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## Effect of farm yard manure and nitrogen on nutrient content and uptake of castor (*Ricinus communis* L.)

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### Abstract

An experiment was conducted during *kharif* season of the year 2017-18 at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the "Effect of farm yard manure and nitrogen on nutrient content and uptake of castor (*Ricinus communis* L.)". Nitrogen content in seed and stalk (%), nitrogen uptake by seed and stalk (kg/ha), available nitrogen in soil (kg/ha) were significantly increased with application of FYM prepared by pit method ( $M_2$ ). Whereas, phosphorus content in seed and stalk (%) and available phosphorus status in soil was not affected due to different methods of FYM preparation. With regard to effect of different nitrogen management treatments on castor, N content as well as N uptake by seed and stalk, available N in soil showed significant improvement due to application of 100% RDN + bio NPK consortium ( $N_3$ ). Remarkably higher phosphorus uptake by seed and stalk of castor was recorded with treatment combination  $M_2N_3$  (application of FYM prepared by pit method + 100% RDN through fertilizer + seed inoculation with bio NPK consortium).

**Keywords:** FYM, pit method, Bio NPK consortium, castor, nitrogen

### Introduction

Castor (*Ricinus communis* L.) is a non-edible oilseed crop having high industrial importance due to presence of unique fatty acid and ricinoleic acid. It belongs to family *Euphorbiaceae* and originated from Ethiopia. India is the world's largest producer of castor and its derivatives contributing to almost 65 per cent share. Gujarat, Rajasthan and Andhra Pradesh are the major castor growing states in India. Castor seed contains 45 to 50 per cent oil, which is considered as versatile industrial raw materials because of ricinoleic acid and hydroxyl fatty acid. The castor oil is differing from vegetable oil due to its non-freezing nature up to  $-18^{\circ}\text{C}$  temperature. It is therefore, considered as the best lubricating agent particularly for both high speed engines and aeroplanes. Castor oil has many medicinal uses, including constipation (when taken internally), relief from pain, inflammation and stomach problems. Castor has emerged as one of the most important agricultural commodities for earning much needed foreign exchange. After extraction of oil from the seeds remaining portion is known as castor cake which contains 4.5 per cent nitrogen, 2.6 per cent phosphorus and 1.0 per cent potash. However, it is unfit as cattle feed due to presence of toxic substance *i.e.* ricin, but extensively used as organic manure.

FYM is the most common organic manure used for crop production by farmers in India, but they do not give adequate attention to the proper conservation and effective use of resource. For preparing better quality FYM, the use of pit method for areas with less than 1000 mm precipitation is recommended (Prasad *et al.*, 2014) <sup>[9]</sup>. The existing practice of preparing farm yard manure by heap method in which heap of manure remains exposed to sun under open space/sky during the composting period. Losses of nutrients may occur through volatilization and leaching when FYM is prepared by heap method as compared to pit method leads to poor in nutrient content and makes it less efficient and decreases its potentiality for increasing crop yield much more than that of FYM prepared by pit method. FYM produced by pit method with nutrient enrichment have good quality FYM with respect to major and micro nutrients content than indigenous heap method. FYM obtained by pit method contains 17.0, 9.0, 27.0, 7.0, 24.0, 7.0 and 10.0 per cent higher nitrogen, phosphorus, potash, iron, zinc, manganese and copper

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than heap method, respectively (CIL, SDAU, S. K. Nagar). In present investigation, FYM contains 0.64% N, 0.22% P<sub>2</sub>O<sub>5</sub> and 0.62% K<sub>2</sub>O prepared by pit method and 0.41% N, 0.17% P<sub>2</sub>O<sub>5</sub> and 0.41% K<sub>2</sub>O prepared by heap method.

Nitrogen is the most important determinant of plant growth and crop yield. Plants lacking in N show stunted growth and yellowish leaves. It is an essential component of the protein that builds cell material and plant tissue. The increasing cost of fertilizers play a significant role in increasing cost of agriculture produce and thereby reduction in net profit. Substitution of chemical fertilizers with biofertilizers found cost effective and eco-friendly. Micro-organisms play a vital role in fixing/solubilizing/mobilizing/recycling of macro and micro nutrients in agricultural eco-system. Although, they occur in soils naturally, their populations are often insufficient to bring about the desired level of nutrient mobilization (Welbaum *et al.*, 2004) [12].

### Materials and Methods

The present experiment was conducted during *kharif* season of the year 2017-18 and laid out on Plot No. B-11 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, North Gujarat on loamy sand soil to study the effect of nutrient content and uptake of castor (*Ricinus communis* L.). The soil of the experimental field was loamy sand in texture, low in organic carbon (0.17%) and available nitrogen (155.7 kg/ha), medium in available phosphorus (33.9 kg/ha), available potash (189.0 kg/ha) with soil pH of 7.2. Castor variety GCH-7 was used as test crop. The data were statistically analysed for various characters as described by Panse and Sukhatme (1985) [6].

The experiment evaluated in Randomized Block Design (Factorial concept) with two methods of FYM preparation M<sub>1</sub>: Heap method and M<sub>2</sub>: Pit method with four nitrogen management N<sub>1</sub>: 100% RDN, N<sub>2</sub>: 75% RDN, N<sub>3</sub>: 100% RDN + bio NPK consortium and N<sub>4</sub>: 75% RDN + bio NPK consortium in with specific criteria which were Recommended Dose of Nitrogen (RDN): 180 kg N/ha, FYM prepared by heap and pit

methods was applied @ 10 t/ha as per treatment, NPK consortium was applied @ 5ml/kg seed as seed inoculation, Phosphorus was applied @ 37.5 kg P<sub>2</sub>O<sub>5</sub>/ha as common dose from SSP and FYM prepared by pit method contain 0.64% N, 0.22% P<sub>2</sub>O<sub>5</sub> and 0.62% K<sub>2</sub>O whereas, FYM prepared by heap method contain 0.41% N, 0.17% P<sub>2</sub>O<sub>5</sub> and 0.41% K<sub>2</sub>O.

### Results and Discussion

#### Effect on nutrient content

#### Effect of methods of FYM preparation on nutrient content of castor

Various methods of FYM preparation exerted their non-significant influence on phosphorus content in seed and stalk of castor. Application of FYM prepared by pit method (M<sub>2</sub>) have recorded 7.40 and 9.43 per cent higher N content in seed and stalk. This might be due to well decomposed FYM and good quality FYM prepared which have higher N content (0.64%) assure more availability of N in the soil which lead to higher uptake of N by plant increase the concentration of N in seed and stalk of castor.

#### Effect of nitrogen management on nutrient content of castor

Various methods of FYM preparation exerted their non-significant influence on phosphorus content in seed and stalk of castor. Whereas application of 100% RDN through inorganic fertilizer + seed inoculation with bio NPK consortium (N<sub>3</sub>) recorded significantly the highest nitrogen content in seed (2.18) and stalk (0.63) over the rest of the treatments. This might be due to application of higher amount of nitrogen under 100% RDN along with seed treatment of bio NPK consortium might have increased better availability of N in the soil to supply nutrient requirement of crop and bio NPK consortium increase N fixation. Thus, combine effect of both might have helped in increase of uptake of nutrients due to release of nutrients at its optimum amount for a longer period. The results are in close proximity with the findings of Lakshmi and Reddy (2006) [3] noted that N content in seed and stalk increased significantly with 80 kg N/ha.

**Table 1:** Nitrogen and phosphorus content in seed and stalk of castor as influenced by different treatments

Treatments	Nutrient content (%)			
	Nitrogen		Phosphorus	
	Seed	Stalk	Seed	Stalk
<b>Methods of FYM preparation (M)</b>				
M <sub>1</sub> : Heap method	1.89	0.53	0.79	0.28
M <sub>2</sub> : Pit method	2.03	0.58	0.81	0.29
S.Em.±	0.03	0.009	0.01	0.005
C.D. (P = 0.05)	0.08	0.026	NS	NS
<b>Nitrogen management (N)</b>				
N <sub>1</sub> : 100% RDN	1.86	0.53	0.81	0.29
N <sub>2</sub> : 75% RDN	1.85	0.53	0.80	0.28
N <sub>3</sub> : 100% RDN + Bio NPK consortium	2.18	0.63	0.81	0.30
N <sub>4</sub> : 75% RDN + Bio NPK consortium	1.95	0.56	0.79	0.29
S.Em.±	0.04	0.013	0.01	0.007
C.D. (P = 0.05)	0.11	0.037	NS	NS
Interaction (M × N)	NS	NS	NS	NS
C.V.%	5.28	6.34	4.53	7.04

### Interaction effect

Interaction effect between methods of FYM preparation and nitrogen management did not impart their significant influence on nitrogen content in seed and stalk of castor.

### Effect on nutrient uptake

#### Effect of methods of FYM preparation on nitrogen uptake by seed and stalk (kg/ha)

Treatment M<sub>2</sub> (Pit method) recorded significantly the highest in nitrogen uptake by seed and stalk 58.04 and 28.03 kg/ha,

respectively as compared to M<sub>1</sub> (Heap method) with the figure of 46.28 and 22.46 kg/ha, respectively. This might be due to higher N content in seed and stalk.

### Effect of nitrogen management on nitrogen uptake by seed and stalk (kg/ha)

In case of nitrogen uptake, treatment N<sub>3</sub> (100% RDN + bio NPK consortium) recorded significantly the highest nitrogen uptake in seed (62.73 kg/ha) and stalk (31.40 kg/ha) over the rest of the treatments. While lower nitrogen uptake in seed (41.83 kg/ha) and stalk (22.16 kg/ha) was recorded under treatment N<sub>2</sub> (75% RDN). However, it remained statistically at par with treatment N<sub>1</sub> and N<sub>4</sub>. This indicated that 13.79 and 20.9 per cent higher N removed by seed and 8.46 and 9.24 per cent higher N removed by stalk with treatment N<sub>3</sub> (100% RDN + bio NPK consortium) as compared to treatments N<sub>1</sub> (100% RDN) and N<sub>2</sub> (75% RDN), respectively. This could be ascribed to higher N content (Table 4.8) and seed and stalk yield (Table 4.6) of castor. These results are in close accordance with the findings of Mathukia and Modhwadia (1995) [4], Chavan *et al.* (2005) [1], Senthil and Kanjana (2009) [10], Paramanik and Bera (2012) [7] and Dodiya *et al.* (2016) [2]. The present findings are in agreement with those reported by Chavan *et al.* (2005) [1] that application of 80 kg N/ha recorded significantly higher nitrogen uptake and Senthil and Kanjana (2009) [10] noted that maximum nitrogen uptake by castor were recorded with application of 75% RDF + ZnSO<sub>4</sub> @ 12.5 kg/ha as basal + ZnSO<sub>4</sub> @ 0.25% foliar spray.

**Table 2:** N uptake by castor seed and stalk as influenced by different treatments

Treatments	Nutrients uptake (kg/ha)	
	Nitrogen	
	Seed	Stalk
<b>Methods of FYM preparation (M)</b>		
M <sub>1</sub> : Heap method	46.28	22.46
M <sub>2</sub> : Pit method	58.04	28.03
S.Em.±	0.97	0.79
C.D. (P = 0.05)	2.83	2.33
<b>Nitrogen management (N)</b>		
N <sub>1</sub> : 100% RDN	48.94	22.94
N <sub>2</sub> : 75% RDN	41.83	22.16
N <sub>3</sub> : 100% RDN + Bio NPK consortium	62.73	31.40
N <sub>4</sub> : 75% RDN + Bio NPK consortium	55.69	24.49
S.Em.±	1.37	1.12
C.D. (P = 0.05)	4.01	3.29
Interaction (M × N)	NS	NS
C.V.%	7.38	12.53

### Interaction effect

An interaction between methods of FYM preparation and nitrogen management did not impart their significant influence on nitrogen uptake in seed and stalk of castor.

### Effect of methods of FYM preparation on phosphorus uptake by seed and stalk (kg/ha)

Treatment M<sub>2</sub> (Pit method) recorded significantly the highest P uptake by seed (23.17 kg/ha) and stalk (13.92 kg/ha) as compared to M<sub>1</sub> (Heap method) which uptake minimum P in seed (19.39 kg/ha) and stalk (11.63 kg/ha). The magnitude of increase in phosphorus uptake by seed was 13.46 and 27.46 per

cent and 17.02 and 28.63 per cent by stalk under treatment N<sub>3</sub> (100% RDN + bio NPK consortium) than treatments N<sub>1</sub> (100% RDN) and N<sub>2</sub> (75% RDN), respectively. This could be ascribed to maximum seed and stalk yield of castor received in this treatment.

### Effect of nitrogen management on phosphorus uptake by seed and stalk (kg/ha)

In case of phosphorus uptake, treatment N<sub>3</sub> (100% RDN + bio NPK consortium) recorded significantly the highest phosphorus uptake in seed (23.76 kg/ha) and stalk (14.78 kg/ha). This might be due to bio NPK consortium enhances available soil phosphorus by dissolving acid soluble phosphorus resulted in higher P removal by plants. The present findings are in accordance with those reported by Shivran and Gajendra (2006) [11] that increase in P uptake due to RDF (80 kg N + 40 kg P<sub>2</sub>O<sub>5</sub>/ha) and Lakshmi and Reddy (2006) [3] found that P uptake in seed and stalks increased significantly with increase in N rate up to 80 kg/ha. Nagdive *et al.* (2007) [5] noticed that application of 75% recommended dose of NPK + FYM @ 5 t/ha + *Azotobacter* + PSB recorded significantly the highest phosphorus uptake.

**Table 3:** P uptake by castor seed and stalk as influenced by different treatments

Treatments	Nutrients uptake (kg/ha)	
	Phosphorus	
	Seed	Stalk
<b>Methods of FYM preparation (M)</b>		
M <sub>1</sub> : Heap method	19.39	11.63
M <sub>2</sub> : Pit method	23.17	13.92
S.Em.±	0.60	0.37
C.D. (P = 0.05)	1.76	1.09
<b>Nitrogen management (N)</b>		
N <sub>1</sub> : 100% RDN	20.94	12.63
N <sub>2</sub> : 75% RDN	18.64	11.49
N <sub>3</sub> : 100% RDN + Bio NPK consortium	23.76	14.78
N <sub>4</sub> : 75% RDN + Bio NPK consortium	21.97	12.20
S.Em.±	0.85	0.53
C.D. (P = 0.05)	2.50	1.54
Interaction (M × N)	Sig.	Sig.
C.V.%	11.30	11.63

### Interaction effect

Interaction effect of method of FYM preparation and nitrogen management was found significant with respect to uptake of phosphorus by seed and stalk of castor. The results revealed that treatment combination M<sub>2</sub>N<sub>3</sub> (application of FYM prepared by pit method along with 100% RDN + bio NPK consortium) recorded significantly the highest phosphorus uptake by seed (27.3 kg/ha) and stalk (17.8 kg/ha). The nutrient uptake is a function of yield and nutrient concentration in plant. Thus, significant improvement in uptake of phosphorus might be attributed to their concentration in seed and stalk as well as significantly higher seed and stalk yield. This might also be attributed to better availability of nutrients in the soil due to application of inorganic fertilizers. The results of present investigation are in close conformity with the findings of Poonia *et al.* (2014) [8]. They noted that application of 50% RDF + 5 t/ha FYM + *Rhizobium* + PSB gave significantly higher N and P uptake by groundnut.

**Table 4:** Interaction effect of M × N on P uptake (kg/ha) by seed of castor

Treatments	N <sub>1</sub> : 100% RDN	N <sub>2</sub> : 75% RDN	N <sub>3</sub> : 100% RDN + Bio NPK consortium	N <sub>4</sub> : 75% RDN+Bio NPK consortium
M <sub>1</sub> : Heap method	19.5	15.7	21.0	21.4
M <sub>2</sub> : Pit method	21.9	22.4	27.3	20.9
S.Em.±	1.20			
C.D. (P = 0.05)	3.53			
C.V.%	11.30			

**Table 5:** Interaction effect of M × N on P uptake (kg/ha) by stalk of castor

Treatments	N <sub>1</sub> : 100% RDN	N <sub>2</sub> : 75% RDN	N <sub>3</sub> : 100% RDN + Bio NPK consortium	N <sub>4</sub> : 75% RDN+Bio NPK consortium
M <sub>1</sub> : Heap method	11.9	11.2	11.8	11.6
M <sub>2</sub> : Pit method	13.3	11.8	17.8	12.8
S.Em.±	0.74			
C.D. (P = 0.05)	2.18			
C.V.%	11.63			

**Effect on post-harvest nutrient status in soil****Effect on available nitrogen (kg/ha)****Effect of methods of FYM preparation on available nitrogen (kg/ha)**

Treatment M<sub>2</sub> (Pit method) recorded significantly the highest available nitrogen (160.9 kg/ha) in soil after harvest of crop. This might be due to higher N content in the FYM produced by pit method.

**Effect of nitrogen management on available nitrogen (kg/ha)**

Treatment N<sub>3</sub> (100% RDN + bio NPK consortium) registered significantly the highest available nitrogen (169.1 kg/ha) in soil as compared to treatments N<sub>1</sub>, N<sub>2</sub> and N<sub>4</sub>. This might be due to the direct addition of N through inorganic fertilizer and greater multiplication of soil microbes inoculated through seed treatment which could convert organically bound N to inorganic form. This finding indicated that combine application of inorganic fertilizer along with bio NPK consortium improved the residual soil fertility particularly N after harvest of castor and the net gain in available N over the initial available nitrogen status in soil. Similar results have also been reported by Chavan *et al.* (2005) [1] noted that application of 80 kg N/ha recorded significantly higher available nitrogen in soil.

**Interaction effect**

Interaction effect between methods of FYM preparation and nitrogen management was found non-significant.

**Table 6:** Available N and P<sub>2</sub>O<sub>5</sub> in soil after harvest of castor as influenced by different treatments

Treatments	Available nutrients in soil (kg/ha)	
	N	P <sub>2</sub> O <sub>5</sub>
<b>Methods of FYM preparation (M)</b>		
M <sub>1</sub> : Heap method	152.3	33.5
M <sub>2</sub> : Pit method	160.9	34.2
S.Em.±	2.0	0.52
C.D. (P = 0.05)	5.9	NS
<b>Nitrogen management (N)</b>		
N <sub>1</sub> : 100% RDN	152.2	33.8
N <sub>2</sub> : 75% RDN	149.3	33.2
N <sub>3</sub> : 100% RDN + Bio NPK consortium	169.1	34.6
N <sub>4</sub> : 75% RDN + Bio NPK consortium	155.8	33.8
S.Em.±	2.8	0.73
C.D. (P = 0.05)	8.3	NS
Interaction (M × N)	NS	NS
C.V.%	5.30	8.66

**Effect on available phosphorus (kg/ha)****Effect of methods of FYM preparation on available phosphorus (kg/ha)**

Various methods of FYM preparation and nitrogen management did not exert their significant influence on available phosphorus status in soil after harvest of crop.

**Effect of nitrogen management on available phosphorus (kg/ha)**

Different nitrogen management had non-significant effect on available phosphorous status of soil after harvest of castor.

**Interaction effect**

Interaction effect between methods of FYM preparation and nitrogen management on available phosphorus in soil was found non-significant.

**Conclusion**

In light of results obtained from present investigation, it is concluded that apply 10 t FYM/ha prepared by pit method along with 100% RDN (180 kg/ha) through fertilizer + seed inoculation with bio NPK consortium increase nutrient content of plant as well as improve the nutrient status of soil.

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