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Integrated nitrogen management in maize (*Zea mays* L.) for profitable production with sustainability

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Abstract
The study was carried out on clayey in texture soil at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the "influence of integrated nitrogen management in summer maize (*Zea mays* L.) Under south Gujarat condition. The soil was slightly alkline in soil reaction (7.98), low in available nitrogen (230kg/ha), medium in available phosphorus (38 kg/ha) and fairly rich in potassium (379 kg/ ha). Eight treatments comprising of inorganic and organic sources of nutrients compared with chemical fertilizers alone and these treatments were tried in Randomized Block Design with three replications. Significantly higher grain and straw yield (4032 and 6039kg/ha, respectively) of maize were recorded under 100% recommended dose of nitrogen through inorganic fertilizer, which were at par with 75% RDN through inorganic fertilizer + 25% RDN from vermicompost, 75% RDN through inorganic fertilizer + 25% RDN from biocompost, 50% RDN from inorganic fertilizer + 50% RDN from vermicompost. Further, it was noticed that the different integrated nitrogen management, 75% RDN through inorganic fertilizer + 25% RDN from vermicompost recorded significantly higher grain and straw yield. The increase in available nitrogen, phosphorus and potassium were significantly higher with the application of $^1/_3$ RDN from inorganic source + $^1/_3$ RDN from biocompost +$^1/_3$ RDN from vermicompost. The maximum net realization of 55308 ₹/ha with BCR 2.37 recorded with 100% RDN though urea followed by treatment 75% RDN through urea + 25% RDN though biocompost.

Keywords: Available nutrients, bicompost, economics, INM, vermicompost, yield

Introduction
Maize (*Zea mays* L.) is one of the most important cereal crop grown all over the globe as poor man's food and also as cattle and poultry feed. It is well known that maize is an exhaustive crop and responds well to applied fertilizers. Though the continuous use of fertilizers had significantly improved the crop productivity, heavy fertilizer application on the same plot every year in continuous maize system will drain the soil fertility rapidly and resulted in reduction in crop productivity, deficiency of several micro nutrients, environmental pollution etc. Therefore, to maintain soil productivity on a sustainable basis an integrated nutrient management approach, using both organic and inorganic sources of nutrients should be adopted. The use of organic manure alone, cannot sustain the cropping system due to unavailability of required quantities and their relatively low nutrient content (Palm *et al.*, 1997) [6]. Thus, it has been realized that application of chemical fertilizers in conjunction with organic manures and bio fertilizers will sustain and maintain the productivity of soil. Therefore, it is necessary to compare various organic as well as biological sources of nutrients with chemical fertilizers. Keeping this point in view, present investigation was conducted to find out best combination of organic, inorganic fertilizers and biofertilizers for maximum production of maize with higher income level in sustainable manner without affecting the soil qualities.

Materials and Methods
Field experiments were conducted during summer season of 2015 by using maize variety GM 6 on clayey in texture soil at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the "influence of integrated nitrogen management in summer maize (*Zea mays* L.) under south Gujarat condition. The soil was slightly alkline in soil reaction (7.98), low in available nitrogen (230kg/ha), medium in available phosphorus (38 kg/ha) and fairly rich in potassium (379 kg/ ha). The experiment was laid out in randomized block design with three replications comprising eight treatments of inorganic, organic and biofertilizers with different proportion.

All the organic nutrient sources were analyzed for available N, P and K content and the required quantity of biocompostand vermicompost for each plot were calculated based on their nitrogen levels. Recommended dose of phosphorus and potassium were applied through chemical fertilizers where ever deficit. As per the treatments these organic sources were applied and incorporated into soil before sowing. The inorganic nutrient sources like N and P were supplied through urea and SSP, respectively. The seeds were sown with the spacing of 60cm x 30cm. Irrigation was given as and when required depending upon soil moisture. The analysis of plant samples were done at harvest for studies (Jackson, 1973) [2] and B: C ratio was calculated.

Results and Discussion

Effect on yield (kg/ha)

Significantly higher grain and straw yield (4032 and 6039kg/ha, respectively) of maize was recorded under 100% recommended dose of nitrogen through urea (T_1), which was at par with 75% RDN through inorganic fertilizer + 25% RDN from vermicompost (T_3, 3903 and 5850 kg/ha, respectively), 75% RDN through inorganic fertilizer + 25% RDN from biocompost (T_2, 3774 and 5578 kg/ha, respectively), 50% RDN from inorganic fertilizer+ 50% RDN from vermicompost (T_5, 3645 and 5314 kg/ha, respectively) and 50% RDN from inorganic fertilizer+ 50% RDN from biocompost only in case of grain yield (T_4, 3516 kg/ha). Percent decreased in grain yield under T_3, T_2, T_5 and T_4 to the tune of 3.20, 6.4, 9.6 and 12.8%, while 3.13, 7.5, 12.0 and 15.3% in straw yield over 100% RDN from inorganic fertilizer. Further, it was noticed that the different integrated nitrogen management, T_3 recorded significantly higher grain and straw yield, which was at par with T_2, T_5 and T_4. The significantly lower grain and straw yield were recorded under application of $^1/_3$ RDN from inorganic fertilizer + $^1/_3$ RDN from biocompost + $^1/_3$ RDN from vermicompost (T_6). The present findings are in close agreement with the results obtained by Iqbal *et al.* (2014) [1] and Nagavani and Subbian (2014) [4] in maize.

Effect on soil nutrient status after harvest

The soil available nitrogen and phosphorus after harvest of crop increased where nitrogen was supplied through integrated approach *i.e.* organic + inorganic sources. The extent of increase in available nitrogen, phosphorus and potassium were significantly higher (225.35, 23.97 and 370.40 kg/ha, respectively) in treatment, where $^1/_3$ RDN from inorganic source + $^1/_3$ RDN from biocompost +$^1/_3$ RDN from vermicompost (T_6) was applied, which was at par with the treatment $T_5$where 50% recommended nitrogen was supplied through inorganic source and rest of 50% through vermicompost (217.52, 23.21 and 330.13kg/ha, respectively) and treatment T_4, where 50% recommended nitrogen was supplied through inorganic source and rest of 50% through bicompost (210.33, 22.55 and 316.76kg/ha, respectively). Significantly lower available nitrogen and phosphorus were recorded under control treatment (T_1) (175.25 and 19.00 kg/ha, respectively). There was a reduction in available potassium after harvest of crop over its initial value (379kg/ha). The extent of increase in available nitrogen under T_5 and T_4 to the tune of 23.21 and 22.55%, respectively over 100% RDN through inorganic fertilizer (T_1). The increase in available nitrogen and phosphorus in treatments where the nitrogen was supplied through integrated sources could be attributed to the production of carbonic acids during decomposition of organics, which mineralize the complex organic substances, which in turn contribute to the nitrogen. The increase could also be attributed to greater multiplication of soil microbes caused by the addition of vermicompost, biocompost and bio-fertilizer, which mineralize organically bound nitrogen to inorganic form and convert unavailable form of nutrients in soil to available form for longer period. The similar effects of different organic and inorganic sources of nutrients on the nutrient status of soil after harvest of the crop were revealed by Shah *et al.* (2007) [7] in maize

Effect on economics (Rs/ha)

The maximum net realization of 55308 ₹/ha with BCR 2.37 recorded with 100% RDN though urea followed by treatment 75% RDN through urea + 25% RDN though biocompost (T_2: 49104 ₹/ha, 2.03, respectively) and T_4, in which 50% RDN through inorganic fertilizer + 50% RDN though biocompost (42896 ₹/ha, 1.70, respectively). The lowest net realization of 26516 ₹/ha with 0.77 BCR value was registered in treatment T_6 n which $^1/_3$ RDN from inorganic fertilizer + $^1/_3$ RDN from biocompost + $^1/_3$ RDN from vermicompost was applied. Integration of biocompost or vermicompost with inorganic fertilizer in different proportion recorded low net realization and B: Cratio mainly due to high cost of manure over 100% RDN through inorganic fertilizer. These results are in accordance with the findings Meena *et al.* (2013) and Nagavaniand Subbian (2014) [4].

Table 1: Influence of integrated nutrient management on yield, available soil nutrients and economics of maize.

	Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Available nutrients status (kg/ha)			Total cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
				N	P_2O_5	K_20			
T_1	100% RDN through inorganic source (120 kg N/ha)	4032	6039	175.25	19.00	276.81	23289	55308	2.37
T_2	75% RDN through inorganic source + 25% RDN from biocompost	3774	5578	181.80	19.67	290.07	24240	49104	2.03
T_3	75% RDN through inorganic source + 25% RDN from vermicompost	3903	5850	188.68	20.35	303.38	30360	45735	1.51
T_4	50% RDN from inorganic source + 50%RDN from biocompost	3516	5117	210.33	22.55	316.76	25195	42896	1.70
T_5	50% RDN from inorganic source + 50% RDN from vermicompost	3645	5314	217.52	23.21	330.13	37470	33147	0.88
T_6	$^1/_3$ RDN from inorganic source + $^1/_3$ RDN from biocompost + $^1/_3$ RDN from vermicompost	3129	4531	225.35	23.97	370.40	34012	26516	0.77
T_7	50% RDN from inorganic source + 25% RDN from biocompost + *Azospirillum*	3258	4864	203.04	21.07	343.52	23950	39512	1.65
T_8	50% RDN from inorganic source + 25% RDN from vermicompost + *Azospirillum*	3387	4994	195.90	21.78	356.90	30070	35717	1.19
	S.Em.±	171	263	10.54	1.04	19.57			
	C.D. at 5%	520	799	31.97	3.17	59.37			
	C.V. %	8.29	8.63	9.14	8.44	10.48			

Conclusion

From the results experimentation, it could be concluded that to obtain higher profitable yield of summer maize GM 6, crop should be fertilized with 100% RDN through inorganic source, but considering the higher profitability with maintaing soil fertility, the crop should be fertilized with 75% recommended nitrogen through urea and 25% through bio-compost under south Gujarat condition.

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