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Effect of integrated nutrient management practices on seed yield and quality of radish, *Raphanus sativus* L cv Chinese Pink

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ABSTRACT

Production of any crop can be increased by supplying quality inputs and seed is the most important input in any crop production programme. Without healthy and quality seed all expenditure incurred on other inputs goes waste. Therefore a study was conducted to assess the effect of integrated nutrient management on seed yield and quality of radish cv Chinese Pink at research farm of Department of Vegetable Science, Dr YS Parmar university of Horticulture and Forestry, Nauni, Solan HP during Rabi season of 2009-10. There were fifteen combinations of different treatments comprising of organic sources (vermicompost, Biovita liquid and granules), biofertilizers (*Azotobacter* and PSB) and inorganic fertilizers (NPK). All the treatments were replicated thrice in RBD. Significant differences were obtained among all the characters under study. Maximum seed yield of 1000-seed weight, seed germination, seedling vigour index I and II were recorded with the application of vermicompost, Biovita (l) + 75 per cent recommended dose of NPK.

Keywords: Radish; foliar spray; seed yield; seed quality

INTRODUCTION

Radish (*Raphanus sativus* L) is a popular vegetable in the temperate and tropical parts of the world. Extensive cultivation of this vegetable round the year is done for more remunerative returns and to make this vegetable more popular. Seed is a crucial, critical, vital and basic input in any crop production programme. Cultivation of radish in India throughout the year requires huge quantity of quality seed to fulfill the seed requirement of the farmers. In the recent years prices of inorganic fertilizers have gone up due to which cost of production has increased and also these inorganic fertilizers cause ecological hazards. Integrated nutrient management is the only answer for the sustainable agriculture. Hence present study has been planned to see the effect of organic, inorganic and biofertilizers on seed yield and quality characters of radish.

MATERIAL AND METHODS

The present experiment was conducted at Vegetable Research Farm, Department of Vegetable Science, Dr YS Parmar university of Horticulture and Forestry, Nauni, Solan during Rabi season of 2009-10. There were fifteen combinations of different treatments (Table 1) comprising of inorganic (NPK), biofertilizers (*Azotobacter*, PSB) and organic sources (Biovita granules and liquid) which were replicated thrice in RBD. All the recommended agronomic practices were followed to raise healthy roots. Stecklings were prepared by observing true to type roots and transplanted at a spacing of 60 cm x 45 cm in the plot size of 1.8 m x 1.8 m. The entire calculated doses of NPK, vermicompost and Biovita granules were

Table 1. Details of treatments used for the study

Treatment Code	Treatment
T_1	Absolute Control
T_2	RD of N,P,K (150:60:54 kg/ha)
T_3	*Azotobacter* (2.5 kg/ha) + PSB (2.5 kg/ha)
T_4	*Azotobacter* (2.5 kg/ha) + PSB (2.5 kg/ha) + 75%RD of NPK (112.5:45:40.5 kg/ha)
T_5	*Azotobacter* (2.5 kg/ha) + PSB (2.5 kg/ha) + 50%RD of NPK (75:30:27 kg/ha)
T_6	Vermicompost (40 q/ha) + 75% RD of NPK (112.5:45:40.5 kg/ha)
T_7	Vermicompost (40 q/ha) + 50% RD of NPK (75:30:27 kg/ha)
T_8	Biovita (*40 kg/ha) + 75% RD of NPK (112.5:45:40.5 kg/ha)
T_9	Biovita (*40 kg/ha) + 50% RD of NPK (75:30:27 kg/ha)
T_{10}	Biovita (**2 ml/L) + 75% RD of NPK (112.5:45:40.5 kg/ha)
T_{11}	Biovita (**2 ml/L) + 50% RD of NPK (75:30:27 kg/ha)
T_{12}	Vermicompost (40 q/ha) + Biovita (*40 kg/ha) + 75% RD of NPK (112.5:45:40.5 kg/ha)
T_{13}	Vermicompost (40 q/ha) + Biovita (*40 kg/ha) + 50% RD of NPK (75:30:27 kg/ha)
T_{14}	Vermicompost (40 q/ha) + Biovita (**2 ml/L) + 75% RD of NPK (112.5:45:40.5 kg/ha)
T_{15}	Vermicompost (40 q/ha) + Biovita (**2 ml/L) + 50% RD of NPK (75:30:27 kg/ha)

*Granules as soil application before replanting of stecklings

**Liquid application as foliar spray twice (first at the time of bolting and second 15 days later)

RD: Recommended dose

applied in the individual plots before the replanting of the stecklings. *Azotobacter* and PSB were applied in the form of root dip. Biovita liquid was applied in the form of foliar spray at the time of bolting and 15 days later. Observations were recorded by selecting five plants randomly for the characters like seed yield, 1000-seed weight, seed germination and seedlings vigour index I and II. Data were statistically analysed as suggested by Panse and Sukhatme (1987).

RESULTS AND DISCUSSION

Seed yield per plot (g): Analysis of variance shows significant variation among all the treatments for seed yield per plot (Table 2). The maximum seed yield per plot (466.75 g) was obtained in T_{14} (Vermicompost (40q/ha) + Biovita (2ml/L) + 75% RD of NPK (112.5:45:40.5 kg/ha) which was significantly superior over T_{15}, T_4, T_{12}, T_2, T_6, T_{13}, T_7 and T_5 having 459.18, 453.84, 452.03, 444.69, 444.10, 438.24, 431.58 and 426.63 gram seed yield per plot respectively. All these treatments were statistically at par with each other. Minimum seed yield (320.13g) was recorded in T_1 (absolute control) which produced significant effects with all other treatments under study.

Seed yield per plant (g): It is evident from the data (Table 2) that different treatments showed significant effect on seed yield per plant. The maximum seed yield per plant (38.90 g) was recorded in T_{14} (vermicompost (40 q/ha) + Biovita (2 ml/ L) + 75% RD of NPK (112.5:45:40.5 kg/ ha) which was significantly superior over T_{15}, T_4, T_{12}, T_2, T_6, T_{13}, and T_7 having 38.27, 37.82, 37.67, 37.06, 37.01, 36.52, and 35.97 gram seed yield per plant respectively. All these treatments were statistically at par with each other. Minimum seed yield (26.68 g) was recorded in T_1 (absolute control) which was statistically significant with all other treatments under study.

Seed yield per hectare (q): There were significant differences among different treatments for seed yield per hectare (Table 2). Maximum seed yield per hectare (11.52 q) was recorded in T_{14} (vermicompost (40 q/ha) + Biovita (2 ml/ L) + 75% RD of NPK (112.5:45:40.5 kg/ ha). This treatment ie T_{14} was closely followed by T_{15}, T_4, T_{12}, T_2, T_6, T_{13}, T_7 and T_5 having 11.34, 11.21, 11.16, 10.98, 10.97, 10.82, 10.66 and 10.53 quintals seed yield per hectare respectively. All these treatments were at par with each other but were statistically superior over the remaining six treatments. Minimum seed yield per hectare (7.90 q) was recorded in the absolute control which showed significant differences with all other treatments. Seed yield is an ultimate objective in any crop especially in the experiments which are conducted exclusively on seed production for getting maximum returns. The maximum seed yield

Table 2. Mean performance of different treatments for various yield and yield contributing characters in seed crop of radish cv Chinese Pink

Treatment code	Seed yield plant(g)	Seed yield/ plot (g)	Seed yield /ha (q)	1000-seed weight	Seed germination (%)	Seed vigour index-I	Seed vigour index-II
T_1	26.68	320.13	7.90	11.25	81.02 (9.00)	1296.30	5.37
T_2	37.06	444.69	10.98	13.26	93.24 (9.65)	1491.87	7.35
T_3	33.58	402.95	9.95	12.39	89.24 (9.44)	1427.87	7.17
T_4	37.82	453.84	11.21	13.46	96.88 (9.84)	1550.02	7.79
T_5	35.55	426.63	10.53	13.42	96.60 (9.83)	1545.68	7.73
T_6	37.01	444.10	10.97	13.25	95.42 (9.77)	1526.76	7.63
T_7	35.97	431.58	10.66	12.99	93.54 (9.67)	1496.59	7.49
T_8	33.14	397.64	9.82	12.28	88.45 (9.40)	1415.13	7.09
T_9	32.29	387.50	9.57	12.07	86.93 (9.32)	1390.81	6.98
T_{10}	33.60	403.24	9.96	12.40	89.29 (9.45)	1428.58	7.16
T_{11}	31.88	382.50	9.44	11.97	86.18 (9.28)	1378.80	6.92
T_{12}	37.67	452.03	11.16	13.13	94.54 (9.72)	1512.57	7.92
T_{13}	36.52	438.24	10.82	12.89	92.79 (9.63)	1484.70	7.79
T_{14}	38.90	466.75	11.52	13.72	98.81 (9.94)	1581.01	8.25
T_{15}	38.27	459.18	11.34	13.57	97.68 (9.88)	1562.84	8.08
Mean	35.06	420.74	10.39	12.80	92.04 (9.59)	1472.63	7.38
$CD_{0.05}$	3.34	40.13	0.99	0.82	5.03 (0.26)	81.87	1.06

Figures in the parenthesis are square root transformed values

per plant, per plot and per hectare was obtained in treatment T_{14} followed by T_{15}. This might be due to more number of siliqua and bolder seeds as a result of availability of major and minor nutrients together with growth regulators, enzymes and amino acid at all the essential stages of growth and development. The increase in seed yield following vermicompost application which act as chelating agent and regulated the availability of micro nutrients to plants thereby increased growth and yield by providing nutrients in available form has also been reported by Giraddi (1993). Application of N: P: K favoured growth, yield and quality of seed. It is also

supported by the findings of workers like Cheema et al (2001) who have also found the positive effect of inorganic fertilizers on growth, yield and quality of sunflower. The increase in yield following NPK application has also been reported due to their role in the synthesis of cholorophyll, carbohydrates, amino acids and translocation of photosynthates into developing grains. The present results confirm the findings of Sharma and Kanaujia (1992) and Panwar et al (2000). Mehta (2010) was of the opinion that better root prolification, more uptake of nutrients and water, higher number of leaves, more photosynthesis and enhanced food accumulation might be the result of recommend doses of NPK in radish. Minimum seed yield per hectare was recorded in absolute control which might be because of unavailability of optimum dose of nutrients for plants to complete various reproductive stages.

1000-seed weight (g): Data pertaining to 1000-seed weight revealed that treatment effects were statistically significant (Table 2). Maximum 1000-seed weight (13.72g) was recorded in T_{14} (vermicompost (40q/ha) + Biovita (2ml/L) + 75% RD of NPK (112.5:45:40.5 kg/ha) which was statistically at par with T_{15} (13.57g), T_4 (13.46g), T_5 (13.42), T_2 (13.26g), T_6 (13.25g), T_{12} (13.13g) and T_7 (12.99g), respectively. Minimum 1000-seed weight (11.25g) was recorded in T_1 (absolute control) which was statistically at par with T_9 (12.07g) and T_{11} (11.97g). Thousand seed weight or test weight is an index which reflects the boldness of seed as well as number of seeds which could be accommodated in one kilogram weight of seed. Obviously more the test weight bolder will be the seed and more will be the corresponding seed vigour which is the most important character in seed studies. In the present studies 1000-seed weight was maximum in the treatment receiving vermicompost + Biovita (liquid) + 75 per cent of recommended dose of NPK followed by the same treatment but with 50 per cent recommended dose NPK. Application of Biovita (liquid) is responsible for producing auxins and cytokinins like substances along with certain nutrients like boron, magnesium, manganese, zinc, sodium, sulphur and calcium. The growth substances are having positive effect on processes like cell division and cell enlargement which are responsible for producing bolder seeds. Similar findings were also reported by Chauhan et al (1995) and Panwar et al (2000). Bilekadari et al (2005) were also of the opinion that higher seed yield and dry matter accumulation in reproductive parts were due to application of vermicompost rather than other organic manures. More 1000-seed weight was due to more leaf area for photosynthesis and effective utilization of these photosynthates from source (leaves) to sink (reproductive parts) which might have resulted in better filling of seeds. Further increase in thousand seed weight in treatments receiving NPK might be due to

better availability of nutrients that might have helped in producing bolder and heavier seeds. Almost identical results have also been expressed by Panwar et al (2000), Lamo (2009) and Mehta (2010). Application of NPK provided optimum quantity of available nutrients at all stages of crop growth which might have resulted in bold, good quality and vigorous seeds, ultimately resulting into maximum 1000-seed weight (Mehta 2010). Minimum values were recorded in absolute control where no fertilizer was added which might be the possible reason for less 1000-seed weight.

Seed germination (%): The data recorded on per cent germination of seeds in the laboratory after harvest have been depicted in Table 2. The statistical analysis of data showed significant differences among different treatments for seed germination. Maximum seed germination (98.81%) was recorded in the treatment T_{14} (vermicompost (40 q/ha) + Biovita (2ml/ L) + 75% RD of NPK(112.5:45:40.5 kg/ ha) followed by T_{15} (97.68%), T_4 (96.88%), T_5 (96.60%), T_6 (95.42%) and T_{12} (94.59%). All these treatments were statistically at par with each other and minimum seed germination (81.02%) was recorded in T_1 (absolute control). This treatment (T_1) however produced highly significant differences with rest of the treatments. Seed germination is a test indicating the capability of the seed to produce normal seedlings under ambient conditions. In the present findings the results pertaining to the effect of different organic manures, inorganic fertilizers and Biovita (liquid) showed that germination percentage was maximum in the treatments receiving vermicompost, Biovita (liquid) and 75 per cent recommended dose of NPK followed by the same treatment but with 50 per cent recommended dose of NPK. Availability of major nutrients like NPK at all the stages of crop growth together with some of the micronutrients like boron, magnesium, manganese, zinc, sodium, sulphur and calcium are responsible for bold, good quality and vigours seeds ultimately resulting in maximum seed germination and plant stand. Singh and Singh (1978) were also of the opinion that improvement in seed quality attributes due to enhanced seed filling might be due to the application of magnesium which helps in increasing the photosynthesis activity of the plants. The present findings are in line with those of Rahman et al (1996) in tomato. Further increase in seed germination due to availability of desired quantity of NPK might be due to improved quality of seed in terms of crude proteins, nitrogen and mineral contents in seeds. Similar are the findings of Bhatia and Pandey (1997) in okra who were also of the opinion that improvement in all the seed quality parameters was because of higher assimilatory surface which was due to photosynthetic capacity of a plant as well as genetic makeup of the crop to respond to recommended dose of fertilizers. Similar findings have also been reported by Lamo (2009). Minimum seed

germination was recorded in absolute control where no fertilizers were added which could be the possible reason for low germination.

Seedling vigour index I: The analysis of variance showed significant effects of different treatments on seedling vigour index I (Table 2). Maximum seedling vigour index I (1,581.01) was recorded in T_{14} (vermicompost (40q/ha) + Biovita (40kg/ ha) + 75% RD of NPK (112.5:45:40.5 kg/ ha) followed by T_{15} (1562.84), T_4 (1550.02), T_5 (1545.68), T_6 (1526.76) and T_{12} (1512.57). All these treatments were statistically at par with each other. Minimum seedling vigour index I (1,296.30) was however recorded in absolute control (T_1).

Seedling vigour index II: Significant variation was observed among all the treatments for seedling vigour index II (Table 2). Maximum seedling vigour index II (8.25) was observed in T_{14} (vermicompost (40q/ha) + Biovita (2ml/L) + 75% RD of NPK(112.5:45:40.5 kg/ha) which was statistically at par with T_{15}(8.08) T_{12}(7.92), T_4(7.79), T_{13}(7.79), T_5(7.73), T_6 (7.63), T_7(7.49), T_2(7.35), T_3(7.17), T_{10} (7.16) and T_8(7.09). Minimum seedling vigour index II (5.37) was recorded in T_1 (absolute control) which produced highly significant differences with rest of the treatments. Seedling vigour index is a very important character as it determines the actual germeability of seed (plant stand) under field conditions. It also shows the vigour of seed to germinate under adverse soil and temperature conditions. The present studies revealed that seedling vigour index I and II were maximum in the plants receiving vermicompost, Biovita (liquid) and 75 per cent recommended dose of NPK followed by the same treatment but with 50 per cent recommended dose of NPK. Higher seedling vigour index might be due to adequate availability of nutrients in the desired quantity that might have helped the plants to produce bolder and heavier seeds (Panwar et al 2000). Increased seedling vigour index might be due to improvement in seed quality attributes mainly the enhanced seed filling by the application of magnesium which might have helped in increasing the photosynthetic capacity of the plant (Karibasappa et al 2007). Similar are the results of Singh and Singh (1978) in mustard and Rahman et al (1996) in tomato. Karibasappa et al (2007) were also of the opinion that improvement in all parameters including seed vigour index of a plant could be attributed to higher assimilatory surface which was due to photosynthetic activity and genetic makeup of the crop. Whereas Bendegubal et al (2008) were of the opinion that vermicompost which acts as chelating agent and regulated the activity of micronutrient in plant might have increased the seed yield and seed vigour by providing nutrients in the available form. Better efficiency of organic fertilizer for increasing seedling vigour index might be due to the fact that this organic fertilizer might have helped the availability of various

micronutrients at optimum level. Application of inorganic fertilizers on the other hand might have helped the plant metabolism by supplying certain micronutrients in the early growth phase which might have produced vigrous seeds resulting into higher vigour. Absolute control has the lowest seedling vigour which might be due to poor performance of seed related trials in the control which receives no fertilizers.

CONCLUSION

It can be concluded from the present study that treatment T_{14} (vermicompost (40 q/ha) + Biovita liquid (2 ml/L) + 75% recommended dose of NPK (150:60:54 kg/ha) was rated as the best treatment for the seed yield and seed quality characters. Foliar spray of Biovita liquid contains essential nutrients, beneficial elements, growth regulators, proteins and amino acids enhanced seed yield and quality.

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