry weight, nitrogen, phosphorus and potash content in maize stover and grains

Treatment	Number of grains/cob	Test Index (per 100 grains)	Stover yield (g/ plant)	Grain yield (g/plant)	Fresh weight (g/ plant)	Dry weight (g/plant)	Stover (%)			Grains (%)			
							N	P	K	N	P	K	Protein
T1	113	22	4.2	78	60	19	0.41	0.18	1.21	0.68	0.55	0.46	4.30
T2	116	23	4.7	86	68	25	1.18	0.18	1.22	0.83	0.65	0.65	5.23
T3	117	23	4.9	90	84	33	1.21	0.18	1.21	0.84	0.72	0.46	5.30
T4	121	23	5.2	92	80	27	1.33	0.18	1.23	0.86	0.46	0.54	5.42
T5	115	24	5.7	95	77	33	1.36	0.18	1.23	0.76	0.55	0.76	4.75
T6	134	24	5.9	98	98	34	1.39	0.19	1.24	0.86	0.77	0.67	5.37
T7	142	24	6.1	102	80	39	1.41	0.19	1.23	0.83	0.76	0.76	5.20
T8	146	25	6.1	103	94	39	1.48	0.19	1.26	0.81	0.86	0.78	5.07
T9	151	24	6.1	105	90	39	1.39	0.19	1.25	0.79	0.88	0.77	4.97
T10	188	26	7.3	126	117	61	1.72	0.19	1.28	0.99	0.55	0.67	6.23
T11	184	26	7.2	121	112	60	1.71	0.19	1.27	0.98	0.65	0.87	6.15
T12	183	26	7.2	120	110	58	1.70	0.19	1.24	0.95	0.70	0.79	5.95
T13	164	26	6.7	104	98	45	1.61	0.19	1.22	0.81	0.77	0.75	5.07
T14	177	26	7.1	114	108	59	1.68	0.19	1.27	0.89	0.58	0.79	5.61
T15	179	26	7.2	109	100	55	1.70	0.19	1.25	0.90	0.70	0.77	5.66
T16	176	26	7.2	108	107	57	1.71	0.19	1.22	0.99	0.78	0.88	6.18
CD	8.35	N/A	1.68	11.18	17.46	14	0.18	N/A	N/A	0.10	N/A	N/A	0.10
SE(m)	2.88	1.754	0.58	3.86	9.49	4.87	0.05	0.00	0.05	0.05	0.00	0.05	0.05
SE(d)	4.08	2.481	0.82	5.46	13.42	6.89	0.08	0.00	0.08	0.08	0.00	0.08	0.08
C V	3.3	12.1	16.0	6.4	18.2	20.6	7.0	5.1	8.0	7.0	5.1	8.0	7.0

T1- 0 kg/ha N + 0 t/ha PM; T2- 0 kg/ha N + 10 t/ha PM; T3- 0 kg/ha N + 20 t / ha PM; T4- 0 kg/ha N + 30 t / ha PM; T5- 100 kg/ha N + 0 t / ha PM; T6- 100 kg/ha N +1 0 t / ha PM; T7- 100 kg/ha N + 20 t / ha PM; T8-100 kg/ha N + 30 t / ha PM; T9- 125 kg/ha N + 0 t / ha PM; T10- 125 kg/ha N + 10 t / ha PM; T11-125 kg/ha N + 20 t / ha PM;T12 -125 kg/ha N + 30t / ha PM; T13- 150 kg/ha N + 0 t / ha PM; T14- 150 kg/ha N + 10 t / ha PM; T15 -15 0 kg/ha N + 20 t / ha PM; T16- 150 kg/ha N + 30 t / ha PM.

Table 2 Effect of different treatments on soil properties after harvesting

Treatment	pH	EC (ds/m)	Organic Carbon (g/kg)	Bulk Density (M/gm^3)	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T1	7.50	0.08	6.00	1.13	180	20.10	271
T2	7.66	0.09	6.13	1.12	232	26.13	287
T3	7.66	0.08	6.13	1.20	238	26.29	290
T4	7. 16	0.12	6.20	1.19	242	27.30	279
T5	7.46	0.07	6.23	1.14	243	27.73	289
T6	7.56	0.08	6.26	1.25	231	28.21	291
T7	7.56	0.07	6.23	1.27	244	27.81	286
T8	7.36	0.08	6.56	1.30	243	28.30	300
T9	7.56	0.08	6.30	1.28	234	28.66	307
T10	7.60	0.07	6.26	1.26	251	28.33	295
T11	7.60	0.10	6.80	1.26	251	32.99	312
T12	7.56	0.11	6.53	1.28	251	32.30	326
T13	7.40	0.10	6.50	1.29	250	25.15	329
T14	7. 68	0.07	6.73	1.27	256	28.26	339
T15	7.46	0.09	6.36	1.26	259	28.33	327
T16	7. 46	0.12	6.80	1.29	263	34.99	329
SE(m)	0.05	0.00	0.20	0.01	5.71	1.96	2.35
SE(d)	0.07	0.01	0.29	0.02	8.07	2.77	3.32
CD(5%)	1.76	0.01	1.77	0.19	26.55	16.68	17.23

on NPK and protein content of maize indicated that the higher values were recorded at higher level of N, PM and combination levels as compare to control. The Maximum N and K content was observed in treatment T_{10} and P in treatment T_{16} in stover.

Lowest *p*H (7.16) was observed in 0 kg/ha N + 30 t/ha PM and the highest *p*H 7.68 in 150 kg/ha N + 10 t/ha PM (Table 2). Highest and lowest EC recorded in T_{16} and 125 kg/ha N+ 10 t/ha PM respectively. The maximum organic carbon value (6.8 g/kg) was observed in treatment T_{11} and T_{16} and minimum in T_1 (6 g/kg). Lowest bulk density (1.12) was found in T_2 and highest in T_{16} (1.30). Available N, P and K was highest in T_{16} and minimum in T_1 (Control). Similar results were also found by Liu *et al.* (2010) and Soro *et al.* (2015).

Study showed that poultry manure helped in improving plant growth and productivity of maize up to 40%. The highest grain yield and test weight were achieved by application of PM @10 t/ha along with 125 kg/ha nitrogen through urea. Thus integrated use of PM and urea not only improved the crop productivity but also helped to maintain the soil health.

SUMMARY

From this study we can conclude that significantly increase the yield of maize due to integrated nitrogen management could be further attributed to increased growth and vigour of plant as evident from increased growth attributes. So, the treatment combinations (T10) of 125 kg/ha Nitrogen through inorganics plus 10 t/ha poultry manure through organics were having significant difference as compared to all other. This might be due to ready supply of nutrients through inorganic in the initial stages of crop growth and slow release of nitrogen and steady supply of other nutrients over an extended period of crop growth by organics. Organics have a priming effect on the release of nitrogen from inorganic fertilizer. Moreover, thoroughly decomposed organics were used in these treatments which might have mobilized native nutrients from soils. Poultry manure showed higher yield and yield attributing characters due to faster mineralization of nitrogen with its narrow C:N ratio (15:1-20:1) as evident by its chemical composition. The proper dose of poultry manure can be used as a source of organic manure for sustainable maize production.

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