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Studies on biofertilizers and inorganics on growth and yield of carrot

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Abstract
The investigation entitled "studies on biofertilizers and inorganics on growth and yield of carrot" was carried out at the Horticultural Research Station, Dr. Y. S. R. Horticultural University, Pandirimamidi, East Godavari District, Andhra Pradesh during *Rabi* 2017-18. The experimental design adopted was the factorial RBD with three replications. The first factor, chemical fertilizers with three levels (100%, 75%, and 50% of RDF) and second factor, the combination of five biofertilizers (PSB, KSB, *Azospirillum*, *Azotobacter*, VAM) were taken. The experiment included 12 treatment combinations. The results revealed that, among the chemical fertilizer levels, the application of 100% recommended dose of fertilizers (75:60:50 kg/ha) and within the biofertilizer levels the combination of PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM showed a significant difference in the growth and yield characters in comparision with other levels. Among the interaction effects the combination of 100% RDF+ PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM recorded highest values in terms of growth characters *viz.*, plant height (72.59 cm), number of leaves (18.60), fresh and dry weight of plant (107.57 g and 34.25 g respectively) and yield characters *viz.*, root length (23.07 cm), fresh and dry weight of root (121.99g and 37.52 g respectively), harvest index (53.55%), yield per plot (5.82 kg/ plot) and yield per hectare (194 q/ha).

Keywords: *Azospirillum*, *Azotobacter*, biofertilizers, carrot, growth, inorganics, yield

Introduction
Vegetables are recognized as an important adjunct for the maintenance of good health and to provide nutritional security. They play a key role in providing valuable vitamins, minerals, carbohydrates, proteins and roughages. The daily requirement of an individual for a balanced diet can be met very well consumtion of 125 g leafy vegetables, 100 g root and tuber vegetables, along with 75 g other vegetables per day (Hazra and Som, 1999) [4]. Among the root vegetables, carrot (*Daucus carota* L.) is a popular cool season root crop all over the world. The roots share many health benifits as they are rich in β - carotene (provitamin A) (Simon & Wolff, 1987, Holdenet *et al.*, 1999) [13, 5], sucrose88.6% moisture, 1.1% protein, 0.2% fat, 9.1% carbohydrates, 1.1% fibre, 12,000 IU of vitamin A along with traces of vitamin B_1, B_2, C and other minerals (Banga, 1963) [2]. Carrots are consumed raw as well as cooked along with peas and very commonly used in preserves, salads and as pickles. Carrots are made into jams, canned, and also the roots are made in the form of discs and slices for dehydration. Purple and black carrots are used for the preparation of a very good appetizer called 'Kanji'.

It has been reported that neither the chemical fertilizer alone nor the organic manure are able to sustain the crop productivity and soil fertility (Vithwel and Kanaujia, 2013) [18] Biofertilizers used in conjunction with chemical fertilizers improve crop productivity and nutrient use efficiency. It is becoming difficult to meet the nutrient need of farming through chemical fertilizer alone and due to its higher costs; the concept of integrated plant nutrient supply system is gaining ground (Sushanta and Rao)

A continual dependence on chemical fertilizers may be accompanied by a fall in organic matter content, increased soil acidity, degradation of soil physical properties and increased rate of erosion due to instability of soil aggregates (Olowoake and Adeoye, 2010) [12]. One of the ways to maintain or improve the soil fertility is by maintaining its organic matter. This is possible through the use of organic sources of fertilizer. Research has shown that organic based fertilizers are less leached into ground water than the chemical fertilizer (Sridhar and Adeoye, 2003) [14].

The bioinoculants, popularly known as biofertilizers are artificially multiplied cultures of latent cells of efficient strains of microorganisms capable of fixing atmospheric N_2, solubilising phosphorus, mobilizing nutrients and absorption of water, decomposing

cellulolytic and lignolytic waste materials and also for effective recycling of solid wastes. These micro-organisms also produce growth promoting substances like indole acetic acid, gibberlic acid, cytokinin and antibiotics which greatly influence the seed germination, root growth and proliferation, its density and volume with higher cation exchange capacity (CEC) (News Letter, 2009) [11]

The chemical fertilizers used in conventional agriculture contain just a few minerals, which dissolve quickly in damp soil and give the plants large doses of minerals (Vernon, 1999) [17]. Commercial and subsistence farming has been and is still relying on the use of inorganic fertilizers for growing vegetables (Lampkin, 1990) [7].

Biofertilizers hold vast potential in meeting the plant nutrient requirements. The biofertilizers are effective in increasing the nutritive potential of soil over a long span of time and hence, a viable combination of chemical fertilisers with that of the biofertilizers would yield effective and efficient results in terms of growth and yeild, from the initial stages of application of these nutrient sources.

Therefore, the work aims to study the effect of inorganic and biofertilizers supplementation on growth and yield characters of carrot.

Material and Methods

Field experiment was conducted at Horticultural Research Station, Pandirimamidi that comes under high altitude tribal zone of Andhra Pradesh, India which is situated at an altitude of 250 m above mean sea level with 17°25' East latitude and 81°45' North longitudes. The experimental site received an annual rainfall of 1186 mm. The pH of irrigation water was recorded as 6.0 and EC was 1.66dSm^{-1}. The land used under the experiment was fairly uniform with pH of 6.5. The experiment consisted of twelve treatment combinations with three levels of inorganics [100% RDF (F_1)- 75:60:50 kg/ha; 75% RDF (F_2)- 56:45:37.5 kg/ha and 50% RDF (F_3)- 37.5:30:25 kg/ha] and four levels of biofertilizers [PSB+ KSB+ *Azospirillum* (B_1), PSB+ KSB+ *Azotobacter* (B_2), PSB+ KSB+ Vesicular Arbuscular Michorrhiza (B_3), PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4)]. The factorial randomized block design was adopted with three replications. The experimental field was thoroughly ploughed to a depth of 30 cm and harrowed twice.

The field was laid at a gross plot size of 2.2 m X 1.8 m and net plot size of 2 m X 1.5 m. The biofertilizers [PSB, KSB, *Azospirillum, Azotobacter,* VAM] were applied to soil, by adding them to well decomposed FYM as per different treatments at the rate of 5 kg/ ha. The field was irrigated and let for the beneficial microorganisms to grow. Carrot seed cv. Pusa Rudhira was sown in ridge and furrow system at a depth of 1 cm. Standard cultural and management practices were adopted. Observations were recorded on various growth and yield parameters on 5 tagged plants in each plot. The data collected was subjected to analysis of variance (ANOVA). The test of significance (t-test) and critical difference was calculated at 0.05% probability.

Results and Discussion

The study revealed that different combinations of chemical fertilizers and biofertilizers showed variation in growth and yield characters of carrot.

Growth characters

Good performance of the crop was observed during the period of growth and a significant difference was recorded among the various treatments and their combinations. The data has been mentioned here under [Table 1&2]. The highest plant height (65.73 cm), maximum number of leaves (17.24) along with fresh and dry weight of the plant (101.67 g and 29.75 g) was obtained with the application of 100% RDF (F_1) followed by 75% RDF (F_2) and 50% RDF (F_3) [Table 1].

The application of biofertilizers PSB +KSB +*Azospirillum* +*Azotobacter* +VAM (B_4) recorded the highest plant height (65.49 cm), highest number of leaves (17.56), highest fresh and dry weight of plant 102.17 g and 30.77 g followed by PSB+ KSB+ *Azotobacter* (B_2) [Table 1].

Better performance in terms various vegetative growth characters were recorded with the application of the combination of 100% RDF+ PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (F_1B_4) with 72.59 cm of plant height, 18.60 numbers of leaves per plant, and with 107.57 and 34.25 of fresh and dry weight of the plant respectively. The application of 100% RDF + PSB+ KSB+ *Azotobacter* (F_1B_2) followed the treatment, which was followed by 75% RDF + PSB+ KSB+ *Azospirillum* +*Azotobacter*+VAM (F_2B_4) [Table 2].

The nutrients supplied through inorganic fertilizers being the straight fertilizers which readily are taken up by the plant system, along with the production of growth promoting hormones through biofertilizers might have added to the increased vegetative growth of the crop. The nitrogen fixation capacity of the *Azospirillum*, *Azotobacter* and increased uptake of phosphorus by VAM might have helped in increasing the nutrient uptake efficiency by exerting their synergistic effect with inorganic fertilizers. This could also have accelerated cell division and elongation as well as greater chlorophyll synthesis and higher metabolic activity. The obtained results were in accordance with Thilakavathy and Ramaswamy (1999) [16] in onion and Jadhao *et al*. (1999) [6] in radish.

Yield characters

The yield characters play an essential role in identifying the treatments that are potential to satisfy the farmer's needs. A linear relationship was observed among the various treatment combinations. The highest dosage of inorganic and biofertilizers combinations recorded the highest yield and its related characters, followed by the lower rates of nutrient doses.

The number of days taken to maturity was not significantly influenced by both the factors (chemical fertilizers and biofertilizers) and also by the combination of the two factors. This may be attributed to the fact that the same var. Pusa Rudhira was used in all the treatments of the experiment and hence, as a varietal character there was no difference observed in the period required by the crop to reach maturity.

The highest values in terms of yield attributes *viz.*, root length (20.07 cm), fresh weight of the root (113.34 g) and dry weight of the root (32.39 g) were obtained with the application of the complete dose of fertililizers through inorganics *i.e.*100% RDF (F_1). The trend was followed by 75% RDF (F_2) and 50% RDF (F_3) [Table 1]. The complete dose of fertilizers might have triggered the maximum potential of photosynthesis in the plants and ultimately producing the higher values in terms of yield related attributes.

The application of biofertilizers PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4) showed a significant variation as compared to other biofertilizer combinations. The results revealed that maximum root length (20.80 cm), fresh weight of the root (110.10 g) and dry weight of the root (31.56 g)

were obtained with the application of PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4). The application of biofertilizers PSB+ KSB+*Azotobacter* (B_2), PSB+KSB+VAM (B_3) and PSB+ KSB+ *Azospirillum* (B_1) showed a proportionate effect on the crop in terms of the yield characters, in a descending order following the treatment of biofertilizers combination PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4) [Table 1].

The treatment combination of the highest level of chemical fertilizer and the biofertilizers *i.e.* 100% RDF+ PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (F_1B_4) was reported as the best treatment in the present experiment as, it recorded the highest root length (23.07 cm), fresh weight of root (121.99 g) and dry weight of root (37.52 g) followed by the combination of 100% RDF+ PSB+ KSB+ *Azotobacter* (F_1B_2) [Table 2]. The lowest values in terms of yield related characters was recorded with the application of the treatment 50% RDF+ PSB+ KSB+ *Azospirillum* (F_3B_1)

The exogenous application of chemical fertilizers directly shows response on yield attributing factors by increasing the immediate nutrient uptake by plants and showing the response in terms of improved cell division, elongation, vegetative growth and in turn the economic growth. The biofertilizers help to mobilise the nutrients and make them easily available to plants. The integrated application of biofertilizers and inorganic fertilizer might have increased the availability of NPK and also improved the fertility status of soil, that in turn helped the plant in improving the water uptake, proper aeration and productivity due to which yield and its attributing characters might have increased. The experimental findings are in accordance with Vithwel and Kanaujia (2013) [18] in carrot and Natalidini *et al.* (2017) [9] in arrow root.

The harvest index is the ratio of the economic yield to the biological yield that is expressed in percentages. The application of 100% RDF (F_1) produced higher root yield and biological yield therefore, recorded the highest harvest index of 52.67%. The lowering levels of chemical fertilizers had considerably reducing percentages of harvest index (Table 1).

Among the biofertilizers the combination of PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4) recorded the highest harvest index of 52.02% and was on par with PSB+KSB+*Azotobacter* (B_2) which recorded 51.45%. Whereas, the lowest harvest index (50.22%) was recorded with the application of PSB+ KSB+ *Azospirillum* (B_1).

The yield is a major attribute considered by any crop grower and the highest yield per plot (5.10 kg) was obtained with the application of the highest rate of application *i.e.* 100% RDF (F_1). The yield per hectare followed a similar pattern as of the yield per plot recording the highest (173.02 q/ha) with the application of 100% RDF (F_1) followed by the other two levels of recommended dose of fertilizers [Table 1].

With respect to the effect of biofertilizers the highest yield per plot (5.28 kg) was obtained with the application of PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4), followed by PSB+KSB+*Azotobacter* (B_2) with 4.81 kg. Whereas, the plants applied with PSB+KSB+VAM (B_3) recorded 4.16 kg and it was found to be on par with PSB+ KSB+ *Azospirillum* (B_1) with 4.14 kg. Similarly, highest yield per hectare (176.18 q/ha) was obtained in the plants applied with PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (B_4) followed by the plants applied with PSB+ KSB+ *Azotobacter* (B_2), PSB+ KSB+ VAM (B_3) and PSB+ KSB+ *Azospirillum* (B_1) [Table 1].

The highest values in terms of harvest index (53.55%), yield per plot (5.82 kg), yield per hectare (173.02 q/ha) were recorded with the application of 100% RDF+ PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (F_1B_4) followed by the combination of 100% RDF+ PSB+ KSB+ *Azotobacter* (F_1B_2) [Table 2]. The lowest values in terms of yield and its related characters was recorded with the application of the treatment 50% RDF+ PSB+ KSB+ *Azospirillum* (F_3B_1) [Table 2].

The best combination recorded in the present experiment is 100% RDF+ PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (F_1B_4), as it contained the complete dose of recommended fertilizers and the combination maximum number of biofertilizers. The obtained result to a much extent can be attributed to the production of growth promoter substances produced by the biofertilizers. A viable combination of chemical fertilizers with biofertilizers would cause synergistic effect in the nutrient uptake and provide better development of the economic part and also lead to the increased soil area explored by the roots thus increase the yield attributes. The obtained results are in line with Devendra *et al.* (2018) [3] in onion. Mohammadi *et al.* (2013) [8] in potato and Navya *et al.* (2017) [10] in elephant foot yam also obtained similar results.

Table 1: Effect of different levels of chemical fertilizers and biofertilizers on growth and yield characters

Treatments	Plant height (cm)	Number of leaves	Fresh weight of plant (g)	Dry weight of plant (g)	Fresh weight of root (g)	Dry weight of root (g)	Harvest index (%)	Root length (cm)	Yield per plot (Kg)	Yield per hectare (ha)
Chemical fertilizers										
100% RDF (F_1)	65.73	17.24	101.67	29.75	113.34	32.39	52.67	20.07	5.10	173.02
75% RDF (F_2)	62.37	16.28	98.06	27.16	104.01	29.29	51.45	18.34	4.56	151.47
50% RDF (F_3)	54.33	16.06	95.46	24.41	92.81	23.31	49.26	17.84	4.12	137.50
C.D. at 5%	1.96	0.21	1.23	1.14	1.30	1.49	0.30	0.56	0.15	5.94
SE(m) ±	0.66	0.07	0.41	0.38	0.44	0.50	0.10	0.19	0.05	2.01
Biofertilizers										
PSB+ KSB+ *Azospirillum* (B_1)	57.61	15.64	95.10	23.53	96.30	25.56	50.22	17.10	4.14	138.26
PSB+ KSB+ *Azotobacter* (B_2)	62.37	16.81	99.30	28.23	107.75	29.11	51.71	19.21	4.81	158.33
PSB+ KSB+ VAM (B_3)	57.77	16.09	97.00	25.90	99.41	27.09	50.56	17.89	4.16	143.22
PSB+KSB+*Azospirillum*+ *Azotobacter* + VAM (B_4)	65.49	17.56	102.17	30.77	110.10	31.56	52.02`	20.80	5.28	176.18
C.D. at 5%	2.27	0.24	1.42	1.32	1.50	1.72	0.34	0.65	0.18	6.86
SE(m) ±	0.77	0.08	0.48	0.44	0.50	0.58	0.11	0.22	0.06	2.32

Table 2: Effect of different combinations of chemical fertilizers and biofertilizers on growth and yield characters

Treatment combinations	Plant height (cm)	Number of leaves	Fresh weight of plant (g)	Dry weight of plant (g)	Fresh weight of root (g)	Dry weight of root (g)	Harvest index (%)	Root length (cm)	Yield per plot (Kg)	Yield per hectare (ha)
100% RDF+ PSB+ KSB+ *Azospirillum* (F_1B_1)	62.32	16.30	96.33	25.59	104.38	27.52	52.00	17.94	4.23	154.33
100% RDF+ PSB+ KSB+ *Azotobacter* (F_1B_2)	69.35	17.33	104.01	33.08	119.92	33.97	53.14	21.06	5.54	182.44
100% RDF+ PSB+ KSB+ VAM (F_1B_3)	58.66	16.73	98.77	26.07	107.08	30.56	52.01	18.22	4.84	161.33
100%RDF+PSB+KSB+*Azospirillum*+ *Azotobacter* + VAM (F_1B_4)	72.59	18.60	107.57	34.25	121.99	37.52	53.55	23.07	5.82	194.00
75% RDF+ PSB+ KSB+ *Azospirillum* (F_2B_1)	56.95	15.40	95.42	23.90	99.00	27.77	50.92	16.90	4.11	137.11
75% RDF+ PSB+ KSB+ *Azotobacter* (F_2B_2)	63.30	16.83	98.52	26.61	106.87	29.62	52.03	18.35	4.67	153.44
75% RDF+ PSB+ KSB+ VAM (F_2B_3)	60.86	15.70	97.87	26.10	100.31	28.52	50.61	18.00	4.36	145.33
75%RDF+PSB+KSB+*Azospirillum*+ *Azotobacter* + VAM (F_2B_4)	68.38	17.20	100.43	32.03	109.88	31.25	52.24	20.10	5.10	170.00
50% RDF+ PSB+ KSB+ *Azospirillum* (F_3B_1)	53.57	15.23	93.56	21.10	85.53	21.38	47.75	16.46	3.49	116.33
50% RDF+ PSB+ KSB+ *Azotobacter* (F_3B_2)	54.48	16.26	95.38	25.00	96.45	23.76	49.98	18.23	4.24	139.11
50% RDF+ PSB+ KSB+ VAM (F_3B_3)	53.80	15.83	94.38	25.53	90.84	22.20	49.04	17.44	3.83	130.00
50%RDF+PSB+KSB+*Azospirillum*+ *Azotobacter* + VAM (F_3 B_4)	55.49	16.90	98.51	26.03	98.44	25.91	50.27	19.23	4.93	164.55
C.D. at 5%	3.93	0.43	2.46	2.28	2.60	2.84	0.60	1.13	0.31	11.88
SE(m) ±	1.33	0.14	0.83	2.28	0.88	1.00	0.20	0.38	0.10	4.02

Conclusion

As, of observed in the above experiment, it can be stated that the factors at their maximum rate of application showed a significant and linear relationship on the growth and yield characters. The interaction effect obtained with the application of 100% RDF+ PSB+ KSB+ *Azospirillum*+ *Azotobacter*+ VAM (F_1B_4). The application of biofertilizers in combination with chemical fertilizers would aid to draw additional nutrients for better crop growth and yield and under a long run would aid to a substantially sustainable soil health.

References

1. Adeoluwa O, Adeogun OO. Evaluation of feather as organic fertilizers on Amaranthus (*Amaranthus caudatus*), in Proceedings of the 1st Technical Workshop on Organic Agriculture Conference, Ladoke Akintola University of Technology, Ogbomoso, Nigeria, 2010, 16-19,
2. Banga O. Origin and distribution of the western cultivated carrot. Genetica Agraria. 1963; 17:357-70.
3. Devendra K, Mahendra KL, Gaurav SP. Effect of *azotobacter* on growth and yield of onion (*Allium cepa* L.). Journal of Pharmacognosy and Phytochemistry. 2018; 7(1):1171-75.
4. Hazra P, Som MG. Technology for vegetable production and improvement. Naya Prakash publishers, Calcutta, 1999, 9.
5. Holdenet JM, Eldridge AL, Beecher GR, Buzzard M, Bhagwat S, Davis CS *et al*. Carotenoid content of U.S. foods: an update of the base. Journal of Food Comp. Anal. 1999; 12:169-96.
6. Jadhao BJ, Kulwal LV, Mahakal KG. Effect of Nitrogen, Phosphorus and Potassium on growth and seed yield of Radish. Vegetable Science. 1999; 26(1):95-96.
7. Lampkin N. Organic farming. Farming press books. Ipswich. United Kingdom, 1990.
8. Mohammadi GR, Rostami AA, Ghobadi ME, Najaphy A. Effects of non-chemical and chemical fertilizers on potato (*Solanum tuberosum* L.) yield and quality. Journal of Medicinal Plants Research. 2013; 7(1):36-42.
9. Natalidini L, Putri P, Supriyono P. Effect on the use biofertilizer and differences type soil on growth and yield arrowroot. Journal of Soil Science and Agro climatology. 2017; 14(1):29-35.
10. Navya K, Desai KD, Tandel YN, Sheth SG. Effect of integrated nutrient management on growth, yield and quality of elephant foot yam [*Amorphophallus paeoniifolius*). International Journal of Chemical Studies. 2017; 5(4):1766-69.
11. News letter, Nutrient Management in Vegetable crops Integration of Biofertilizers with Chemical Fertilizers, 2009.
12. Olowoake AA, Adeoye GO. Comparative efficacy of NPK fertilizer and composted organic residues on growth, nutrient absorption and dry matter accumulation in maize. International Journal of Organic Agriculture Research and Development. 2010; 2:43-53.
13. Simon PW, Wolff Y. Carotenes in typical and dark orange carrots. J Agric. Food Chem. 1987; 35:1017-22.
14. Sridhar MKC, Adeoye GO. Organomineral fertilizer from urban wastes. The Nigerian Field. 2003; 68:91-111.
15. Sushanta KP, Rao DLN. All India Network Project on Biofertilizers. Department of Soil Science and Agricultural Chemistry, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar-751 003, Orissa.
16. Thilakavathy S, Ramaswamy N. Effect of inorganic and biofertilizers on yield and quality parameters of multiplier onian (*Allium cepa* L. var. Aggregatum) Vegetable Science. 1999; 26(1):97-98.
17. Vernon G. Sustainable vegetable production. Ithca Inc. New York. USA, 1999.
18. Vithwel, Kanaujia SP. Integrated nutrient management on productivity of carrot and fertility of soil. SAARC Journal of Agriculture. 2013; 11(2):173- 81.