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Effect of Different Levels of Fertilizer Application along with Organic Manure on Maize Yield and Soil Fertility

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A B S T R A C T

A field experiment was conducted at at Regional Agricultural Research Station, Maruteru, West Godavari district, Andhra Pradesh during *Rabi*,2014-15 and 2015-16 to find out integrated nutrient management effect on maize with ten treatments *i.e*. T1 (Control), T2 (100% RDF), T3 (100% RDF + 25% RDF through FYM and vermicompost), T4 Soil Test Based Fertilizer Recommendation, T5 (125% RDF), T6 (150 % RDF), T7 Farmers Practice in RBD with 3 replications. Maize variety Kaveri Corn-50 was taken for study. The results revealed that the grain yield of maize respond significantly with the different treatment combination. The result showed highest grain yield (85.52 q ha^{-1}) with the application of 150% RDF, which was on par with the125% and 100% Recommended Dose of Fertilizers along with organics. The organic carbon content of the soil and available nutrient status of soil was found to be high in integrated nutrient management treatments and nutrient uptake in grain and stalk was also found to be high with the treatment receiving 150% recommended dose of fertilizers.

Introduction

Maize (*Zea mays* L.) is one of the important cereal crop after wheat and rice in the world. In India, it ranks third after rice and wheat. Maize is being consumed as food by human being, fodder by animals and also required by the various industries. The predominant maize growing states that contribute more than 80% of total maize production are Andhra Pradesh (20.9%), Uttar Pradesh (6.1%), and Madhya Pradesh (5.7%) Himachal Pradesh (4.4%) apart from these states maize is also grown Jammu and Kashmir and northern states (www. Farmers.gov.in). Andhra Pradesh is the non-traditional maize growing state but, the climate of the state is very favourable for the maize crop and hence maize can be grown in any season in the state. Moreover, winter maize is more assured crop with higher productivity potential compared to monsoon season. Therefore, areas where winter rice

crop suffers due to water scarcity, the maize has emerged as potential alternative like, Guntur, Krishna, and west Godavari districts. This shift is due to no-till maize in rice-maize system and cultivation of Single Cross hybrids. Maize hybrids grown during the winter season have an attainable grain yield of 10 to 12 t/ha. Such biomass generation can often be associated with removal of 200 kg N, 30 kg P, 167 kg K, and 42 kg S per hectare. Continuous production of high yielding maize will lead to the rapid depletion of mineral nutrients from soil because of the greater nutrient uptake and removal by maize. The present farming system totally depends on use of chemical fertilizers, pesticides and growth regulators for enhancing crop production. But deterioration in soil health associated with escalation in the prices of chemical fertilizers and environmental hazards due to excessive use of fertilizers, lead to emphasize on supplementation or substitution of chemical fertilizers with low priced nutrient sources such as organic and bio sources. Application of these nutrient sources alone or in combination with inorganic sources had been found beneficial not only in enhancing the productivity of maize and wheat but also had the beneficial impact on soil properties. Hence, the present experiment was conducted to find out the effect of integrated nutrient management and the levels of fertilizer application on yield attributes, yield and nutrient uptake of maize.

Materials and Methods

A field experiment was conducted at Regional Agricultural Research Station, Maruteru, West Godavari district, Andhra Pradesh during Rabi,14-15 and 15-16 seasons with seven treatments *i.e.,* Control, Recommended Dose of Fertilizers (120-32-32 NPK/acre), Integrated Nutrient Management (100% RDF + 25% RDF organic through FYM and vermicompost), Soil Test Based Fertilizer Recommendations (160-22-32 KPK/acre), 125% Recommended dose of fertilizers, 150% Recommended dose of fertilizers and Farmers practice (200-60-40 NPK/acre) with three replications. Maize hybrid (Kaveri Corn-50) was sown was sown in lines in a unit plot size of 8.0 m x 4.0 m with a spacing of 60 cm x 20cm. Application of farm yard manure was done before sowing of the maize crop in the given treatment. Urea as Nitrogen source was applied in three splits as Basal, at knee high and flowering stage. Single Super Phosphate, a phosphorus source was applied completely as basal; Muriate of potash, a potassium source was applied in two splits as basal and at flowering stage.

Observations on yield and yield parameters was done by selecting plants randomly in each net plot and were tagged with a level for recording various observations on growth and yield parameters. Biometric observation: Biometric observation such as plant population, average plant height at maturity, number of cobs, length of cobs, test weight of 1000 grain, cob girth, number of grain, number of row were recorded treatment wise grain and stalk yields were recorded per plot and converted into quintal ha-1. For recording yield data two border rows from each side as border were first removed from the field to avoid error. The crop in net plot was harvested for calculation on yield data.

Soil analysis pH:- pH of the soil determined by using soil water suspension (1:2.5) with the help of digital pH meter. EC: - EC also determined using soil water suspension (1:2.5) with help of conductivity meter (Jackson, 1967). Organic carbon: Organic Carbon was determined by Walkley and Black‟s rapid titration method as described by Jackson (1967). Available Nitrogen: It was determined by Alkaline Potassium Permagnate Method described by Subbiah and Asija (1956). Available Phosphorus: It is determined by

Olsen's method using 0.5 M NaHCO3 (Olsen *et al.,* 1954). Available Potassium:- Potassium is determined by using Neutral Normal Ammonium Acetate (pH 7.0) by Flame Photometer. Nitrogen in plant sample was determined by micro Kjeldahl method. Other nutrients like P, K, Ca, Mg, S and micronutrients were determined by using diacid digestion of plant sample and respective uptakes were calculated (Piper, 1966).

Initial Soil Analysis: The soils of the experimental field was clay loam having low available nitrogen (136.5 kg/ha), phosphorus (92.0 kg/ha) and potassium (268.5 kg/ha). pH and Electrical Conductivity of soil was 7.09 and 0.18 dS/m respectively. Organic carbon content of initial soil sample was 0.92%.

Results and Discussion

Yield parameters

The Cob length, No of grains per cob and test weight (100 kernels) among all treatments control treatment showed low as compared to all other treatments. Application of 150% and 125% recommended dose of fertilizers showed highest number of grains per cob. This indicates that the nutrient application resulted in augmented photosynthetic activity due to combined and balance effect of nutrients in maize. Increase in yield attributing parameters within 125% RDF and 150% RDF were noted in general significant. This might be attributed to increase in cell expansion and various metabolic processes in the presence of adequate available nutrient. Similar results were in accordance with the Kumar *et al.,* (2017) revealed that treatment T3 (150% RDF) recorded significantly higher growth parameters and yield attributes viz. plant height (201.90 cm), number of grains cob-1 (393.20), test weight (223.25 g) and grain yield (52.05 q ha ha-1) which was closely followed by treatment T5 (RDF+5 tons FYM ha–1 and recorded plant height (200.30 cm), number of grains cob-1 (391.95), test weight (223.15 g) and grain yield (51.70 q ha ha-1) and was found to be at par to treatment T3. However, Mehta *et al.,* (2005) also reported significant increase in cobs plant-1 of maize with application of 100 % RDF along with FYM at 10 t ha^{-1} over control.

However, treatment receiving Organic fertilizers along with chemical fertilizers also resulted in cob length, no. of grains per cob and 100 kernal weight. This might be due to the reason that, Organics besides release their own nutrient might have increased the nutrient use efficiency of applied inorganic fertilizer in maize crop. The result of the present study is in agreement with those of several investigators Sujatha *et al.,* (2008) and Kumar *et al.,* (2017).

Soil parameters

Regarding the soil pH and Electrical Conductivity no significant variation was observed. Variation in Soil organic carbon content among the different treatments was also not significant, however, treatment receiving Organics through farm yard manure resulted in highest organic carbon content in soil compared to all other treatments. Owing to the nature and the pattern of mineralization combined use of organic manures improved the physico chemical properties of the soil rather than application of chemical fertilizers. Similar results were also reported by Manickam (1993), Swarup Anand (1991) and Ramesh (1998).

Soil available nutrient status was also found to be low in case of control treatment as compared to that of all other treatments. There was no significant difference in soil available nutrient status among the levels of chemical fertilizers and treatment receiving chemical and organic fertilizers.

Table.1 Effect of levels of fertilizers application on yield attributes and yield of maize

S.No	Treatments	length of the cob			no. of rows per cob			No. of grains per cob			100 grain wt (g)			Grain yield (Q/ha)		
		2014	2015	Mean	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
1	Control	126	161	144	18.1	20.9	19.5	126	161	144	18.1	20.9	19.5	32.2	36.3	34.2
2	Recommended Dose of Fertilizers	255	261	258	27.2	29.2	28.2	255	261	258	27.2	29.2	28.2	70.0	80.5	75.3
3	Soil Test Based Fertilizer Recommendation	267	245	256	25.1	28.4	26.7	267	245	256	25.1	28.4	26.7	72.3	69.7	71.0
4	Integrated nutrient management	285	312	299	27.1	27.4	27.3	285	312	299	27.1	27.4	27.3	71.6	80.1	75.9
5	125% RDF	301	309	305	28.4	31.2	29.8	301	309	305	28.4	31.2	29.8	76.6	79.9	78.2
6	150% RDF	317	325	321	29.0	30.7	29.8	317	325	321	29.0	30.7	29.8	82.2	82.5	82.4
7	Farmers practice	300	297	299	24.4	28.4	26.4	300	297	299	24.4	28.4	26.4	72.9	74.6	73.8
	Mean	264	273	269	25.6	28.0	26.8	264	273	269	25.6	28.0	26.8	68.3	71.9	70.1
	CV (%)	10.73	13.65		8.94	9.24		15.50	16.74		9.60	10.25		16.95	15.27	
	CD (0.05)	3.06	21.50		2.01	1.94		36.21	40.16		4.21	3.96		9.80	11.63	

Table.2 Effect of levels of fertilizers application on soil physico chemical properties

S. No	Treatments	pH			E.C(ds/m)			Organic Carbon (%)		
		2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
1	control	6.49	6.6	**6.54**	0.54	0.55	**0.545**	0.89	0.91	**0.90**
2	Recommended Dose of Fertilizers	6.24	6.46	**6.35**	0.68	0.74	**0.71**	0.95	0.98	**0.96**
3	Soil Test Based Fertilizer Recommendation	6.06	6.24	**6.15**	0.62	0.64	**0.63**	1.00	1.04	**1.02**
4	Integrated nutrient management	6.21	6.29	**6.25**	0.63	0.53	**0.58**	1.04	1.04	**1.04**
5	125% RDF	5.98	6.06	**6.02**	0.76	0.74	**0.75**	1.01	0.97	**0.99**
6	150% RDF	6.12	6.15	**6.13**	0.67	0.67	**0.67**	0.91	0.94	**0.92**
7	Farmers practice	6.37	6.42	**6.39**	0.53	0.52	**0.52**	0.92	0.89	**0.90**
	Mean	**6.21**	**6.32**	**6.26**	**0.63**	**0.63**	**0.63**	**0.96**	**0.96**	**0.96**
	Initial	**6.09**			**0.18**			**0.92**		
	CV (%)	8.13	5.47		9.04	8.05		9.15	6.32	
	CD (0.05)	NS	NS		NS	NS		NS	NS	

Table.3 Effect of levels of fertilizers application on soil nutrient available status

S.No	Treatments	Available Nitrogen (Kg/ha)			Available Phosphorus (kg/ha)			Available Potassium (kg/ha)		
		2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
1	control	88.5	83.1	**85.8**	59.2	58.9	**59.05**	177.5	165.7	**171.6**
2	Recommended Dose of Fertilizers	115.7	109.9	**112.8**	81.6	69.4	**75.5**	203.6	223.9	**213.75**
3	Soil Test Based Fertilizer Recommendation	101.3	96.2	**98.75**	69.1	58.7	**63.9**	241.4	249.0	**245.2**
4	Integrated nutrient management	121.0	134.8	**127.9**	80.7	78.6	**74.65**	251.7	278.2	**264.95**
5	125% RDF	113.7	108.0	**110.85**	77.4	65.8	**71.6**	217.5	227.2	**222.35**
6	150% RDF	108.5	103.1	**105.8**	80.4	68.4	**74.4**	229	225.7	**227.35**
7	Farmers practice	105.4	100.1	**102.75**	80.1	68.1	**74.1**	215.1	236.5	**225.8**
	Mean	**107.73**	**101.3**	**104.51**	**75.5**	**65.4**	**70.45**	**219.4**	**269.5**	**244.45**
	Initial	**136.5**			**92.0**			**268.5**		
	CV (%)	14.4	11.36		12.19	10.62		14.29	11.16	
	CD (0.05)	8.41	10.2		5.41	6.20		22.79	29.8	

Table.4 Effect of levels of fertilizers on nutrient uptake of maize

S.No	Treatments	Nitrogen Uptake (Kg/ha)			Phosphorus Uptake (kg/ha)			Potassium Uptake (kg/ha)		
		2014	**2015**	**Mean**	**2014**	**2015**	**Mean**	**2014**	**2015**	**Mean**
1	control	45.3	39.6	**42.5**	11.1	11.4	**30.0**	21.9	20.7	**27.8**
2	Recommended Dose of Fertilizers	132.7	121.4	**127.1**	20.4	18.6	**84.0**	85.6	78.8	**83.6**
3	Soil Test Based Fertilizer Recommendation	133.3	124.4	**128.9**	20.8	17.0	**84.9**	84.8	78.2	**84.0**
4	Integrated nutrient management	139.0	133.5	**136.3**	24.4	15.1	**89.7**	92.8	86.6	**89.7**
5	125% RDF	132.3	121.1	**126.7**	20.2	19.5	**84.0**	83.6	87.2	**84.3**
6	150% RDF	142.5	134.4	**138.5**	20.3	14.0	**89.9**	94.7	88.1	**90.3**
7	Farmers practice	129.1	120.3	**124.7**	18.2	19.1	**82.3**	83.6	77.2	**81.8**
	Mean	**122.0**	**113.5**	**117.8**	**19.3**	**16.4**	**77.8**	**78.1**	**73.8**	**77.4**
	CV (%)	12.3	16.5		12.3	10.7		8.91	9.60	
	CD (0.05)	13.17	12.2		1.32	1.68		5.14	8.72	

Fig.1

Fig.2

However, soil available nutrient status in treatments receiving nutrients through only chemical fertilizers also indicated slight decrease in available nutrient status, but significant trend was not observed among the treatments receiving nutrients through only chemical fertilizers.

Treatment with Integrated nutrient management practice maintained soil available nutrient status for two seasons. Similar results were also reported by Lalith Kannan *et al.,* 2013 and Priyavarath Mishra *et al.,* 2019.

Plant nutrient uptake

Plant nutrient uptake was also found to low in case of control plot. However, plant nutrient uptake was high with chemical fertilizers and it was increased with the increase in level of fertilizer application. It might be due to the increase in dry weight or yield of maize, nutrient uptake also increased. There was not much significant increase in nutrient uptake was not observed among the chemical treatments and treatment receiving organic fertilizers. However, the nutrient uptake followed the same trend as that of maize yield.

The results obtained from the field experiments conducted to study effect of integrated nutrient management and the levels of fertilizer application on yield attributes, yield and nutrient uptake of maize revealed that, application of recommended dose of inorganic fertilizer along with FYM and vermicompost to maize not only enhanced productivity of maize over the control and recommended N, P and K respectively, but also improved soil fertility in terms of higher available N, P, K and organic carbon.

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