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Response of integrated nutrient management (INM) to yield and nutrient uptake of *rabi* Castor

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Abstract

A field experiment was conducted on Inceptisols of College Farm, Navsari Agricultural University, Navsari, Gujarat (India) during *rabi* 2004-2005 to study the effect of Integrated nutrient management (INM) in *rabi* castor (GCH-4) grown on of *Vertic Ustrochrepts* of South Gujarat. Response of castor to yield and nutrient uptake was significant due to both the levels of inorganic fertilizers and organic manures as well as their interaction. The yield of castor seed and stalk were significantly higher with higher levels of inorganic fertilizers (100 % RDF). Application of bio compost @ 5 t/ha increased the seed and stalk yield of castor. The N, P, K, Fe, Mn and Zn uptake by crop was significant due to levels of inorganic fertilizers and source of organic manures and their interaction over control. Significantly highest uptake of most of the nutrients was found due to application of bio compost @ 5 t/ha along with 100 per cent RDF.

Key words: Integrated nutrient management, nutrient uptake, yield, castor

Introduction

Oil seed crops have a unique significance in recent era of energy crisis as they play pivotal role in the agricultural industry and export trade of India. Castor holds first position among the non-edible oilseeds and occupies 38 and 36 per cent production and area, respectively in India. The integrated management of plant nutrient resources through judicious use of organic, inorganic and bio-fertilizers offer an opportunity to sustain agriculture along with minimizing any soil and environmental damage. On the contrary, it has been clearly evidenced that balanced and integrated nutrient management improves the soil organic matter content as well as soil quality which is an index of better soil health and sustainability of the system (1, 2, and 3). However, the quantification of nutrient removed by the *rabi* castor under South Gujarat condition has not been studied so far, hence, the present study was planned to assess the impact of Integrated Nutrient Management on the productivity of *rabi* castor.

Material and methods

A field experiment was conducted during rabi season 2004-05 at College Farm, NAU, Navsari, (Gujarat-India) situated at 21° 07' N latitude and 73° 40' E longitude with an elevation of 10 m above mean sea-level, entitled " Integrated nutrient management (INM) in *rabi* castor (GCH-4) grown on of *Vertic Ustrochrepts* of South Gujarat ". The experiment was laid out in factorial randomization block design (FRBD) with 16 treatments composed of 4 levels of fertilizers (F_0: No fertilizer, F_1: 50 % RDF, F_2: 75 % RDF, F_3: 100 % RDF) and 3 sources of manures (M_0 – No organic manure, M_1 – Farm Yard Manure @ 5 t/ha, M_2 – Bio compost @ 5 t/ha, M_3 – Vermi compost @ 2 t/ha) and it was replicated thrice. The experimental soil is classified under the order 'Inceptisols' comprises members of fine, montmorillonitic, isohyperthemic family of *Vertic Ustrochrepts* and soil series Jalalpur. The color of dry soil is dark brown and texture is clay and neutral to slightly alkaline in reaction. Soil samples from the experimental plots were drawn from 0-22.5 cm and 22.5-45 cm depths before sowing and after harvest of castor crop to determine the physico-chemical properties. The experimental soil was low in available N, medium in available P_2O_5 and high in available K_2O with slight problem of excess soluble salts and compactness due to the puddling for *kharif* rice crop. Yield of castor in each plot was recorded at each harvest and yield per hactare was calculated based on the total yield obtained from the net plot. Fresh castor plant samples were analyzed for N, P, K, Fe, Mn and Zn content by standard analytical

techniques. Statistical analysis was carried out as per the methods described by Panse and Sukhatme (4).

Results and discussion

The results of study indicated that castor seed and stalk yield was significantly affected due to the different levels of inorganic fertilizers (Table 1). Application of 100 per cent RDF through inorganic fertilizers (F_3) significantly produced 34 per and 50 per cent higher seeds and stalk yield of castor, respectively over control treatments (F_0). The 50 per cent RDF through inorganic fertilizers failed to increase the seed yield might be due to the lack of translocation of these nutrients from vegetative parts to yield contributors or might be due to the short supply of nutrients. Similar results were also reported by Sree and Reddy (5). Application of bio compost @ 5 t/ha recorded higher seed (1691.2 kg/ha) and stalk (1505.1 kg/ha) yield over control, while vermi compost and FYM showed more or less similar yield over control. The results evidenced the supremacy of bio compost (M_2) over rest of the treatment could be because of better nutrient supply through out the cropping period and also might be due to the better aggregate formation. Application of vermi compost and FYM though produced positive effect over control but, failed to increase the seed yield might be due to the different rate of application and quantity of nutrients supplied through them. Sjgnificantly 84 and 49 per cent higher castor seed and stalk yield was registered at 100 per cent RDF along with 5 t bio compost/ha (M_2F_3) over the treatment combinations M_1F_0 and M_0F_0, respectively. This was possible due to the improvement in all the growth and yield attributes which might have generated a cumulative effect on seed yield. Another reason might be due to the additive effect of bio compost which might be possible

Table 1. Effect of INM on seed and stalk yield (kg/ha) of castor

Treatments	Seed				
	M_0	M_1	M_2	M_3	Mean
F_0	1256.7	1241.5	1373.6	1345.3	1304.3
F_1	1301.1	1339.8	1439.4	1291.6	1343.0
F_2	1374.0	1584.5	1663.9	1390.7	1503.3
F_3	1486.6	1731.2	2288.0	1485.3	1747.8
Mean	1354.6	1474.3	1691.2	1378.2	
	S. Em. +	C.D. at 5 %			
M	52.0	150.3			
F	52.0	150.3			
M x F	104.1	300.6			
C. V. %	12.20				
	Stalk				
	M_0	M_1	M_2	M_3	Mean
F_0	1083.8	1095.9	1116.6	1097.6	1098.5
F_1	1144.2	1294.4	1303.0	1337.5	1269.8
F_2	1270.2	1427.3	1479.1	1543.7	1430.1
F_3	1348.1	1651.7	2121.7	1473.7	1648.8
Mean	1211.6	1367.3	1505.1	1363.1	
	S. Em. +	C.D. at 5 %			
M	43.0	124.1			
F	43.0	124.1			
M x F	85.9	248.2			
C. V. %	10.90				

Table 2. Effect of INM on N, P and K uptake (kg/ha) of castor crop

Treatments		N				
		M_1	M_2	M_3	Mean	
F_0		29.81	28.97	30.50	31.63	30.23
F_1		31.94	33.13	35.43	31.66	33.04
F_2		34.43	37.79	38.52	34.32	36.26
F_3		35.39	39.44	46.19	36.53	39.39
	Mean	32.89	34.83	37.66	33.54	
		S. Em. +	C.D. at 5 %			
	M	1.27	NS			
	F	1.27	3.67			
	M x F	2.54	NS			
	C. V. %	12.66				
		P				
		M_0	M_1	M_2	M_3	Mean
F_0		8.11	9.14	8.77	8.81	8.71
F_1		9.40	9.79	10.23	9.35	9.69
F_2		10.78	11.86	11.89	10.23	11.19
F_3		11.84	13.48	16.14	11.30	13.19
	Mean	10.03	11.07	11.76	9.92	
		S. Em. +	C.D. at 5 %			
	M	0.29	0.83			
	F	0.29	0.83			
	M x F	0.58	1.67			
	C. V. %	9.36				
		K				
		M_0	M_1	M_2	M_3	Mean
F_0		18.79	20.14	21.13	20.24	20.07
F_1		20.96	22.96	25.70	23.50	23.28
F_2		23.28	27.16	30.02	26.04	26.63
F_3		25.06	31.92	43.15	27.67	31.95
	Mean	22.02	25.54	30.00	24.36	
		S. Em. +	C.D. at 5 %			
	M	0.83	2.40			
	F	0.83	2.40			
	M x F	1.66	4.79			
	C. V. %	11.27				

Table 3. Effect of INM on Fe, Mn and Zn uptake (g/ha) of castor

Treatments		Fe				
		M_0	M_1	M_2	M_3	Mean
F_0		75.90	80.07	100.50	87.57	86.01
F_1		93.00	105.13	116.40	102.43	104.24
F_2		107.40	136.40	135.03	118.03	124.22
F_3		137.60	158.07	217.73	125.47	159.72
	Mean	103.48	119.92	142.42	108.38	
		S. Em. +	C.D. at 5 %			
	M	3.73	10.78			
	F	3.73	10.78			
	M x F	7.46	21.55			
	C. V. %	10.90				
				Mn		
		M_0	M_1	M_2	M_3	Mean
F_0		32.94	36.53	47.08	45.01	40.39
F_1		52.60	59.46	66.50	62.04	60.15
F_2		67.75	80.70	89.30	78.49	79.06
F_3		86.77	105.41	195.36	118.77	126.58
Mean		60.02	70.53	99.56	76.08	
		S. Em. +	C.D. at 5 %			
	M	2.94	8.48			
	F	2.94	8.48			
	M x F	5.87	16.96			
	C. V. %	13.29				
				Zn		
		M_0	M_1	M_2	M_3	Mean
F_0		49.88	53.78	59.43	58.59	55.42
F_1		64.61	69.55	78.03	71.22	70.86
F_2		76.32	90.30	110.23	86.98	90.96
F_3		102.35	119.10	198.38	111.76	132.90
Mean		73.29	83.18	111.52	82.14	
		S. Em. +	C.D. at 5 %			
	M	3.63	10.49			
	F	3.63	10.49			
	M x F	7.27	20.98			
	C. V. %	14.38				

because of better soil condition, mineralization of essential plant nutrients, addition of micronutrients in the soil, the enhanced activities of microbes and release of growth stimulants (enzymes) due to the increased activities of microorganisms. Similar results were also reported by Arangarasan *et al.* (6) and Laxminarayana (7).

The data presentated in table 2 on total uptake of N, P and K by castor crop were significant due to both levels of inorganic fertilizers and organic manures as well as their interaction. Significantly higher N (39.39 kg/ha) uptake was noticed under 100 per cent RDF through inorganic fertilizers (F_3). Higher total N uptake was registered in treatment F_3 followed by F_2, however, both were found at par with each other but, significantly superior over F_0. This was possible due to the better dry matter production and content in different component of castor plant. Similar results were also observed by Thanki *et al.* (8). The variation in N uptake was not observed due to the sources of organic manure and their interaction. Application of 100 per cent RDF through inorganic fertilizers (F_3) recorded higher amount (13.19 kg/ha) of P uptake. The P uptake by castor crop was linearly increased with levels of inorganic fertilizers to the tune of 11, 28 and 51 per cent over control at F_1, F_2 and F_3, respectively. Application of 5 t bio compost/ha (M_2) resulted significantly higher (17 %) total P uptake over control (M_0), however, it was at par with application of 5 t FYM/ha (M_1). The total uptake of P and K was significantly highest at M_2 (5 t bio compost/ha) over rest of the treatments but, it was at par with M_1 (5 t FYM/ha). This might be due to higher percentage of P and K in seed and stalk and also better dry matter production. Similar results were also reported by Sree and Reddy (5) and Thanki *et al.* (8). The lower total P uptake was seen when vermi compost was applied and it was at par with control. Significantly highest (16.14 kg/ha) amount of P was removed when 100 per cent RDF along with 5 t bio compost/ha was applied (M_2F_3) over rest of the interactions. The data presented in table 2 revealed that K uptake of castor plants was affected significantly due to the application of different levels of inorganic fertilizers (F). Significantly higher K uptake (31.95 kg/ha) was found at F_3 (100 % RDF level which was found 59 per cent higher over the control. Data further noted the significant effect of organic manures on K uptake. Significantly higher K uptake (30.00 kg/ha) was also registered at M_2 level *i.e.* application of 5 t bio compost/ha. The interaction M_2F_3 (application of 5 t bio compost/ha along with 100 per cent RDF through inorganic fertilizers) significantly registered higher K uptake (43.15 kg/ha). The reasons for significance might be due to instant supply of plant nutrients enhancing the crop growth or absorption of nutrients and might be better soil condition.

The data presented in table 3 revealed that Fe, Mn and Zn uptake was significantly affected due to the application of different levels of inorganic fertilizers (F). Significantly higher Fe, Mn and Zn uptake (159.72, 126.58 and 132.90 g/ha, respectively) was found at F_3 level *i.e.* application of 100 per cent RDF through inorganic fertilizers to castor crop which exhibited 86, 213 and 140 per cent higher uptake of Fe, Mn and Zn, respectively over control. This might be due to higher percentage of Fe, Mn and Zn in different components and higher dry biomass of castor. Significantly highest Fe, Mn and Zn uptake by (142.42, 99.56 and 111.52 g/ha, respectively) was registered at M_2 (5 t bio compost/ha) level. Application of 5 t bio compost/ha (M_2) increased Fe, Mn and Zn uptake by 38, 66 and 52 per cent higher over no application of organic manure (M_0), respectively. The supremacy could be due to many reasons, firstly due to release of more micronutrients which caused micro change in soil pH resulting in better nutrient availability, alteration in soil condition and better root netting. The increase in uptake of these micronutrient cations could also be due to the perceptible increase in the biomass due to the active synthesis of tryptophan in presence of Zn, the precursor of indole acetic acid which stimulated the growth of plant tissues (9) and also more absorption of these nutrients by the crop. The interaction M_2F_3 (application of 5 t bio compost/ha along with 100 per cent RDF through inorganic fertilizers) significantly registered higher Fe, Mn and Zn uptake *i.e.* 217.73, 195.36 and 198.38 g/ha, respectively. The interaction M_0F_0 (neither application of organic manures nor inorganic fertilizers) resulted lower Fe, Mn and Zn uptake.

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