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Effect of inorganic fertilizers and bio-fertilizers on growth and root yield of Radish (*Raphanus sativus* L.) cultivar 'Safed Mooli – 2' under Punjab condition

Vikas, Thaneshwari*, Rishu Sharma, Neelam Thakur, Poonam Kumari and Homraj Sahare

School of Agriculture, Lovely Professional University, Jalandhar
Corresponding author: ttchanchal@gmail.com

Abstract

The present studies entitled "Effect of inorganic fertilizers and biofertilizers on growth and root yield of radish (Raphanus sativus L.) cultivar 'Safed Mooli– 2' under Punjab condition" was carried out at Agriculture Research Farm, LPU, Phagwara, Punjab in the year 2018-19 using Randomized Block Design. The objectives of this research were to find out the effect of inorganic fertilizer, biofertilizer and their interactions on growth and yield of radish. The experiments had twenty-six treatment combinations which are replicated thrice. The results revealed that the application of 75% RDF + Azotobacter + Arka Microbial Consortium + Pseudomonas recorded maximum value for plant height (35.73 cm), number of leaves per plant (21.70), length of leaves (23.93 cm), root diameter (3.10 cm), root weight (200.63 g), dry weight of leaves per plant (17.93 g), yield per plot (8.02 kg), and total yield per hectare (595.34 q/ha).

Keywords: *Arka Microbial Consortium, Pseudomonas, Fertilizer, Biofertilizer, Radish.*

Introduction

Radish is botanically known as *Raphanus sativus* L. and it belongs to the family Brassicaceae. It is grown for its young tender fusiform root and is a popular root vegetable in both temperate and tropical regions. The edible roots of this crop can be eaten as raw salad or cooked. It is good source of Ca, P, K and vitamin C. Radish roots are considered as an appetizer and are also useful in recovering from piles, urinary complaints and in gastrodynia. In homeopathy, it is used for sleeplessness and chronic diarrhea (Kumar *et al*., 2014). It is predominantly a cool season vegetable crop and sown during winter from September to January in northern plains. In India radish is cultivated on area of 209, 000 ha with total production of 3174,000 MT (Anonymous, 2018). Nutrient management is of prime importance for increasing

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the yield of radish and other crop in sustainable way. For the production of sustainable and good quality radish optimum fertilization through inorganic and biofertilizers are essential. Among biofertilizer; *Azotobacter*, phosphorus solubilizing biofertilizer and Arka Microbial Consortium are the main biofertilizer which are biologically active products containing bacteria which help in improving soil health and fertility as well as improve the productivity of crop. *Azotobacter* can add 20-25 kg N ha^{-1} and phosphorus solulibizing bacterial biofertilizer can solubilize 30-50 kg P_2O_5 ha^{-1}. They liberate growth promoting substances and vitamins which may increase crop yield (Sharma *et al.,* 2013). Arka Microbial Consortium is a carrier based biofertilizer product which contains N Fixing, phosphorus and zink Solubilizing and plant growth promoting micro-organism as a single formulation. This biofertilizer can be applied through soil, seed, water and coco-peat. It helps in early seed germination, early transplanting, increasing seed vigor, reduction of use of synthetic fertilizer. Very less research work is available regarding the effect of bio-fertilizers alone or in combination with synthetic fertilizer on growth and yield of radish particular in Punjab. So, the present research was conducted to analyse the effect of inorganic fertilizers, bio-fertilizers and their combination on yield of Radish (*Raphanus sativus* L.) cultivar 'Safed Mooli – 2' under Punjab condition".

Material and methods

The present investigation entitled "Effect of inorganic fertilizers and biofertilizers on growth and yield of radish (*Raphanus sativus* L.) cultivar 'Safed Mooli-2' under Punjab condition" was carried out at research farm of LPU, Punjab during rabi season of 2018. Crop was sown on 01/11/2018 and harvested on 05/01/2019. Maximum and minimum temperatures during growing season were 31˚C and 7˚C respectively, relative humidity varied between 60 to 85 per cent. The experiment field was prepared by ploughing with disc plough and planking to bring the field to a good tilth condition. Each experimental unit was demarcated and layout was drawn as per plan. The ridge and furrows were made 45 cm apart in each plot and irrigation channels were provided for proper irrigation. The present research work was conducted with twenty-six treatments including control as mention in table number 1.

Seed were treated with biofertilizer according to treatment before sowing. Seed were dibbed halfway down the ridges at a distance of 7.5cm. Thining was done at 10 day after sowing by

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retaining one seedling per hill. After making of plots, vermicompost was applied to all the plots @ 15kg in field. The crop was fertilized with recommended dose of 25 kg of N and 12 kg of P_2O_5 per acre, as a basal dose as per the treatment. The observations were recorded for plant height, number of leaves per plant, leaf length, root length and diameter, root and leaf dry weight and yield per plot. These observations were recorded from ten sampled plant per plot.

Table 1. Details of Experimental Treatments

T_1	RDF (Recommended dose of fertilizer) 25:12:0 kg /acre N:P:K
T_2	*Azotobacter*
T_3	AMC (Arka Microbial Consortium)
T_4	*Pseudomonas*
T_5	75 % RDF + *Azotobacter*
T_6	75 % RDF + AMC
T_7	75 % RDF + *Pseudomonas*
T_8	50 % RDF + *Azotobacter*
T_9	50 % RDF + AMC
T_{10}	50 % RDF + *Pseudomonas*
T_{11}	25 % RDF + *Azotobacter*
T_{12}	25 % RDF + AMC
T_{13}	25 % RDF + *Pseudomonas*
T_{14}	75 % RDF + *Azotobacter* + AMC
T_{15}	50 % RDF + *Azotobacter* + AMC
T_{16}	25 % RDF + *Azotobacter* + AMC
T_{17}	75 % RDF + *Azotobacter*+ *Pseudomonas*
T_{18}	50 % RDF + *Azotobacter*+ *Pseudomonas*
T_{19}	25 % RDF + *Azotobacter*+ *Pseudomonas*
T_{20}	75 % RDF + AMC + *Pseudomonas*
T_{21}	50 % RDF + AMC + *Pseudomonas*
T_{22}	25 % RDF + AMC + *Pseudomonas*

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T_{23}	75 % RDF + *Azotobacter* + AMC + *Pseudomonas*
T_{24}	50 % RDF + *Azotobacter* + AMC + *Pseudomonas*
T_{25}	25 % RDF + *Azotobacter* + AMC + *Pseudomonas*
T_{26}	Control (without fertilizer)

Result and discussion

A perusal of data given in Table 2 revealed that different dose of inorganic fertilizers, bio-fertilizers and their combination significantly affected the plant height, number of leaves per plant and leaf length.

The dose of different inorganic fertilizers, bio-fertilizers and their combination significantly affected the plant height at harvest. The maximum plant height (35.73 cm) was recorded in treatment T_{23} (75 % RDF + *Azotobacter* + AMC + *Pseudomonas*) followed by treatment T_{24} (50 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (34.36 cm). The minimum plant height (22.40cm) was recorded in control treatment T_{26}. The treatment T_{17} (75 % RDF + *Azotobacter*+ *Pseudomonas*) and treatment T_{25} (25 % RDF + *Azotobacter* + AMC + *Pseudomonas*) was found to be statically at par with respect to the effect on plant height. The plant height in these two treatments was reported as 33.80 cm and 33.40 cm respectively. Increase in plant height with the combined application of inorganic fertilizer along with above-mentioned biofertilizers was found to be statically superior then separate application of synthetic fertilizer and biofertilizers.

The maximum number of leaves per plant (21.70) was recorded in treatment T_{23} (75 % RDF + *Azotobacter*+ AMC + *Pseudomonas*) while the minimum number of leaves per plant (10.40) was recorded in T_{26} (control), where the plant has not to be treated with inorganic fertilizer and bio-fertilizer. Treatment T_{17} (75 % RDF + *Azotobacter* + *Pseudomonas*) and treatment T_{20} (75 % RDF + AMC + *Pseudomonas*) was found to be statically at par with respect to the effect on a number of leaves per plant. The number of leaves per plant in these two treatments was recorded as 20.80 and 20.66 respectively. Increases in number of leaves per plant

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with the combined application of inorganic fertilizer along with above-mentioned biofertilizers was found to be statically superior then solo application of synthetic fertilizer and biofertilizer.

The maximum length of leaves (23.93) was recorded in treatment T_{23} (75 % RDF + *Azotobacter* + AMC + *Pseudomonas*) followed by T_{24} treatment (50 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (22.36 cm) while the minimum length of leaf was recorded in T_{26}Control (without fertilizer) valued (12.33 cm). Treatment T_{14} (75 % RDF + *Azotobacter*+ AMC) and treatment T_{20} (75 % RDF + AMC + *Pseudomonas*) was found to be statistically at par. Length of leaves in these two treatments was reported as 20.36 cm. Maximum length of leaves was reported with the application of a combination of 75% RDF of NPK along with A *Azotobacter*, AMC and pseudomonas followed by application of 50% RDF of NPK + *Azotobacter* + AMC + *Pseudomonas*.

Table 2. Effect of inorganic fertilizer, biofertilizer and their combination on plant height, number of leaves per plant and length of leaves.

Treatments	Plant height (cm)	Numbers of leaves per plant	Length of leaves (cm)
T_1	15.167	15.13	28.26
T_2	13.200	14.70	27.36
T_3	12.233	13.36	26.30
T_4	13.267	13.50	25.26
T_5	16.20	17.86	31.80
T_6	16.90	16.53	29.40
T_7	16.26	16.33	28.80
T_8	15.33	16.30	30.80
T_9	15.80	15.30	28.33
T_{10}	15.23	15.36	27.36
T_{11}	14.66	14.33	29.46
T_{12}	14.26	15.30	27.80
T_{13}	14.63	14.33	26.70
T_{14}	20.23	20.36	32.80

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T_{15}	19.33	19.43	31.70
T_{16}	18.33	18.60	30.26
T_{17}	20.80	20.70	33.80
T_{18}	19.03	19.73	32.70
T_{19}	18.36	18.80	32.40
T_{20}	20.66	20.36	31.80
T_{21}	19.30	19.93	31.36
T_{22}	18.60	18.33	30.80
T_{23}	21.70	23.93	35.73
T_{24}	20.36	22.36	34.36
T_{25}	19.76	20.76	33.40
T_{26}	10.40	12.33	22.40
CV	1.033	1.63	0.54
CD at 5 %	0.28	0.47	0.26
SE(d)	0.14	0.23	0.13
SE(m)	1.03	0.16	0.09

The increased value for all these parameters can be attributed to a reason that, application of biofertilizer helps in the production of the plant promoting substances by plant growth promoting microbes which were known to enhance cell division. The application of these biofertilizer also helps in nitrogen fixation by nitrogen-fixing bacteria, phosphorus and zinc solubilization by phosphorous solubilizing bacteria and zinc solubilizing bacteria respectively. Uptake of more nitrogen with the help of nitrogen-fixing bacteria biofertilizer may be the reason for more vegetative growth of the plants. Similar result was also reported by Sharma *et al*. (2013), Sentiyangla *et al*. (2010) and Meena *et al*. (2014), Khalid *et al.* (2015).

A perusal of data given in Table 3 revealed that different dose of inorganic fertilizers and bio-fertilizers significantly affected the root length (cm), root diameter, fresh root weight, root yield per plot and root yield per ha.

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The maximum root length was recorded in treatment T_{23} (75 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (26.80 cm) followed by T_{24} treatment (50 % RDF + *Azotobacter*+ AMC + *Pseudomonas*) valued (25.40 cm) while the minimum root length was recorded in T_{26} control (without fertilizer) valued (13.63 cm). Maximum root length was reported with the application of combination of 75% RDF of NPK along with *Azotobacter*, AMC and pseudomonas followed by application of 50% RDF of NPK + *Azotobacter*+ AMC + *Pseudomonas*. Increase in root length with the combined application of inorganic fertilizer along with biofertilizers was found to be statically superior then solo application of synthetic fertilizer and biofertilizer.

The maximum root diameter was recorded in treatment T_{23} (75% RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (3.10 cm) followed by T_{24} treatment (50 % RDF + *Azotobacter*+ AMC + *Pseudomonas*) valued (3.07 cm) while the minimum root diameter was recorded in T_{26} control (without fertilizer) valued (1.35cm).

The maximum fresh root weight recorded in treatment T_{23} (75 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (200.63 gm) followed by T_{24} treatment (50 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (195.73 gm). The minimum fresh root weight was recorded in control treatment T_{26} where the plant has not to be treated with inorganic fertilizer and bio-fertilizer valued (145.60 gm).

The maximum dry weight of leaves per plant was recorded in treatment T_{23} (75 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (17.93 gm) followed by T_{24} treatment (50 % RDF + *Azotobacter*+ AMC + *Pseudomonas*) valued (16.97 gm) while the minimum dry weight of leaves was recorded in control treatment T_{26} (without fertilizer) valued (2.99 gm).

Table 3. Effect of inorganic fertilizer, biofertilizer and their combinations on root length (cm), root diameter, fresh root weight, dry matter of leaves and root yield per plot.

Treatments	Root length (cm)	Root diameter (cm)	Fresh weight of root (gm)	Dry matter of leaves (gm)	Root yield per plot (kg)
T_1	1.97	155.80	4.56	6.23	18.76
T_2	1.94	154.66	4.98	6.18	16.30

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T_3	1.87	152.63	4.93	6.10	15.30
T_4	1.83	151.73	3.97	6.06	17.30
T_5	2.58	171.43	9.97	6.85	19.70
T_6	2.53	169.70	9.93	6.78	18.76
T_7	2.48	168.33	8.98	6.73	20.53
T_8	2.44	166.76	8.93	6.67	18.36
T_9	2.38	163.53	8.31	6.54	17.56
T_{10}	2.33	161.53	7.94	6.46	19.33
T_{11}	2.28	160.53	7.60	6.42	17.43
T_{12}	2.24	158.43	6.96	6.33	16.30
T_{13}	2.21	156.70	6.93	6.26	18.33
T_{14}	2.71	176.70	11.93	7.06	22.26
T_{15}	2.68	174.66	10.98	6.98	21.33
T_{16}	2.64	172.53	10.93	6.90	20.70
T_{17}	2.88	182.60	13.93	7.30	23.80
T_{18}	2.84	180.53	13.31	7.22	23.20
T_{19}	2.77	178.46	12.93	7.13	22.53
T_{20}	2.95	189.03	15.93	7.56	22.80
T_{21}	2.82	187.50	14.97	7.50	21.76
T_{22}	2.73	184.60	14.93	7.38	20.80
T_{23}	3.10	200.63	17.93	8.02	26.80
T_{24}	3.07	195.73	16.97	7.82	25.40
T_{25}	3.03	192.70	16.93	7.70	24.26
T_{26}	1.35	145.60	2.99	5.82	13.63
CV	1.16	0.15	2.92	0.21	0.64
CD at 5 %	0.04	0.44	0.49	0.24	0.21
SE(d)	0.02	0.22	0.24	0.12	0.10
SE(m)	0.01	0.15	0.17	0.09	0.07

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It is explicit from data that combined application of different doses of inorganic fertilizers and bio-fertilizers significantly increases root yield per plot in radish. The maximum yield per plot was recorded in treatment T_{23} (75 % RDF + *Azotobacter* + AMC + *Pseudomonas*) valued (8.02 kg) and the minimum yield per plot was recorded in control treatment T_{26} (without fertilizer) valued (5.82kg). Treatment T_{17} (75 % RDF + *Azotobacter* + *Pseudomonas*) treatment T_{24} (50 % RDF + *Azotobacter* + AMC + *Pseudomonas*) and treatment T_{25} (25 % RDF + *Azotobacter* + AMC + *Pseudomonas*) was found to be statistically at par.

The increase in root length, root diameter, fresh root weight, dry leaf weight and root yield per plot can be attributed to a reason that, application of biofertilizer helps in production of plant growth inhancing substances by plant growth promoting microbes which were known to enhance cell division. The application of these biofertilizer also helps in nitrogen fixation, phosphorus and zinc solubilization. These all factors may have influenced the increase in fresh root weight and a similar finding was reported by Singh and co worker (2007), Subramani *et al.* (2011), Khalid and coworker (2015). The increase in dry weight of leaves per plant was also recorded by Patel and co worker (2011) and Shinde and co worker (2013). Increased yield with the application of biofertilizer and combination of organic and inorganic fertilizer has also been reported by Meena *et al*. (2015).

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