The Pharma Innovation Journal 2022; 11(8): 1020-1024

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(8): 1020-1024

www.thepharmajournal.com
Received: 10-05-2022
Accepted: 11-06-2022

KK Patel
Ph.D., Scholar, Department of Agricultural Chemistry and Soil Science, CP College of Agriculture, SD Agricultural University, Sardarkrushinagar, Gujarat, India

SK Shah
Assistant Research Scientist, Soil Science, Oil Seed Research Station, SD Agricultural University, Sardarkrushinagar, Gujarat, India

CJ Patel
Assistant Research Scientist, Oil Seed Research Station, SD Agricultural University, Sardarkrushinagar, Gujarat, India

JM Patel
Associate Research Scientist, Soil Science, Bio Science Research Center, SD Agricultural University, Sardarkrushinagar, Gujarat, India

Corresponding Author:
KK Patel
Ph.D., Scholar, Department of Agricultural Chemistry and Soil Science, CP College of Agriculture, SD Agricultural University, Sardarkrushinagar, Gujarat, India

Effect of castor transplanting and different organic manures on growth, yield and quality of castor (*Ricinus Communis* L.) under north Gujarat agro climatic conditions

KK Patel, SK Shah, CJ Patel and JM Patel

Abstract

A field experiment was conducted at Castor Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *Kharif* 2020-21 to investigate the "Effect of castor transplanting and different organic manures on growth, yield and quality of castor (*Ricinus communis* L.) Under North Gujarat agro climatic conditions". The soil of the experimental area was loamy sand in texture, slightly alkaline in soil reaction, low in organic carbon, available nitrogen and available sulphur, medium in available phosphorus and available potash. The experiment comprised of main plot treatments of four levels of age of seedling (A_1: Two week old seedling, A_2: Three week old seedling, A_3: Four week old seedling and A_4: Normal sowing), four levels of source of manures (S_1: No compost, S_2: Vermicompost, S_3: FYM and S_4: Castor shell compost) was laid out in randomized block design with factorial concept with three replication. Castor variety GCH 8 was used as a test crop. The plant height at 60 DAS was found significantly highest (50 cm) with treatment of normal sowing while it was at par with transplanting of two week old seedling and three weeks old seedling. Number of leaves at 60 DAS was found significantly highest (16.28) with normal sowing while, it was found at par with treatment of two weeks old seedling. Number of effective branches plant^{-1} was found significantly highest (17.95) with treatment of normal sowing, while it was at par with transplanting of three week old seedling. Significantly higher seed yield (3165kg ha^{-1}) was recorded with treatment of normal sowing, but it was found at par with treatment of three week old seedling and two week old seedling. Interaction effect of age of seedling and source of manures recorded significantly higher seed yield (3656kg ha^{-1}) with treatment three week old seedling + castor shell compost.

Keywords: Transplanting and Organic manures, Interaction, Growth, Yield, Quality, Economics, Castor, Loamy sand soil

1. Introduction

Castor [(*Ricinus communis* L., 2n = 20 (Family: *Euphorbiaceous*)] is a non-edible industrially important 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 18.42lakh tones of production and an average productivity of 1761 kg per ha. Gujarat is the leading castor growing state in India having 7.36lakh cultivated area with 14.31lakh tones production and 1944 kg per ha average productivity, which is highest in the world. (Economics and Statistics, Ministry of Agriculture, Government of India). Only the Gujarat state 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. In global context, India produces around 85 per cent of world's total castor production and dominating the global castor supply as it meets more than 80 per cent of the demand of castor oil, thereby enjoying a key position in the world castor scenario.

Commercially, castor oil is extracted using solvent extraction methods from the seeds. The oil content can be between 42-58 per cent of the seed mass (Fernandez-Martínez and Velasco, 2012) [5]. The oil includes triglycerides like ricinoleic, linoleic, oleic, palmitic, stearic and linolenic acid, in decreasing order (Mutlu and Meier, 2010) [9]. However, castor oil does not include ricin toxin. The ricin toxin remains in the bean mass after the extraction of the castor oil (Mutlu and Meier, 2010) [9]. This mass can be also called castor cake.

Propagation of castor using seedlings started in plastic bags or root plugs has been studied as an alternative for regions with short-growing seasons (Severino *et al.*, 2012) [12].

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 (Severino *et al.*, 2004) [11]. The N mineralization rate can be influenced by temperature, soil moisture, aeration, soil texture, pH, and organic-N content (Severino *et al.*, 2001) [13]. In any organic material, the carbon to nitrogen ratio (C:N) is one of the most important factors affecting the decomposing rate (Kumar *et al.*, 2010) [7].

2. Materials and methods

The experiment was carried out in LRS - 5 of the Castor-Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *Kharif* season of 2020-21.

The details of the experimental technique employed for the investigation on "Effect of castor transplanting and different organic manures on growth, yield and quality of castor (*Ricinus communis* L.) under North Gujarat agro climatic conditions" had main plot treatments of four levels of age of seedling (A_1: Two week old seedling, A_2: Three week old seedling, A_3: Four week old seedling, A_4: Normal sowing), four levels of source of manures (S_1: No compost, S_2: Vermicompost, S_3: FYM and S_4: Castor shell compost) was laid out in randomized block design with factorial concept with three replication. Castor variety GCH 8 was used as a test crop. The soil of the experimental area was loamy sand in texture, slightly alkaline in soil reaction, low in organic carbon, available nitrogen and available sulphur, medium in available phosphorus and available potash.

3. Results and discussion

3.1 Effect of age of seedling

3.1.1 On growth, yield and quality

Effect of age of seedling on number of plants net plot^{-1} did not exert any significant influence on plant population recorded at harvest.

Number of effective branches plant^{-1} at harvest was significantly higher in treatment A_4 (Normal sowing) 17.95 followed by and A_2 (Three week old seedling) 17.93 compared to rest of the treatments (A_1 and A_3). The significantly lowest number of effective branches plant^{-1} 16.58 was recorded with treatment A_3 (Four week old seedling). The root establishment and capacity to bear the transplantation shock was found minimum when castor seedling of 21 days older. This could be perhaps due to sufficient number of leaves along with the most adaptive tap root and secondary and lateral roots. These results were supported by the findings of Rodriguez *et al.* (2019) where they have transplanted castor at 63 DAS after root pruning as castor has fast growing and higher propagation capabilities.

Data indicated that the different age of seedling did not influence significantly on number of nodes plant^{-1} at harvest of castor (Table 1).

Higher number of nodes plant^{-1} 16.26 were observed with treatment A_2 (Three week old seedling) compare to other treatment (A_4, A_1 and A_3) during the period of investigation. Numerical higher value of nodes in A_2 could be due advantage of better plant growth above ground and underground.

Data indicated that the different age of seedling did not influence significantly on length of primary spike (cm) of castor (Table 1). However, the maximum length of primary spike (71.27 cm) was observed with treatment A_4 (Normal sowing). This indicated that the age of seedling of castor under transplanting could not affect the length of primary spike.

Number of capsules in primary spike was found non-significantly influenced by different age of seedling. The numerical higher number of capsules in primary spike (91.52) was recorded under the treatment of (Normal sowing) A_4 while the numerically lower number of capsules in primary spike (90.80) was recorded under the treatment of (Four week old seedling) A_3. This shows that the castor grown by castor seeding transplanting of any age perform as equal as normal or conventional sown castor.

Data presented in Table 1 pertaining to 100 seed Wight (g) was found non-significant due to different age of seedling. The maximum numeric value of 100 seed weight 33.48g was recorded under the treatment of (Normal sowing) A_4, whereas, the minimum numeric value of 100 seed weight of 32.94 g was recorded under the treatment of (Four week old seedling) A_3. This shows that the castor grown by castor seedling transplanting of any age perform as equal as normal or conventional sown castor. Rodriguez *et al.* (2019) found that the castor root architecture, horizontal and vertical distribution, proliferation of secondary and lateral roots is influencing much on the growth and development of castor plant.

Data presented in Table 1 pertaining to the seed yield was found significantly by different age of seedling. Significantly the highest seed yield 3165 kg ha^{-1} was recorded under the treatment of A_4 (Normal sowing) which is at par with treatment A_2 (Three week old seedling) 2995 kg ha^{-1} and A_1 (Two week old seedling) 2934. Whereas, significantly lowest seed yield 2512 kg ha^{-1} was recorded under the treatment of (Four week old seedling) A_3. There is no compensation for yield loss.

Table 1: Effect of age of seedling and source of manures on growth, yield of castor

Treatments	Plant Population	Number of effective branches plant^{-1}	Number of nodes plant^{-1}	Length of primary spike (cm)	Number of capsules in primary spike	100 seed weight (g)	Seed yield (kg ha^{-1})
Age of seedling (A)							
A_1: Two week old seedling	15.8	16.93	16.17	68.37	91.15	33.22	2934
A_2: Three week old seedling	15.9	17.93	16.26	68.87	91.48	33.45	2995
A_3: Four week old seedling	15.8	16.58	15.98	67.78	90.80	32.94	2512
A_4: Normal sowing	15.9	17.95	16.19	71.27	91.52	33.48	3165
S.Em. ±	0.10	0.34	0.39	1.54	1.96	0.62	79.85
CD (*P=0.05*)	NS	0.98	NS	NS	NS	NS	230.63
Source of manures (S)							

S_1: No compost	15.8	17.02	15.84	67.65	90.45	32.94	2600
S_2: Vermicompost	15.9	17.40	16.16	69.05	90.98	33.26	2818
S_3: FYM	15.8	17.23	16.24	69.12	92.40	33.29	2938
S_4: Castor shell compost	15.8	17.75	16.37	70.47	92.12	33.60	3250
S.Em. ±	0.10	0.34	0.39	1.54	1.96	0.62	79.85
CD (*P=0.05*)	NS	NS	NS	NS	NS	NS	230.63
Interaction (A x S)							
S.Em. ±	0.20	0.68	0.78	3.09	3.91	1.24	159.71
CD (*P=0.05*)	NS	NS	NS	NS	NS	NS	461.27
CV %	2.16	6.74	8.37	7.74	7.41	6.45	9.53

There are several patents claiming that castor transplanting could increase castor production in various conditions. (Anonymous, 2014) [3]. Disclosed a high-yield planting method of simultaneously ripe five-spike *Ricinus communis*, where the castor seedling of 2 true leave stage was recommended. (Anonymous, 2007) [2] Method for cultivating castor-oil plant for better yield of castor. However, Singh *et al.* (2019) [14] concluded that significantly higher values of most of the growth and yield parameters were observed where transplanting of the seedlings was done on 13th October during both the years. Similarly, the seed yield was increased by 15-20 per cent under transplanting techniques over direct seeding of the crop.

Perusal of data revealed that the variation in oil content was found non-significant due to different age of seedling (Table 3). However, the maximum numeric value of oil content was recorded 49.34 per cent under the treatment of (Normal sowing) A_4. The minimum numeric value of oil content was recorded 48.79 per cent under treatment of (Four week old seedling) A_3. The range of oil content was in line of the conclusion of Shah *et al.* (2015) [15].

Perusal of data revealed that the variations in ricin oleic acid per cent were found non-significant due to different age of seedling (Table 3). However, the maximum ricin oleic acid was recorded 88.26 per cent under the treatment of (Normal sowing) A_4. The minimum ricin oleic acid was recorded 88.05 per cent under treatment of (Four week old seedling) A_3. The range of ricin oleic acid was in line of the conclusion of Shah *et al.* (2015) [15].

Table 2: Interaction effect of age of seedling and source of manures on yield of castor

Treatments	**Seed yield (kg ha^{-1})**			
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 week old seedling)	2186	2843	3295	3414
A_2 (Three week old seedling)	2675	2988	2662	3656
A_3 (Four week old seedling)	2473	2373	2523	2679
A_4 (Normal sowing)	3064	3070	3272	3252
S.Em. ±	159.71			
CD (*P=0.05*)	461.27			
CV %	9.53			

Table 3: Effect of age of seedling and source of manures on quality of castor

Treatments	**Oil content (%)**	**Ricin oleic acid (%)**
Age of seedling (A)		
A_1: Two week old seedling	49.15	88.20
A_2: Three week old seedling	49.18	88.06
A_3: Four week old seedling	48.79	88.05
A_4: Normal sowing	49.34	88.26
S.Em. ±	0.45	0.579
CD (*P=0.05*)	NS	NS
Source of manures (S)		
S_1: No compost	48.80	88.28
S_2: Vermicompost	49.05	88.07
S_3: FYM	49.25	88.14
S_4: Castor shell compost	49.36	88.08
S.Em. ±	0.45	0.579
CD (*P=0.05*)	NS	NS
Interaction (A x S)		
S.Em. ±	0.90	1.157
CD (*P=0.05*)	NS	NS
CV %	3.17	2.27

4. Economics

Data presented in Table 4, it could be seen that the maximum gross and net realizations of 1,74,075 ha^{-1} and 1,33,092 ha^{-1}, respectively with treatment A_4 (Normal sowing). It was followed by treatment A_2 (Three week old seedling). The minimum gross and net realizations were noted under treatment A_3 (Four week old seedling). However, numerically higher benefit: cost ratio (BCR) was recorded with treatment A_4 (Normal sowing).

Table 4: Effect of age of seedling and source of manures on economics of castor

Treatment	Seed yield (kg ha^{-1})	Gross realization (₹ ha^{-1})	Common cost (₹ ha^{-1})	Variable cost (₹ ha^{-1})	Total cost (₹ ha^{-1})	Net realization (₹ ha^{-1})	BCR
Age of seedling							
A_1 = Two week old seedling	2934	161370	39264	9279	48543	112827	3.32
A_2 = Three week old seedling	2995	164725	39264	9279	48543	116182	3.39
A_3 = Four week old seedling	2512	138160	39264	9279	48543	89617	2.85
A_4 = Normal sowing	3165	174075	39264	1719	40983	133092	4.25
Source of manure							
S_1 = No compost	2600	143000	39264	0	39264	103736	3.64
S_2 = Vermicompost	2818	154990	39264	19439	58703	96287	2.64
S_3 = FYM	2938	161590	39264	11110	50374	111216	3.21
S_4 = Castor shell compost	3250	178750	39264	4168	43432	135318	4.12

5. Effect of source of manures

5.1 On growth, yield and quality

The data revealed that there is no significant effect of treatment combinations on plant population at harvest and whatsoever results obtained was due to the effect of treatment combinations only. This indicated that the transplanting of castor seedling of different days raised on different manures were successful to maintain the plant population.

It is seen from the result given in Table 1 showed that the number of effective branches plant^{-1} was found non-significantly influenced due to different source of manures. However, higher values of number of effective branches plant^{-1} 17.75 were obtained under the treatment S_4 (Castor shell compost). This could be due to better supply of plant nutrients provided by castor shell compost to the growing castor plants. Castor shell compost contains relatively higher concentration of nitrogen, phosphorus and potassium as well as good water holding capacity which might have promoted castor number of effective branches plant^{-1} (Castor Annual Report, 2020) [1]. Javiya (2019) [6] also reported that castor shell compost effective in groundnut by increasing yield attributing characters.

Number of nodes plant^{-1} of castor had no significant differences due to various source of manures. However, higher number of nodes plant^{-1} 16.37 were observed with treatment S_4 (castor shell compost) compare to other treatment S_3, S_2 and S_1 (Table 1). The best possible explanation for this could be the balanced supply of major and micro nutrient as per castor plant requirement from the castor shell compost.

Length of primary spike (cm) of castor had no significant differences due to various source of manures. However, maximum value of length of primary spike 70.47cm was observed with treatment S_4 (Castor shell compost) followed by treatment S_3 (FYM) compare to other treatment S_2 and S_1 (Table 1). However, Kumar and Kanjana (2009) [8] found that the balanced application of FYM @ 12.5 t ha^{-1} + Azospirillum @ 2kg ha^{-1} + Phospho-bacteria @ 2 kg ha^{-1} to castor under irrigated conditions recorded significantly maximum length of primary spike under normal sowing conditions.

It is seen from the result given in Table 1 showed that the number of capsules in primary spike was found non-significantly influenced due to different source of manures. However, higher values of number of capsules in primary spike (92.40) was obtained under the treatment S_3 (FYM). However, Kumar and Kanjana (2009) [8] found that the integrated application of FYM @ 12.5 t ha^{-1} + Azospirillum @ 2 kg ha^{-1} + Phospho-bacteria @ 2 kg ha^{-1} to castor under irrigated conditions recorded significantly maximum number of capsules in primary spike under normal sowing conditions.

Data presented in Table 1 pertaining to 100 seed Wight (g) was found non-significant due to different source of manures. The numerical higher value of 100 seed weight 33.60 g was recorded under the treatment of (Castor shell compost) S_4. Javiya (2019) [6] also reported that castor shell compost effective in groundnut by increasing yield attributing characters.

Data presented in Table 1 pertaining to the seed yield was found significantly by different source of manures. Significantly the highest seed yield 3250 kg ha^{-1} was recorded under the treatment of (Castor shell compost) S_4. Whereas, significantly the lowest seed yield 2500 kg ha^{-1} was recorded under the treatment of (No compost) S_1. However, Javiya (2019) [6] also reported that castor shell compost effective in groundnut by increasing yield.

Data presented in Table 3 pertaining to the oil content were found non-significantly by different sources of manures. The highest oil content 49.36 per cent was recorded under the treatment of (Castor shell compost) S_4. Whereas, the lowest oil content 48.80 per cent was recorded under the treatment of (No compost) S_1. Kumar and Kanjana (2009) [8] found that the integrated application of FYM @ 12.5 t ha^{-1}+ Azospirillum @ 2 kg ha^{-1} + Phospho-bacteria @ 2 kg ha^{-1} to castor under irrigated conditions recorded significantly higher oil yield under normal sowing conditions.

Data presented in Table 3 pertaining to the ricin oleic acid per cent were found non-significantly by different level of source of manures. The highest ricin oleic acid 88.28 per cent was recorded under the treatment of (No compost) S_1. Whereas, the lowest ricin oleic acid 88.07 per cent was recorded under the treatment of (Vermicompost) S_2. The range of ricin oleic acid was in line of the conclusion of Shah *et al.* (2015) [15].

5.2 Economics

The highest gross and net realizations as well as benefit: cost ratio (BCR) due to source of manures S_4 (Castor shell compost) was observed. The maximum gross realization 1,78,750 ha^{-1} and net realization 1,35,318 ha^{-1} with as benefit: cost ratio (BCR) 4.12 through source of manures S_4 (Castor shell compost) as shown in Table 4.

5.3 Interaction effect

Significantly the highest seed yield (3656kg ha^{-1}) was recorded under treatment combination of three week old seedling + Castor shell compost (A_2S_4) but it was found at par with treatment *viz.,* Two week old seedling + FYM (A_1S_3), Two week old seedling + Castor shell compost (A_1S_4), Normal sowing + FYM (A_4S_3), Normal sowing + Castor shell compost (A_4S_4). Significantly the lowest seed yield (2186 kg ha^{-1}) was recorded under treatment combination two week old seedling + No compost (A_1S_1), (Table 2). This could be due to the optimum root development, early nutrient availability and balanced nutrition in the very close vicinity of roots. Two week seedlings are more adaptive for establishment and absorbed transplant shock when grown with FYM and Castor shell compost. The three week seedlings are most yielded due to early and better establishment as well as better nutrient supply to the plants. Kumar and Kanjana (2009) [8] found that the integrated application of FYM @ 12.5t ha^{-1}+ Azospirillum @ 2kg ha^{-1} + Phospho-bacteria @ 2 kg ha^{-1} to castor under irrigated conditions recorded significantly maximum yield under normal sowing conditions.

5.4 Economics

The higher gross realization 2,01,099 ha^{-1} and net realization 1,48,387 ha^{-1} was accrued with treatment combination of three week old seedling + Castor shell compost (A_2S_4). The higher benefit: cost ratio (BCR) 3.82 was accrued with treatment combination of three week old seedling + Castor shell compost (A_2S_4) as shown in Table 5.

Table 5: Interaction effect of age of seedling and source of manures on economics of castor

Treatment combinations	Seed yield (kg ha^{-1})	Gross realization (₹ ha^{-1})	Common cost (₹ ha^{-1})	Variable cost (₹ ha^{-1})	Total cost (₹ ha^{-1})	Net realization (₹ ha^{-1})	BCR
A_1S_1	2186	120213	39264	9279	48544	71669	2.48
A_1S_2	2843	156342	39264	28718	67983	88359	2.30
A_1S_3	3295	181216	39264	20389	59654	121562	3.04
A_1S_4	3414	187763	39264	13447	52712	135051	3.56
A_2S_1	2675	147118	39264	9279	48544	98574	3.03
A_2S_2	2988	164318	39264	28718	67983	96335	2.42
A_2S_3	2660	146316	39264	20389	59654	86662	2.45
A_2S_4	3656	201099	39264	13447	52712	148387	3.82
A_3S_1	2473	136041	39264	9279	48544	87498	2.80
A_3S_2	2372	130462	39264	28718	67983	62479	1.92
A_3S_3	2523	138756	39264	20389	59654	79103	2.33
A_3S_4	2679	147360	39264	13447	52712	94648	2.80
A_4S_1	3064	168545	39264	9279	48544	120001	3.47
A_4S_2	3070	168866	39264	28718	67983	100884	2.48
A_4S_3	3272	179974	39264	20389	59654	120321	3.02
A_4S_4	3252	178883	39264	13447	52712	126171	3.39

6. Conclusion

Based on the present study, it is concluded that castor should be growth by transplanting of three week old castor seedling raised with castor shell compost (300 g/nursery bag) or by normal sowing besides recommended doses of N-P_2O_5-K_2O-S (180:37.5:00:20 kg/ha) for achieving higher seed yield and net realization under loamy sand of North Gujarat Agro-climatic condition.

7. Reference

1. Indian Institute of Oilseeds Research. Castor Annual Report, Rajendranagar, Hyderabad, 2020.
2. Anonymous. Method for cultivating castor-oil plant, 2007. Available at https://patents.google.com/patent/CN1943308A/en. Accessed on 5th April, 2021.
3. Anonymous. High-yield planting method of simultaneously ripe five-spike Ricinus communis, 2014. Available at https://patents.google.com/patent/ CN103210756A/en. Accessed on 8th June, 2021.
4. Economic and Statistics. Ministry of Agriculture, Government of India, 2019-20.
5. Fernandez-Martinez J, Velasco L. Technological innovations in major world oil crops. 2012;1:237–265.
6. 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.
7. Kumar M, Ou YL, Lin JG. Co-composting of green waste and food waste at low C/N ratio. Waste Manage. 2010;30:602-609.
8. 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.
9. Mutlu H, Meier MAR. Castor oil as a renewable resource for the chemical industry. European Journal Lipid Science Technology. 2010;112:10–30.
10. Rodríguez OAV, Vázquez AP. Seedling Characteristics of Three Oily Species before and after Root Pruning and Transplant. Plants. 2019;8(258):1-19.
11. Severino LS, Cardoso GD, Vale LS, Santos JW. Métodopara determinac¸ ao da area foliar da mamoneira. Revista Brasileira de Oleaginosas Fibrosas. 2004;8:73-72.
12. Severino LS, Dick LA, Marco B, Candido MJD, Chen G, Crosby W, *et al.* A Review on the Challenges for Increased Production of Castor. Agronomy Journal. 2012;104(4):853-880.
13. Severino LS, Mendonc AES, Neves YP, Barros UV, Barbosa CM. Formas de nitrogênio e propriedades do soloem cultivo adensado de café. Revista Ceres. 2001;48:71–80.
14. Singh H, Meena MK, Choudhary RL, Dotaniya ML, Meena MD, Jat RS, *et al.* Effect of Direct Sowing and Transplanting on Yield Performance of Indian Mustard. International Journal of Current Microbiology and Applied Sciences. 2019;8(2):509-515.
15. 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.