



E-ISSN: 2278-4136

P-ISSN: 2349-8234

[www.phytojournal.com](http://www.phytojournal.com)

JPP 2021; 9(6): 1713-1716

Received: 11-08-2020

Accepted: 14-10-2020

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## Effect of different sowing dates and spacing on the growth and yield of radish- A review

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**Abstract**

Radish is a well-known root crop that belongs to the family brassicaceae. It is very popular because of its wider adaptability to varying climatic conditions, easy to cultivation methods and also its diverse uses. Plant population has an important effect on the growth, development and yield. Due to closer spacing, competition among plants is increased and the development of the radish roots is negatively affected. Likewise with wider spacing, the yield of individual plants will be higher due to increase in length and weight of roots but the yield per hectare may be reduced due to lower plant population. Hence, an appropriate plant population is important so that higher yield per hectare can be achieved. Maintaining proper spacing is a useful way in current agriculture in production in terms of increasing yield, good size of tuber and effective for conserving soil nutrient. The selection of a suitable sowing time offers abundant scope for increasing the yield of radish.

**Keywords:** Radish, time of sowing, spacing, quality, yield

**Introduction**

Vegetables are rich and comparatively cheaper source of vitamins and minerals. Their consumption in sufficient quantity provides taste and palatability, increase appetite, also provide fair amount of fibre to our diet. They are currently recognized as an important adjunct for maintenance of good health and beneficial in protecting against some degenerative diseases. They also play a key role in neutralizing acids produced during the digestion of proteins and fatty food and also provide valuable roughages which promote digestion and help in preventing constipation. In general, for a balanced diet the daily requirement of some of the essential nutrients like proteins, minerals and vitamins can be met very well if an individual consumes 125 g leafy vegetables, 75 g other vegetables and 100 g root and tuber vegetables [1]. Amongst the root vegetables, radish (*Raphanus sativus* L.) which belongs to family brassicaceae is the most popular and widely grown vegetable in both tropical and temperate regions. Radish is grown for its tender fleshy edible roots. The present area under radish in India is 2.84 lakh ha with the production of 35.21 lakh tonnes and productivity of 12390 kg/ha [2].

Radish is consumed raw as salad or cooked as vegetable. It is rich in calcium, potash, phosphorus and vitamin C containing 34-40 mg per 100 g of edible portion. It is very refreshing when eaten fresh. The leafy tops are rich in vitamins like A, B and C and possess little quantity of carbohydrates, iron and proteins [3]. The characteristic pungent flavour of radish is due to presence of volatile isothiocyanates which helps in digestion. The leaves of radish are also good source for extraction of proteins on a commercial scale [4]. The radish seed is a potential source of non-drying fatty acid oil suitable for soap making and for edible purpose. It is normally grown commercially during winter season in the plains and during summer season in the hills.

It is very difficult to raise the good quality radish roots because of excessive forking, splitting, cracking and pithiness, which is highly influenced by spacing and time of sowing. Hence, selection of optimum sowing time and spacing are key factors for successful radish production. Growers tend to manipulate sowing time and plant spacing in order to obtain better growth with higher yield and quality. The time of sowing is also adjusted so as to synchronize the time of harvest with market demands. For the good quality and more root production, radish requires optimum sowing date and plant density. There are few recommendations that sowing date and plant density have brought classical changes in growth and root yield of radish crop with economical returns. This review provides an outline on the use of different sowing dates and spacing that have been used in radish to increase the yield and quality of roots.

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**Effect of sowing dates****Effect of sowing dates on days to germination**

In beet root it was reported that seeds sown on 10<sup>th</sup> and 20<sup>th</sup> September took minimum period of 6.25 and 6 days for germination respectively. While crop sown on 20<sup>th</sup> and 30<sup>th</sup> October took maximum period of 13.22 and 15.72 days for germination [5].

**Effect of sowing dates on plant height**

It was observed that the planting of 75 days old seedlings on 15<sup>th</sup> December produced maximum plant height (32.63 cm) during both years i.e. 1979-80 and 1980- 81 over 75 days old plants on 15<sup>th</sup> January and 15<sup>th</sup> February in radish variety HR - 1 under Hissar conditions [6].

recorded that plant height was maximum (20.35cm) when seeds sown on 10<sup>th</sup> September while a gradual decrease in the plant height (15.13 cm) was enumerated for those which were sown later on 30<sup>th</sup> October in beetroot crop under sub-mountainous climatic conditions, Pakistan [7].

In their studies on effect of sowing time on growth and yield of sugar beet under Tamil Nadu conditions recorded the maximum plant height (39.97 cm) on 1<sup>st</sup> fortnight of June and the gradual decrease in the plant height was noted in the later sowing dates i.e., 2<sup>nd</sup> fortnight of November (29.69 cm) [8]. The maximum plant height (28.46 cm) was recorded from November 1<sup>st</sup> sowing while the lowest plant height (23.44cm) was observed with delayed sowing on 15<sup>th</sup> November and 1<sup>st</sup> December in radish under Bangladesh conditions [9]. Significant differences in plant height among sowing dates were observed and it was reported that November (167.22cm) and December (166.03 cm) sown plants were significantly taller than January (141.14 cm) and February plants (140.24 cm) in carrot under Ethiopia conditions [10].

**Effect of sowing dates on number of leaves per plant**

The maximum number of leaves per radish plant (16.3) was obtained from November 1<sup>st</sup> sowing which was identical with date of sowing on November 15<sup>th</sup> (14.2). Date of sowing on December 1<sup>st</sup> showed the lowest number of leaves per plant (11.1) under Dhaka conditions [9].

**Effect of sowing dates on root-shoot ratio**

An experiment was conducted at Sirsi, Karnataka in radish to find out the suitable time of sowing and it was found that November sowing produced maximum root-shoot ratio (1.16) as compared to the delayed sowing in March [11].

**Effect of sowing dates on days to maturity**

Under Akola conditions, crop showed vigorous growth and took longer period for maturity (121-122 days) and the crop from February planting made poor growth and also matured earlier (95-97 days) [12]. A trial was conducted under Ethiopia conditions in carrot and it was found that the delayed planting on mid-February took minimum number of days for root maturity (266.66 days) over the early planting on mid-November (244.33 days) [10].

**Effect of sowing dates on root length**

Evaluated on sowing dates from May to November in carrot cultivar Fancy. Delaying sowing for one or two months after the beginning of May resulted in a reduction of growth of carrot roots [13]. The maximum root length (26.6 cm) was observed with 31<sup>st</sup> October sowing in radish variety Nerima Long [14]. Observed in three varieties viz. Tasaki San, Red Bombay, Jama rusan and found that, longest root per plant

(25.6 cm) was obtained from November 1<sup>st</sup> sowing. While the shortest root length per plant (23.5cm) was obtained from December 1<sup>st</sup> planting. It was observed that root length per plant reduced considerably in the later sowings in radish [9].

**Effect of sowing dates on root girth**

An experiment was conducted in carrot in different genotypes with different sowing dates under U.K conditions and observed that greater root diameter (3.53cm) was produced with a March sown crop as opposed to the May sown crop [15]. In their studies on effect of sowing time on growth and yield of sugarbeet under Tamil Nadu conditions recorded the maximum root girth (28.21 cm) on 1<sup>st</sup> fortnight of June and the gradual decrease in the root girth was noted in the later sowing dates i.e., 2<sup>nd</sup> fortnight of November (20.96 cm) [16]. Investigated that root girth per plant was decreased gradually with delayed sowing on 15<sup>th</sup> November (2.5cm) and 1<sup>st</sup> December (3.3cm). Highest root girth per plant was observed from date of sowing on 1<sup>st</sup> November (5.9 cm) in radish [9].

**Effect of sowing dates on weight of the root**

Noted that the November 1<sup>st</sup> sowing produced the heavier weight of fresh roots per plant (535.6g) which was statistically different from other two sowings i.e., 15<sup>th</sup> November (485.5g) and 1<sup>st</sup> December (450.0g) in radish under Dhaka conditions [9].

**Effect of sowing dates on yield/ha**

They observed that the early planting on 10<sup>th</sup> December gave the highest yield with good quality roots while the delayed sowing gave the lowest yield in turnip cv. Purple Top [17]. Observed that the highest root yield was observed with 1<sup>st</sup> October sowing and root yield was decreased with delayed sowing in sugar beet [18]. Reported that the maximum root yield and quality was observed with 5<sup>th</sup> February and March sowing over delayed sowing on 5<sup>th</sup> May in sugarbeet [19]. Highest yield in sugarbeet was found in earlier sowing on 1<sup>st</sup> October as compared to the 15<sup>th</sup> October and 1<sup>st</sup> November sowing [20]. Conducted an experiment in carrot in different genotypes with different sowing dates under U.K conditions and observed that maximum yield and quality was produced with a March sown crop as opposed to the May sown crop [21]. Recorded the highest root yield/ha with the early sowing on June first fortnight (78.37 t) over the delayed sowing on November second fortnight (58.21 t) in sugar beet under western zone of Tamil Nadu conditions [16]. revealed that maximum root yield plot/ha and root yield/ha was obtained from earlier sowing of 1<sup>st</sup> November (41.3kg and 81.8 ton respectively) and minimum was obtained with December 1<sup>st</sup> sowing (34.7 kg and 68.8 ton respectively) under Dhaka conditions [9].

**Effect of Spacing****Effect of spacing on germination percentage**

They reported that the seed from wider spacing of 50x50 cm showed the maximum germination percentage (84.0%) while considerably lowest germination was noted with the closer spacing of 40x10cm (79.1%) in carrot under Haryana conditions [22].

**Effect of Spacing on height**

They conducted an experiment in radish cv. Forty days with different plant spacing of 5, 10 and 15 cm and with arrow spacing of 37.5cm. it was observed that maximum plant height (47.2cm) was reported with the spacing of 10 cm under

Pakistan conditions<sup>[23]</sup>. conducted an experiment in radish cv. White Icicle with inter-row spacing of 10 and 20 cm and intra-row spacing of 5 and 10 cm. Maximum plant height (33.41cm) was observed with spacing of 20 cm between row and 10 cm between plants<sup>[24]</sup>.

In an experiment, conducted at Haryana with different spacing in carrot<sup>[22]</sup>. observed that, the closer spacing of 40x10cm produced the maximum plant height (134.3cm) whereas minimum plant height (117.8cm) was recorded with the wider plant spacing of 50x50 cm. studied the performance of carrot under varying plant densities. Among the three spacing tried, the closet spacing 30x30cm significantly highest plant height (107.80cm) at harvest stage compared wider spacing 45x30cm (112.92 cm) and 45x45 cm (107.80 cm)<sup>[25]</sup>.

#### Effect of plant spacing on leaves per plant

Recorded that leaves per plant were maximum with the wider spacing of 60x60 cm as compared to closer spacing 60x15 cm in 'Pusa Chetki' variety of radish under Akola conditions<sup>[26]</sup>. found that the number of leaves per plant were maximum with the spacing of 37.5x15 cm (18.7) followed by 37.5x10 cm (16.3) in radish cv. Forty days<sup>[23]</sup>. revealed that the maximum number of branches per plant were maximum (10.7) with wider spacing of 60x45cm as compared to the closer spacing of 60x30 cm and 45x45cm in carrot cv. Nantes under Uttaranchal conditions<sup>[27]</sup>. conducted an experiment in radish cv. White Icicle with inter-row spacing of 10 and 20 cm and intra- row spacing of 5 and 10 cm. Maximum number of leaves per plant (11.91) was observed in the treatment with 20x10 cm spacing<sup>[24]</sup>.

#### Effect of spacing on root shoot ratio

In an experiment conducted with cultivar White Icicle of radish recorded the maximum root-shoot ratio (1.16) with a wider spacing of 20x10 cm as compared with a closer plant spacing 5 cm<sup>[24]</sup>.

#### Effect of spacing on leaf area

Reported that the maximum leaf area was observed with the lower densities (1and2 plants/pot) as compared to higher plant densities (3 and 4 plants/pot) in radish under greenhouse conditions<sup>[28]</sup>.

#### Effect of plant spacing on days to maturity

Conducted a trail under Ethiopia conditions in carrot found that the closer spacing of 50x5 cm took minimum number of days for root maturity (255.08 days) over the wider spacings of 50x10 cm, 75x5 cm and 75x10 cm<sup>[10]</sup>.

#### Effect of spacing on length of the root

Recorded that maximum root length was produced with the spacing of 37.5x15cm (36.2cm) which was at par with 37.5x10 cm (35.4cm) spacing in radish under Faisalabad conditions<sup>[23]</sup>.

conducted an experiment in radish cv. White Icicle with inter-row spacings of 10 and 20 cm and intra –row spacings of 5 and 10cm. Maximum root length (20.11cm) was observed in closer spacing of 10x5 cm as compared to wider spacing<sup>[24]</sup>.

#### Effect of spacing on root girth

In an experiment conducted with forty days cultivar of radish under Faisalabad conditions recorded the maximum root girth with plant spacing of 15 cm (4.9 cm) and found at par with 10 cm (4.6 cm) spacing compared to the closer plant spacing of 5

cm<sup>[23]</sup>. conducted an experiment in radish cv. White Icicle with inter-row spacing of 10 and 20 cm and intra-row spacing of 5 and 10 cm. Maximum root girth was (3.43 cm) observed in wider spacing of 20x 10 cm<sup>[24]</sup>.

#### Effect of Spacing on weight of root

conducted an experiment in radish cv. White Icicle with inter-row spacing of 10 and 20 cm and intra -row spacing of 5 and 10 cm. maximum root weight was observed in wider row and plant spacing of 20 and 10 respectively<sup>[24]</sup>.

#### Effect of spacing on weight of the plant

found that minimum plant weight was observed in 5 cm plant spacing and maximum with 15cm plant spacing (289.5g) followed by 10cm (251.8 g) in forty days cultivar of radish under Faisalabad conditions<sup>[23]</sup>.

In an experiment conducted with cultivar White Icicle of radish recorded the maximum plant weight (262.63 g) with a wider spacing of 20 cm x 10 cm as compared with a closer plant spacing 5 cm<sup>[24]</sup>.

#### Conclusion

The effect of different sowing time and spacing as discussed by different researchers has shown that it helps to increase the yield and is also good for vegetative growth of plant. The growth and yield parameters has shown that it has significant effects on different attributes. Therefore, in coming days farmers can modify the sowing time and spacing to improve vegetative growth, improve soil health while producing more yield.

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