



Effect of Different Planting Methods and Spacing on Growth, Yield and Quality of Round Red Radish (*Raphanus sativus*) CV. Scarlet Globe

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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

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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 (cm²), root diameter (cm) and chlorophyll content (SPAD-502) were found maximum in treatment T₆ (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 T₄ (5x 5 cm + raised bed). In terms of quality parameters, TSS (3.8°Brix) and Ascorbic acid (5.5 mg/100 g) were observed in treatment T₅ (10x 10 cm + raised bed).

Keywords: Planting method; spacing; growth parameter; quality parameter; crop yield.

1. INTRODUCTION

Among the root vegetables, radish (*Raphanus sativus L.*) is a widely grown vegetable belonging to family Brassicaceae. 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 [1] 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., [2] 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.

2. 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 and B4- Ridge bed) and three spacings (S1 - 5 x 5 cm, S2 - 10 x 10 cm and S3 - 15 x 15 cm) was laid out in Factorial Randomised Block Design (FRBD) with three replications. Whole experimental area was 55 m², which was divided into total 39 plots with 13 treatments. Size of each plot was 1 x 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 28-30 days 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.

3. RESULTS AND DISCUSSION

3.1 Growth Parameter

In this experiment, statistically data showed that the maximum plant height (cm) was recorded 11.3 cm in treatment T₆ (15 x 15cm + raised bed) (S3B2) followed by treatment T₄ (5 x 5 cm + raised bed) (S1B2) with value 10.8 cm while minimum plant height were recorded 6.1cm in treatment T₇ (5cm x 5cm + sunken bed) (S1B3) followed by treatment T₅ (10 x 10cm + raised bed) (S2B2) with value 7.7 cm. Similar result were observed by Gorakh et al., [3], Kumari et al., [4]. Among all the treatments T₆ (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 T₄ (5 x 5cm + raised bed) (S1B2) followed by treatment T₁₂ (15 x 15cm + ridge bed) (S3B4) with value 8.00 while minimum number of leaves per plant were recorded 5.7 in treatment T₆ (15 x 15cm + raised bed) (S3B2) and treatment T₁₁ (10cm x 10cm + ridge bed) (S2B4) followed by treatment T₇ (5 x 5 cm + sunken bed) (S1B3) with value 6.00. Similar findings were reported by Anjum et al. [5], Dawar et al., [6]. Among all the treatment T₄ (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 (cm²) data observed that the maximum leaf area was 45.4 cm² in treatment combination T₆ (15 x 15cm + raised bed) (S3B2) followed by treatment T₅ (10 x 10cm + raised bed) (S2B2) with value 42.8 cm² whereas minimum leaf area were recorded 32.9 cm² in treatment T₇ (5 x 5cm + sunken bed) (S1B3) followed by control T₀ with value 33.1cm². Among all the treatment T₆ (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 T₆ (15 x 15cm + raised bed) (S3B2) had highest chlorophyll content with value 34.4 followed by treatment T₂ (10 x 10 cm + flat bed) (S2B1) with value 34.3 while minimum chlorophyll content measured in treatment T₇ (5 x 5cm + sunken bed) (S1B3) with value 31 followed by treatment T₁₁ (10 x 10 cm + ridge bed) (S2B4) with value 31.3. Among all the treatment T₆ (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.

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

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

3.2 Yield Parameter

Root diameter (cm) showed that maximum value 12.4 cm in treatment T₆ (15 x 15cm + raised bed) (S3B2) and treatment T₃ (15 x 15cm +flat bed) (S3B1) followed by treatment T₂ (10 x 10cm + flat bed) (S2B1) and treatment T₄ (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 (T₀) followed by T₅ (10 x 10cm + raised bed) (S2B2) with value 9.8 cm [7,8]. Among all the treatments T₆ (15 x 15cm + raised bed) was observed non-significant in spacing and their interaction (Spacing x planting method) whereas significant with planting method.

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 (cm²) 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

In crop yield (g. /plot) the maximum value recorded 786.1g in treatment T₄ (5 x 5cm + raised bed) (S1B2) followed by treatment T₁ (5 x 5cm + flat bed) (S1B1) with value 550.9 g whereas minimum crop yield were recorded 111.1g in treatment T₉ (15 x 15cm + sunken bed) (S3B3) followed by control (T₀) with value 114.8g [1,9,10]. Among all the treatments T₄ (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.

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

3.3 Quality Parameter

In TSS, the maximum value 3.8 °Brix showed in treatment T₅ (10 x 10cm + raised bed) (S2B2) and also ascorbic acid recorded a maximum value 5.5 mg/100g fresh weight in treatment T₅ (10 x 10cm + raised bed) (S2B2) [11]. Among all the treatments T₅ 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.

4. CONCLUSION

From the present investigation, it is concluded that treatment T₆ (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 T₄ (5 x 5cm + raised bed).

In terms of root yield, treatment T₄ had the highest with (78.61q/ha), however, treatment T₆ had the maximum root diameter. In terms of B: C ratio, T₄ had the highest ratio (7.5). Therefore, the closer spacing (5 x 5cm) with raised bed is recommended.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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