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Studies on effect of biofertilizers in combination with inorganic nutrients on yield and its attributes of sprouting broccoli (*Brassica oleracea* var. *italica* L.)

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Abstract
The present investigation entitled "effect of biofertilizers in combination with inorganic nutrients on yield and its attributes of sprouting broccoli (*Brassica oleracea* var. *italica* L.)" was conducted during *rabi*, 2017 at College of Horticulture, Venkataramannagudem, West Godavari District, Andhra Pradesh. The experiment was laid out in a randomized block design with three replications comprising fourteen treatments. The results indicated that there was a significant differences among the fourteen treatments and treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) was recorded the maximum head diameter (14.02 cm), head weight per plant (0.305 kg), yield per plot (10.07 kg) and estimated yield per hectare (111.83 q).

Keywords: Biofertilizers, sprouting broccoli, head diameter

Introduction
Broccoli (*Brassica oleracea* var. *italica* L.) with chromosome number 2n=18 belongs to cruciferous family. The name broccoli has been derived from Italian word 'brocco' means shoot and the word sprouting broccoli refers to development of young flower bud which have been used as vegetable. Broccoli has good organoleptic properties and is a very delicious vegetable. It contains high protein (3.3%), vitamin C (137 mg/100g), vitamin A (3500 IU), vitamin B_2 (0.12 mg/100g), Iron (205 mg/100g) and Calcium (0.80 mg/100g). Cancer Research Centre of USA indicated that broccoli has several anti-cancerogenic effects due to the presence of Sulforaphane (Damato *et al*., 1994) [3].

Material and Methods
The present investigation entitled "Effect of biofertilizers in combination with inorganic nutrients on growth, yield and quality of sprouting broccoli (*Brassica oleracea* var. *italica* L.)" was conducted during *Rabi*, 2017 at College of Horticulture, Venkataramannagudem, West Godavari District, and Andhra Pradesh. The soil is of red sandy loam with good drainage and moderate water holding capacity. The physical composition of soil was sand 70%, silt 20% and clay 10% and the chemical composition of soil was soil p^H 6.96, E.C. 0.24 dS m^{-1}, Organic Carbon 0.34%, available nitrogen 136.26 kg/ha, available phosphorus 38.74 kg/ha and available potassium 166.22 kg/ha**.** The experiment was carried out on Pusa KTS-1 of sprouting broccoli. The experiment was laid out in a randomized block design with three replications comprising fourteen treatments. The experimental area was prepared by ploughing once with a mould board plough followed by two harrowing and divided into plots of 3m x 3m. The seedlings of thirty five days old and a height of 15 cm with three to four leaves were transplanted in the second week of November, 2017 in the experimental field. At the time of final field preparation, farm yard manure @ 20 t/ha was applied to the soil as a basal dose as per the recommendation. Biofertilizers such as *Azotobacter*, phosphorous solubilizing bacteria and potassium solubilizing bacteria were thoroughly mixed with FYM for rapid multiplication under shade, prior to application in main field. They were applied as basal dressing (5 kg/ha). Both organic and inorganic fertilizers were applied on treatment basis. Irrigation and other Intercultural operations were done when necessary.

The effect biofertilizers in combination with inorganic nutrients on yield and its attributes was observed.

Results and Discussion

The results obtained from the present investigation are presented in the Table 1. The treatment T4 (100% RDF+ *Azotobacter* + PSB + KSB) recorded maximum head diameter (14.02 cm). These findings are in line with Bashyal (2011) [1], Kumar *et al.* (2013) [9] and Tekasangla *et al*. (2015) [15] in cauliflower, Mohapatra *et al.* (2013) [11], Srichandan *et al* (2015) [14] and Goutam and Biradar (2017) [5] in broccoli and Kumar (2018) [17] in Knol-Khol. The treatment T4 (100% RDF+ *Azotobacter* + PSB + KSB) was recorded the maximum head weight per plant (0.305 kg). *Azotobacter* inoculation helped in increasing nitrogen availability because it is a micro acrophillic nitrogen fixer. It colonizes the root mass, fixes nitrogen in loose association with plants and these bacteria induce the plant root to secrete a mucilage which creates low oxygen involvement and help to fix atmospheric nitrogen which as reflected by producing better yield attributes. The solubilization effect of PSB is mainly due to the production of organic acids by this organism. They are also known to produce amino acids, vitamins, growth promoting substance like indole acetic acid and gibberellic acid which helps in achiving better growth of plant as well as yield and yields attributes.

Table 1: Effect of biofertilizers in combination with inorganic nutrients on Head diameter (cm), Head weight per plant (kg), yield per plot (kg) and estimated yield per hectare (q) in sprouting broccoli (*Brassica oleracea* var. *italica* L.)

T. No	Treatments	Head diameter (cm)	Head weight per plant (kg)	Yield per plot (kg)	Estimated yield per hectare (q)
T_1	100% RDF + *Azotobacter*	13.65	0.276	9.10	101.07
T_2	100% RDF + PSB	12.89	0.267	8.82	98.02
T_3	100%RDF + KSB	12.77	0.243	8.01	88.98
T_4	100% RDF + *Azotobacter* + PSB + KSB	14.02	0.305	10.07	111.83
T_5	75% RDF + *Azotobacter*	11.97	0.201	6.64	73.82
T_6	75% RDF + PSB	12.41	0.188	6.20	68.93
T_7	75% RDF + KSB	11.47	0.182	6.01	66.73
T_8	75% RDF + *Azotobacter* + PSB + KSB	13.92	0.286	9.43	104.74
T_9	50% RDF + *Azotobacter*	11.23	0.174	5.74	63.80
T_{10}	50% RDF + PSB	10.82	0.168	5.54	61.60
T_{11}	50% RDF + KSB	10.57	0.159	5.25	58.30
T_{12}	50% RDF + *Azotobacter* + PSB + KSB	12.03	0.212	6.99	77.61
T_{13}	*Azotobacter* + PSB + KSB	10.21	0.146	4.82	53.53
T_{14}	100% RDF (100:60:40 NPK kg ha^{-1})	12.19	0.225	7.44	82.62
	S Em ±	0.362	0.012	0.402	4.463
	CD at 5%	1.059	0.036	1.174	13.044

Potassium solubilizing bacteria can solubilize K-bearing minerals and convert the insoluble K to soluble forms of K and make them available to

Plant uptake. KSB can dissolve silicate minerals and release K through the production of organic and inorganic acids. The more plants growth and dry mater production in turn resulted in better head development and ultimately the higher yield. More number of leaves may accelerate the synthesis of chlorophyll, more photosynthetic activity, amino acids, enzymes, carbohydrate use, enhanced food accumulation and better mobilization of plant nutrients particularly nitrogen and phosphorus during later stage of plant growth thus resulting ultimately in the increased head weight. These findings are in line with Singh *et al* (2016) [13], Goutam and Biradar (2017) [5], Verma and Choudhary (2017) [16] in broccoli, Kumar (2018) [7] in knol-khol and Chaudhary *et al.* (2018) [2] in cabbage. The treatment T4 (100% RDF+ *Azotobacter* + PSB + KSB) was recorded the maximum yield per plot (10.07 kg) and estimated yield per hectare (111.83 q). It was due to the highest number of leaves and leaf area which enhances the synthesis and translocation of photosynthates from leaves to head. This might have resulted in the maximum head weight and head diameter of the crop. Higher uptake of N, P and K by plants was also observed in treatment T4 (100% RDF+ *Azotobacter* + PSB + KSB). Hence it can be concluded that, the cumulative effect of all the above parameters have resulted in maximum yield in T4 (100% RDF+ *Azotobacter* + PSB + KSB) treatment. These findings are in line with Tekasangla *et al*. (2015) [15] in cauliflower, Srichandan *et al.* (2015) [14], Hanaa *et al.* (2016) [6], Singh *et al* (2016) [13], Ekta *et al*. (2017) [4], Goutam and Biradar (2017) [5], Kumar *et al.* (2017) [8] in broccoli, Sable *et al.* (2016), Kumar and Devi (2016) [10] and Chaudhary *et al.* (2018) [2] in cabbage and Kumar (2018) [7] in Knol-Khol.

Conclusion

From the above study, it was concluded that, among different treatment combinations, treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) was superior in yield and its attributes is due to the combined effect of biofertilizers and inorganic fertilizers.

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