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Effect of different organic inputs and transplanting dates on seed quality parameters of radish (*Raphanus sativus* L.)

D. P. Singh*, S. C. Verma, H. K. Sharma, D. K. Mehta, K. S. Thakur and N. K. Bharat

Department of Seed Science and Technology, Entomology and Vegetable Science, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan-173230 (H. P.), INDIA

*Corresponding author. E-mail: d.p.singhag@gmail.com

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Abstract: An investigation was carried out during two consecutive years (2014-15 and 2015-16) at experimental farm of Department of Seed Science and Technology, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan-273230 (H. P.). The experiment was conducted on effect of different organic inputs like vermicompost, FYM, *Azotobactor*, PSB and PGPR and transplanting dates on seed quality attributes of radish (*RaphanussativusL.*). The transplanting was done on three different dates during both years. There were seven treatments including control and each treatment was replicated thrice. The data was analysed in factorial randomized block design. The study revealed that all the seed quality parameters like germination % (95.08), seedling length (24.46 cm), shoot length (13.02 cm), root length (13.04 cm), seedling dry weight (0.110 mg), seed vigour index I (2329.07) and seed vigour index II (10419.25) were found maximum with treatment Vermicompost (@ 50 q ha^{-1}) + *Azotobacter* (root dip @ 2.5 Kg/ ha^{-1}) + PSB (root dip @ 2.5 Kg/ ha^{-1}) + NSKE (5 %) and maximum 1000 seed weight (12.52 g) was found with treatment FYM @100 q ha^{-1} + *Azotobacter* @ 2.5 kg ha^{-1} (root dip) + PSB @ 2.5 kg ha^{-1} (root dip) + NSKE @ 5 % in 4th November transplanting. All parameters showed a decreasing trend as sowing date was delayed.

Keywords: Seed quality parameters, Organic inputs, *Raphanussativus*, Transplanting dates

INTRODUCTION

Radish (*Raphanus sativus* L.) belongs to the family Brassicaceae where the edible part is root. It is a popular vegetable in both tropical and temperate regions of the world. It is one of the most ancient vegetable. It is being cultivated in India over an area of 1, 69, 000 ha with annual production of 22, 03, 000 MT (Anonymous, 2015). Radish is a good source of Vitamin A and Vitamin C and minerals like calcium, potassium, iron and phosphorus. The most popular eating part of radish is the tuberous roots although the entire plant is edible and the tops can be used as a leafy vegetable. Radish has got several medicinal properties. It increases appetite; prevent constipation, beneficial for the patients suffering from piles, liver trouble, enlarged spleen, jaundice, gall bladder and urinary disorders. The growth and yield of radish greatly depends on soil and climatic conditions. Different varieties have different soil and climatic requirements for their optimum performance. India being a vast country with varied agro-climatic regions *viz.,* temperate, subtropical, tropical and coastal tropical humid regions, a single variety may not be suitable for all the agro-climatic regions. Hence, different varieties have to be identified for specific regions (Khadem *et al*., 2010; Tung and Fernandez, 2007).

To overcome the ecological problems resulting from the loss of plant nutrients and to increase crop yield, microorganisms that allow more efficient nutrient use or increase nutrient availability can provide sustainable solutions for present and future agricultural practices. It is well known that the biofertilizers contain a variety of beneficial microorganisms which accelerate and improve plant growth and protect plants from pests and diseases. Organic agriculture practices rely upon recycling of crop residues, animal manure, farm organic residues and wastes etc. (Choudhary *et al.,* 2002; Stockdale *et al.,* 2001 and Bhuma, 2001). In view of higher cost of synthetic fertilizers and its contribution to poor health of soil and water it becomes imperative to go for alternative and cheaper source like organic manures.

MATERIALS AND METHODS

Two field experiments were conducted in 2014 and 2015 at Pandah Research Farm, Department of Seed Science and Technology, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan-273230 (H. P.), India. Radish var. Japanese White *Raphanussativus* L. was subjected to seven treatments *viz*., (T_1) FYM @ 100 q/ha + NSKE (5 %), (T_2) vermicompost @ 50 q/ha + NSKE (5 %), (T_3) FYM (@ 100 q/ha) +

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PGPR (1 litre/ha) + NSKE (5 %), (T_4) Vermicompost @ 50 q/ha + PGPR (1 litre/ha) + NSKE (5 %), (T_5) FYM (@ 100 q/ha) + *Azotobacter* (root dip @ 2.5 Kg/ ha) + PSB (root dip @ 2.50 Kg/ha) +NSKE (5 %), (T_6) Vermicompost (@ 50 q/ha) + *Azotobacter* (root dip @ 2.5 Kg/ha) + PSB (root dip @ 2.5 Kg/ha) + NSKE (5 %) and (T_7-Control) RDF+ Malathion (0.05 %) with three transplanting dates (4th November, 19th November and 4th December in both years).

Organic manures and fertilizers were applied as per the recommendations. Data were statistically analysed as suggested by Cochran and Cox (1964). 100 seeds from all replications of each treatment were used for conducting the germination test as per ISTA (Anonymous, 1985). This was carried out by using paper roll method in the seed germinator at 25 ^{O}C. The first and final counts were taken after 7 and 10 days, respectively. Seed vigour indexes were calculated as per method of Abdul-Baki and Anderson, (1973).

RESULTS AND DISCUSSION

Data presented in Table 1 that all the treatments produced significant effects on seed quality parameters in both the years and all parameters showed a decreasing trend as sowing date was delayed. Among the organic treatments, significantly maximum 1000 seed weight (13.69 g) was found with I (4th November) date of transplanting followed by II (November 19th) date (11.96 g) and III (4th December) date of transplanting (10.73 g). Maximum 1000 seed weight (12.52 g) was recorded with treatment T_5 which was statistically at par with T_6 (12.41 g). Minimum 1000 seed weight was recorded with treatment T_2 (11.68 g). On I date of transplanting, maximum 1000 seed weight (13.98 g) was recorded with treatment T_5 which was statistically at par with T_6 (13.96 g) and both the treatments were statistically at par with T_7 control (14.19 g) of the same transplanting date and significantly differed from II and III date of transplanting. This might be due to bulk planting density on account of higher seed rates used that eventually declined the seed weight. The results are in accordance with the findings of Shahzad *et al.* (2007) who also observed that earlier sowing resulted in better development of the grain due to longer growing period. Similar findings were also reported by Chauhan *et al.* (1995); in raya, Panwar *et al.* (2000); in radish Lamo (2009) in radish and Mehta (2010) in radish.

Among the organic treatments, significantly maximum germination percentage (96.96) was found with I (4th November) date of transplanting followed by II (November 19th) date (94.04) and III (4th December) date of transplanting (91.91). Maximum germination percentage (95.08) was recorded with treatment T_6 which was statistically at par with T_5 (94.92) and both the treatments were statistically at par with T_7 control (95.29). Minimum germination percentage was recorded with treatment T_1 (93.54). On I date of transplanting, maximum germination percentage (97.38) was recorded with treatment T_6 which was statistically at par with T_5 (97.13) and both the treatments were statistically at par with T_7 control (97.75) of the same transplanting date and significantly differed from II and III date of transplanting.. In general, the gradual delay in sowing resulted in the reciprocal increase in the seed germination period which is a result of lowering down of the temperature. Shrivastava *et al.* (1992) and Pervez *et al.* (2004). Similar results were also obtained under different climatic conditions as influenced sowing time by *Lamo* (2009) and Gill and Gill (1995). Similarly, maximum seedling length (26.96 cm) was recorded with I (4th November) date of transplanting followed by II (November 19th) date (23.68 cm) and III (4th December) date of transplanting (19.38 cm). Maximum seedling length (24.46 cm) was recorded with treatment T_6 which was statistically at par with T_7 control (24.69 cm). Minimum seedling length was recorded with treatment T_1 (21.94 cm). On I date of transplanting, significantly maximum seedling length (28.24 cm) was recorded with treatment T_6 which was differed from rest of the treatments of same date of transplanting and II as well as III date of transplanting. Similar results were observed under different set of climatic conditions as influenced by time of planting in radish by Gill and Gill (1995) and Warde *et al.* (2004). The seed quality characters were significantly influenced by time of planting. This might be due to wider spacing helped the individual plant to utilize more water, nutrient, light and air.

Maximum shoot length (14.23 cm) was found with I (4th November) date of transplanting followed by II (November 19th) date (12.26 cm) and III (4th December) date of transplanting (10.30 cm). Maximum shoot length (13.02 cm) was recorded with treatment T_6 which was statistically at par with T_5 (12.87 cm). Minimum shoot length was recorded with treatment T_1 (11.36 cm). On I date of transplanting, significantly maximum shoot length (15.33 cm) was observed with treatment T_6 which was differed from rest of the treatments of same date of transplanting and II as well as III date of transplanting. Similar results were obtained by El-Kalla *et al.* (1997) on faba bean, Hewedy (1999) on tomato. The above results were in close agreement with the finding of Kumaran *et al.* (1998) who tested different organic sources i.e. FYM, Neem cake, Vermicompost, *Azotobacter* and PSB in different combinations in tomato. Similar kind of results were also observed by Singh *et al.* (2014) in broccoli; Kumar *et al.* (2013) in tomato; Kashyap *et al.* (2014) in brinjal; Kumar *et al.* (2014) in radish, Dushyant *et al.* (2014) in stevia. Significantly maximum root length (12.50 cm) was found with I (4th November) date of transplanting followed by II (November 19th) date (11.40 cm) and III (4th December) date of transplanting (9.08

Table 1. Effect of different organic inputs and transplanting dates on seed quality parameters of radish (*Raphanussativus*L.) (pooled data).

Treatments / Parameters*	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Mean	C.D. (0.05)	
1000 seed weight (g)**										
1st Transplanting	13.46	13.38	13.35	13.53	13.98	13.96	14.19	**13.69**	Transplanting	0.098
2nd Transplanting	11.56	11.60	11.75	11.61	12.45	12.23	12.53	**11.96**	Treatments	0.150
3rd Transplanting	10.65	10.05	10.30	10.89	11.12	11.04	11.08	**10.73**	Interaction	0.260
Mean	**11.89**	**11.68**	**11.80**	**12.01**	**12.52**	**12.41**	**12.60**	**12.13**		
Germination (%)										
1st Transplanting	96.88	96.63	96.75	96.25	97.13	97.38	97.75	**96.96**	Transplanting	0.348
2nd Transplanting	93.25	93.50	93.75	93.50	95.00	94.50	94.75	**94.04**	Treatments	0.532
3rd Transplanting	90.50	91.00	91.00	91.50	92.63	93.38	93.38	**91.91**	Interaction	0.922
Mean	**93.54**	**93.71**	**93.83**	**93.75**	**94.92**	**95.08**	**95.29**	**94.30**		
Seedling length (cm)										
1st Transplanting	25.20	25.42	25.65	25.87	27.83	28.24	28.64	**26.69**	Transplanting	0.137
2nd Transplanting	22.60	22.92	23.49	23.51	24.31	24.45	24.46	**23.68**	Treatments	0.210
3rd Transplanting	18.02	17.76	18.45	19.29	20.53	20.69	20.97	**19.38**	Interaction	0.363
Mean	**21.94**	**22.03**	**22.53**	**22.89**	**24.22**	**24.46**	**24.69**	**23.25**		
Shoot length (cm)										
1st Transplanting	13.06	13.41	13.49	13.65	14.95	15.33	15.72	**14.23**	Transplanting	0.099
2nd Transplanting	11.66	11.78	12.39	12.16	12.65	12.48	12.70	**12.26**	Treatments	0.152
3rd Transplanting	9.36	9.43	9.78	9.96	11.00	11.24	11.35	**10.30**	Interaction	0.262
Mean	**11.36**	**11.54**	**11.89**	**11.92**	**12.87**	**13.02**	**13.26**	**12.26**		
Root length (cm)										
1st Transplanting	12.14	12.14	12.17	12.22	12.88	13.04	12.92	**12.50**	Transplanting	0.107
2nd Transplanting	10.94	11.14	11.10	11.35	11.65	11.85	11.74	**11.40**	Treatments	0.164
3rd Transplanting	8.66	8.33	8.67	9.33	9.52	9.44	9.62	**9.08**	Interaction	0.284
Mean	**10.58**	**10.54**	**10.64**	**10.97**	**11.35**	**11.44**	**11.43**	**10.99**		
Seedling dry weight (mg)										
1st Transplanting	0.113	0.114	0.114	0.116	0.120	0.121	0.124	**0.117**	Transplanting	0.0010
2nd Transplanting	0.101	0.102	0.104	0.106	0.109	0.110	0.111	**0.106**	Treatments	0.0016
3rd Transplanting	0.089	0.083	0.088	0.091	0.098	0.098	0.098	**0.092**	Interaction	0.0027
Mean	**0.101**	**0.099**	**0.102**	**0.104**	**0.109**	**0.110**	**0.111**	**0.105**		
Seed vigour index-I										
1st Transplanting	2438.12	2453.08	2475.34	2489.89	2702.37	2749.96	2799.49	**2586.89**	Transplanting	14.764
2nd Transplanting	2107.74	2142.98	2202.50	2198.14	2309.69	2310.58	2317.16	**2226.97**	Treatments	22.552
3rd Transplanting	1630.45	1615.88	1678.87	1764.67	1901.34	1926.67	1953.44	**1781.62**	Interaction	39.061
Mean	**2058.77**	**2070.65**	**2118.90**	**2150.90**	**2304.47**	**2329.07**	**2356.69**	**2198.49**		
Seed vigour index-II										
1st Transplanting	10957.13	10952.25	11024.75	11116.38	11594.38	11783.25	12083.38	**11358.79**	Transplanting	101.748
2nd Transplanting	9441.88	9513.00	9703.38	9864.50	10378.75	10371.50	10493.63	**9966.66**	Treatments	155.422
3rd Transplanting	8030.75	7564.75	8052.00	8243.00	9007.88	9103.00	9103.00	**8443.48**	Interaction	269.199
Mean	**9476.58**	**9343.33**	**9593.38**	**9741.29**	**10327.00**	**10419.25**	**10560.00**	**9922.98**		

*4 replications and **3 Replications

cm). Maximum root length (11.44 cm) was recorded with treatment T_6 which was statistically at par with T_5 (11.35 cm) and both the treatments were statistically at par with T_7 control (11.43 cm). Minimum root length was recorded with treatment T_2 (10.54 cm). On I date of transplanting, maximum root length (13.04 cm) was recorded with treatment T_6 which was statistically at par with T_5 (12.88 cm) and both the treatments were statistically at par with T_7 control (12.92) of same transplanting date and significantly differed from II and III date of transplanting. Such results are obtained on account of favourable conditions available during the growing period and also early sowing possibly attributed to maximum photosynthesis with longer growth period than the later plantings, which also faced severe winter months after planting causing cessation of growth. Similar results were made by Joshi *et al.* (1975) and Gill and Singh (1979). Vermicompost may influence plant growth directly via the supply of plant growth regulating substances (PGRs) proposed Tomati and Galli (1995) in radish. Similarly maximum seedling dry weight (0.117 mg) was found with I (4th November) date of transplanting followed by II (November 19th) date (0.106 mg) and III (4th December) date of transplanting (0.092 mg). Maximum seedling dry weight (0.110 mg) was recorded with treatment T_6 which was statistically at par with T_5 (0.109 mg) and both the treatments were statistically at par with T_7 control (0.111 mg). Minimum seedling dry weight was recorded with treatment T_2 (0.099 mg). On I date of transplanting, maximum seedling dry weight (0.121 mg) was recorded with treatment T_6 which was statistically at par with T_5 (0.120 mg) and both the treatments were statistically at par with T_7 control (0.124 mg) of same transplanting date and significantly differed from II and III date of transplanting. Similar results were observed under different set of climatic conditions as influenced by time of planting in radish by Brahma *et al.* (2009) and Khan *et al.* (2012). Whereas Bendegubal *et al.* (2008) were of the opinion that vermicompost which acts as chelating agent and regulated the activity of micronutrient in radish plant might have increased the seed yield and seed vigour by providing nutrients in the available form.

Significantly maximum seed vigour index-I (2586.89) was found with I (4th November) date of transplanting followed by II (November 19th) date (2226.97) and III (4th December) date of transplanting (1781.62). Maximum seed vigour index-I (2329.07) was recorded with treatment T_6 which was found differed from rest of the treatments. Minimum seed vigour index-I was recorded with treatment T_1 (2058.77). On I date of transplanting, maximum seed vigour index-I (2749.69) was observed with treatment T_6 which was statistically at par with T_7 control (2799.49) of same date of transplanting and significantly differed from II as well as III date of transplanting. Similarly maximum seed vigour index-II (11358.79) was observed with I (4th November) date of transplanting followed by II (November 19th) date (9966.66) and III (4th December) date of transplanting (8443.48). Maximum seed vigour index-II (10419.25) was recorded with treatment T_6 which was found differed from rest of the treatments. Minimum seed vigour index-II was recorded with treatment T_1 (2058.77). On I date of transplanting, maximum seed vigour index-II (2749.69) was observed with treatment T_6 which was statistically at par with T_5 (10327.00) and both the treatments were statistically at par with T_7 control (10560.00) of same date of transplanting and significantly differed from II as well as III date of transplanting. Higher seedling vigour index might be due to adequate availability of nutrients in the desired quantity that might have helped the radish plants to produce bolder and heavier seeds (Panwar *et al.* 2000). Similar are the results of Singh and Singh (1978) in mustard and Rahman *et al.* (1996) in tomato. Karibasappa *et al.* (2007) were also of the opinion that improvement in all parameters including seed vigour index of a plant could be attributed to higher assimilatory surface which was due to photosynthetic activity and genetic makeup of the crop.

Conclusion

Based on the above results, it is concluded that application of Vermicompost @ 50 q/ha + *Azotobacter* root dip @ 2.5 Kg/ha + PSB root dip @ 2.5 Kg/ha + NSKE (5 %) and FYM (@ 100 q/ha + *Azotobacter* (root dip @ 2.5 Kg/ha) + PSB root dip @ 2.50 Kg/ha + NSKE (5 %) followed by control (RDF) was found more beneficial and significantly improved quality and yield components in radish. However, the variety Japanese white was found to be best, suitable for I date of transplanting (4th November) when concern to quality and yield components.

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