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Effect of integrated nutrient management practices on seed yield and yield contributing characters in radish (*Raphanus sativus* L) cv. CHINESE PINK

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ABSTRACT : Seed is a crucial, critical, vital and basic input in any crop production programme. The production of good quality seeds in abundance is necessary to fulfill the increasing demand of seeds in the country as well as for export potential. Therefore, a field experiment was conducted at research farm of the department of Vegetable Science, Dr. Y. S. Parmar university of Horticulture and Forestry, Nauni, Solan, HP during *Rabi* season of 2009-10 to see the effect of integrated nutrient management on seed yield and yield contributing characters in radish cv. Chinese Pink. Fifteen combinations of different treatments comprising of organic sources (vermicompost, biovita liquid and granules), biofertilizers (*Azotobacter* and PSB) and inorganic fertilizers (NPK) were choosen for the study. These treatments were replicated thrice in RBD. Significant differences were obtained among all the characters under study. The maximum seed yield, pod length, number of seeds per pod, average seed weight per pod and harvest index was recorded with the application of vermicompost + biovita (L) +75% recommended dose of NPK.

Key Words : Radish, Biovita foliar spray, Seed yield, Yield contributing characters

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Radish (*Raphanus sativus* L.) is the one of the most important root crops belonging to the family Cruciferae. It is grown both in tropical and temperate regions of the world and is probably a native of Europe and Asia (Gill, 1993). Radish is grown for its edible young, tender and fusiform roots which are eaten raw as salad or cooked as vegetable. It is a good source of minerals, vitamins A and C and also reported to have medicinal properties. Production of any crop can be increased by supplying quality inputs and seed is the most important input in any crop production programme. Good quality seed is one of the most important criteria to increase productivity. Chemical fertilizers deteriorate the quality of the produce and are expensive too, leading to reduction in net profit and returns to the farmers. Alarmed with the decline in soil health and chemicalization of modern day farming, greater emphasis on integrated nutrient management system is being given in the recent past (Kumar and Srivastava, 2006). The integrated nutrient management system approach utilizes a judicious combination of inorganic fertilizers and organic manures in building soil fertility and to increase the production potential of any crop (Yadav *et al*., 2004). Moreover, this approach is economically cheap, technically sound, practically feasible and is capable of maintaining the sustainability in production (Kumar and Srivastava, 2006). Therefore, integrated nutrient management practice is the only answer for the production of good quality seed without any ill effect. Keeping in view the above facts in mind, the present studies have been planned to use organic, inorganic and biofertilizers on seed yield and yield contributing characters of radish.

RESEARCH PROCEDURE

The present investigation was carried out at vegetable research farm, Department of Vegetable Science, Dr. Y. S. Parmar university of Horticulture and Forestry Nauni, Solan during *Rabi* season of 2009-10. Fifteen combination of different treatments comprising of inorganic (NPK), biofertilizers (*Azotobacter*, PSB) and organic sources (biovita granules and liquid) were choosen, which were replicated thrice in RBD. All the recommended agronomic practices were followed to raise healthy roots (Anonymous, 2009). Stecklings were prepared by observing healthy and true to type roots and transplanted

Table A: Details of treatments used for the study

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

at a spacing of 60 cm x 45cm in the plot size of 1.8m x 1.8m. The entire calculated doses of NPK, vermicompost and biovita granules were applied in the individual plots before 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. Observation were recorded by selecting five plants randomly for the characters, like seed yield, pod length, number of seeds per pod, average seed weight per pod and harvest index. Data were statistically analysed as suggested Panse and Sukhatme (1987). Details of treatments are given Table A.

RESEARCH ANALYSIS AND REASONING

The results of the present study as well as relevant discussions have been presented under following sub heads:

Seed yield per plot (g) :

Analysis of variance showed significant variation among all the treatments for seed yield per plot (Table 1). Maximum seed yield per plot (466.75 g) was obtained in T_{14} (Vermicompost (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (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 1) 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 (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (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 35.97gram seed yield per plant, respectively. All these treatments were statistically at par with each other. Minimum seed yield (26.68g) 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 1). Maximum seed yield per hectare (11.52q) was recorded in T_{14} (Vermicompost (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (112.5:45:40.5 kg/ha). This treatment *i.e.* 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 (7.90q), was recorded in the absolute control which showed significant differences with all other treatments. The main objective of cultivation is to have maximum yield for better returns. Seed yield is an ultimate objective in any crop especially in the experiments which are conducted exclusively on seed production. The maximum seed yield per plant and per hectare was obtained with the application of vermicompost, biovita (liquid) and 75 per cent recommended dose of NPK, closely followed by the same treatment but with 50 per cent recommended dose of NPK. This may 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. More seed yield may be due to better performance of all the yield contributing characters. In general, those treatments which performed better for all yield contributing characters also enhanced seed yield directly or indirectly. 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 nutrient in available form has also been reported by Giraddi (1993). In the present studies, application of biovita which contains some essential nutrients, growth regulators and amino acids contributed towards enhanced seed yield. This may be due to the effect of auxins to cause physiological modifications in the plants mainly on increased fruit set, fruit weight and higher photosynthetic activity as well as synthesis and translocation of metabolites from source to sink point. 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). The increase in yield following NPK application have 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 Kanaujia and Sharma (1998) and Panwar *et al.* (2000). Mehta (2010) was of the opinion that better root prolification, more uptake of nutrient and water, higher number of leaves, more photosynthesis and enhanced food accumulation may be the result of recommend dose of NPK in radish. Minimum seed yield per hectare was recorded in absolute control which may be because of unavailability of optimum dose of nutrients for plants to complete various reproductive stages.

Pod length (cm) :

The analysis of variance showed significant effects of different treatments on pod length (Table 1). Maximum pod length (6.37 cm) was recorded in T_{14} (Vermicompost (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (112.5:45:40.5 kg/ha) which was statistically at par with T_{15} (6.22 cm), T_4 (6.16 cm), T_5 (6.12 cm), T_{12} (6.10 cm) and T_2 (6.09 cm) . Minimum pod length (5.24 cm) was, however, recorded in absolute control (T_1). Length of pod was maximum in the treatment 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. This may be due to synergistic interaction between inorganic, organic and certain nutrients resulting in enhanced production of growth promoting substances like IAA, GA_3 and dihydrozeatin which have positive influence on the physiological activity of the plants resulting into enhanced pod length. These results are in confirmity with the findings of Ghuge *et al.* (2007) in cabbage and Mehta (2010) in radish. Increased pod length may be due to increase in growth related attributes which could be because of certain growth promoting substances and nutrient elements present in biovita. These substances besides increasing the availability of nitrogen and soil phosphorus also play a role in better root and shoot development, maximum uptake of water, nutrients and their transportation. Similar is the finding of

Table 2 Mean performances of different treatments for various yield and yield contributing characters in seed crop of radish cv. CHINESE PINK

Treatments code	Seed yield/ plant(g)	Seed yield/ plot(g)	Seed yield/ ha(q)	Pod length (cm)	Number of seeds per pod	Average seed weight per pod (g)	Harvest index (%)
T_1	26.68	320.13	7.90	5.24	5.09	0.038	3.61(1.90)#
T_2	37.06	444.69	10.98	6.09	6.05	0.051	5.01(2.24)
T_3	33.58	402.95	9.95	5.72	5.66	0.046	4.54 (2.13)
T_4	37.82	453.84	11.21	6.16	6.19	0.053	5.11 (2.26)
T_5	35.55	426.63	10.53	6.12	6.14	0.052	4.80 (2.19)
T_6	37.01	444.10	10.97	6.02	6.02	0.051	5.00 (2.23)
T_7	35.97	431.58	10.66	5.85	5.82	0.048	4.86 (2.20)
T_8	33.14	397.64	9.82	5.72	5.66	0.046	4.48 (2.11)
T_9	32.29	387.50	9.57	5.60	5.52	0.044	4.36 (2.09)
T_{10}	33.60	403.24	9.96	5.98	5.98	0.050	4.54 (2.13)
T_{11}	31.88	382.50	9.44	5.84	5.81	0.048	4.31(2.07)
T_{12}	37.67	452.03	11.16	6.10	6.12	0.052	5.09 (2.25)
T_{13}	36.52	438.24	10.82	6.02	6.02	0.051	4.94 (2.22)
T_{14}	38.90	466.75	11.52	6.37	6.44	0.057	5.26 (2.29)
T_{15}	38.27	459.18	11.34	6.22	6.26	0.054	5.17 (2.27)
Mean	35.06	420.74	10.39	5.94	5.92	0.049	4.74 (2.17)
$CD_{0.05}$	3.34	40.13	0.99	0.32	0.44	0.005	0.66 (0.15)

Figures in the parenthesis are square root transformed values

Chattoo *et al*. (2007). Minimum pod length was observed in the absolute control (no application of fertilizers) which may be due to unavailability of optimum dose of nutrients for the plant to complete various growth and reproductive stages.

Number of seeds per pod :

Analysis of variance showed significant variation among all the treatments for number of seeds per pod (Table 1). All the treatments recorded more number of seeds per pod than T_1 (absolute control). Maximum number of seeds per pod (6.44) were observed in T_{14} (Vermicompost (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (112.5:45:40.5 kg/ha), which was statistically at par with T_{15} (6.26), T_4 (6.19), T_5 (6.14), T_{12} (6.12), T_2 (6.05), T_6 (6.02) and T_{13} (6.02). Minimum number of seeds per pod (5.09) was recorded in T_1 (absolute control), which was at par with T_9 (Biovita (40kg/ha) + 50% R D of N, P, K (75:30:27 kg/ha) having 5.52 seeds per pod. More the number of seeds per pod more will be the yield and hence, more returns. Therefore, number of seeds per pod is directly correlated with yield. In the present studies, number of seeds per pod was more in the treatment receiving vermicompost in combination with biovita (liquid) and 75 per cent recommended dose of NPK followed by the same treatment but with 50 per cent of NPK. This may be because of the availability of optimum dose of nutrients for plants to complete various reproductive stages. Similar results were also reported by Lamo (2009) and Mehta (2010). Another possible reason for increased number of seeds per pod due to the application of ample quantity of NPK along with organic manures and essential nutrient elements may be due to synergistic interaction between inorganic and biofertilizers which may have resulted in enhanced production of growth promoting substances like IAA, GA_3 and dihydrozeatin which might have positive influence on the physiological activity in the plants resulting in more number of seeds per pod. The present results are in line with those of Ghuge *et al.* (2007). Minimum number of seeds per pod was observed in absolute control (no application of fertilizers and nutrients) which may be due to deficiency of optimum dose of nutrients in the plants to complete various reproductive stages.

Average seed weight per pod (g) :

Significant differences were observed regarding average seed weight per pod (Table 1). Maximum average seed weight per pod (0.057g) was recorded in T_{14} (vermicompost (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (112.5:45:40.5 kg/ha) which was statistically at par with T_{15} (0.054g), T_4 (0.053g), T_5 (0.052g) and T_{12} (0.052g) . On the other hand, minimum average seed weight per pod (0.038g) was found in T_1 (absolute control). Average seed weight per pod was maximum in the plants receiving vermicompost, biovita (liquid) and 75 per cent recommended dose of NPK. Most of the treatments receiving different nutrients provided by inorganic fertilizers and organic manures and some treatments receiving biofertilizers produced average seed weight per pod of the same magnitude. Bendegumbal *et al*. (2008) were of the opinion that vermicompost which acts as chelating agent regulated the availability of micronutrients to plants thereby increased growth and yield by providing nutrients in available form. Absolute control gave statistically less average seed weight per pod as compared to other treatments. This may be due to the tendency of plant diverting more energy towards weight of seeds per pod in the desired quantity. Vermicompost produced more dry matter content in the reproductive parts producing more seed weight per pod and consequently more seed yield.

Harvest Index (%) :

The analysis of variance showed significant effects of different treatments on harvest index (Table 1). Maximum harvest index (5.26%) was recorded in T_{14} (Vermicompost (40q/ha) + biovita (2ml/L) + 75% R D of N, P, K (112.5:45:40.5 kg/ha) which was statistically at par with T_{15} (5.17%), T_4 (5.11%), T_{12} (5.09%), T_2 (5.01%), T_6 (5.00%), T_{13} (4.94%), T_7 (4.86%) and T_5 (4.80%) . Minimum harvest index (3.61%) was recorded in T_1 (absolute control). Harvest index means more seed weight per plant at the cost of other plant organs. In the present studies, maximum value of harvest index was observed in the plants receiving vermicompost as organic manure, combined with biovita as liquid application and 75 per cent recommended dose of NPK as inorganic fertilizers. More harvest index due to application of combination of inorganic + organic + other nutrients provided by biovita may be due to more number of siliqua and bolder seeds as a result of availability of major and minor nutrients in all the essential stages of growth and development of a plant. Biovita contains certain beneficial elements which may help in the synthesis of various growth promoters, antibiotic and antifungal substances. All these processes might have increased yield and yield contributing characters resulting into more harvest index. Similar are the findings of Cheema *et al*. (2001), Sofi *et al*. (2004). Bendegumbhal *et al.* (2008) was also of the opinion that organic manures regulate the availability of micronutrients to plants thereby increasing the growth and yield by providing nutrients in available form as well as accumulate dry matter in reproductive parts of plants. Minimum harvest index in the absolute control may be because of unavailability of optimum doses of nutrients available for the plants to complete various reproductive stages.

Conclusion :

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

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