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Effect of different time of transplanting and organic fertilizers on plant growth and seed yield parameters of radish (*Raphanus sativus* L.)

Divya Prakash Singh, SC Verma and Sujata Kumari

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 time of transplanting, organic fertilizers and their interactions on growth and seed yield of radish (*Raphanus sativus* L.). 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 was revealed that all the growth and seed yield parameters like minimum days to 50% bolting (88.17 days) and days to 50% flowering (95.33 days), maximum number of branches plant^{-1} (12.82) and maximum number of siliqua plant^{-1} (488.03) were recorded with treatment vermi compost @50 q ha^{-1} + *Azotobacter* @2.5 kg ha^{-1} (root dip) + PSB @2.5 kg ha^{-1} (root dip) + NSKE @5% and siliqua length (7.15 cm), plant height (111.65 cm), number of seed siliqua^{-1} (6.35), seed yield plant^{-1} (20.11 g), seed yield plot^{-1} (301.60 g) and seed yield (881.04 kg ha^{-1}) were recorded maximum with treatment RDF+ Malathion @0.05% in 4th November transplanting. All parameters showed a decreasing trend as sowing date was delayed. The study reveals that interactions of different transplanting and organic fertilizers had significant impact on all growth and yield parameters.

Keywords: growth parameters, organic fertilizers, radish, seed yield, transplanting dates

Introduction
Radish (*Raphanus sativus* L.) belongs to the family Brassicaceae where the edible part is roots. It is a popular vegetable in both tropical and temperate regions of the world. It is one of the most ancient vegetables. It is being cultivated in India over an area of 1, 69,000 ha with annual production of 22, 03,000 MT (Anonymous, 2015) [2]. 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. Good quality seed is one of the important means to increase productivity in any crop (Verma and Phogat, 1994) [40].

Modern agriculture largely depends on the use of agrochemicals which leads to loss of soil fertility, soil degradation, killing of beneficial insects and has adversely impacted agricultural productivity, besides environmental pollution. According to Kevan (1999) [18] the increase uses of agro chemicals have led to the reduction in beneficial arthropod species richness in agriculture landscapes. The adoption of vegetable seed production as an industry in Himachal Pradesh has several problems.

One of the factors responsible for reduced growth and lower yield of vegetables is cultural practices like time of sowing and spacing. The scientific vegetable production reveals the significance and importance of sowing dates and plant population to be used for raising vegetable crops in order to get higher production of good quality vegetables. For good quality and better root production, radish requires optimum sowing date and plant density (Alam *et al.*, 2010) [1]. The present investigation was therefore taken up to determine the effect of organic fertilizers and suitable time of transplanting and their interaction in order to have maximum seed production of radish.

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 was subjected to seven treatments *viz*., FYM@100 q/ha + NSKE (5%) (T_1), vermi compost @50 q/ha + NSKE (5%) (T_2), FYM (@ 100 q/ha) +PGPR (1 litre/ha) +NSKE (5%) (T_3), Vermi compost (50 q/ha) +PGPR (1 litre/ha) + NSKE (5%) (T_4), FYM (@100q/ha) +*Azotobacter* (root dip @2.5 Kg/ha) + PSB (root dip@ 2.50 Kg/ha) +NSKE (5%) (T_5), Vermicompost (@50 q/ha) +*Azotobacter* (root dip @2.5 Kg/ha) + PSB (root dip @2.5 Kg/ha) + NSKE (5%) (T_6) and RDF+ Malathion (0.05%) (T_7-Control) with three transplanting dates (4^{th} November, 19^{th} November and 4^{th} 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) [6]. Growth and seed yield parameters studied were days to 50% bolting, days to 50% flowering, number of branches plant^{-1}, siliqua length (cm), number of siliqua plant^{-1}, plant height (cm), number of seed siliqua^{-1}, seed yield plant^{-1} (g), seed yield plot^{-1} (g) and seed yield (kg ha^{-1}).

Result and Discussion

It is evident from Table 1 that all the treatments produced significant effects on growth and seed yield parameters consistently in both the years and all parameters showed a decreasing trend as sowing date was delayed. Days to 50% bolting (88.17 days) attained earlier with treatment T_6 which was at par with T_7 in 1^{st} transplanting (4^{th} November) and maximum days to 50% bolting (97.00 days) was recorded with treatment T_1 followed by T_4 in 3^{rd} transplanting (4^{th} December).

Days to 50% flowering (95.33 days) attained earlier with treatment T_6 which was at par with T_7 followed by T_5 in 1^{st} transplanting (4^{th} November) and maximum days to 50% flowering (107.67 days) was recorded same with two treatments T_2 and T_4 which was at par with T_1 followed by T_3 in 3^{rd} transplanting (4^{th} December). Vermi compost may influence plant growth directly via the supply of plant growth regulating substances (PGRs) proposed by Tomati *et al.* (1990) [38]; Grapelli *et al.* (1987) and Tomati and Galli (1995) [37]. The trend of present result is also in agreement with the finding of Kadam *et al.* (1990) [15]; Thakur *et al.* (2012) [36]; Meena *et al.* (2007) [25]; Nag and Roy (2008) [26] and Reddy *et al.* (2011) [28]. The increase in these parameters might be due to the *Azotobactor* it fixes the atmospheric nitrogen hence it increased the availability of Nitrogen in the soil and secret growth promoting substances, which accelerates the physiological process like synthesis of carbohydrate. Similar findings were reported by Basavaraju *et al.* (2002) [4] in Brinjal, and Sajan *et al.* (2002) in chilli.

Maximum number of branches plant^{-1} (12.82) was also recorded with treatment T_6 followed by T_5 in 1^{st} transplanting (4^{th} November) and minimum number of branches plant^{-1} (6.90) was recorded with two treatments T_3 and T_4 which was at par with T_1 and T_2 followed by T_5 in 3^{rd} transplanting (4^{th} December). Appropriate and proper time of sowing is one of the basic requirements for obtaining maximum yield and high return of any crop. As emphasized by Snoek (1981) [35], the total yield of the crop is markedly influenced by different sowing and transplanting times. Similar results have also been observed by Wood *et al.* (1980) [42]. The above results were in close agreement with the finding of Kumaran *et al*. (1998) [23] who tested different organic sources i.e. FYM, Neemcake, Vermicompost, *Azotobacter* and PSB in different combinations in tomato and recorded more plant height and number of branches per plant with the application of organic manure and inorganic fertilizers. Similar kind of results were also observed by Kumar and Srivastava (2006) [21]; Chaudhary *et al*. (2005) [5] and Krishna and Alloli (2005) [19]; Singh *et al.* (2014) and Kumar *et al*. (2013) in tomato.

Maximum siliqua length (7.15 cm) was recorded with treatment T_7 which was at par with T_5 followed by T_6 in 1^{st} transplanting (4^{th} November) and minimum siliqua length (4.06 cm) was recorded with treatment T_4 which was at par with followed by T_3 in 3^{rd} transplanting (4^{th} December). Similar results were obtained by Dakhly and Abdel Mageed (1997) on other vegetable crops and Sharma (2002) on cabbage, for *Azotobacter* El-Kalla *et al.* (1997) on faba bean and Hewedy (1999) on tomato.

Maximum number of siliqua plant^{-1} (488.03) was recorded with treatment T_6 which was at par with treatment T_7 followed by T_5 in 1^{st} transplanting (4^{th} November) and minimum number of siliqua plant^{-1} (363.58) was recorded with treatment T_1 which was at par with treatment T_2 followed by T_3 in 3^{rd} transplanting (4^{th} December). Similar results were observed under different set of climatic conditions as influenced by time of planting in radish by Ghormade *et al* (1989), Sharma and Kanauja (1992), Kanwar (1993) and Gill and Gill (1995).

Plant height (111.65 cm) was observed higher with treatment T_7 which was at par with treatment T_6 followed by T_5 in 1^{st} transplanting (4^{th} November) and minimum plant height (88.88 cm) was recorded with treatment T_4 which was at par with treatment T_1 in 3^{rd} transplanting (4^{th} December). Hamma *et al.* (2012) observed that earlier planting date performed better in terms of growth because the crop gets enough duration to complete the vegetative phase fully.

The increase in this parameters might be due to the *Azotobactor* it fixes the atmospheric nitrogen hence it increased the availability of Nitrogen in the soil and secret growth promoting substances, which accelerates the physiological process like synthesis of carbohydrate. Similar findings were reported by Basavaraju *et al.* (2002) [4] in Brinjal, and Sajan *et al.* (2002) in chilli. The above results were in close agreement with the finding of Kashyap *et al*. (2014) in brinjal; Kumar *et al*. (2014) [17] in radish, Dushyant *et al*. (2014) in stevia.

Maximum number of seed siliqua^{-1} (6.35) was also recorded with treatment T_7 which was at par with treatment T_5 in 1^{st} transplanting (4^{th} November) and minimum number of seed siliqua^{-1} (3.60) was recorded with treatment T_1 which was at par with treatment T_2 and T_3 followed by T_4 in 3^{rd} transplanting (4^{th} December). Better vegetative growth might be due to fact that vermi compost and farm yard manure supplying additional amount of nutrients and also improve the physico-chemical and microbial environment of the rhizosphere leading to better expression of response [Kumaran *et al*., (1998) [23] and Sharma and Thakur, (2001)] [31].

Maximum seed yield plant^{-1} (20.11 g) was recorded with treatment T_7 which was at par with treatment T_5 followed by T_6 in 1^{st} transplanting (4^{th} November) and minimum seed yield plant^{-1} (12.49 g) was recorded with treatment T_2 which was at par with treatment T_1 and followed by T_4 in 3^{rd} transplanting (4^{th} December).

Maximum seed yield plot^{-1} (301.60 g) was recorded with treatment T_7 followed by treatment T_5 in 1^{st} transplanting (4^{th} November) and minimum seed yield plot^{-1} (187.38 g) was recorded with treatment T_2 which was at par with treatment T_1 and T_3 followed by T_4 in 3^{rd} transplanting (4^{th} December).

Maximum seed yield (881.04 kg ha^{-1}) was recorded with treatment T_7 which was at par with treatment T_6 followed by treatment T_5 in 1st transplanting (4th November) and minimum seed yield (555.19 kg ha^{-1}) was recorded with treatment T_2 which was at par with treatment T_3 and T_1 followed by T_4 in 3rd transplanting (4th December). Similar findings have been reported by Malik *et al.* (1999), Rao and Manhar (1990), Warde *et al*. (2004) and Gill and Gill (1995). Similar findings were also reported by Sharma and Thakur (2001); Kumar *et al.* (2001); Kumar and Srivastava (2006) [21] Kumar *et al.* 2014. This finding is also in accordance with the results of Asghar *et al*. (2006) and Velmurugan *et al*. (2005).

Table 1: Effect of different time of transplanting and organic fertilizers on growth and seed yield parameters of radish (*Raphanus sativus* L.) (pooled data)

Treatments Parameters*	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Mean	C.D. (0.05)	
50% Bolting										
1st Transplanting	89.67	90.67	90.50	90.50	89.17	88.17	88.67	89.62	Transplanting	0.353
2nd Transplanting	93.83	94.00	94.33	93.50	93.50	93.00	92.67	93.55	Treatments	0.539
3rd Transplanting	97.00	96.50	96.00	96.67	95.50	95.33	94.83	95.98	Interaction	0.934
Mean	93.50	93.72	93.61	93.56	92.72	92.17	92.06	93.05		
50% Flowering										
1st Transplanting	96.83	98.17	98.00	98.17	96.17	95.33	95.83	96.93	Transplanting	0.451
2nd Transplanting	103.17	101.50	101.83	102.67	102.17	101.50	101.50	102.05	Treatments	0.689
3rd Transplanting	107.50	107.67	107.00	107.67	105.33	105.17	105.00	106.48	Interaction	1.194
Mean	102.50	102.44	102.28	102.83	101.22	100.67	100.78	101.82		
Number of branches plant^{-1}										
1st Transplanting	10.74	10.76	11.00	10.86	12.69	12.82	12.67	11.65	Transplanting	0.200
2nd Transplanting	8.61	8.62	8.48	8.54	9.56	9.65	9.49	8.99	Treatments	0.306
3rd Transplanting	6.93	7.14	6.90	6.90	7.29	7.81	7.82	7.25	Interaction	0.530
Mean	8.76	8.84	8.79	8.76	9.84	10.09	10.00	9.30		
Siliqua length (cm)										
1st Transplanting	6.19	6.24	6.12	6.27	7.03	6.96	7.15	6.57	Transplanting	0.069
2nd Transplanting	5.25	5.23	5.23	5.15	5.81	5.88	5.87	5.49	Treatments	0.105
3rd Transplanting	4.25	4.09	4.21	4.06	4.64	4.78	4.82	4.41	Interaction	0.182
Mean	5.23	5.18	5.19	5.16	5.83	5.88	5.94	5.49		
Number of siliqua plant^{-1}										
1st Transplanting	462.63	449.58	457.78	463.37	486.25	488.03	487.78	470.78	Transplanting	2.991
2nd Transplanting	418.03	423.50	425.03	423.23	442.40	441.30	442.47	430.85	Treatments	4.568
3rd Transplanting	363.58	364.02	364.20	371.55	386.23	392.85	388.17	375.80	Interaction	7.912
Mean	414.75	412.37	415.67	419.38	438.29	440.73	439.47	425.81		
Plant height (cm)										
1st Transplanting	106.62	106.26	105.78	106.48	110.62	110.90	111.65	108.33	Transplanting	0.863
2nd Transplanting	101.27	101.02	100.84	101.33	103.50	103.57	103.87	102.20	Treatments	1.319
3rd Transplanting	91.57	90.23	91.52	88.88	97.50	97.46	98.97	93.73	Interaction	2.284
Mean	99.82	99.17	99.38	98.90	103.87	103.98	104.83	101.42		
Number of seed siliqua^{-1}										
1st Transplanting	5.41	5.38	5.47	5.31	6.05	6.14	6.35	5.73	Transplanting	0.085
2nd Transplanting	4.60	4.59	4.53	4.66	5.12	5.34	5.15	4.86	Treatments	0.130
3rd Transplanting	3.60	3.64	3.65	3.73	4.13	4.14	4.20	3.87	Interaction	0.225
Mean	4.54	4.54	4.55	4.57	5.10	5.21	5.23	4.82		
Seed yield plant^{-1} (g)										
1st Transplanting	18.07	17.91	17.94	18.11	19.82	19.77	20.11	18.82	Transplanting	0.154
2nd Transplanting	15.37	15.59	15.83	15.90	16.84	16.81	17.01	16.19	Treatments	0.235
3rd Transplanting	12.62	12.49	12.67	12.86	13.70	13.66	14.05	13.15	Interaction	0.407
Mean	15.35	15.33	15.48	15.62	16.79	16.75	17.06	16.05		
Seed yield plot^{-1} (g)										
1st Transplanting	271.00	268.65	269.15	271.60	297.23	296.53	301.60	282.25	Transplanting	2.308
2nd Transplanting	230.48	233.23	237.43	238.43	252.65	252.20	255.08	242.87	Treatments	3.525
3rd Transplanting	189.30	187.38	190.00	192.95	205.45	204.95	210.80	197.26	Interaction	6.105
Mean	230.26	229.95	232.19	234.33	251.78	251.23	255.83	240.79		
Seed yield (kg ha^{-1})										
1st Transplanting	802.96	796.00	792.79	805.41	863.56	879.56	881.04	831.61	Transplanting	7.457
2nd Transplanting	682.89	692.81	689.41	717.38	720.08	749.26	750.60	714.63	Treatments	11.390
3rd Transplanting	560.89	555.19	558.82	567.63	586.74	605.41	625.61	580.04	Interaction	19.728
Mean	682.25	681.33	680.34	696.80	723.46	744.74	752.41	708.76		

*3 replications

Conclusion

From the present investigation, it could be concluded that the transplanting on 4th November recorded good growth parameters such as minimum days to 50% bolting and days to 50% flowering, maximum number of branches plant^{-1}, siliqua length (cm), number of siliqua plant^{-1}, plant height (cm), number of seed siliqua^{-1} and maximum seed yield. Hence for seed production, transplanting on 4th November could be recommended for radish crop.

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