EFFECT OF CASTOR TRANSPLANTING AND DIFFERENT ORGANIC MANURES ON NUTRIENT CONTENT, UPTAKE AND SOIL FERTILITY STATUS AFTER HARVEST OF CASTOR (*Ricinus communis*L.) UNDER NORTH GUJARAT AGRO CLIMATIC CONDITIONS

ABSTRACT

An attempt was made to investigate the effect of castor transplanting and different organic manures on content, uptake and soil fertility status after harvestof castor (*Ricinus communis* L.) under North Gujarat agro climatic conditions.The field experiment comprised of four levels of age of seedling (A_1: Two weeks old seedling, A_2: Three weeksold seedling, A_3: Four weeksold seedling and A_4:Normal sowing) and four levels of source of manures(S_1:No compost, S_2: Vermicompost, S_3: FYM and S_4: Castor shell compost) laid out in randomized block design with factorial concept with three replication. Castor variety GCH 8 was used as a test crop.And the result indicated that Nitrogen, phosphorus, potassium and sulphur content in castor seed did not differed significantly due to different age of seedling and different source of manures. But uptake of nitrogen, phosphorus, potassium and sulphur were significantly higher under treatment A_4 (Normal sowing) and S_4 (Castor shell compost). The available nitrogen, phosphorus, potash and sulphur in soil were unaffected due to age of seedling and source of manures. However, organic carbon was found significantly higher (0.204 %) with treatment S_4 (Castor shell compost). Interaction effect of age of seedling and source of manures exhibited significant effect on content of sulphur and uptake of nitrogen, phosphorus, potassium as well as sulphur.

Keywords: Castor transplanting, Organic manures, Nutrient content and uptake, Soil fertilitystatus, Loamy sand

INTRODUCTION

"Castor [(*Ricinuscommunis*L., 2n=20 (Family: *Euphorbiaceae*)] is an industrially important non-edible oilseed crop widely cultivated in the arid and semi-arid regions of the world. In the year 2019-20, the area under castor in India was 10.46 lakh ha with 18.42 lakh tones of production and an average productivity of 1761 kg per ha. In India, Gujarat is the leading castor growing state having 7.36 lakh ha cultivated area with 14.31 lakh tones production and 1944 kg per ha productivity, which is highest in the world"[1]. "Gujarat contributes more than 84 per cent of the castor production from about 68 per cent of the area in the country. The other major castor growing states in India are Rajasthan, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka and Orissa. Castor seed oil is mostly used in industries of dyes, paint, ink, cosmetics, polymer, pharmaceutical, *etc*."[2]. The hydroxylatedricinoleic acid found as major component of fatty acid of castor oil make it unique oil among vegetable oils. Castor oil contains about 90 per cent ricinoleic acid[3]. Castor is grown at wide spacing (150 cm × 120 cm) or more in most of the castor growing belt of Gujarat and Rajasthan. Better fertility and assured irrigation facilitate better growth of castor. Any gap in plant population is directeconomic loss to the farmer. This can be compensated with gap filling, the seed again take time to germinate and establish, in general yield gap is observed most of the time. Alternatively, farmers can use castor transplanting, this is a new concept for castor. Very scanty information is available on scientific study on castor transplanting.

An option for areas with short growth seasons has been researched: castor seedlings planted in plastic bags or root plugs[2].

"Constantly applying large amounts of inorganic fertilizer and switching to intensive cropping with less use of organic manures are causing the soil's health to deteriorate, which eventually lowers output. In order to preserve soil health, it is imperative that a sufficient amount of organic manure be added to the soil. The biological and physical conditions of the soil are also improved by the addition of organic manure.Farmyard manure refers to the decomposed mixture of dung and urine of farm animals, litter and leftover material from roughages or fodder fed to the cattle. FYM also improves the physical condition of the soil. Vermicompost are peat-like materials with a high porosity, aeration, drainage and water-holding capacity and microbial habitat and action which are stabilized by interactions between earthworms and soil microorganisms under a non-thermophilic environment"[4]. "Vermicompost have large surface areas that provide many micro sites for microbial activity and for the strong retention of nutrients"[5]. "The castor cake, however, is mineralized extremely fast, and as a large quantity of N is released in a short period of time, high concentrations of mineral N (nitrate and ammonical) can cause plant toxicity. The mineralization of castor meal measured by microbial evolution of carbon di-oxide gas is almost seven times faster than bovine manure and 15 times speedy than sugarcane bagasse"[6]. "The N mineralization rate can be influenced by temperature, soil moisture, aeration, soil texture, pH and organic-N content"[7].

In the light of above facts, the present study "Effect of castor transplanting and different organic manures on nutrient content, uptake and soil fertility status after harvest of castor (*Ricinus communis*L.) under North Gujarat agro climatic conditions" was undertaken.

MATERIALS AND METHODS

The experiment was carried out at Castor-Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar, District Banaskantha, Gujarat, India during *kharif* season of 2020-21. Geographically, Sardarkrushinagar is situated at 24°-19' N latitude and 72°-19' E longitude with an altitude of 154.52 m above the mean sea level. It is located in the North Gujarat Agro-climatic Zone. This zone is characterised by semi-arid climate with extreme cold winter, hot and dry windy summer and warm and moderately humid monsoon.The experimenthad four levels of age of seedling (A_1: Two weeks old seedling, A_2: Three weeksold seedling, A_3: Four weeksold seedling and A_4: Normal sowing) and four levels of source of manures in composting bags (S_1:No compost, S_2: Vermicompost, S_3: FYM and S_4: Castor shell compost) laid out in randomized block design with factorial concept with three replication.For transplanting bags, soil to compost ratio was kept 60:40 and the quantity of manures taken for the study was 300 g of castor shell compost (2.24 % N); 500 g vermicompost (1.35% N) and 1000 g FYM (0.66 %N) to obtain equal quantity of N. Castor variety GCH 8 was used as a test crop. [15] The soil of the experimental area was loamy sand in texture, soil reaction slightly alkaline, low in organic carbon, available nitrogen and sulphur, medium in available phosphorus and potash. The statistical analysis of the data collected for different characters was carried out following the procedure of Randomized Block Design (Factorial) of an experiment as described by Panse and Sukhatme[8]. The value of calculated 'F' was worked out and compared with the value of table "F" at 5 per cent level of significance. The value of S.Em.±, C.D. at 5 per cent and coefficient of variation (C.V. %) were also calculated.

RESULTS AND DISCUSSION

Influence of seedling age on nutrient content and uptake in castor plants

Various age of seedling did not make any significantly difference on nitrogen, phosphorus, potassium and sulphur content of castor seed. However, numerically higher nitrogen(4.73 %) and S content (0.277 %) were recorded under A_2 (Three weeks old seedling) compared to rest of the treatments (Table 1). While higher P (1.11%) content found under A_4 (Normal sowing) and K (1.037%) content recorded under A_1 (Two weeks old seedling).Nutrients uptake by castor seedwere significantly affected by age of seedling. Treatment A_4 (Normal sowing) gave significantly highest nitrogen (148.98 kg ha^{-1}), phosphorus (35.02 kg ha^{-1}), potassium (32.22 kg ha^{-1}) and sulphur (8.69 kg ha^{-1}) uptake by castor seed which was found statistically at par with treatment A_2 (Three weeks old seedling) and A_1 (Two weeks old seedling). However, treatment A_3 (Four weeks old seedling) recorded significantly lowest nitrogen (116.66 kg ha^{-1}), phosphorus (27.07 kg ha^{-1}), potassium (25.60 kg ha^{-1}) and sulphur (6.47 kg ha^{-1}) uptake by castor seed. Because of their increased surface area to volume ratio, younger plants are better able to absorb nutrients.The results are in line with those reported by Patel[9].The organic acids produced from decomposition of organic matter might be responsible for quick release of nutrients from native pool, result in greater availability on nutrients to growing plants and increase nutrient uptake by crop[10].

Effect of source of manureson nutrient content and uptake in castor plants

Different nutrients (N, P, K and S) content in castor seed after harvesting were found statistically non-significant with the application of different organic manures. However, numerically higher N (4.78 %) and P (1.11%) content in castor seed were recorded with the treatment of S_4 (Castor shell compost). Potassium (1.049 %) content in castor seed was found higher under treatment S_1 (No compost) and higher sulphur (0.281%) content in castor seed was recorded with the treatment of S_3 (FYM). The mean data indicated that uptake of different nutrients by seed were significantly affected by application of various source of manures. Treatment S_4 (Castor shell compost) gave significantly highest nitrogen (155.43 kg ha^{-1}), phosphorus (36.20 kg ha^{-1}), potassium (33.22 kg ha^{-1}) and sulphur (8.86 kg ha^{-1}) uptake by castor seed. In case of S uptake by castor seed, treatment S_3 (8.22 kg ha^{-1}) (FYM) was found at par with S_4 (Castor shell compost). Nahar and Pan [11] reported that the nitrogen content in castor plant was affectedby the nitrogen form and supply from the soil. Javiya [10] reported that castor shell compost is effective in phosphorus uptake in shell of groundnut. The organic acids produced from decomposition of organic matter might be responsible for quick release of nutrients from native pool, resulting in greater availability of nutrients to growing plants and increase nutrient uptake by crop. The results are in line with those reported byCastor Annual Report[12]. The organic acids produced from decomposition of organic matter might be responsible for quick release of nutrients from native pool, result in greater availability on nutrients to growing plants and increase nutrient uptake by crop [10].

Interaction effect

The combined effect of treatment A_2S_4 (Three weeks old seedling + Castor shell compost) showed significantly maximum nitrogen (173.0 kg ha^{-1}) and potassium (38.3 kg ha^{-1}) uptake by castor seed and also found at par with treatment combinations*viz.*,A_1S_3 (Two weeks old seedling + FYM), A_1S_4 (Two weeks old seedling + Castor shell compost), A_4S_3 (Normal sowing + FYM), A_4S_4 (Normal sowing + Castor shell compost).The plant growth especially above ground and under ground are most crucial for the nitrogen uptake from the soil. The easy availability of soil organic carbon in very close proximity of roots make nitrogen more usable to plants.The decreasing order of nitrogen content among the manures used under experimentation were Castor shell compost> Vermicompost >FYM. The age of seedling also influence on the uptake of nutrients. Nutrient uptake is mostly carried out by the secondary and lateral roots Rodriguez *et al.* [13]. Kumar and Kanjana[14] reported that application of FYM @ 12.5 t ha^{-1} and microbial treatments to irrigated castor recorded significantly higher K uptake.

A_1S_4 (Two weeks old seedling + Castor shell compost) treatment combination gave significantly maximum phosphorus uptake (41.1 kg ha^{-1}) but it was found at par with treatment combinations *viz.*, A_2S_4 (Three weeks old seedling + Castor shell compost), A_4S_3 (Normal sowing + FYM), A_4S_4 (Normal sowing + Castor shell compost).The plant growth especially above ground and underground are most crucial for the phosphorus uptake from the soil. The early establishment of roots are more crucial for phosphorus uptake. The easy available source of organic acids secreted by a mix of microbes, manures decomposition and plant roots in very close proximity of roots make phosphorus in chelated form which is available to plants. The age of seedling also influence on the uptake of nutrients. Phosphorus uptake is mostly carried out by the secondary and lateral roots these result was confirmed by the finding with Rodriguez *et al.*[13].

Significantly the maximum sulphur content (0.32 %) was recorded (Table 2) under treatment combination of A_4S_4 (normal sowing + Castor shell compost) but it was found at par with treatment *viz.*,A_1S_3 (Two weeks old seedling + FYM), A_2S_3 (Three weeks old seedling + FYM).Significantly the maximum sulphur uptake (10.6 kg ha^{-1}) was recorded (Fig. 2) under treatment combination of A_4S_4 (Normal sowing+ Castor shell compost) but it was found at par with treatment *viz.*,A_1S_3 (Two weeks old seedling + FYM), A_2S_4 (Three weeks old seedling + Castor shell compost).

Soil status after harvest of crop

The analysis of soil samples after harvest of castor crop did not reveal significant changes in EC (dS m^{-1}) and pH of soil either due to different age of seedling and source of manures (Table 3).

Influence of seedling age on soil fertility

From the data (Table 3), it was observed that the organic carbon (%) of soil after harvest of the crop was non significantly influenced by age of seedling. However, higher value of organic carbon (0.194 %) was found in treatment A_1 (Two weeks old seedling). The age of seedling has no significant influence on available nitrogen content after harvest of the crop. However, higher available nitrogen (142 kg ha^{-1}) content was recorded with treatment A_2 (Three weeks old seedling). It was recorded that age of seedling has no significant influence on available phosphorus content after harvest of the crop. However, higher available phosphorus (48.1 kg ha^{-1}) content was recorded with treatment A_4 (Normal sowing). The age of seedling has no significant influence on available potassium content at after harvest of the crop. However, higher available potassium (255 kg ha^{-1}) content was recorded with treatment A_4 (Normal sowing).The age of seedling has no significant influence on available sulphur content at after harvest of the crop. However, higher available sulphur (12.6 mg kg^{-1}) content were recorded with treatment A_1 (Two weeks old seedling), A_2 (Three weeks old seedling) and A_4 (Normal sowing).

Effect of source of manures on soil fertility

The data presented in Table 3 indicated that organic carbon (%) was affected remarkably by source of manures. The significantly highest organic carbon content (0.204 %) in soil was found with treatment castor shell compost (S_4). However, lowest value (0.175 %) found with the treatment no compost (S_1). Increased organic carbon content can be ascribed to beneficial effect of castor shell compost application resulted in increasing organic carbon in soil due to the addition of organic matter presence of castor shell compost, as it is known that there is a favourable effect castor shell compost application on organic carbon content of soil reported by Javiya [10].The available nitrogen status in soil after harvest of castor crop did not differ significantly by source of manures. However the maximum available nitrogen (141 kg ha^{-1}) was found in treatment S_4 (Castor shell compost).The available phosphorus status in soil after harvest of castor crop did not differ significantly by source of manures. Although the maximum available phosphorus (48.4 kg ha^{-1}) was found in treatment S_4 (Castor shell compost).Available potassiumstatus in soil after harvest of castor crop did not differ significantly by source of manures. However the maximum available potassium(254 kg ha^{-1}) was found in treatment S_4 (Castor shell compost). Available sulphur status in soil after harvest of castor crop did not differ significantly by source of manures. Although the maximum available sulphur (12.9 mg kg^{-1}) was found in treatment S_4 (Castor shell compost).

CONCLUSIONS

The present investigation demonstrated that nutrient content of castor seed did not show any significant result under different age seedling and different source of organic manures but the uptake shows significant result. Combined application of three weeks old seedling + Castor shell compost gave better result. The soil fertility status didn't affected except organic carbon found significant with the application of castor shell compost.Farmers can use suitable combination of best treatment for getting higher nutrient use efficiency and better soil fertility status.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

Reference

1. Economic And Statistics, Ministry of Agriculture, Government of India (2019-20).
2. Severino LS, Auld DL, Baldanzi M, Cândido MJ, Chen G, Crosby W, Tan D, He X, Lakshmamma P, Lavanya C, Machado OL, Mielke T, Milani M, Miller TD, Morris JB, Morse SA, Navas AA, Soars DJ, Sofiatti V, Wang ML, Zanotto MD, Zielder HA. A review on the challenges for increased production of castor. Agronomy journal. 2012;104(4):853-880.
3. Shah SK, Patel DK, Patel RM, Patel PS. Seed and oil quality characteristics of some castor (*Ricinus communis* L.) inbred lines. International Journal of Agriculture, Environment and Biotechnology. 2015;8(1):177-181.
4. Edwards CA, Burrows I. Potential of earthworm composts as plant growth media. In: Earthworms in waste and environmental management. C. A. Edwards and Neuhauser. (Eds.). SPB Academic Publishing B.V., The Netherlands. 1988; 211-220.
5. Shi-wei Z, Fu-Zhen H. The nitrogen uptake efficiency from 15N labeled chemical fertilizer in the presence of earthworm manure (cast). In: Advances in management and conservation of soil fauna. 1991; 539-542.
6. Severino LS, Cardoso GD, Vale LS, Santos JW. Método para determinação da área foliar da mamoneira. RevistaBrasileira de OleaginosasFibrosas. 2004; 8:73-72.
7. Severino LS, Mendonça ED, Neves YP, Barros UV, Barbosa CM. Formas de nitrogênio e propriedades do solo emcultivoadensado de café. Revista Ceres. 2001; 48:71-80.
8. Panse VG, Sukhatme PV. Statistical methods for agricultural workers (II Edn.). Indian Council of Agricultural Research, New Delhi;1967
9. Patel, A. Effect of age of seedlings, organic manures and nitrogen levels on productivity of transplanted *kharif* rice (*Oryza sativa* L.) under middle Gujarat conditions. Ph. D. Thesis, AAU;2010.
10. Javiya, K. Effect of sulphur and potassium with and without castor shell compost on yield and quality of groundnut (*Arachis hypogaea* L.) in loamy sand. M.Sc. (Agri.) Thesis, SDAU, Sardarkrushinagar;2019.
11. Nahar K, Pan WL. Urea fertilization: Effects on growth, nutrient uptake and root development of the biodiesel plant, Castor Bean (*Ricinus communis* L.). American Journal of Experimental Agriculture. 2015;5(4):320-335.
12. Annual Report, castor. ICAR- Indian Institute of oilseeds Research, Rajendranagar, Hyderabad;2020.
13. Rodriguez OAV, Perez-Vazquez A. Seedling characteristics of three oily species before and after root pruning and transplant. Plants. 2019;8(258):1-19.
14. Kumar NS, Kanjana D. Influence of integrated nutrient management practices on yield attributes, seed yield, oil yield and nutrient uptake of castor under irrigated conditions. Indian Journal of Agricultural Research. 2009;43(3):200-205.

15. KK Patel, SK Shah, CJ Patel and JM PatelEffect of castor transplanting and different organic manures on growth, yield and quality of castor (RicinusCommunis L.) under north Gujarat agro climatic conditions2022; 11(8): 1020-1024

Table 1: Effect of age of seedling and source of manures on nutrient content (%) and uptake(kg ha^{-1}) ofcastor seed

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur	
	Content	Uptake	Content	Uptake	Content	Uptake	Content	Uptake
Age of seedling (A)								
A_1:Two weeks old seedling	4.72	138.96	1.10	32.11	1.037	30.19	0.271	7.97
A_2:Three weeks old seedling	4.73	141.61	1.07	32.08	1.036	31.11	0.277	8.25
A_3:Four weeks old seedling	4.65	116.66	1.09	27.07	1.028	25.60	0.260	6.47
A_4: Normal seedling	4.70	148.98	1.11	35.02	1.020	32.22	0.274	8.69
S.Em. ±	0.09	4.17	0.024	1.08	0.023	0.91	0.007	0.25
CD(*P=0.05*)	NS	12.03	NS	3.12	NS	2.62	NS	0.74
Source of manures (S)								
S_1: No compost	4.62	120.12	1.06	27.45	1.049	27.09	0.265	6.86
S_2:Vermicompost	4.70	132.53	1.09	30.59	1.022	28.87	0.265	7.44
S_3:FYM	4.71	138.14	1.09	32.05	1.029	29.94	0.281	8.22
S_4: Castor shell compost	4.78	155.43	1.11	36.20	1.021	33.22	0.271	8.86
S.Em. ±	0.09	4.17	0.024	1.08	0.023	0.91	0.007	0.25
CD (*P=0.05*)	NS	12.03	NS	3.12	NS	2.62	NS	0.74
Interaction (A x S)								
S.Em. ±	0.17	8.33	0.049	2.16	0.05	1.81	0.014	0.51
CD (*P=0.05*)	NS	24.07	NS	6.25	NS	5.24	0.040	1.47
CV %	6.28	10.57	7.737	11.87	7.61	10.55	8.798	11.26

Table 2: Interaction effect of age of seedling and source of manures on sulphur content of castor seed

Treatments	Sulphur content (%)			
Age of seedling (A)	Source of manures (S)			
	S_1 (No compost)	S_2 (Vermi-compost)	S_3 (FYM)	S_4 (Castor shell compost)
A_1 (Two weeks old seedling)	0.27	0.26	0.29	0.26
A_2 (Three weeks old seedling)	0.28	0.27	0.29	0.27
A_3 (Four weeks old seedling)	0.26	0.28	0.26	0.23
A_4 (Normal sowing)	0.24	0.25	0.28	0.32
S.Em. ±	0.014			
CD (*P=0.05*)	0.040			
CV %	8.798			

Table 3: Effect of age of seedling and source of manures on soil fertility after harvest of crop

Treatments	EC (dSm^{-1})	pH	Organic carbon (%)	N ($kg\ ha^{-1}$)	P_2O_5 ($kg\ ha^{-1}$)	K_2O ($kg\ ha^{-1}$)	S ($mg\ kg^{-1}$)
Age of seedling (A)							
A_1: Two weeks old seedling	0.122	7.23	0.194	139	47.1	249	12.6
A_2:Three weeks old seedling	0.122	7.23	0.186	142	47.1	249	12.6
A_3:Four weeks old seedling	0.122	7.28	0.184	136	46.7	247	12.5
A_4: Normal sowing	0.120	7.28	0.190	138	48.1	255	12.6
S.Em. ±	0.003	0.09	0.0041	3.406	1.173	7.197	0.313
CD (*P=0.05*)	NS	NS	NS	NS	NS	NS	NS
Source of manures (S)							
S_1: No compost	0.124	7.32	0.175	135	46.0	246	12.3
S_2:Vermicompost	0.121	7.27	0.184	139	46.5	248	12.4
S_3:FYM	0.124	7.25	0.190	139	47.9	252	12.8
S_4: Castor shell compost	0.116	7.18	0.204	141	48.4	254	12.9
S.Em. ±	0.003	0.09	0.0041	3.406	1.173	7.197	0.313
CD (*P=0.05*)	NS	NS	0.0120	NS	NS	NS	NS
Interaction (A x S)							
S.Em. ±	0.007	0.18	0.0083	6.813	2.346	14.395	0.627
CD (*P=0.05*)	NS	NS	NS	NS	NS	NS	NS
CV %	9.476	4.34	7.6215	8.516	8.601	9.978	8.638

Fig.1Three weeks old seedling + Castor Shell Compost

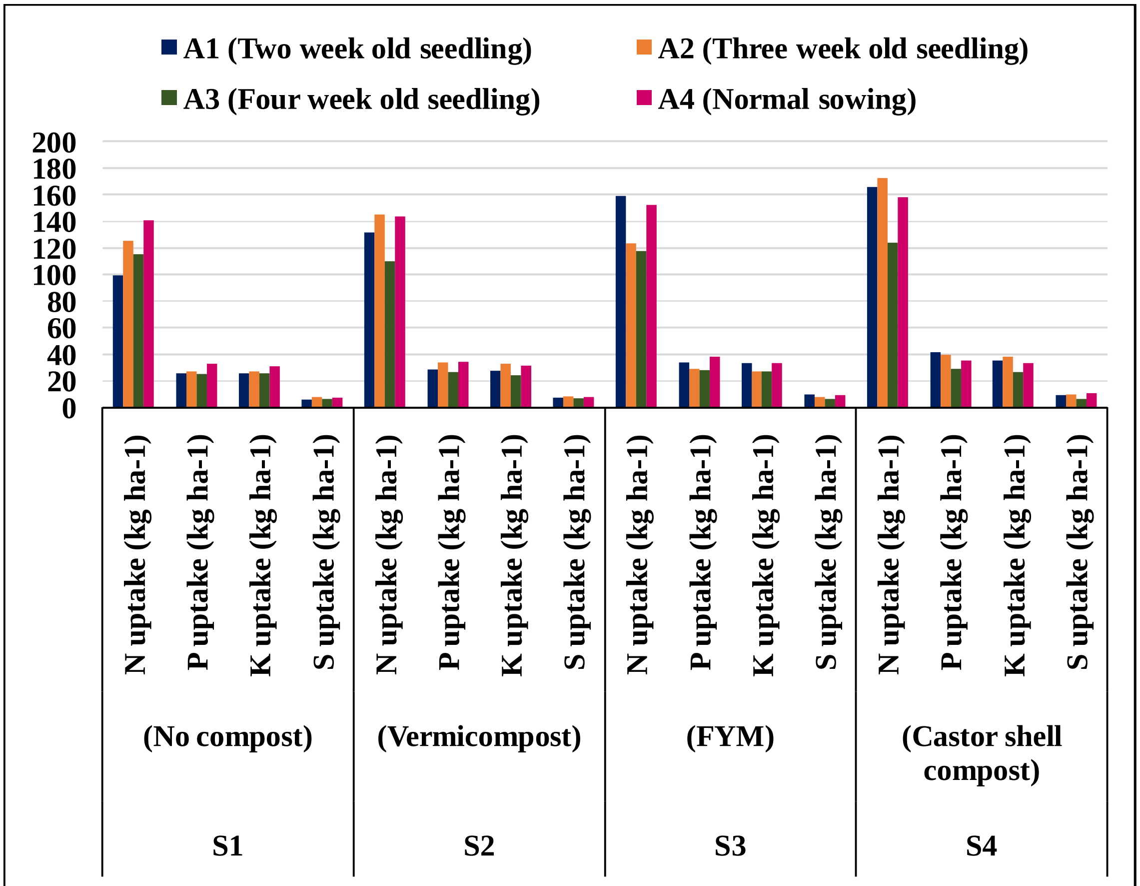

Fig. 2 Interaction effect of age of seedling and source of manures on nitrogen, phosphorus, potassium and sulphur uptake by castor seed