EFFECT OF DIFFERENT PLANTING METHODS AND SPACING ON GROWTH, YIELD AND QUALITY OF ROUND RED RADISH (*Raphanus sativus*) CV. SCARLET GLOBE

Abstract

An experiment was conducted at Vegetable research farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj- 211007 (U. P.) India. During the period from December 2021 to February 2022 on the topic "effect of different planting methods and spacing on growth, yield and quality of round red radish (*Raphanus sativus L.*) C.V. Scarlet globe". The experiment was laid out in Factorial Randomised Block Design (FRBD) with 13 treatments and 3 replications. The seeds were sown on four different planting methods viz., flat bed, raised bed, sunken bed and ridge bed with different plant spacings of 5 cm × 5 cm, 10 cm × 10 cm and 15 cm × 15 cm. The result showed that all the growth parameters like plant height (cm), leaf area (cm^2), root diameter (cm) and chlorophyll content (SPAD-502) were found maximum in treatment T_6 (15 x 15 cm+ raised bed). Whereas other parameters like the number of leaves (11.00) and crop yield (78.61q/ha) were found maximum in closer spacing treatment T_4 (5x 5 cm + raised bed).In terms of quality parameters, TSS (3.8^0Brix) and Ascorbic acid (5.5 mg/100g) were observed in treatment T_5 (10x 10 cm + raised bed).

***Key words**: Planting method, spacing, growth parameter, quality parameter, crop yield.*

Introduction

Among the root vegetables, radish (*Raphanus sativus L.)* is a widely grown vegetable belonging to family Brassicacae. Radish is an annual or biennial herb and originated from Central or Western China. Radish is a cool season crop is divided broadly into two groups: European or temperate and Asiatic or tropical. Asiatic types produce roots and seeds under tropical climate, whereas, European types produce roots under sub-tropical and tropical climate. However, seed production of European types is possible only under temperate conditions in hills since these require chilling temperatures for seed production. The Asiatic varieties although are higher yielders and poor in quality attributes, whereas, European varieties are small in size, mild in pungency, early in maturity and rich in quality

parameters. For cool season crops average monthly temperature of 10-15°C is favourable for growth and development. It has rosette leaves, which may vary in size from 10-45 cm depending on the varieties. The edible portion of root develop from both primary root and hypocotyls. It is an excellent source of carbohydrates, protein, vitamins A, C, B6, minerals (calcium, copper, magnesium and potassium), riboflavin and folic acid. It is a root cum leafy vegetable suitable for tropical and temperate climate. India is blessed with all kinds of climatic conditions; radish is being grown throughout the country. Due to its high nutritive value, its suitability for cultivation in different climates and short durational growth nature, radish is grown as main crop as well as intercropped with fruits and vegetables in India.

Plant population is function of spacing of crops grown and significantly influence the plant growth, development and productivity. At wider spacing, there is wastage of resources while at lower spacing, there is competition among plants for available resources and resulting in drastic reduction in yield due to poor growth and development. Therefore, it is necessary to identify the suitable spacing for radish crop for efficient utilization of nutrients applied. The scientific vegetable production reveals the significance and importance of planting method and spacing 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 plant spacing and planting method. There are few recommendations that spacing and planting method have brought classical changes in growth and root yield of radish crop with economical returns. According to researcher **Sikder *et al.* (2008)** observed that the wider plant spacing produced the maximum number of leaves per plant, plant height, maximum diameter and fresh weight while the closer spacing produced maximum yield.

Lavanya *et al.*, (2014) founded that the closer spacing resulted in maximum plant height, whereas all other vegetative parameters like number of leaves, leaf area, and plant weight were found maximum with wider spacing.

The standardization of plant spacing and planting method for any crop is essential to maximize yield and effective utilization of resources provided. This will not only minimize the cost of cultivation but also the yield and quality of produce will be improved and size of radish root will be better and marketable. Considering the significance of plant spacing and planting method for radish crop, the research was done with the objective to evaluate the effect of different planting method and spacing on growth, yield and quality of round red radish.

Materials and Methods

The experiment was designed to study the effect of different planting methods and spacing on growth, yield and quality of round red radish (*Raphanus sativus*) C.V. Scarlet globe. It was conducted at Horticulture Research Field of Department of horticulture, Naini Agricultural institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (U.P.) during the period of December, 2021 to February, 2022.

The factorial experiment consisting of four planting methods (B1-Flat bed, B2-Raised bed,B3-Sunken bed andB4- Ridge bed) and three spacings (S1 - 5 × 5 cm, S2 - 10 × 10 cm and S3 - 15 × 15 cm) was laid out in Factorial Randomised Block Design (FRBD) with three replications. Whole experimental area was 55 m^2, which was divided into total 39 plots with 13 treatments. Size of each plot was 1 × 1m.

Organic manures and fertilizers were applied as per the recommendations. Seeds sown at the rate of 10 kg/ha in about 1.5 cm depths in lines continuously and covered by loose soil. The other cultural practices like irrigation, weeding, earthing up and plant protection operation were carried out as and when required. Crop was harvested after 28-30days after sowing. Five representative individual plants were evaluated on each parameter at different intervals. The observations were recorded on growth, yield and quality parameter.

Statistical analysis was done by using method of analysis of variance (ANOVA) for factorial randomized block design (FRBD) by Panse and Sukhtme (1984). The overall significance of difference among the treatment was tested, using critical difference (C. D. at 5%) level of significance.

Table 1. List of treatment combination

S.No.	Treatment symbol	Treatments	Treatment description
1	T_0	Control	Recommended spacing (10 x 5 cm)
2.	T_1	S1B1	5cm x 5cm+ Flat bed
3.	T_2	S2B1	10cm x 10cm+Flat bed
4.	T_3	S3B1	15cm x15cm+Flat bed
5.	T_4	S1B2	5cm x 5cm+ raised bed
6.	T_5	S2B2	10cm x 10cm+raised bed
7.	T_6	S3B2	15cm x15cm+raised bed
8.	T_7	S1B3	5cm x 5cm+ sunken bed
9.	T_8	S2B3	10cm x 10cm+sunken bed

10.	**T_9**	S3B3	15cm x15cm+sunken bed
11.	**T_{10}**	S1B4	5cm x 5cm+ ridge bed
12.	**T_{11}**	S2B4	10cm x 10cm+ridge bed
13.	**T_{12}**	S3B4	15cm x15cm+ridge bed

Results and Discussion

Growth parameter

In this experiment, statistically data showed that the maximum plant height (cm) was recorded 11.3 cm in treatment T_6 (15 x 15cm + raised bed) (S3B2) followed by treatment T_4 (5 x 5 cm + raised bed) (S1B2) with value 10.8 cm while minimum plant height were recorded 6.1cm in treatment T_7 (5cm x 5cm + sunken bed) (S1B3) followed by treatment T_5 (10 x 10cm + raised bed) (S2B2) with value 7.7 cm. Similar result were observed by Gorakh *et al.,* (2021), Kumari *et al.,* (2018) Among all the treatments T_6 (15 x 15cm + raised bed) was observed non-significant in spacing and their interaction (Spacing x planting method) whereas significant in planting method.

In terms of number of leaves, the maximum number of leaves per plant were recorded 11.00 in treatment T_4 (5 x 5cm + raised bed) (S1B2) followed by treatment T_{12} (15 x 15cm + ridge bed) (S3B4) with value 8.00 while minimum number of leaves per plant were recorded 5.7 in treatment T_6 (15 x 15cm + raised bed) (S3B2) and treatment T_{11} (10cm x 10cm + ridge bed) (S2B4) followed by treatment T_7 (5 x 5 cm+ sunken bed) (S1B3) with value 6.00. Similar findings were reported by Anjum *et al.* (1989), Dawar *et al.,* 2007. Among all the treatment T_4 (5 x 5cm + raised bed) was found significant in spacing and their interaction (Spacing x planting method) whereas non-significant in planting method. This result might be due to closer spacing because Plant population per unit area was higher.

In leaf area (cm^2) data observed that the maximum leaf area was 45.4 cm^2 in treatment combination T_6 (15 x 15cm + raised bed) (S3B2) followed by treatment T_5 (10 x 10cm + raised bed) (S2B2) with value 42.8 cm^2 whereas minimum leaf area were recorded 32.9 cm^2 in treatment T_7 (5 x 5cm + sunken bed) (S1B3) followed by control T_0 with value 33.1cm^2.Among all the treatment T_6 (15 x 15cm + raised bed) showed that non-significant in spacing, planting method and their interaction (Spacing x planting method).

At the time of harvest, the data analysis Showed that treatment T_6 (15 x 15cm + raised bed) (S3B2) had highest chlorophyll content with value 34.4 followed by treatment T_2 (10 x 10 cm + flat bed) (S2B1) with value 34.3 while minimum chlorophyll content measured in treatment T_7 (5 x 5cm +

sunken bed) (S1B3) with value 31 followed by treatment T_{11} (10 x 10 cm + ridge bed) (S2B4) with value 31.3.Among all the treatment T_6 (15 x 15cm + raised bed) was recorded non-significant in spacing, planting method and their interaction (Spacing x planting method).

In plant height, leaf area and chlorophyll content, among all the treatment maximum value reported in T6 due to wider spacing and appropriate bed which causes individual plants to be able to use adequate water or moisture, more nutrients, appropriate light, air and temperature which is essential for growth parameter. These are the factors that affect the plant growth. Adequate water or moisture help in germination and protect from dehydration, more nutrient help in growth and appropriate light, air and temperature stimulate plant growth, break the dormancy and speed up photosynthesis.

Yield parameter

Root diameter (cm) showed that maximum value 12.4 cm in treatment T_6 (15 x 15cm + raised bed) (S3B2) and treatment T_3 (15 x 15cm +flat bed) (S3B1) followed by treatment T_2 (10 x 10cm + flat bed) (S2B1) and treatment T_4 (5 x 5cm + raised bed) (S1B2) with value 11.6 cm at the time of harvest and while minimum root diameter (cm) were recorded 9.1 cm in control (T_0) followed by T_5 (10 x 10cm + raised bed) (S2B2) with value 9.8cm.(Kodi *et al.*,2022, Tripathi *et al.*,2017)Among all the treatments T_6 (15 x 15cm + raised bed) was observed non-significant in spacing and their interaction (Spacing x planting method) whereas significant with planting method.

In crop yield (g. /plot) the maximum value recorded 786.1g in treatment T_4 (5 x 5cm + raised bed) (S1B2) followed by treatment T_1 (5 x 5cm + flat bed) (S1B1) with value 550.9 g whereas minimum crop yield were recorded 111.1g in treatment T_9 (15 x 15cm + sunken bed) (S3B3) followed by control (T_0) with value 114.8g. (Sikder *et al.,* 2008, Kharsan *et al.,* 2009, Sandipan *et al.,* 2021).Among all the treatments T_4 (5 x 5cm + raised bed) was observed significant in spacing, planting method and their interaction (Spacing x planting method).

From above discussion, the result might be due to better utilization of water, nutrient, light and air at wider spacing resulting in better and efficient utilization of nutrients and appropriate bed resulting in good drainage and moisture while at closer spacing, the plant population per unit area was higher, resulting more number of plant population causes high yield produced. This increase in yield as well as yield attributes by wider spacing may be due to increase vegetative growth and foliage giving better opportunities for photosynthetic activities and consequently increasing carbohydrates in the root resulting high yield.

Quality parameter

In TSS, the maximum value 3.8 □Brix showed in treatment T_5 (10 x 10cm + raised bed) (S2B2) and also ascorbic acid recorded a maximum value 5.5 mg/100g fresh weight in treatment T_5 (10 x 10cm + raised bed) (S2B2). (Naruka *et al.*, 2001,). Among all the treatments T_5 was found maximum value might be due to wider spacing which causes good moisture holding capacity, proper light, moisture and major nutrient availability in soil which enhance the quality parameter.

Table 2: Effect of different planting methods and spacing on plant height (cm) of round red radish at harvest

SPACING	PLANTING METHODS			
	Flat bed (B1)	Raised bed (B2)	Sunken bed (B3)	Ridges (B4)
Control	8.5	8.5	8.5	8.5
S1 (5 x 5cm)	11	10.8	6.1	10.6
S2 (10 x 10cm)	9.2	7.7	10.6	10.5
S3 (15 x 15cm)	10	11.3	9.6	10
Spacing				
F-test	NS	NS	NS	NS
S(Ed.)	1.5	0.9	0.7	1.5
CD	3.6	2.3	1.8	3.8
Planting method				
F-test	NS	S	NS	NS
S(Ed.)	1.5	0.9	0.7	1.5
CD	3.6	2.3	1.8	3.8
Spacing x planting method				
F-test	NS	NS	S	NS
S(Ed.)	2.1	1.3	1.0	2.2
C.D	5.2	3.2	2.6	5.4
CV	27	17.0	15.1	27.7

Table 3: Effect of different planting methods and spacing on Number of leaves per plant of round red radish at harvest

SPACING	PLANTING METHODS			
	Flat bed (B1)	Raised bed (B2)	Sunken bed (B3)	Ridges (B4)
Control	6.2	6.2	6.2	6.2
S1 (5 x 5cm)	6.1	11.0	6.0	7.0
S2 (10 x 10cm)	6.4	7.1	6.6	5.7
S3 (15 x 15cm)	7.1	5.7	6.9	8.0
Spacing				
F-test	NS	S	NS	NS
S(Ed.)	0.4	0.84	0.53	0.26
C.D	1.1	2.07	1.30	0.64
Planting method				
F-test	NS	NS	NS	S
S(Ed.)	0.4	0.84	0.53	0.26
CD	1.1	2.07	1.30	0.64
Spacing x planting method				
F-test	NS	S	NS	S
S(Ed.)	0.6	1.19	0.75	0.37
CD	1.5	2.93	1.84	0.91
CV	12	19.5	14.4	6.8

Table 4: Effect of different planting methods and spacing on leaf area (cm^2) of round red radish at harvest

SPACING	PLANTING METHODS			
	Flat bed (B1)	Raised bed (B2)	Sunken bed (B3)	Ridges (B4)
Control	33.1	33.1	33.1	33.1
S1 (5 x 5cm)	40.6	40.6	32.9	36.9
S2 (10 x 10cm)	40.7	42.8	40.9	41
S3 (15 x 15cm)	42	45.4	40.6	41.4
Spacing				
F-test	NS	NS	NS	NS
S(Ed.)	2.6	4.4	2.3	5.4
CD	6.4	10.8	5.7	13.3
Planting method				
F-test	NS	NS	NS	NS
S(Ed.)	2.6	4.4	2.3	5.4
CD	6.4	10.8	5.7	13.3
Spacing x planting method				
F-test	NS	NS	S	NS
S(Ed.)	3.7	6.2	3.3	7.6
CD	9.0	15.3	8.1	18.8
CV	11.6	18.9	11.04	24.7

Table 5: Effect of different planting methods and spacing on chlorophyll content (SPAD-502) of round red radish at harvest

SPACING	PLANTING METHODS			
	Flat bed (B1)	Raised bed (B2)	Sunken bed (B3)	Ridges (B4)
Control	34.1	34.1	34.1	34.1
S1 (5 x 5cm)	32.4	32.5	31	32.9
S2 (10 x 10cm)	34.3	31.5	32.3	31.3
S3 (15 x 15cm)	30.9	34.4	31.9	32.1
Spacing				
F-test	NS	NS	NS	NS
S(Ed.)	1.15	2.39	2.24	1.50
CD	2.83	5.85	5.49	3.68
Planting method				
F-test	NS	NS	NS	NS
S(Ed.)	1.15	2.39	2.24	1.50
CD	2.83	5.85	5.49	3.68
Spacing x planting method				
F-test	NS	NS	NS	NS
S(Ed.)	1.63	3.38	3.17	2.12
CD	4.01	8.28	7.77	5.21
CV	6.10	12.52	12.05	8.01

Table 6: Effect of different planting methods and spacing on crop yield (g/plot) of round red radish at harvest.

SPACING	PLANTING METHODS			
	Flat bed (B1)	Raised bed (B2)	Sunken bed (B3)	Ridges (B4)
Control	114.8	114.8	114.8	114.8
S1 (5 x 5cm)	550.9	786.1	451.5	161.3
S2 (10 x 10cm)	209.6	221.1	134.6	137.0
S3 (15 x 15cm)	200.8	171.0	111.1	112.9
Spacing				
F-test	S	S	S	NS
S(Ed.)	47.3	57.4	35.5	18.8
CD	115.8	140.6	86.9	46.1
Planting method				
F-test	S	S	S	NS
S(Ed.)	47.3	57.4	35.5	18.8
CD	115.8	140.6	86.9	46.1
Spacing x planting method				
F-test	S	S	S	NS
S(Ed.)	66.9	81.2	50.2	26.6
CD	163.8	198.8	123.0	65.3
CV	30.4	30.7	30.3	24.8

Table 7: Effect of different planting methods and spacing on root diameter (cm) of round red radish at harvest.

SPACING	PLANTING METHODS			
	Flat bed (B1)	Raised bed (B2)	Sunken bed (B3)	Ridges (B4)
Control	9.1	9.1	9.1	9.1
S1 (5 x 5cm)	10.9	11.6	11.0	11.5
S2 (10 x 10cm)	11.6	9.8	11.0	10.6
S3 (15 x 15cm)	12.4	12.4	10.6	10.5
Spacing				
F-test	S	NS	NS	NS
S(Ed.)	0.6	0.5	0.6	0.8
CD	1.5	1.3	1.6	2.1
Planting method				
F-test	NS	S	NS	NS
S(Ed.)	0.6	0.5	0.6	0.8
CD	1.5	1.3	1.6	2.1
Spacing x planting method				
F-test	NS	NS	NS	NS
S(Ed.)	0.8	0.7	0.9	1.2
CD	2.1	1.8	2.3	3.0
CV	9.9	8.6	11.2	14.5

Conclusion

From the present investigation, it is concluded that treatment T_6 (15 x 15cm + raised bed) gave best result in terms of growth parameter i.e. plant height (cm), leaf area (cm), and chlorophyll content. However, number of leaves were highest in treatment T_4 (5 x 5cm + raised bed)

In terms of root yield, treatment T_4 had the highest with (78.61q/ha), however, treatment T_6 had the maximum root diameter. In terms of B: C ratio, T_4 had the highest ratio (7.5). Therefore, the closer spacing (5 x 5cm) with raised bed is recommended.

Reference

1. **Lavanya, A.V.N., Vani Sudha, V, V. Reddy, Sundar, Syam P. and Chaitanya1 K., (2014).** Effect of sowing dates and spacing on growth and yield of radish (*Raphanus sativus L.*) Plant Archives Vol. 14 No. 1, pp. 619-623.
2. **Gorakh Yogendra Singh, Tyagi Dinesh Baboo, Nehal Nikita, Singh Shailesh Kumar * Tomar Shiv Singh, Singh Sanjay and Bakshi Manish (2021).** Influence of Different Levels of Nitrogen Application and Spacing on Growth and Yield of Radish (*Raphanus Sativus L.).Plant Cell Biotechnology and Molecular Biology* 22(53&54):10-20;
3. **Tripathi Anuj Kumar, Ram R.B., Rout Sandeep, Kumar Ashok, Patra Sitanshu Sekhar (2017).** Effect of Nitrogen Levels and Spacing on Growth and Yield of Radish (*Raphanus sativus* L.) Cv. Kashi Sweta. *Int. J. Pure App. Biosci.* 5 (4): 1951-1960
4. **Koodi Sunita, Singh SP, Rolaniya Manoj Kumar, Gochar Premraj (2022).**Vegetative growth, yield and quality of sweet potato influenced by various plant spacing. The Pharma Innovation Journal 2022; SP-11(8): 443-445
5. **Sikder M., Mondal F., Mohammed D., Alam, M.S. and Amin, M.B., (2008)** Effects of spacing, and depth of planting on the growth and yield of two varieties of onion (Allium cepa) J. Agrofor. Environ. 2 (2): 9-13.
6. **Naruka I. S., and Dhaka R.S., (2001).** Effect of row spacing and nitrogen fertilization on growth, yield and composition of bulb in garlic *(Allium sativum L.)* cultivars. *Journal of Spices and Aromatic Crops* 10 (2): 111-117.
7. **Kumari Shilpa, Kumar Rahul (2017).** Assessment of the effect of different levels of nitrogen and plant spacing on growth, yield and quality of onion (*Allium cepa L.)* cv. Agrifound Light Red.*International journal of bio-resource and stress management.*vol 8(3) P.No.424-428.
8. **Kharsan M, Nag K, Sahu DK, Bhardwaj LP and Ajeet (2019).**To assess the effect of spacing on growth and yield of carrot (*Daucus carota L.*) Cv. Pusa Kesar. *Journal of Pharmacognosy and Phytochemistry* Vol; 8(5S):77-80.

9. **Sandipan Saurabh Toradmal, Rawat Monisha (2020).** Effect of different sowing dates and spacing on the growth and yield of radish. *Journal of Pharmacognosy and Phytochemistry* 9(6): 1713-1716.

10. **Anjum1 Akbar, Muhammad and Amjad2 Muhammad, (2002)**.Influence of mother root size and plant spacing on carrot *(Daucus carota var. sativus)* seed production. *Journal of Research (Science),* Vol.13, No.2, pp. 105-112.

11. Dawar Mahmood Nasir, Wazir Khan Faridullah, Dawar Manhaj-ud-Din and Dawar Hussain Shah (2007). Effect of planting density on growth and yield of onion varieties under climatic conditions of Peshawar. *Sarhad J. Agric. Vol.* 23, No. 4,