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Research Article

Productivity and uptake of NPK by maize (*Zea mays* L.) as influenced by integrated nutrient management practices

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Abstract : A field study was carried out at College of Agriculture, Navile, Shimoga during *Kharif* 2009 to study the productivity and uptake of NPK by maize (*Zea mays* L.) as influenced by integrated nutrient management practices. There were two levels of nitrogen applied through organics (FYM and vermicompost) and inorganics involving nine treatments combinations were treid in a RCBD with three replications.Significantly higher grain (9.50 t ha^{-1}) and stover (11.00 t ha^{-1}) yield and total uptake of N, P and K by maize were recorded by the treatment involving package of practices compared to the treatments which received nitrogen levels in the form of inorganics and organics. However, the integrated treatment did not differ significantly with each other in respect of yield and uptake of NPK by maize.

Key Words : Integrated nutrient management, Yield, Quality soybean and economic returns, FYM

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INTRODUCTION

Maize (*Zea mays* L) is considered as an economically important cereal crop, major ingredient for food, feed and other products. It assumes an important role next to rice and wheat in the farming sector and macro economy of agrarian countries.

Maize has high genetic yield potential than other cereal crops. Hence, it is called as 'miracle crop' and also as 'queen of cereals'. Being a C_4 plant, it is very efficient in converting solar energy in to dry matter. As heavy feeder of nutrients, maize productivity is largely dependent on nutrient management. Therefore, it needs fertile soil to express its yield potential. Ideal soils are rarely found in nature. Hence, soils have to be improved to suit the crop not only by adding nutrients, but also by other soil amendments, like organic matter for maintaining the activity of 'soil life'.

Intensive cultivation, growing of exhaustive crops, use of unbalanced and inadequate fertilizers accompanied by restricted use of organic manures and biofertilizers have made the soils not only deficient in the nutrients, but also deteriorated the soil health resulting in decline in crop response to recommended dose of N – fertilizer in the region under such situation, integrated plant nutrient system (IPNS) has assumed a great importance and has vital significance for the maintenance of soil productivity. Organic manures, particularly FYM, vermicompost and green manures, not only supply macronutrients but also meet the requirements of micronutrients, besides improving soil health. Boosting yield, reducing production cost and improving soil health are three inter -linked components of the sustainable triangle. Therefore, suitable combination of chemical fertilizer and organic manures cultures need to be developed for particular cropping system and soil.

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EXPERIMENTAL METHODS

The experiment was conducted at College of Agriculture, Navile, Shimoga during *Kharif* 2009 to study the productivity and uptake of N, P and K as influeced by integrated nutrient management practices. The soil of experimental field was sandy loam in texture (Typic Haplustalf) having initial pH 5.10 and organic carbon control of soil were 0.33 per cent. The fertility status of experimental field was found to be low in available nitrogen (197.20 kg ha^{-1}), high in available P_2O_5 (52.80 kg ha^{-1}) and medium in available K_2O (182.40 kg ha^{-1}) (Table A). The experiment was laid out in randomized complete block design with three replications.

Table A : Physical and chemical properties of the representative soil of the experimental site

Properties	Values
Soil taxonomy	Typic Haplustalf
Sand (%)	71.78
Silt (%)	11.89
Clay (%)	16.33
Textural class of soil	Sandy Loam
Soil pH	5.10
Organic carbon (%)	0.33
Available macronutrient status	
Nitrogen (kg ha^{-1})	197.20
Phosphorus (kg P_2O_5 ha^{-1})	52.80
Potassium (kg K_2O ha^{-1})	182.40

The treatments were as follows : T_1–Absolute control, T_2–100 per cent N hrough fertilizer, T_3–150 per cent N through fertilizer, T_4–100 per cent N + 7.5 t ha^{-1} FYM (Package of practices), T_5–150 per cent N + 7.5 t ha^{-1} FYM, T_6–100 per cent N (50 % N through fertilizer + 50% N through FYM), T_7 – 150 per cent N (75% N through fertilizer + 75% N through FYM), T_8–100 per cent N (50% N through fertilizer + 50% N through Vermicompost), T_9–150 per cent N (75% N through fertilizer + 75% N through vermicompost)

(Note: 100 % P and K applied to all treatments except absolute control)

The recommended dose of FYM (7.5 t ha^{-1}) was applied to all treatments except T_1, T_2 and T_3 treatments two weeks before sowing of seeds. At the time of sowing, recommended dose of phosphorus (50 kg P_2O_5 ha^{-1}) and potassium (25 kg K_2O ha^{-1}) were applied in the form of single super phosphate and murate of potash, respectively to all plots except T_1(absolute control). Nitrogen was applied in the form of inorganic (urea) and organic (FYM and vermicompost) form. Inorganic(fertilizer) nitrogen as mentioned in the treatments was applied in splits *i.e.,* 50 per cent at time of sowing and the remaining 50 per cent of nitrogen in two splits (30 and 60 days after sowing) and calculated quantities of FYM and vermicompost equal to the 50 and 75 per cent nitrogen were applied as per treatment details to the respective plots(T_6-T_9) at the time of sowing. Then the maize seeds were sown in each plot with a spacing of 60 cm between the rows and 30 cm between the plants. Weeds were removed as and when they appeared and also other inter cultivation operations were taken up as per package of practices.

EXPERIMENTAL RESULTS AND ANALYSIS

Significantly lower yield (3.30 t ha^{-1}) of stover was recorded in absolute control compared to other treatments (Table 4). Among the treatments except control, the treatments (T_2 and T_3) which received nitrogen only through fertilizers recorded significantly lower yield over other treatments. The maximum stover yield (11.00 t ha^{-1}) was recorded in the treatment T_4 (100% N + 7.5 t ha^{-1} FYM) and followed by T_5 (150% N + 7.5 t ha^{-1} FYM) which recorded the stover yield of 10.20 t ha^{-1}. Further, it was noticed that all treatments which received nitrogen in integrated form of fertilizers and organics without any significant difference among themselves, significantly increased the stover yield over the treatments which received nitrogen recorded only through fertilizers.

Owing to their addition through NPK, FYM and vermicompost and release of nutrients from the native sources in soil due to high biological activity in soil particularly under the treatment of T_4 (100% N + 7.5 t ha^{-1} FYM) resulted in high dry matter production as indicated by plant height, number of leaves per plant, high leaf area and leaf area index which ultimately increased the stover yield of maize in the above treatments. Similar findings were also reported by Sharma *et al.* (1987), Gupta *et al.* (1996) and Kale *et al.* (1991) who indicated that application of organic manures along with NPK fertilizers leads to improvement in the soil fertility due to increase in the population of beneficial micro-flora in soil in addition to the improvement physical properties of soil.

Similarly, all treatments recorded significantly higher grain yield compared to the control (2.20 t ha^{-1}) which received neither fertilizers nor organic manures. Whereas, treatments(T_2 and T_3) which received nitrogen only through fertilizers recorded significantly lower grain yield (5.80 and 6.20 t ha^{-1}, respectively) compared to all other treatments except control (T_1) which in turn did not differ with each other significantly in respect of grain yield. However, a maximum of 9.50 t ha^{-1} grain yield was recorded by the treatment T_4 (100% N + 7.5 t ha^{-1} FYM) followed by T_5 (150% N + 7.5 t ha^{-1} FYM.) which recorded the grain yield of 9.17 t ha^{-1}. It was noticed that a magnitude of variation in the grain yield was proportional to the variation in the yield attributing parameters like cob length, cob girth and test weight of grains and their variation was attributed to the availability of nutrients in soil as indicated by significant and positive correlation observed between grain yield and available nitrogen status in soil (Table 3). Further, all those treatments which received nitrogen in integrated form recorded significantly higher grain yield compared to the treatments which received nitrogen only through fertilizers. An increase in the grain yield with FYM and vermicompost application along with NPK fertilizers may be due to the fact that added FYM and vermicompost served as store house of several macro and micro-nutrients which are released during the process of mineralization. In addition to release of plant nutrients from the organic matter, the organic acids formed in the decomposition process also release the native nutrients in soil and increases their availability to plants. Similar results were reported by Badiyala and Verma (1991), Negi *et al.* (1992) and Dahama (1996). Among the treatments, the treatments T_4 and T_5 recorded higher grain yield compared to other treatments probably because of optimum supply of nutrients at right time of crop requirement and maize responds well to fertilizer application as a result of its well developed root system, crop absorbed required nutrients from soil for effective dry matter production and

Table 1 : Effect of integrated nutrient management practices on plant height and number of leaves per plant at different growth stages of maize

Treatments	Plant height (cm)			Number of leaves per plant		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_1- Absolute control	22.40	96.26	142.14	4.82	7.90	8.00
T_2-100% N through fertilizer	35.22	170.67	180.16	5.80	12.35	11.53
T_3-150% N through fertilizer	38.56	172.49	183.74	5.80	12.40	11.70
T_4-100% N+7.5t ha^{-1} FYM	55.58	206.12	218.85	7.25	14.23	14.40
T_5-150% N+7.5t ha^{-1}FYM	47.66	190.00	214.26	6.88	14.00	13.87
T_6- 100%N (50%N through fertilizer+50%N through FYM)	43.18	186.43	206.93	6.57	13.60	13.23
T_7- 150% N (75%N through fertilizer+75%N through FYM)	46.63	189.84	208.00	6.86	13.70	13.70
T_8- 100% N (50%N through fertilizer+50%N through vermicompost)	42.74	186.16	204.58	6.47	13.40	13.16
T_9- 150 % N (75%N through fertilizer+75%N through vermicompost)	46.24	188.00	207.60	6.70	13.60	13.66
S.E.±	1.58	2.68	3.04	0.26	0.21	0.41
C.D. (P=0.05)	4.74	8.06	9.13	0.78	0.63	1.23

DAS- Days after sowing
Note: 100% P and K applied to all treatments except absolute control

Table 2 : Effect of integrated nutrient management practices on leaf area and leaf area index at different growth stages of maize

Treatments	Leaf area (dm^2 $plant^{-1}$)			Leaf area index		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
T_1- Absolute control	16.78	48.23	44.18	0.92	2.67	2.45
T_2-100% N through fertilizer	32.23	64.16	62.23	1.78	3.56	3.45
T_3-150% N through fertilizer	35.22	66.82	63.11	1.95	3.71	3.50
T_4-100% N+7.5t ha^{-1} FYM	55.62	88.12	85.04	3.08	4.89	4.73
T_5-150% N+7.5t ha^{-1}FYM	53.06	86.40	84.78	2.94	4.76	4.68
T_6- 100%N (50%N through fertilizer+50%N through FYM)	39.10	78.53	78.20	2.16	4.37	4.34
T_7- 150% N (75%N through fertilizer+75%N through FYM)	40.26	83.26	82.14	2.23	4.64	4.55
T_8- 100% N (50%N through fertilizer+50%N through vermicompost)	39.34	78.20	78.83	2.18	4.30	4.37
T_9- 150 % N (75%N through fertilizer+75%N through vermicompost)	40.06	82.30	81.87	2.22	4.55	4.54
S.E.±	2.65	2.21	3.84	0.14	0.11	0.21
C.D. (P=0.05)	7.94	6.63	11.53	0.44	0.35	0.63

DAS - Days after sowing
Note: 100% P and K applied to all treatments except absolute control

Table 3 : Effect of integrated nutrient management practices on length of cob, girth of cob and test weight of maize

Treatments	Length of cob (cm)	Girth of cob (cm)	Test weight (g)
T_1- Absolute control	8.50	9.32	20.50
T_2-100% N through fertilizer	13.15	13.81	26.71
T_3-150% N through fertilizer	13.90	14.02	28.72
T_4-100% N+7.5t ha^{-1} FYM	18.32	18.25	37.87
T_5-150% N+7.5t ha^{-1}FYM	16.74	16.60	36.73
T_6- 100%N (50%N through fertilizer+50%N through FYM)	15.00	15.15	32.00
T_7- 150% N (75%N through fertilizer+75%N through FYM)	15.45	15.90	35.80
T_8- 100% N (50%N through fertilizer+50%N through vermicompost)	15.24	14.82	32.12
T_9- 150 % N (75%N through fertilizer+75%N through vermicompost)	15.94	15.62	33.64
S.E.±	0.62	0.39	1.56
C.D. (P=0.05)	1.87	1.17	4.68

Note: 100% P and K applied to all treatments except absolute control

Table 4: Effect of integrated nutrient management practices on stover and grain yield of maize

Treatments	Stover yield (t ha^{-1})	Grain yield (t ha^{-1})
T_1- Absolute control	3.30	2.20
T_2-100% N through fertilizer	7.90	5.80
T_3-150% N through fertilizer	8.03	6.20
T_4-100% N+7.5t ha^{-1} FYM	11.00	9.50
T_5-150% N+7.5t ha^{-1}FYM	10.20	9.17
T_6- 100%N (50%N through fertilizer+50%N through FYM)	9.95	8.90
T_7- 150% N (75%N through fertilizer+75%N through FYM)	10.04	9.06
T_8- 100% N (50%N through fertilizer+50%N through vermicompost)	9.83	8.76
T_9- 150 % N (75%N through fertilizer+75%N through vermicompost)	9.93	8.93
S.E.±	0.40	0.33
C.D. (P=0.05)	1.22	0.99

Note: 100% P and K applied to all treatments except absolute control

Table 5 : Effect of integrated nutrient management practices on primary nutrients uptake by stover and grain of maize

Treatments	Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})	
	Stover	Grain	Stover	Grain	Stover	Grain
T_1- Absolute control	34.20	15.56	5.03	2.86	38.05	18.18
T_2-100% N through fertilizer	86.90	52.09	22.10	11.49	101.91	57.78
T_3-150% N through fertilizer	96.40	56.90	20.06	12.32	104.70	62.79
T_4-100% N+7.5t ha^{-1} FYM	135.50	113.80	34.10	22.40	154.00	114.00
T_5-150% N+7.5t ha^{-1}FYM	132.80	112.43	31.62	21.08	142.80	110.00
T_6- 100%N (50%N through fertilizer+50%N through FYM)	119.44	106.80	31.82	19.05	138.33	106.86
T_7- 150% N (75%N through fertilizer+75%N through FYM)	120.48	108.80	33.14	19.96	140.56	109.70
T_8- 100% N (50%N through fertilizer+50%N through vermicompost)	118.00	105.03	31.43	20.92	135.72	105.92
T_9- 150 % N (75%N through fertilizer+75%N through vermicompost)	119.20	108.90	32.85	21.41	139.12	108.30
S.E.±	7.97	3.63	1.96	1.21	5.91	4.33
C.D. (P=0.05)	23.90	10.89	5.90	3.64	17.72	13.00

Note: 100% P and K applied to all treatments except absolute control translocation of photosynthates from leaves to the sink for better development of grains. This is in conformity with the work of Kamalakumari and Singaram (1996) and Paulpandi *et al.* (1999).

Uptake of nitrogen by stover was significantly higher (135.50 kg ha^{-1}) compared to all other treatments except the treatment T_5 (150% N + 7.5 t ha^{-1} FYM) which recorded the nitrogen uptake of 132.80 kg ha^{-1}(Table 5). Treatments which received nitrogen in integrated form did not differ with each other significantly with respect to nitrogen uptake by stover but they were found to be significantly superior in increasing the uptake of nitrogen by stover. In case of nitrogen uptake by grain, the treatments control, T_2 and T_3 recorded significantly lower uptake of nitrogen by grain compared to all other treatments which in turn did not differ with each other significantly in respect of nitrogen uptake by grain. However, maximum uptake of nitrogen (113.80 kg ha^{-1}) was noticed in treatment T_4 (100% N + 7.5 t ha^{-1} FYM) compared to all other treatments. Even the phosphorus and potassium uptake by stover and grains of maize was followed the trend of nitrogen uptake by grain due to the imposed treatments. Here also the treatment T_4 (100% N + 7.5 t ha^{-1} FYM) recorded the maximum uptake of phosphorus (34.10 and 22.40 kg ha^{-1}) and potassium (154.00 and 114.00 kg ha^{-1}) by stover and grain, respectively. Further, all those treatments which received nitrogen in integrated form were found to be significantly superior over the control, treatments T_2 (100% N through fertilizers) and T_3(150% N through fertilizers) but they were found to be at par with rest of the treatments. As nutrient uptake by plant is a product of dry matter yield and its nutrient content, any variation in NPK uptake by stover and grain of maize may be attributed to the variation in the yield obtained and nutrient contents of stover and grain due to the imposed treatments and it was proportional to the stover and grain yield of maize crop which in turn dependent on availability of NPK in soil as indicated by a positive and significant correlation observed between available nitrogen status in soil and uptake of nitrogen by stover and grain of maize. These results corroborate with the findings of Zhao and Haung (1991), Bhandari *et al.* (1992), Hundekar (1992), Alokkumar and Yadav (1995), Stephenes *et al.* (1997) and Vyas *et al.* (1997).

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