RESEARCH ARTICLE

RESPONSE OF RAINFED MAIZE (*ZEAMAYS*) AS INFLUENCED BY VARIOUSINTEGRATED NUTRIENT MANAGEMENT PRACTICES

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Abstract: A field experiment wasconducted at Research farm, Ambikapur during the *kharif* season of 2018-19 to study the various integrated nutrient management practices on production and profitability of maize. The experiment was conducted in randomized block designandreplicated thrice. The eleven nuitrient combinations100% RDF (150:80:60 NPK kg ha^{-1}), 75% RDF, 50% RDF excluding and including FYM and used *Azotobacter*and legume intercropping in three treatments and compared with state practice.Amongst the various nutrient management practices, the higher grain yield was recorded with application of 100% RDF + FYM 5 t ha^{-1} (7846.7 kg ha^{-1}) was significantly superior over all other treatments. However, it was on par with 100% RDF + Zn 5 kg ha^{-1} (7313.3 kg ha^{-1}) and 100% RDF (6717.8 kg ha^{-1}). Stover yield, shelling percentage and harvest index was recorded significantly higher with 100% RDF + FYM 5 t ha^{-1}. Again 100% RDF + FYM 5 t ha^{-1} was the best treatment with the highest net return (₹ 68814.9) and benefit cost ratio (1.58) found at par with 100% RDF + Zn 5 kg ha^{-1} (₹ 64138.2 and 1.56, respectively) and 100% RDF (₹ 55957.4 and 1.38, respectively)

Keywords: Integrated nutrient management, Maize, Net return

INTRODUCTION

Maize (*Zeamays* L.) is the most versatile and popular cereal crop in India. It has high yielding potentiality of hybrid varieties in both irrigated as well as rainfed condition with wider adaptability in varied agro-ecological conditions.It is the 3rd most important crop of India after rice and wheat. Maize crop also known as “queen of cereals” occupies pride place among rainy season (*kharif*) crops in India, contributes to the nearly 24% of total cereal production and contributes around 9% in the national food basket (Singh *et al*., 2011).

Maize is a staple food for Asian people, also serves as basic row material and industrial products that may include oil, starch, alcoholic, beverages, food sweetener, cosmetic, film, gum etc. In India at present, about 35% of the maize produced in the country is used for human consumption, 25% as animal feed and 15% as processed food. In view of huge demand, particularly used for poultry and cattle feed industry, maize is achieved popularity in our country.

Maize is highly nutrient exhaustive crop, it responds up to 200 kg N/ha, 100 kg P_2O_5/ha and 60 kg K_2O/ha. Hence, there is need to explore high the supply of these nutrients through organic and inorganic sources. The organic source of nutrient supply has distinct advantages of sustainability of crop production. In this context, practices such as green manuring, recycling crop residues, use of FYM, biofertilizer and vermicompost are important in agriculture.However, beneficial role of these practices on soil and crops has been well documented. Appropriate combination of organic and inorganic fertilizers helps to sustain soil productivity (Rao *et al*., 2002).

Fertilizers use to play an important role in agriculture production and productivity in India but continuous and imbalanced use of chemical fertilizer makes problem in the yield potential and deterioration of soil health. Future sustainability of maize production greatly depends on the improvement in soil resources based through the balanced fertilizer application.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season 2018 at Research Farm Ambikapur is situated in the north of Chhattisgarh and lies between 23° 10' North latitude and 83º 15' East longitudes having an altitude of 623 meter above mean sea level.The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.7), medium in organic carbon (0.56), available nitrogen (234 kg ha^{-1}), available phosphorus (8.4 kg ha^{-1}) and available potassium (268 kg ha^{-1}). The experiment was laid out in randomized block design with 11 treatment combinations:unmanured, 100% RDF (150:80:60 NPK kg ha^{-1}), 75% RDF, 50% RDF, FYM 10 t ha^{-1} + *Azotobacter*, maize + legume intercropping with FYM 10 t ha^{-1} + *Azotobacter*, 100% RDF + FYM 5 t ha^{-1}, 75% RDF + FYM 5 t ha^{-1}, 50% RDF + FYM 5 t ha^{-1}, 100% RDF + Zn 5 kg ha^{-1} and FYM 5 t ha^{-1} (state practice) with three replications. Sowing and spacing were made as per treatment.Experimental plots were sownmaize var. “JK super 502 by making furrow at 75 cm and dibbling 1 seed per hill at 5 to 7 cm depth maintaining spacing of 75 X 20 cm whereas in state practice spacing was 60 X 20 cm.

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After sowing, seeds were covered with thin layer of soil. As per treatment, two rows of cowpea have been sown as intercrop in between maize rows at 5 cm depth.Nutrient management was done as per treatment. Inrecommended dose of fertilizers was@ 150:80:60 kg ::NPK ha^{-1}.Fertilizers were applied through iffco (12:32:16), urea (46% N) and MOP (60% K_2O). The quantity of fertilizers and manures to be applied were computed per hectare then for plot. As per treatment, total amount of farmyard manure, phosphorus and potassium were applied as basal dose at sowing time whereas nitrogen was used in three equal splits *i.e.* once at the sowing time, second dose at knee high stage (30 DAS) and third dose at tasseling stage (50 DAS).Weed management was done as experimental plots. No chemicals were used in T_5 and T_6. The pre-emergence herbicides were applied next day after sowing whereas post-emergence herbicides were applied 25 DAS. Phorate granules (10G) were applied @ 1.5 kg ha^{-1} in sand mix to protect the crop against stem borer at 20 DAS. Monocrotophos was sprayed twice at 2 ml l^{-1} of water during crop growth against pod borers in cowpea. Five random plants were tagged randomly from each plot for recording of growth and yield attributes. Gross returns, net returns and benefit: cost ratios were calculated on the basis of prevailing market price of inputs and produce. All data obtained in the was statistically analysed using *F*- test, the procedure given by Gomez & Gomez (1984), critical difference (CD) values at *P*= 0.05 were used to determine the significance of differences between means.

RESULTS AND DISCUSSION

Growth attributes

Different nutrient management practices expressed significant effect on plant height and number of leaves plant^{-1} (Table 1). Higher plant height and number of leaves plant^{-1}were recorded with T_7*i.e.*, 100% RDF + FYM 5 t ha^{-1}found at par with T_{10}*i.e.*, 100% RDF + Zn 5 kg ha^{-1}, T_2*i.e.*, 100% RDF, T_8*i.e.*, 75% RDF + FYM 5 t ha^{-1}, T_3*i.e.*, 75% RDF, T_{11}*i.e.*, but found significantly superior over FYM 5 t ha^{-1} (state practice), T_9*i.e.*, 50% RDF + FYM 5 t ha^{-1} and T_4*i.e.*, 50% RDF, T_6*i.e.*, maize + legume intercropping with FYM 10 t ha^{-1} + *Azotobacter*, T_5*i.e.*, FYM 10 t ha^{-1} + *Azotobacter* and T_1*i.e.*, unmanured. Plant height and number of leaves plant^{-1} are important indices of plant growth which directly influences the dry matter production of maize crop. Combination of balanced fertilizer and organic manures significantly influence plant height and significantly higher plant height was recorded due to best nutrient management adopted in 100% RDF + FYM 5 t/ha treatment. This result is found to be in close conformity with Kumar *et al.* (2005).

Yield attributes

Various nutrient management practices produced significant expression on cob length (cm), cob girth (cm), no. of kernel rows cob^{-1} and no. of kernels row^{-1}(Table 1).The highest yield attributes were recorded with T_7 *i.e.*, 100% RDF + FYM 5 t ha^{-1}found on par with T_{10}*i.e.*, 100% RDF + Zn 5 kg ha^{-1} and T_2*i.e.*, 100% RDF but significantly superior over rest of the treatments viz., T_8*i.e.*, 75% RDF + FYM 5 t ha^{-1}, T_3*i.e.*, 75% RDF, T_{11}*i.e.*, FYM 5 t/ha (state practice) (16.88 cm), T_9*i.e.*, 50% RDF + FYM 5 t ha^{-1}, T_4*i.e.*, 50% RDF, T_6*i.e.*, maize + legume intercropping with FYM 10 t ha^{-1} + *Azotobacter*, T_5*i.e.*, FYM 10 t ha^{-1} + *Azotobacter* and T_1*i.e.*, unmanured.Increased growth attributes with application of 100% RDF + FYM 5 t ha^{-1} might have resulted due to release of sufficient amount of nutrients by mineralization as well as absorption of nutrients that in turn gave higher yield attributing characters. Shakunthala *et al.*, (2018)

Table 1. Effect of different integrated nutrient management practices on growth and yield attributes of maize

Treatments	Growth attributes		Yield attributes			
	Plant height (cm)	Number of leaves plant^{-1}	Cob length (cm)	Cob girth (cm)	No. of kernel rows cob^{-1}	No. of kernels row^{-1}
Unmanured	141.00	6.27	10.27	9.23	8.63	21.57
100% RDF (150:80:60 NPK)	228.60	9.18	20.62	14.53	15.01	37.23
75% RDF (112:60:45 NPK)	220.90	8.52	19.04	14.01	13.89	33.82
50% RDF (75:40:30 NPK)	196.90	8.07	14.82	12.63	12.53	28.80
FYM 10t/ha + Azotobacter	145.33	6.45	10.36	12.12	10.47	22.33
Maize + legume intercropping with FYM 10t/ha + Azotobacter	147.53	6.57	12.57	12.52	10.53	23.63
100% RDF + FYM 5 t/ha	235.20	9.75	20.96	14.99	15.24	38.56

75% RDF + FYM 5 t/ha	226.60	9.03	19.75	14.10	13.9	35.80
50% RDF + FYM 5 t/ha	199.37	8.40	15.32	13.10	13.67	29.37
100% RDF + Zn 5 kg/ha	231.60	9.21	20.71	14.74	15.01	38.17
FYM 5 t/ha (state practice)	212.40	8.61	16.88	13.47	13.86	31.66
Sem±	6.04	0.43	0.32	0.20	0.39	0.84
C.D. (0.05)	17.81	1.25	0.94	0.60	1.14	2.49

Yield

The kernel, cob and stover yield were significantly influenced due to different treatment combinations (Table 2). The maximum yield (cob, kernel and stover) were recorded with T_7*i.e.*, 100% RDF + FYM 5 t ha^{-1} which was found at par with T_{10}*i.e.*, 100% RDF + Zn 5 kg ha^{-1} and T_2*i.e.*, 100% RDF but significantly superior over T_6*i.e.*, maize + legume intercropping with FYM 10 t ha^{-1} + *Azotobacter*, T_8*i.e.*, 75% RDF + FYM 5 t ha^{-1}, T_3*i.e.*, 75% RDF, T_{11}*i.e.*, FYM 5 t ha^{-1} (state practice), T_9*i.e.*, 50% RDF + FYM 5 t ha^{-1}, T_4*i.e.*, 50% RDF, T_5*i.e.*, FYM 10 t ha^{-1} + *Azotobacter* and T_1*i.e.*, unmanured which recorded minimum yield. The yield (grain and stover) is the function of cumulative effect of yield attributes and the growth characters. The grain yield of maize positively influenced by cob length, cob girth, number of rows cob^{-1}, number of kernels $row^{-1}$and 100 grain weight. Yield attributes of maize were significantly influenced by adapting different nutrient management practices and higher value were noticed with 100 % recommended dose of fertilizer along with FYM. Use of FYM not only favored the crop plants with more availability of micro nutrients but also improve soil structure facilitating vigorous growth of crop plants. These results are found to be in close conformity with Jat *et al*., (2013).

Economics

Different nutrient management practices had significant influence on net return and benefit: cost ratio. Net return was significantly influenced with various treatments. Maximum net return achieved with T_7*i.e.*, 100% RDF + FYM 5 t ha^{-1} (₹68,814.9 ha^{-1}) which was found at par with T_{10}*i.e.*, 100% RDF + Zn 5 kg ha^{-1} (₹64,138.2 ha^{-1}), and T_2*i.e.*, 100% RDF (₹55,957.4 ha^{-1}) and all these treatments were found significantly superior over T_3*i.e.*, 75% RDF (₹50,431.9ha^{-1}), T_6*i.e.*, maize + legume intercropping with FYM 10 t ha^{-1} + *Azotobacter* (₹ 40,656.4 ha^{-1}), T_8*i.e.*, 75% RDF + FYM 5 t ha^{-1} (₹49,176.2 ha^{-1}), T_9*i.e.*, 50% RDF + FYM 5 t ha^{-1} (₹43,592.4 ha^{-1}), T_{11}*i.e.*, FYM 5 t ha^{-1} (state practice) (₹42,170.1 ha^{-1}), T_4*i.e.*, 50% RDF (₹31,995.7 ha^{-1}), T_5*i.e.*, FYM 10 t ha^{-1} + *Azotobacter* (₹7,194.9 ha^{-1}) and minimum net return was achieved with T_1*i.e.*, unmanured (₹6,945.6 ha^{-1}).

The maximum benefit cost ratio was recorded under T_7*i.e.*, 100% RDF + FYM 5 t ha^{-1} (1.58) which was found on par with T_{10}*i.e.*,100% RDF + Zn 5 kg ha^{-1} (1.56) followed by T_2*i.e.*, 100% RDF (1.38), T_3*i.e.*, 75% RDF (1.31), T_8*i.e.*, 75% RDF + FYM 5 t ha^{-1} (1.19) but significantly superior over T_9*i.e.*, 50% RDF + FYM 5 t ha^{-1} (1.11), T_6*i.e.*, maize + legume intercropping with FYM 10 t ha^{-1} + *Azotobacter* (0.82), T_{11}*i.e.*, FYM 5 t ha^{-1} (state practice) (0.91), T_4*i.e.*, 50% RDF (0.88), T_1*i.e.*, unmanured (0.24) and minimum benefit cost ratio was obtained with T_5*i.e.*, FYM 10 t ha^{-1} + *Azotobacter* (0.17).

The practical utility of any nutrient management practices can be best judged because of net return and B:C ratio. Nutrient management treatments showed significant direct yield advantage over unmanured treatment in maximizing net return as well as B:C ratio. This was because of more net returns than the money spent in crop production under these treatments. These results are found to be in close conformity with findings of Mahesh *et al*., (2010).

CONCLUSIONS

Based on the experiment it can be concluded that application of 100% RDF + FYM 5 t ha^{-1} was most effective combination of balanced fertilizer and organic manure to enhanced yield attributes and yield of maize which was at par with 100% RDF + Zn 5 kg ha^{-1}, 100% RDF and significantly superior over rest of the treatments. 100% RDF + FYM 5 t ha^{-1} produced the yield 15.30% more than 100% RDF alone.

Table 2. Effect of different integrated nutrient management practices on yield and economics of maize

Treatments	Yield			Economics	
	Kernel yield (kg ha^{-1})	Cob yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Unmanured	2435.6	3404.22	4396.75	6945.6	0.24
100% RDF (150:80:60 NPK)	6717.8	8589.65	8331.64	55957.4	1.38
75% RDF (112:60:45 NPK)	6135.6	8032.19	8103.28	50431.9	1.31
50% RDF (75:40:30 NPK)	4697.8	6232.01	6188.64	31995.7	0.88
FYM 10 t/ha + Azotobacter	3428.9	4661.10	4539.98	7194.9	0.17
Maize + legume intercropping with FYM 10 t/ha + Azotobacter	6443.0*	4933.85	4802.24	40656.4	0.82
100% RDF + FYM 5 t/ha	7846.7	9904.60	9511.58	68814.9	1.58
75% RDF + FYM 5 t/ha	6268.9	8137.87	8194.51	49176.2	1.19
50% RDF + FYM 5 t/ha	5706.7	7536.16	7542.30	43592.4	1.11
100% RDF + Zn 5 kg/ha	7313.3	9309.51	9293.29	64138.2	1.56
FYM 5 t/ha (state practice)	6095.6	8003.37	8244.34	42170.1	0.91
Sem±	411.7	533.33	566.18	5915.6	0.15
C.D. (0.05)	1214.5	1573.35	1670.27	17451.4	0.44

***Equivalent yield in terms of maize**

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