

Effect of Spacing and Fertilizer Levels on Growth, Seed Yield and Quality of Radish*

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Abstract: The results of the experiment on effect of spacing and fertilizer levels on growth yield and quality of radish revealed that wider spacing (60 x 45 cm) significantly increased the number of branches per plant (9.25). Higher fertilizer level (130:55:55 NPK/ha) significantly increased the plant height (124cm), number of branches per plant (9.47), seed yield per plant (12.3g), per hectare (5.13 q) and test weight (9.9g) compared to recommended dose of fertilizer. Though the seed yield per plant was significantly higher (11.7g) in wider spacing, but the closer spacing recorded significantly higher seed yield per hectare (5.07 q). The interaction due to spacing and fertilizer levels was non-significant. Significantly higher germination (93.3 and 97.1%), field emergence (86.92 and 90.4%), seedling vigour index (1628 and 1853) and lower electrical conductivity for seed leachate (0.48 and 0.43 dSm⁻¹) were recorded by seeds produced with wider spacing and higher fertilizer dose, respectively.

Introduction

Among the root vegetables, radish (*Raphanus stivus* L.) is a popular Brassicaceae vegetable in both tropical and temperate region. It can be cultivated extensively in almost all seasons of the year. Pusa chetki is a cultivated variety, suitable on account of its versatile adaptability through out the year and also suitable to tropical condition. Among the various factors influencing seed production, inadequate and lack of balanced nutrition and plant spacing are the most important and play major role in deciding the seed yield and quality. Though spacing and fertilizer requirement of radish for "Vegetable seed production" has been standardised (Singh, 2001), the information on seed yield and seed quality is lacking for seed production purpose. Keeping this point in view, investigations were initiated to study the effect of plant spacing and fertilizer levels on the seed yield and quality in radish Cv. Pusa Chetki under Dharwad conditions of north Karnataka.

Material and Methods

Field investigations were undertaken at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during rabi season of 2001. The foundation seeds of radish Cv. Pusa Chetki was used for this study. Agronomic practices are followed as per the package of practices (Singh, 2001). Protective irrigation (15-16) was given during the drought conditions.

The treatment details are as follows

A . Factor (plant spacing)

S₁-60 x 30 cm (51282 plants/ha) and
S₂-60x 45 cm (32407 plants/ha)

B. Factor (levels of fertilizer NPK kg/ha)

F₁- 95:45:45, F₂-95:45:55, F₃-95:55:45,
F₄- 95:55:55, F₅- 115:45:45, F₆-115:45:55,
F₇-115:55:45, F₈-115:55:55, F₉-130:45:45,
F₁₀-130:45:55, F₁₁-130:55:45, F₁₂-130:55:55
F₁₃-75:37:37 (RDF)

RDF- Recommended dose of fertilizer

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Total of 26 treatment combinations were tried in split plot design with three replications in a plot size of 4.8 x 4.5 m for each treatment. The treatments were imposed as per the plan. The observations on plant growth, seed yield and quality components were recorded for the net plot. After the harvest of the crop, observations on seed yield components like number of pods per plant, seed yield per plant, per hectare, test weight and seed quality parameters like germination percentage, vigour index and electrical conductivity of seed leachate were recorded.

Results and Discussion

Lower plant height (112.8 cm) and significantly lower seed yield per hectare (4.00q) but significantly higher number of branches (9.25), number of pods per plant (334.8) and seed yield per plant (11.7 g) were recorded at 60 x 45 cm wider spacing. Whereas, closer spacing (60x30cm) recorded lower number of branches (8.04), pods per plant (288.7), seed yield per plant (10.0g) and higher seed yield per hectare (5.07 g). The difference in spacing brought significant variation in number of pods (334.8) harvested per plant in wider spacing than with the closer spacing (S_1) which seems to be mainly due to less competition for nutrition and light which lead to more number of branches ultimately more number of pods and yield. Similar results were also obtained by several scientists viz., Singh *et al.* (1990), Sharma and Lal (1991) and Malik *et al.* (1999) in radish seed production. The seed yield per plant is higher in wider spacing. This increase seed yield per plant may be due to well establishment of the plant which in turn resulted in production of more number of pods per plant. But the higher seed yield per hectre was recorded incloser spacing. This may be because of increased plant population per unit area. Similar results were also obtained by Sharma and Lal (1987), Sharma and Lal (1991) and Malik *et al.* (1999) in radish.

The wider spacing recorded significantly higher thousand seed weight (9.91g) over closer spacing. The reason for increased thousand seed weight may be attributed to less competition among the plants which ultimately resulted in to better nurishment and plant growth. Similar results were also recorded by Malik *et al.* (1999) in radish.

Laboratory studies revealed that seed production at wider spacing (60 x45 cm) recorded significantly higher seed quality attributes. This might be due to less competition among the plants for nutrients which ultimately resulted in better establishment of plants and proper development of seeds, this also reflected in higher test weight and other seed quality attributes like higher germination, seedling root shoot growth, seedling dry matter and ultimately increased seedling vigour index. These results are in accordance with the findings of Srivastava *et al.* (1992) and Malik *et al.* (1999) in radish.

The higher seed yield per plant, per hectare and thousand seed weight were due to more leaf area for photosynthesis and the efficient utilization of these photosynthates from source (leaves) to sink (reproduction parts) might have enhanced the better filling of seeds, more number of pods, thus resulting in increased seed weight. These results are in agreement with the report of Srivastava *et al.* (1992), Gill *et al.* (1995) and Sharma (2000) in radish.

Application of 130:55:55 kg NPK per ha caused significantly higher number of pods per plant (349.9) seed yield per plant (12.3g) and seed yield per hectare (5.13 q/ha) compared to F_1, F_2, F_3, F_4, F_5 , and RDF (243.4/plant, 7.9g/plant & 3.31 q/ha, respectively). The increased number of pods under higher dose of fertilizer may be attributed to better plant growth, more number of branches per plant and more leaf area index. Similar results were obtained from Singh *et al.* (1990), Sharma and Lal (1991), Samnotra *et al.* (1998) in radish. The seed weight per plant (12.3g)

Table 1. Effect of spacing and fertilizer level on plant height, number of branches, number of pods, seed yield per plant and per hectare in radish Cv. Pusa Chetki.

Fertilizer levels (NPK kg/ha)	Plant height (cm)			Number of branches per plant			Number of pods per plant			Seed yield (g/plant)			Seed yield (q/ha)		
	S ₁	S ₂	Mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean
	CD (0.05)			CD (0.05)			CD (0.05)			CD (0.05)			CD (0.05)		
F ₁ -95:45:45	105.8	104.3	105.0	7.57	8.38	7.98	261.5	283.2	272.4	8.6	10.2	11.7	4.34	3.66	4.00
F ₂ -95:45:55	106.4	104.8	105.6	7.58	8.41	7.99	276.2	319.9	298.1	9.7	11.5	10.6	4.86	3.90	4.38
F ₃ -95:55:45	108.3	106.7	107.5	7.91	8.53	8.22	279.4	337.9	308.7	9.7	11.8	10.8	5.02	4.03	4.57
F ₄ -95:55:55	108.8	107.3	108.0	7.92	8.56	8.25	299.7	344.6	322.2	10.0	12.1	11.0	5.05	4.09	4.57
F ₅ -115:45:45	112.5	111.3	111.9	8.08	9.01	8.55	273.9	325.1	299.5	10.0	11.6	10.8	5.03	3.94	4.49
F ₆ -115:45:55	112.6	112.0	112.3	8.09	9.04	8.57	291.7	343.0	317.3	10.2	12.0	11.2	5.15	4.11	4.63
F ₇ -115:55:45	116.5	115.2	115.8	8.10	9.12	8.61	296.4	355.8	326.1	10.4	12.1	11.2	5.23	4.08	4.66
F ₈ -115:55:55	118.5	117.0	117.6	8.12	9.13	8.63	317.7	362.3	340.0	11.2	12.7	11.9	5.62	4.30	4.96
F ₉ -130:45:45	120.8	120.0	120.4	8.43	10.31	9.37	286.3	337.7	312.0	10.1	11.8	10.9	5.09	4.05	4.57
F ₁₀ -130:45:55	121.6	121.2	121.4	8.45	10.39	9.42	305.8	354.8	330.0	10.7	12.3	11.5	5.39	4.21	4.80
F ₁₁ -130:55:45	123.7	123.2	123.4	8.48	10.41	9.45	309.2	358.0	333.6	10.9	12.4	11.6	5.50	4.23	4.86
F ₁₂ -130:55:55	124.9	123.5	124.2	8.51	10.42	9.47	325.9	373.8	349.9	11.5	13.2	12.3	5.78	4.48	5.13
F ₁₃ -75:37:37	102.6	100.9	101.8	7.23	8.50	7.87	229.9	256.8	243.4	7.3	8.4	7.9	3.69	2.94	3.31
Mean	114.0	112.8	113.4	8.04	9.25	8.64	288.7	334.8	311.8	10.0	11.7	10.9	5.07	4.00	4.53
For comparing the mean of	S.E.m±	CD (0.05)		S.E.m±	CD (0.05)		S.E.m±	CD (0.05)		S.E.m±	CD (0.05)		S.E.m±	CD (0.05)	
Plant spacing (S)	1.26	NS		0.10	0.58		4.27	26.01		0.16	0.94		0.06	0.37	
Fertilizer levels (F)	5.39	15.32		0.41	1.15		13.78	39.17		0.45	1.27		0.19	0.53	
F at same levels of S	7.62	NS		0.58	NS		19.49	NS		19.49	NS		0.27	NS	
S at same or different levels of F	7.43	NS		0.56	NS		19.21	NS		19.21	NS		0.26	NS	
S- Spacing	F-Fertilizer levels	NS- Non significant		RDF-Recommended dose of fertilizer		S ₁ -60x30 cm		S ₂ -60x45 cm							

Table 2. Effect of spacing and fertilizer levels on test weight, germination percentage, field emergence, vigour index and electrical conductivity in radish Cv. Pusa Chetki

Fertilizer levels (NPK kg/ha)	Test weight (g)			Germination (%)			Field emergence (%)			Seedling vigour index			Electrical conductivity (dSm ⁻¹)		
	S ₁	S ₂	Mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean
F ₁ -95:45:45	9.32	9.76	9.54	87.00	87.00	87.00	81.75	82.00	82.00	1338	1370	1354	0.55	0.54	0.54
	(68.89)	(68.90)	(68.89)	(64.72)	(65.09)	(64.91)									
F ₂ -95:45:55	9.35	9.79	9.57	88.75	89.25	89.00	82.50	83.50	83.00	1386	1424	1405	0.54	0.53	0.53
	(70.41)	(70.90)	(70.65)	(65.28)	(66.05)	(65.66)									
F ₃ -95:55:45	9.37	9.82	9.59	88.00	88.75	88.38	82.25	83.00	82.63	1389	1464	1426	0.52	0.50	0.51
	(69.78)	(70.46)	(70.12)	(65.09)	(65.67)	(65.38)									
F ₄ -95:55:55	9.39	9.84	9.62	89.00	90.00	89.50	83.00	84.00	83.50	1433	1514	1473	0.51	0.50	0.51
	(70.64)	(71.59)	(71.12)	(65.66)	(66.44)	(66.05)									
F ₅ -115:45:45	9.45	9.89	9.67	93.75	95.50	94.63	87.00	87.25	87.13	1549	1630	1589	0.51	0.49	0.50
	(75.57)	(77.85)	(76.71)	(68.88)	(69.11)	(68.99)									
F ₆ -115:45:55	9.45	9.88	9.69	94.75	95.75	95.25	87.25	89.25	88.25	1623	1676	1649	0.50	0.48	0.49
	(76.97)	(78.16)	(77.57)	(69.10)	(70.88)	(69.99)									
F ₇ -115:55:45	9.47	9.99	9.73	94.25	96.75	95.50	87.50	89.25	88.38	1569	1732	1698	0.48	0.47	0.48
	(76.16)	(79.75)	(77.85)	(69.32)	(70.88)	(70.10)									
F ₈ -115:55:55	9.49	9.96	9.73	94.75	96.15	95.63	88.25	88.75	88.50	1696	1745	1721	0.47	0.46	0.47
	(76.90)	(79.36)	(78.14)	(69.98)	(70.44)	(70.21)									
F ₉ -130:45:45	9.57	10.04	9.81	95.00	95.75	95.88	87.75	90.50	89.13	1724	1746	1745	0.47	0.46	0.46
	(77.21)	(78.19)	(79.53)	(72.08)	(70.80)										
F ₁₀ -130:45:55	9.59	10.06	9.83	95.50	96.75	96.13	89.30	89.20	89.25	1769	1808	1789	0.46	0.44	0.45
	(77.85)	(79.75)	(78.80)	(70.89)	(70.85)	(70.86)									
F ₁₁ -130:55:45	9.26	10.06	9.84	96.25	97.00	96.63	88.25	90.75	89.50	1617	1840	1820	0.44	0.43	0.44
	(79.30)	(80.21)	(79.76)	(69.98)	(72.37)	(71.16)									
F ₁₂ -130:55:55	9.67	10.16	9.91	96.25	98.00	97.13	89.50	91.25	90.38	1825	1879	1853	0.43	0.42	0.43
	(79.30)	(82.21)	(80.63)	(71.12)	(72.83)	(71.97)									
F ₁₃ -75:37:37	8.99	9.51	9.25	85.75	86.50	86.13	80.50	81.25	80.88	1251	1358	1305	0.56	0.54	0.55
	(67.83)	(68.46)	(68.15)	(63.80)	(64.35)	(64.07)									
Mean	9.44	9.91	9.67	92.23	93.35	92.79	85.73	86.92	86.33	1572	1628	1600	0.49	0.48	0.49
	(74.35)	(75.83)	(75.09)	(67.93)	(68.99)	(68.46)									
For comparing the mean of	S.E.m±	CD (0.05)	S.E.m±	CD (0.05)	S.E.m±	CD (0.05)	S.E.m±	CD (0.05)	S.E.m±	CD (0.05)	S.E.m±	CD (0.05)	S.E.m±	CD (0.05)	S.E.m±
Plant spacing (S)	0.06	0.26	0.15	0.69	0.14	0.64	4.67	4.67	4.67	0.002	NS	NS	NS	NS	NS
Fertilizer levels (F)	0.12	0.33	0.66	1.86	0.39	1.12	12.98	36.55	36.55	0.005	0.013	0.013	0.005	0.006	NS
F at same levels of S	0.17	NS	0.93	NS	0.56	NS	18.36	NS	18.36	0.006	NS	NS	0.006	0.006	NS
S at same or different levels of F	0.17	NS	0.91	NS	0.55	NS	18.36	NS	18.36	0.006	NS	NS	0.006	0.006	NS
	S- Spacing	F- Fertilizer levels	NS- Non significant	RDF- Recommended dose of fertilizer	S ₁ -60x30 cm	S ₂ -60x45 cm									

*Figures in parenthesis indicates arcsine transformed values

Effect of Spacing and Fertilizer.

and per hectare (5.13q) were significantly higher in 130:55:55 kg NPK/ha. Significantly higher seed germination (97.13%), field emergence (90.38%), seedling vigour index (1853) and lower electrical conductivity of seed leachate (0.43 dSm^{-1}) over other fertilizer levels and RDF (86.13%, 80.88%, 1305 and 0.55 dSm^{-1} , respectively) were recorded with 130:55:55 NPK kg/ha. This might be due to higher nutrients level which strengthened the cell membrane integrity and resulted in low leachate as indicated by lower EC value. This also helped for proper development of seed, accumulation of

higher seed weight and nutrients which in turn might have supplied adequate food reserves during germination. This kind of improvement was also reported by Singh *et al.* (1996) in radish. From the study, it can be concluded that for nucleus and breeder seed production of radish, a fertilizer level of 130:55:55 kg NPK per ha with wider spacing of 60 x 45 cm is beneficial while, for certified seed production, the same fertilizer level can be adopted with closer spacing of 60 x 30 cm.

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