International Journal of Farm Sciences **2(1)** : 47-53, 2012

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

YR SHUKLA, SAPANA MEHTA and RAJINDER SHARMA

Horticultural Research Station, Kandaghat 173215 Solan, HP
Email for correspondence: yrshukla@rediffmail.com

ABSTRACT

The present investigations were carried out at vegetable research farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP from October 2008 to May 2009 with radish cv Chinese pink. Fifteen treatment combinations comprising of inorganic (N, P and K) and bio-fertilizers (Azospirillum, phosphorus solubilizing bacteria and vesicular arbuscular mycorrhizae) were replicated thrice in RBD. Significant impact of different treatment combinations was observed on all the characters under study. It was noticed that combined maximum values for most of the characters like seed yield, 1000-seed weight and seedling vigour index-II were recorded with the application of Azospirillum + recommended NPK. This treatment also recorded maximum seed yield ie 10.2 q per ha.

Keywords: Bio-fertilizers, seed yield, radish

INTRODUCTION

Radish (*Raphanus sativus* L) is a popular root vegetable grown all over the world. It is native of Europe and Asia and belongs to family cruciferae (Gill 1993). In India it is grown in one or other part of the country throughout the year. Its edible fusiform roots are eaten raw as salad or cooked vegetable. Its leaves are rich in minerals and vitamins A and C and are also cooked as leafy vegetable. Besides this its immature pods usually called 'mongree' are either eaten raw or cooked as vegetable alone or mixed with other vegetables. Due to its high medicinal value it is prescribed for patients suffering from piles, liver troubles and jaundice (Brar and Nandpuri 1972).

Bio-fertilizers or microbial inoculants are eco-friendly, non-bulky, cheap and renewable sources of nutrients for plants. These inoculants render nutrients in available form and in adequate amounts which are otherwise inaccessible to the plants. The application of bio-fertilizers also helps in improving biological activities of soil. The integration of organic (both bulky and non-bulky) sources of nutrients with

chemical fertilizers have significant impact on physical, chemical and biological properties of soil without hampering the yield and quality of seed.

MATERIAL AND METHODS

The present investigations were carried out at vegetable research farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP from October 2008 to May 2009. There were 15 treatment combinations comprising of inorganic (N, P and K) and bio-fertilizers (Azospirillum, phosphorus solubilizing bacteria and vesicular arbuscular mycorrhizae) replicated thrice in RBD. Stecklings were spaced at 60 x 45 cm in plots of size 2.40 x 1.80 m. The entire calculated doses of NPK and bio-fertilizers were applied in the individual plots before transplanting of stecklings. Azospirillum (5 kg/ha), PSB (7.5 kg/ha) and VAM (12.5 kg/ha) were evenly applied to the specified plots before transplanting after their volume was increased by mixing evenly with fine FYM. Observations were recorded on five randomly selected plants in each plot for seed yield per plant (g), seed yield per plot (g), seed yield per ha (q), 1000-seed weight (g), seed germination (%), and vigour index. Data were subjected to statistical analysis as suggested by Panse and Sukhatme (1987).

RESULTS AND DISCUSSION

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 (34.00 g) obtained in T_2 (Azospirillum + recommended NPK) was statistically at par with T_1, T_7, T_4 and T_5 having 33.00, 32.33 30.73 and 29.47 g seed yield per plant respectively. Minimum seed yield (24.33 g) was however recorded in T_{15} (control) being at par with T_{10}, T_{14}, T_9, T_{13}, T_6, T_{11}, T_8, T_{12} and T_3 having 25.00, 25.17, 25.33, 25.67, 26.00, 26.67, 26.67, 27.33 and 29.00 gram seed yield per plant respectively.

Seed yield per plot

Data (Table 2) indicated that seed yield per plot varied from minimum of 381.67g in T_{15} (control) to maximum of 544.00 g recorded in T_2 (Azospirillum + recommended NPK). The top five best treatments were T_2 (544.00 g), T_1 (528.00 g), T_7 (517.33 g), T_4 (491.73 g) and T_5 (471.47 g) which produced non-significant effects among themselves but they were statistically superior over rest of the treatments. Minimum seed yield per plot (381.67g) was however recorded in T_{15} (control) which showed non-significant differences with T_9 (389.33 g), T_{10} (391.33 g), T_{14} (402.67 g), T_6 (407.67 g), T_{13} (410.67 g), T_8 (419.33 g), T_{11} (426.67 g), and T_{12} (437.33 g).

Seed yield per hectare

Table 1. Treatments used for the study

Treatment code	Treatment Details
T_1	R D of NPK (150:60:54 kg/ha)
T_2	Azospirillum (5 kg/ha) + R D of NPK (150:60:54 kg/ha)
T_3	Azospirillum (5 kg/ha) + 75% N (113 kg/ha) + R D of PK (60:54 kg/ha)
T_4	Azospirillum (5 kg/ha) + 50% N (75 kg/ha) + R D of PK (60:54 kg/ha)
T_5	PSB (7.5 kg/ha) + R D of NPK (150:60:54 kg/ha)
T_6	PSB (7.5 kg/ha) + 75% P (45 kg/ha) + R D of NK (150:54 kg/ha)
T_7	PSB (7.5 kg/ha) + 50% P (30 kg/ha) + R D of NK (150:54 kg/ha)
T_8	VAM (12.5 kg/ha) + R D of NPK (150:60:54 kg/ha)
T_9	VAM (12.5 kg/ha) + 75% P (45 kg/ha) + R D of NK (150:54 kg/ha)
T_{10}	VAM (12.5 kg/ha) + 50% P (30 kg/ha) + R D of NK (150:54 kg/ha)
T_{11}	Azospirillum (5 kg/ha) + PSB (7.5 kg/ha) + VAM (12.5 kg /ha)
T_{12}	T_{11}+ 75 % NP (113: 45 kg/ha) + R D of K (54 kg/ha)
T_{13}	T_{11}+ 75 % NP (113: 45 kg/ha) + R D of K (54 kg/ha)
T_{14}	T_{11}+ 50 % NP (75:30 kg/ha) + R D of K (54 kg/ha)
T_{15}	Control (no application of fertilizers)

RD= recommended dose

There were significant differences among different treatments for seed yield per hectare (Table 2). Maximum seed yield (10.20 q) recorded in T_2 (Azospirillum + recommended NPK) was closely followed by T_1 (9.90 q), T_7 (9.70 q), T_4 (9.22 q) and T_5 (8.84 q). All these treatments were at par with each other but were statistically superior over rest of the treatments. Minimum seed yield (7.30 q) recorded in T_{15} (control) was at par with one another treatments except T_5, T_4, T_7, T_1 and T_2. The overall mean seed yield per hectare was 8.41 q. Seed yield is an ultimate objective in any crop especially in the experiments which are conducted exclusively for seed production. The maximum seed yields per plant and per hectare were obtained with the application of recommended NPK + Azospirillum. More seed yield may be due to better performance of all the yield attributing characters. In general those treatments which performed better for all yield contributing characters also enhanced yield per hectare directly or indirectly. Seed yield per hectare was calculated from seed yield per plant which was worked out from seed yield per plot. Application of NPK favoured yield and quality of seed. Lamo (2009) in a study with radish cv Chinese

Pink was also of the opinion that NPK combined with bio-fertilizers resulted into more seed yield per plant. The increase in yield following Azospirillum application has been reported due to production of many phytohormones in turmeric (Balashanmugam 1994). Azospirillum also has beneficial effects like fixation of atmospheric nitrogen and synthesis of various growth promoting, antibiotic and antifungal substances (Dixit et al 2007). Minimum seed yield per hectare was recorded in control which may be because of unavailability of optimum level of nutrients for plants to complete various reproductive stages. Similar results have also been reported by Srinivas and Shaik (2002).

1000-Seed Weight (g)

Data pertaining to 1000-seed weight revealed that treatment effects were statistically significant (Table 2). The mean performance of different treatments showed that 1000-seed weight was maximum (13.10 g) in T_2 (Azospirillum + recommended NPK) followed by T_1 (13.09 g), T_7 (13.03 g), T_9 (12.72 g), T_{14} (12.67 g), T_{13} (12.67 g), T_{11} (12.60 g), T_8 (12.53 g), T_{12} (12.50 g), T_6 (12.46 g), T_3 (12.45 g), T_{10} (12.45 g) and T_5 (12.45 g). All these treatments were statistically superior over T_{15} (control) having 1000-seed weight of 11.63 gram. Thousand seed weight or test weight is an index which decides the boldness of seed and 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 seed vigour which is the most important character in seed studies. In the present studies 1000-seed weight was maximum in the treatment receiving recommended NPK + Azospirillum followed by NPK and the plots receiving PSB with inorganic fertilizers. Application of bio-fertilizers especially Azospirillum is responsible for producing IAA, GA and cytokinin like substances along with nitrogen fixation. 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 Panwar et al (2000). Further, increase in 1000-seed weight in treatments receiving NPK may be due to better availability of nutrients over control. Almost similar findings have been expressed by Lamo (2009) in radish. Application of NPK provides optimum quantity of available nutrients at all stages of crop growth which might have resulted in bold seeds ultimately resulting into maximum 1000-seed weight. Minimum values were recorded in control where no fertilizer was added which may be the possible reason for less t1000-seed weight.

Seed germination (%)

The data recorded on per cent germination of seed in the laboratory after harvest have been depicted in Table 2. The statistical analysis of data showed significant differences among different treatments for

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

Treatment	Seed yield/ Plant (g)	Seed yield/ plot (g)	Yield/ ha (q)	1000-seed weight	Seed germination (%)	Seed vigour Index-I	Seed vigour Index-II
T_1	33.00	528.00	9.90	13.09	98.00 (9.89)*	8.80	1556.34
T_2	34.00	544.00	10.20	13.10	96.37 (9.82)	7.89	1370.03
T_3	29.00	464.00	8.70	12.45	90.49 (9.51)	5.58	1157.77
T_4	30.73	491.73	9.22	12.38	95.50 (9.77)	7.87	1365.53
T_5	29. 47	471.47	8.84	12.45	93.65 (9.68)	7.39	1257.28
T_6	26.00	407.67	7.77	12.46	88.67 (9.41)	6.11	11.39.99
T_7	32.33	517.33	9.70	13.03	96.99 (9.85)	6.96	1180.25
T_8	26.67	419.33	9.97	12.53	94.65 (9.73)	6.21	1141.40
T_9	25.33	389.33	7.60	12.72	97.51 (9.87)	7.04	1209.01
T_{10}	25.00	391.33	7.50	12.45	91.64 (9.57)	6.34	1103.96
T_{11}	26.67	426.67	8.00	12.60	92.33 (9.60)	7.81	1302.54
T_{12}	27.33	737.33	8.20	12.50	89.90 (9.48)	6.21	1276.14
T_{13}	25.67	410.67	7.70	12.67	93.62 (9.68)	7.13	1183.84
T_{14}	25.17	402.67	7.55	12.67	95.17 (9.75)	7.01	1100.94
T15	24.33	381.67	7.30	11.63	83.28 (9.13)	5.21	1097.69
Mean	28.05	445.55	8.41	12.58	93.13 (9.65)	6.90	1229.50
$CD_{0.05}$	4.71	81.55	1.42	0.70	(0.37)	1.57	176.24

*Figures in the parentheses represent square root transformed values

seed germination. The maximum seed germination (98.00%) was recorded in the treatment T_1 (recommended NPK) followed by T_9 (97.51%), T_7 (96.99%), T_2 (96.37%), T_4 (95.50%), T_{14} (95.17%), T_8 (94.65%), T_5 (93.65%), T_{13} (93.62%), T_{11} (92.33%) and T_{10} (91.64%). All these treatments were statistically at par with one another. Minimum seed germination (83.28 %) was recorded in T_{15} (control) being statistically at par with three other treatments viz T_6, T_{12} and T_3 having seed germination of 88.67, 89.97 and 90.49 per cent respectively. In the present findings the results pertaining to the effect of different inorganic and bio-fertilizers showed that germination percentage was maximum in the plots receiving NPK followed by VAM. Availability of major nutrients like NPK at all the stages of crop growth is responsible for bold, good quality and vigorous seeds ultimately resulting in maximum seed

germination and stand. Further, increase in seed germination due to recommended doses of NPK may be due to improved quality of seeds in terms of crude portien, nitrogen and mineral content in seed. Similar findings have also been reported by Subbiah and Narayanswamy (2001) and Lamo (2009). Minimum seed germination was recorded in control which may be ascribed to no application of essential nutrients.

Improved seed germination by applying PSB has also been reported by Sharma et al (2007) in *Cicer arietinum*.

Seedling Vigour index-I

The data recorded on seedling vigour index-I have been presented in Table 2. It is apparent from the data that there were significant differences among various treatments for seedling vigour index-I. Maximum seedling vigour index-I (8.80) was recorded in T_1 (recommended NPK) followed by T_2 (7.89), T_4 (7.87), T_{11} (7.81) and T_5 (7.39) which were statistically at par with one another. Minimum seedling Vigour index-1 (5.21) was recorded in T_{15} (control) which was also at par with other treatments except T_7 (6.96), T_{14} (7.01), T_9 (7.04) and T_{13} (7.13). The over all mean value for seedling Vigour index-I was 6.90.

Seedling Vigour index-II

The data recorded on seedling vigour index-II have been presented in Table 2. It is apparent from the data that there were significant differences among various treatments for seedling vigour index-II. Maximum seedling vigour index-II (1556.34) was recorded in T_1 (recommended NPK) followed by 1370.03 in T_2 (Azospirillum + recommended NPK). Minimum (1097.69) seedling vigour index-II was recorded in T_{15} (control) followed by $T_{14,}$ T_{10}, $T_{6,}$ T_8, T_3, T_7, T_{13}, T_9 and T_5 which were statistically at par with one another.

Seedling vigour index is a very important character as it determines the actual germinability of seed 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 recommended dose of NPK followed by recommended dose of NPK + Azospirillum. Minimum seed vigour index-I and II were recorded in control. Macro nutrients like NPK had positive effect on germination and seed quality (bold seeds) that directly improves vigour index. Increased seed vigour index may also be due to better root proliferation, more uptake of nutrients and water, higher number of leaves and more photosynthates due to balanced application of NPK which might have enhanced food accumulation in the seeds. The present results are in conformity with the findings of Mengistu and Singh (1999) and Yadav et al (2004). Better efficiency of inorganic fertilizers for increasing seedling vigour index could be due to the fact that these inorganic fertilizers

might have helped the availability of various micro nutrients in an optimum level. Application of inorganic fertilizers might have helped in the plant metabolism through supply of certain micro nutrients in the early growth phase which might have produced vigorous seeds. Almost identical results have been expressed by Birwa et al (2009). Control had the lowest seedling vigour index which might be due to poor performance of seed related traits in the control.

REFERENCES

Balashanmugam PV 1994. Studies on the influence of Azospirillum and phosphobacteria on growth, yield and quality of turmeric (*Curcuma longa* L) cv BSR 1. PhD (Hort) thesis, Tamil Nadu Agricultural University, Coimbatore, India.

Birwa HL, Mahawer LN, Shukla AK, Kaushik RA and Mathur SR 2009. Response of integrated nutrient management on growth, yield and quality of okra (*Abelmoschus esculentus*). Indian Journal of Agricultural Science **79(5):** 55-58.

Brar JS and Nandpuri KS 1972. Cultivation of root crops. Punjab Agriculture University Bulletin, pp 10-15.

Dixit SK, Kumar Sanjay, Meena ML and Ram RB 2007. Bio-fertilizers may be a substitute of chemical fertilizers. Asian Journal of Agricultural Sciences **2(2):** 298-300.

Gill HS 1993. Improvement of root crops. In: Advances in horticulture: Volume 5. Vegetable crops (eds) KL Chadha and G Kalloo, Malhotra Book Depot, New Delhi, pp 201-206.

Lamo K 2009. Effect of organic and bio-fertilizers on seed production of radish (*Raphanus sativus* L) cv Chinese Pink. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, India.

Mengistu Fentahun and Singh Narendra 1999. Effect of bio-fertilizers on growth, yield and nutrient uptake of onion (*Allium cepa* L). Vegetable Science **26(2):** 193-195.

Panse V and Sukhatme P 1987. Statistical Methods for Agricultural Workers, ICAR, New Delhi, India.

Panwar AS, Raiyan JS and Verma VS 2000. Yield and quality of radish (*Raphanus sativus* L) seed as affected by fertility levels and bio-fertilizers. Indian Journal of Agronomy **45(4):** 822-826.

Sharma K, Dak G, Agrawal A, Bhatnagar M and Sharma R 2007. Effect of phosphate solubilizing bacteria on germination of *Cicer arietinum* seed and seedling growth. Journal of Herbal Medicine and Toxicology **1(1):** 61-63.

Srinivas M and Shaik M 2002. Performance of green gram and response function as influenced by different levels of nitrogen and phosphorus. Field Abstracts **56(5)**: 564.

Subbiah K and Narayanasamy T 2001. Interaction effect of phosphatic and biofetilizers on phosphorus use efficiency, yield and quality of fruits in bhindi (*Abelmochus esculentus* L). South Indian Horticulture **49(Special):** 168-169.

Yadav BD, Khandelwal, RB and Sharma YK 2004. Use of bio-fertilizers (Azospirillum) in onion. Haryana Journal of Horticultural Sciences **33(3/4):** 281-283.

Received : 16.7.2011 *Accepted: 18.9.2011*