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Influence of inorganic nutrients and biofertilizers on growth and yield of tropical radish (*Raphanus sativus* L.) Cv. Pusa Chetki

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Abstract
The present investigation entitled "Influence of inorganic nutrients and biofertilizers on growth and yield of tropical radish (*Raphanus sativus* L.) Cv. Pusa Chetki." was carried out during the rabi season of the year 2020-21 at the College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University. Telangana. The experiment was laid out in Randomized Block Design (RBD) with seven treatments replicated thrice. The results revealed that application of 75% RDF +Arka Microbial Consortium @ 2.5 kg ha-1 + KSB @1.25 kg ha-1 recorded significantly higher plant height (33.76 cm plant-1), number of leaves (11.50 plant-1), leaf length (28.80 cm plant-1), leaf width (8.87 cm plant-1), fresh weight of leaves (120.20 g plant-1) and yield attributes like root length (24.63 cm), root diameter (5.03 cm), fresh weight of root (250.83 g) and root yield (19.53 kg per plot).

Keywords: Arka microbial consortium, inorganic nutrients, biofertilizers, radish

1. Introduction
Radish (*Raphanus sativus* L.) is an important root vegetable 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) [8].

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 205, 000 ha with total production of 3107,000 MT (Anonymous, 2019) [1]. Radish being a short duration crop and quick growing crop, root growth should be rapid and uninterrupted. Hence, for the production of good quality roots and higher yield, optimum fertilization through inorganic and biofertilizers are essential. many workers reported that with the increased application of phosphorous and potassium results in increase in vitamin – C content. (Joshi and Patil, 1988 and Chang and Chang, 2000) [6, 4]. Among biofertilizer; Azotobacter, Phosphorus Solubilizing Biofertilizer, Potassium Solubilizing Bacteria 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, Phosphorus Solubilizing bacterial biofertilizer can solubilize 30-50 kg P2O5 ha-1 and Potassium Solubilizing bacterial biofertilizer not only enhance plant growth and yield but also can lessen the use of agrochemicals and support eco-friendly crop production. They liberate growth promoting substances and vitamins which may increase crop yield (Sharma *et al*., 2013) [10]. Arka Microbial Consortium is a carrier based biofertilizer product which contains N Fixing, phosphorus and zinc Solubilizing and plant growth promoting microorganism as a single formulation. 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 biofertilizers alone or in combination with synthetic fertilizer on growth and yield of radish particularly in Telangana. So, the present research was conducted to analyse the "Influence of inorganic nutrients and bio-fertilizers on growth and yield of Radish (*Raphanus sativus* L.) Cv. Pusa Chetki" at the field unit College of Horticulture, Rajendranagar, during 2020-21.

Materials and Methods

The present investigation entitled "Influence of inorganic nutrients and biofertilizers on growth and yield of tropical radish (*Raphanus sativus* L.) Cv Pusa Chetki." was carried out during the rabi season of theyear 2020-21 at the College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University. Telangana. The experiment was laid out in Randomized Block Design (RBD) with 7 treatments and three replications *viz*., T1-100% RDF (90: 50: 90 kg ha-1), T2 -75% RDF + Biofertilizers [Azotobacter + Phosphorous solubilizing bacteria (PSB) + Potassium solubilizing bacteria (KSB)] (Each @1.25 kg ha-1),T3 - 50% RDF + Azotobacter + PSB + KSB (Each @ 2.5 kg ha-1), T4 - 25% RDF + Azotobacter + PSB + KSB (Each @ 3.75 kg ha-1), T5 - 75% RDF + Arka Microbial Consortium (AMC) @ 2.5kg ha-1 + KSB @1.25kg ha-1, T6 -50% RDF +Arka Microbial Consortium (AMC) @ 5 kg ha-1 + KSB @ 2.5 kg ha-1, T7 - 25% RDF + Arka Microbial Consortium (AMC) @ 7.5kg ha-1 + KSB @ 3.75kg ha-1.

Plant height in cm was recorded from the base of the plant to the tip of leaves with the help of measuring scale and average was worked out. Height of the plants were measured and expressed in centimeter. Numbers of fully opened leaves from five randomly selected plants were counted and mean values were computed. The foliage length and width were measured with the help of measuring scale and average was worked out and expressed in centimeter. Leaves from each plot were weighed at after harvest. The average was worked out and expressed as fresh weight of leaves in grams. Plants whose foliage weight taken after harvest, roots of those plants were weighed at harvesting stage and their average was calculated and expressed in grams. The length and diameter of roots from each plant was measured at harvesting and the means were worked out and expressed in centimeter. The weight of root of five tagged plants was measured with the help of weighing machine and average weight was calculated and expressed in grams. The data collected from the experimental field was analyzed statistically following the procedure as described by Gomez and Gomez (1984) [5]. The level of significance used in 'F' and 't' test was P=0.05. Critical differences were calculated wherever 'F' test was significant.

Results and Discussion

Growth attributes

A perusal of data given in Table 1 revealed that inorganic nutrients and bio-fertilizers significantly affected the plant height, number of leaves per plant, fresh weight of leaves, leaf length and width. The maximum plant height (33.76 cm) was recorded in treatment T5 (75% RDF + Arka Microbial Consortium (AMC) @ 2.5kg ha-1 + KSB @1.25kg ha-1) followed by treatment T2 (75% RDF + Azotobacter + PSB+ KSB (Each @1.25 kg ha-1) valued (32.20 cm). The minimum plant height (24.73 cm) was recorded T1. Increase in plant height with the combined application of inorganic nutrients along with Arka Microbial Consortium was found to be statistically superior than other treatments.

The maximum number of leaves per plant (11.50) was recorded in treatment T5 (75% RDF + Arka Microbial Consortium (AMC) @ 2.5kg ha-1 + KSB @1.25kg ha-1) while the minimum number of leavesper plant (8.30) was recorded in T1, where the plant has to be treated with only recommended dose of fertilizers. Increases in number of leaves per plant with the combined application of inorganic nutrients along with Arka Microbial Consortium was found to be statically superior than other treatments.

Maximum length (28.80 cm) and width of leaves (8.87 cm) was reported with the application of combination of 75% RDF + AMC @ 2.5kg ha-1 + KSB @ 1.25kg ha-1 followed by application of 75% RDF + Azotobacter + PSB + KSB (Each @1.25 kg ha-1).

Maximum fresh weight of leaves (120.23 g) was recorded under treatment T5 (75% RDF + AMC @ 2.5kg ha-1 + KSB @1.25kg ha-1) followed by (118.13 g) T2 (75% RDF + Azotobacter + PSB + KSB Each @1.25 kg ha-1). However, the minimum (95.1 g) fresh weight of leaves was observed in treatment T1 where recommended dose of fertilizers was applied.

The increased value for all these parameters might be due to the presence of readily available form of nitrogen through both inorganic nutrients and biofertilizers, wherein inorganic source could have exerted positive influence on extended nutrient availability to match the physiological needs of the crop which triggered to produce elevated stature of the growth components. In addition to the Integration of biofertilizers might have resulted in beneficial influence of amelioration of soil physio chemical properties. Besides, it may be due to rapid elongation and multiplication of cell in the presence of adequate quantity of nitrogen (Berman *et al*, 2014) [2]. Similar results were reported by Kumar *et al*. (2014) [8], Shani *et al*. (2016) in radish and Bhattarai and Maharjan (2013) [3] in carrot.

Yield attributes

A perusal of data given in Table 2 revealed that inorganic nutrients and bio-fertilizers significantly affected the root length (cm), root diameter, fresh root weight, root yield per plot and root yield per ha.

Maximum root length (24.63 cm) was reported with the application of combination of 75% RDF+ AMC @ 2.5kg ha-1 + KSB @1.25kg ha-1 followed by application of 75% RDF + Azotobacter + PSB+ KSB Each @1.25 kg ha-1. Increase in root length with the combined application of inorganic fertilizer along with AMC and KSB was found to be statically superior then solo application of RDF. The maximum root diameter was recorded in treatment T5 (75% RDF + AMC @ 2.5kg ha-1 + KSB @1.25kg ha-1) valued (5.03 cm) followed by T2 treatment (75% RDF + Azotobacter + PSB + KSB Each @1.25 kg ha-1) valued (4.71 cm) while the minimum root diameter was recorded in T1 (100% RDF) valued (3.20 cm). The maximum fresh root weight recorded in treatment T5 (75% RDF + AMC@ 2.5kg ha-1 + KSB @1.25kg ha-1) valued (250.83 gm) followed by T2 treatment (75% RDF + Azotobacter + PSB + KSB Each @1.25 kg ha-1) valued (247.96 gm). The minimum fresh root weight was recorded in treatment T1 where the plant has to be treated with recommended dose of fertilizers valued (159.16 gm).

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 recordedin treatment T5 (75% RDF + AMC @ 2.5kg ha-1 + KSB @1.25kg ha-1) valued (19.53 kg) and the minimum yield per plot was recorded in control treatment T1(100% RDF) valued (10.63 kg).

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 enhancing substances by plant growth promoting microbes which were known to enhance cell division. The

application of these biofertilizer also helps in nitrogen fixation, phosphorus, potassium and zinc solubilization. These all factors may have influenced the increase in fresh root weight and a similar finding was reported by Singh *et al*. (2007) [11], Subramani *et al*. (2011) [12] and Khalid *et al*. (2015) [7]. Increased yield due to better availability of nutrients and balanced C: N ratio might have increased synthesis of carbohydrates which ultimately promoted greater yield (Shani *et al*, 2016) [9]

Table 1: Plant height, number of leaves, leaf length, leaf width and fresh weight of leaves of Radish Cv Pusa Chetki as influenced by inorganic nutrients and biofertilizers.

Treatments	Plant height(cm) at 45 DAS	Number of leaves at 45 DAS	Leaf length (cm) at 45 DAS	Leaf Width(cm) at 45 DAS	Fresh weight of leaves (g)
T1	24.73	8.30	23.86	7.02	95.10
T2	32.20	10.20	27.13	8.50	118.13
T3	31.30	9.90	25.96	8.13	111.20
T4	28.73	9.00	24.86	7.43	98.93
T5	33.76	11.50	28.80	8.87	120.23
T6	31.50	10.10	26.76	8.26	112.07
T7	30.30	9.40	25.03	7.80	106.50
S.Em±	0.61	0.64	1.39	0.12	1.41
CD at 5%	0.19	0.20	3.01	0.04	0.73

Table 2: Root length, root diameter, fresh weight of root, root yield per plot of Radish Cv Pusa Chetki as influenced by inorganic nutrients and biofertilizers.

Treatments	Root length (cm)	Root diameter (cm)	Fresh weight of root (g)	Root yield per plot (kg)
T1	18.36	3.20	159.16	10.63
T2	23.76	4.71	247.96	18.37
T3	22.23	4.44	219.83	15.57
T4	20.40	4.26	187.96	13.41
T5	24.63	5.03	250.83	19.53
T6	22.33	4.69	229.36	16.78
T7	21.50	4.43	198.00	14.56
S.Em±	0.20	0.20	1.84	0.75
CD at 5%	0.62	0.06	0.59	0.24

Conclusion

From this study, it can be concluded that application of 75% RDF + AMC @ 2.5kg ha-1 + KSB@1.25kg ha-1 has realised higher growth parameters (plant height, number of leaves, leaf length, leaf width and fresh weight of leaves) and yield attributes like root length, root diameter, fresh weight of root and root yield per plot in Radish Cv. Pusa Chetki as compare to other treatments. Thus, proper management of nutrient increased the growth and development of Radish

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