



Research Article

INFLUENCE OF VARIETIES AND FERTILITY LEVELS ON GROWTH, YIELD AND QUALITY OF RADISH (*Raphanus sativus* L.) UNDER MALWA REGION OF MADHYA PRADESH

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Abstract- A field experiment was conducted during Rabi season, 2014-15 at Vegetable Research Field, College of Horticulture, Mandsaur (M.P.). The experiment comprised of three radish varieties (V₁- Japanese White, V₂ - Kashi Hans and V₃- Kashi Sweata) and eight fertility levels (F₁-0:50:50 NPK kg ha⁻¹, F₂ - 0:80:50 NPK kg ha⁻¹, F₃ - 60:50:50 NPK kg ha⁻¹, F₄- 60:80:50 NPK kg ha⁻¹, F₅ -80:50:50 NPK kg ha⁻¹, F₆ -80:80:50 NPK kg ha⁻¹, F₇ -100:50:50 NPK kg ha⁻¹, F₈- 100:80:50 NPK kg ha⁻¹). All together 24 treatment combinations were laid out in Factorial Randomized Block Design with three replications. Variety V₃ (Kashi Sweata) exhibited maximum plant height (44.30 cm), number of leaves (9.38), leaf length (41.98 cm), fresh weight (150.61 g) and dry weight of shoot (17.88 g). Maximum root length (27.17 cm), root diameter (4.51 cm), root weight (228.45 g), root yield (580.58 q/ha), harvest index (81.08 %) and earliest days to harvest (41.67) were observed with variety V₃ (Kashi Sweata). Under quality parameters highest fiber content (664.00 mg/100 g), T.S.S. (4.51°Brix) and ascorbic acid (33.54 mg/100 g) in root were also found in case of variety V₃ (Kashi Sweata). Among fertility levels, application of F₈ (100-80-50 NPK kg ha⁻¹) showed maximum growth, yield and quality parameters with all the three varieties of radish. The net income and B:C ratio i. e. 1:6.52 and 1:7.75 was found to be superior with variety V₃ (Kashi Sweata) and fertility level F₈ (100-80:50 NPK kg ha⁻¹). The interaction effect of varieties and fertility levels was non-significant with all the characters.

Keywords- Radish, fertility levels, NPK, yield, fiber content, B:C ratio.

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Introduction

Radish (*Raphanus sativus* L.) is a popular Brassicaceae vegetable both in tropical and subtropical region. In India it is widely cultivated in northern and southern plains, as well as in hills. It can be cultivated under cover for early production but large scale production in field is more common in India. Radish has cooling effect, prevents constipation and increases appetite. It is recommended for patients suffering from piles, liver troubles and jaundice. The juice of fresh leaves is used as diuretic and laxative. Radish is a good source of vitamin-C (ascorbic acid), containing 15-40 mg per 100 g of edible portion and supplies a variety of minerals. Trace elements in radish include aluminum, barium, lithium, manganese, silicon, titanium, fluorine and iodine. Pink skinned radish is generally richer in ascorbic acid than the white skinned one. The characteristics pungent flavor of radish is due to the presence of volatile isothiocyanates [4]. The growth and yield of radish greatly depend on soil & climatic condition. Varieties differ in their soil and climatic requirements for optimum performance. In India being a vast country with varied agro climatic regions, therefore, a single variety may or may not be suitable for all the agro climatic regions. Hence, under these circumstances specific selection of varieties is need of hour [14]. Radish is a short duration and fast growing crop. Hence, judicious and proper uses of fertilizers are essential to get good yield and excellent root quality along with higher fertilizer use efficiency. It requires sufficient and readily available plant nutrients.

Increased use of the fertilizer nitrogen is probably the most important single factor

that has enabled the crop production to increase significantly in recent years. Among the major essential nutrients required by the plants for their normal growth, development and yield, the role of nitrogen is accepted as it is necessary component of protein, nucleic acids, chlorophyll and certain important enzymes. Phosphorus is an essential macro element necessary for growth and developments of plants. Its shortage results poor growth of plants and they remain immature. Hence, for production of radish optimum fertilizer is essential. Keeping this point in view, investigations were initiated to study the effect of varieties and fertility levels on growth, yield and quality of radish (*Raphanus sativus* L.) under Malwa Region of Madhya Pradesh.

Material and Methods

The field experiment was conducted at Research Field of the Department of Vegetable Science, College of Horticulture, Mandsaur, Madhya Pradesh during rabi season, 2014-15. Mandsaur is situated in Malwa plateau in western part of Madhya Pradesh at northbetween latitude of 23°45' to 24°13' north and longitude of 74°44' to 75°18' East at an altitude of 435.20 m above mean sea level. The topography of the experimental field is plain. The soil of the experimental field was light alluvial soil having sandy loam texture with uniform topography.

The treatments consisted of three radish varieties (V₁- Japanese White, V₂ - Kashi Hans and V₃- Kashi Sweata) and eight fertility levels (F₁-0:50:50 NPK kg ha⁻¹, F₂ - 0:80:50 NPK kg ha⁻¹, F₃ - 60:50:50 NPK kg ha⁻¹, F₄- 60:80:50 NPK kg ha⁻¹, F₅ -

80:50:50 NPK kg ha⁻¹, F₆ -80:80:50 NPK kg ha⁻¹, F₇ -100:50:50 NPK kg ha⁻¹, F₈ -100:80:50 NPK kg ha⁻¹). The experiment was laid out in a factorial randomized block design with twenty four treatment combinations each replicated three times. Entire quantity of P and K and half dose of N as per treatment was applied in the form of DAP, MOP and Urea, respectively before sowing at the time of field preparation. Whereas the remaining dose of nitrogen was given by top dressing after 30 days of sowing. The soil samples were collected before and after the experimentation and analyzed. The plots were irrigated with drip irrigation system by providing two laterals per bed. The drippers of 2 lph were fixed at 30 cm apart on 16 mm lateral. The beds were irrigated regularly to keep the soil moderately moist by giving 4-5 liters of water per square meter per day before noon or late in the evening to keep the soil moderately moist. All the standard agronomic practices were followed. The observations on plant growth, yield and quality components were recorded for the net plot. Five plants were randomly selected from each plot and tagged. The observations were taken on growth, yield and quality parameters.

Results and Discussion

Growth parameters

The findings pertaining to growth parameters viz., plant height, number of leaves per plant, leaf length, fresh weight of shoot and dry weight of shoot were observed at 30 and 45 days after sowing. There was significant effect of genotypes and fertility levels on all the growth parameters.

Variety, V₃ (Kashi Sweta) recorded maximum plant height at all stage followed by

V₂, while minimum plant height was found with variety V₁ (Japanese White). The variation in plant height of radish varieties may be due to their genetic constituent. These findings are in agreement with the finding of Parthasarathi *et al.* (1999), Singh and Rajodia (2001) and Rawat *et al.* (2014) [12,14,17].

Among fertility levels, N₈ (NPK-100-80-5 kg ha⁻¹) has reported maximum plant height at all the growth stages. While minimum plant height was found with fertility level N₁. Nitrogen, phosphorus and potash are the most common nutrients required for up growth and adequate supply of these nutrients to crop helps in photosynthesis of carbohydrates, protein and lipid by plants. Increased plant height may be attributed due to synthesis of chlorophyll content of leaves resulting in increased synthesis of carbohydrates which are further utilized in buildup of new cells. Similar results have been reported by Jadhao *et al.* (1999) [7].

The number of leaves per plant was influenced significantly due to different treatments of genotypes and fertility levels. Maximum number of leaves per plant was observed in variety V₃ (Kashi Sweta) at all the growth stages, followed by variety V₂ (Kashi Hans). Minimum number of leaves per plant was observed with variety V₁ (Japanese White). These findings are in agreement with the findings of Singh and Rajodia (2001) [17], while the minimum number of leaves per plant was recorded under N₁ (NPK-00-50-50 kg ha⁻¹). Highest numbers of leaves in similar findings have been reported by Kumar *et al.* (1994), Parthasarathi *et al.* (1999), Thapa *et al.* (2003), Reddy and Reddy (2005) and Akoumianakis *et al.* (2011) [1, 10, 12, 15, 19].

Table-1 Effect of varieties and fertility levels on growth of radish

Treatments	Plant height (cm)		Number of leaves plant ⁻¹		Leaf length (cm)		Fresh weight of shoot (g)		Dry weight of shoot (g)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
Varieties										
V ₁ (Japanese White)	34.58	40.41	6.95	8.24	33.46	37.00	123.00	135.97	13.43	14.45
V ₂ (Kashi Hans)	35.59	42.86	7.43	9.19	35.81	39.60	131.23	147.55	14.61	15.78
V ₃ (Kashi Sweta)	37.56	44.30	7.78	9.38	36.77	41.98	136.78	150.61	16.77	17.88
SEm±	0.77	1.01	0.17	0.22	0.74	0.96	2.92	4.17	0.38	0.37
CD _{5%}	2.20	2.88	0.50	0.62	2.13	2.74	8.32	11.88	1.09	1.06
Fertility levels										
F ₁	32.47	38.45	6.57	7.38	31.81	34.78	118.55	125.81	12.8	13.81
F ₂	33.55	40.00	6.75	7.62	33.02	35.55	119.61	132.34	13.42	14.44
F ₃	34.75	40.44	7.17	8.36	34.05	38.03	125.00	132.96	13.67	15.06
F ₄	35.28	42.45	7.32	8.65	34.72	39.12	126.96	140.43	14.3	15.55
F ₅	35.71	43.10	7.45	9.12	35.35	39.68	131.76	141.93	15.17	16.23
F ₆	36.77	44.06	7.57	9.47	36.32	41.21	134.13	146.55	15.88	16.92
F ₇	37.45	44.76	7.67	9.90	36.85	41.61	136.37	159.05	16.15	17.2
F ₈	41.25	47.32	8.52	10.96	40.58	46.21	150.26	178.57	18.08	19.05
SEm±	1.26	1.65	0.29	0.35	1.22	1.57	4.77	6.81	0.62	0.61
CD _{5%}	3.60	4.71	0.82	1.02	3.47	4.49	13.58	19.40	1.78	1.74

Table-2 Effect of varieties and fertility levels on yield, quality and economics of radish

Treatments	Root length (cm)	Root diameter (cm)	Fresh weight of root (g)	Days to harvest	Root yield (q ha ⁻¹)	Harvest index (%)	Fiber content (mg/100g)	T.S.S. content (%Brix)	Ascorbic acid (mg/100g)	Net income (Rs. Ha ⁻¹)	B : C ratio
Varieties											
V ₁ (Japanese White)	25.12	41.46	169.00	47.08	507.12	77.46	606.08	4.23	30.88	215112	5.58
V ₂ (Kashi Hans)	26.57	42.45	202.08	46.75	523.26	78.92	621.79	4.36	32.00	223180	5.78
V ₃ (Kashi Sweta)	27.17	45.16	230.29	41.67	580.58	81.08	664.00	4.51	33.54	251837	6.52
SEm±	0.59	0.96	4.98	0.47	13.06	1.02	12.95	0.05	0.73	6528	0.17
CD _{5%}	1.67	2.72	14.18	1.33	37.17	2.89	36.87	0.15	2.06	18584	0.48
Fertility levels											
F ₁	23.72	36.99	182.22	47.00	407.65	75.00	507.67	4.09	28.67	167288	4.58
F ₂	24.39	39.71	191.67	46.56	417.28	75.56	516.78	4.17	29.44	170214	4.43
F ₃	25.24	41.22	194.00	46.00	451.23	76.78	551.00	4.19	30.56	187960	4.99
F ₄	26.19	42.41	198.11	45.22	521.60	78.22	621.22	4.24	31.44	221656	5.66
F ₅	26.56	43.20	199.78	44.78	558.64	79.67	658.22	4.29	32.44	241289	6.34
F ₆	26.93	44.98	205.56	44.44	604.93	80.67	698.11	4.52	33.11	262949	6.65
F ₇	27.20	45.60	211.00	44.00	635.80	81.22	715.44	4.57	34.00	279497	7.28
F ₈	30.06	50.06	221.33	43.33	698.76	86.11	776.56	4.86	37.44	309490	7.76
SEm±	0.96	1.56	8.13	0.76	21.32	1.66	21.15	0.08	1.18	10661	0.28
CD _{5%}	2.73	4.45	23.15	2.17	60.70	4.73	60.21	0.24	3.37	30348	0.79

The results revealed that different varieties significant difference in leaf length all the stages. Variety V₃ (Kashi Sweta) recorded maximum leaf length followed by variety V₂ (Kashi Hans). Variety V₁ (Japanese White) had registered minimum leaf length at all the growth stages. Similar results were made by Parthasarathi *et al.* (1999) and Sing and Rajodia (2001) [12,18]. Fertility levels had exerted significant effect on length of leaf. Among the fertility levels maximum length of leaves were recorded with fertility level N₈ (NPK:100-80-50 kg ha⁻¹) which was followed by N₇ (100-60-50), while minimum leaf length was observed under fertility level N₁ (NPK:00-50-50 kg ha⁻¹). The increase in leaf length may be due to increased availability of higher dose of fertility levels. Similar results have been reported by Parthasarathi *et al.* (1999) and Thapa *et al.* (2003) [12, 19].

Maximum fresh weight and dry weight was recorded with variety V₃ (Kashi Sweta) followed by variety V₂ (Kashi Hans). Minimum fresh weight and dry weight of shoot per plant was recorded with variety V₁ (Japanese White). These finding are corroborated with those of Rawat *et al.* (2014) [14]. Fertility levels had showed significant effect on fresh weight and dry weight in radish. Highest fresh weight and dry weight was found under fertility level N₈ (NPK:100-80-50 kg ha⁻¹) at all the growth stages. The minimum fresh and dry weight of shoot was recorded with fertility level N₁ (NPK:00-50-50 kg ha⁻¹). These finding are agreement with Inam *et al.* (2011) and Baloch *et al.* (2014) [2, 6].

Yield parameters

Among the varieties, maximum length of root was recorded with variety V₃ (Kashi Sweta). It was followed by V₂ (Kashi Hans). Minimum length of root was observed by variety V₁ (Japanese White). These results are agreement with Sharma and Parthasarathi *et al.* (1999), Sharma and Chadha (2006) and Rawat *et al.* (2014) [12,14,16]. Fertility levels had also exerted significant effect on length of root. Longer roots were found in fertility level N₈ (NPK:100-80-50 kg ha⁻¹). Minimum root length was reported in fertility level N₁ (NPK:00-50-50 kg ha⁻¹). Similar results have been reported by Parthasarathi *et al.* (1999), Pervez *et al.* (2004) and Jilali *et al.* (2010). [8,12,13].

Among the variety, V₃ (Kashi Sweta) recorded maximum root diameter followed by V₂ (Kashi Hans), minimum root diameter was observed in case of variety, V₁ (Japanese White). Significant differences among varieties for root diameter have been also reported by Guvenc *et al.* (2002) and Kanwar *et al.* (2013) [5,9]. Root diameter was significantly affected by fertility levels. Maximum root diameter was found under N₈ (100-80-50) as compared to other fertility levels while minimum root diameter was observed in fertility level N₁ (NPK:00-50-50 kg ha⁻¹). Highest level of fertilizer had favorable effect on vegetative growth and carbohydrate synthesis. Which had enhanced the yield attributes and consequently root diameter. Parthasarathi *et al.* (1999), Jilani *et al.* (2010) and Baloch *et al.* (2014) [12,8,2] in radish have also found similar effect of nitrogen and phosphorus on root diameter.

Finding revealed significant effect of variety and fertility levels on days to harvest in radish. Variety, V₁ (Japanese White) had taken maximum days to harvest of marketable root. It was followed by V₂ (Kashi Hans). Minimum days to harvest of root were taken by variety V₃ (Kashi Sweta). Similar results have been reported by Rawat *et al.* (2014) [14]. Among the fertility levels, N₁ (NPK:00-50-50 kg ha⁻¹) has recorded maximum days to harvest. Minimum days to harvest were recorded in fertility level N₈ (NPK:100-80-50 kg ha⁻¹).

Finding revealed significant effect of varieties and fertility levels on average root weight in radish. Variety V₃ (Kashi Sweta) recorded maximum root weight which was followed by V₂ (Kashi Hans) with significant deference. Minimum root weight was observed in case of varieties V₁ (Japanese White). Significant difference among varieties for root weight has also been reported by Kumar and Sharma (2011) and Rawat *et al.* (2014) [11,14]. Average root weight was significantly affected by fertility levels. Maximum average root weight was found under N₈ (100-80-50) treatment. Fertility level N₁ (NPK:00-50-50 kg ha⁻¹) showed minimum average weight. Jilani *et al.* (2010) and Baloch *et al.* (2014) also obtained similar result in radish [8,2].

It is evident from the result that the individual effect of varieties and fertility levels on root yield at the harvesting stage was statically significant. Variety, V₃ (Kashi Sweta) recorded maximum root yield followed by V₂ (Kashi Hans) with significant

difference. Minimum root yield was observed in variety, V₁ (Japanese White). The difference in root yield may be attributed to genetic makeup of the varieties. There result are in agreement with Kumar and Sharma (2011), Rawat *et al.* (2014) and Baloch *et al.* (2014) in radish [11, 14, 2]. Highest root yield was found with fertility level N₈ (NPK:100-80-50 kg ha⁻¹) followed by N₇ (NPK:100-50-50 kg ha⁻¹). Minimum root yield was recorded in case of fertility level N₁ (NPK:00-50-50 kg ha⁻¹). The possible effect of nitrogen in increasing the production may be explained from the fact that nitrogen being a major constituent of chlorophyll, proteins and amino acids synthesis. This was perhaps accelerated by the increased supply of it. Higher level of phosphorus might have increased the yield due to its capacity to promote uptake of nitrogen. Similar results were recorded by Reddy *et al.* (2001), Basavaraju *et al.* (2002) and Thapa *et al.* (2003) [15, 3, 19].

Harvest index was recorded after harvesting. The data exhibited significant effect of varieties and fertility levels on harvesting index. Among the variety, V₃ (Kashi Sweta) recorded maximum harvest index followed by V₂ (Kashi Hans). Minimum harvest index was observed in case of variety, V₁ (Japanese White). Significant different among varieties for harvest index have been also reported by Parthasarathi *et al.* (1999) [12]. Harvest index was significantly affected by fertility levels. Maximum harvest index was found under fertility level N₈ (NPK:100-80-50 kg ha⁻¹) which was followed by N₇ (100-50-50). The lowest harvest index was recorded under fertility level N₁ (NPK:00-50-50 kg ha⁻¹). Similar results were obtained by Shrinivas and Naik (1990) [18].

Quality parameters

There was significant effect of varieties on total soluble solids content in radish at harvesting stage. Variety, V₃ (Kashi Sweta) had registered maximum total soluble solids content which was higher than all other varieties. Minimum total soluble solids were observed in case of variety V₁ (Japanese White). Though the difference between V₁ and V₂ was non-significant. Similar results have been also reported by Kumar and Sharma (2011) [11] in radish. Fertility levels had exhibited significant effect on total soluble solids content. Highest total soluble solids content was found with fertility level N₈(NPK:100-80-50 kg ha⁻¹). Minimum total soluble solids was observed in case of fertility level N₁ (NPK:00-50-50 kg ha⁻¹).

The findings of the present experiment revealed significant effect of varieties on ascorbic acid content in root. Among the varieties, maximum ascorbic acid content was recorded with variety V₃ (Kashi Sweta) which was followed by V₂ (Kashi Hans). Minimum ascorbic acid content was noted with variety, V₁ (Japanese White). There finding are in agreement with Kumar and Sharma (2011) and Rawat *et al.* (2014) [11, 14]. Fertility levels had also exhibited significant effect on ascorbic acid content in radish. Highest ascorbic acid content was recorded with fertility level N₈ (NPK:100-80-50 kg ha⁻¹) followed by fertility level N₇. Minimum ascorbic acid content was revealed under fertility level N₁ (NPK: 00-50-50 kg ha⁻¹). Similar results were obtained by Kumar and Sharma. (2011) and Rawat *et al.* (2014) [11, 14].

The data indicated significant influence of varieties on fiber content in radish. Variety, V₃ (Kashi Sweta) had recorded maximum fiber content followed by V₂ (Kashi Hans). Minimum fiber content was recorded with variety, V₁ (Japanese White). Similar findings were obtained by Kumar and Sharma (2011) [11]. There was significant effect of fertility levels on fiber content. Fertility level N₈ (NPK: 100-80-50 kg ha⁻¹) had showed maximum fiber content. Minimum fiber content was observed in fertility level N₁.

Economics of different treatments

The viability of any practices is evolved on the basis of experimentation and depends upon its economic feasibility. A best treatment, if not fetching appropriate monetary returns, may not be acceptable to farmers. With a view to evaluate various treatments in terms of economic return, the marketable yield of the crop converted in to monetary returns. Among the varieties, V₃ (Kashi Sweta) recorded maximum net income and B: C ratio followed by V₂ (Kashi Hans) while minimum net income and B:C ratio was recorded with V₁ (Japanese White). These finding are in agreement with Rawat *et al.* (2014)[14] in radish. Fertility levels indicated significant effect on net income and B:C ratio. Highest net income and B:C ratio was found with fertility level N₈ (NPK:100-80-50 kg ha⁻¹) where as lowest net

income and B:C ratio was observed in fertility level N₁(NPK: 00-50-50 kg ha⁻¹).

Conclusion

It may be concluded from the findings of the present study that among the different varieties of radish, variety V₃ (Kashi Sweta) recorded superior performance for growth, yield and quality attributes. Among the fertility levels, application of N₈ (NPK: 100-80-50 kg ha⁻¹) is superior for growth, yield, quality parameters of radish. The combined effect of varieties and fertility levels was non-significant with all the characters.

Application of research: This study is helpful for vegetable growers for application of optimum dose of fertilizer for optimum yield and selection of variety for Malwa region of Madhya Pradesh

Research Category: Varietal evaluation and fertilizer study

Abbreviations:

DAS- days after sowing

Ha- hectare

cm- Centimeter

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