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Studies on effect of biofertilizers in combination with inorganic nutrients on yield and economics 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 economics 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 yield per ha (111.83 q/ha) and BC ratio (3.12).

Keywords: Biofertilizers, sprouting broccoli, yield and economics

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, 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 economics was observed.

Results and discussion

The data on yield and economics are presented in the Table 1. The treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) recorded maximum estimated yield per hectare (111.83 q) is due to enhancement of phytohormone production, nitrate reduction, nitrogen fixation, phosphate solubilization, specific activities of enzymes involved in the tricarboxylic acid cycle and the glycolysis pathway might be the reason behind yield increase. Hormone induced modification in root morphology leads to enhanced uptake of mineral nutrients which might help in increasing yield. It can also be attributed to increase in uptake of nutrients resulting in faster synthesis and translocation of photosynthates from source (leaves) to sink (head). These findings are in line with Tekasangla *et al.* (2015) [14] in cauliflower, Srichandan *et al.* (2015) [13], Hanaa *et al.* (2016) [6], Singh *et al* (2016) [12], Ekta *et al.* (2017) [4], Goutam and Biradar (2017) [5], Kumar *et al* (2017) [8] in broccoli, Sable *et al.* (2016) [11], Kumar and Devi (2016) [9] and Chaudhary *et al* (2018) [2] in cabbage and Kumar (2018) [2] in knol-khol. The treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) showed highest BC ratio (3.12), which is due to highest yield and maximum returns obtained per hectare. It is also evident from the table that, estimated gross returns are found to be maximum (Rs 2,23,660/ha) in T_4 (100% RDF+ *Azotobacter* + PSB + KSB) due to highest yield recorded in that treatment. Similar trend was obtained for net returns also which was maximum (Rs 1,51,980/ha) in T_4 (100% RDF+ *Azotobacter* + PSB + KSB). These findings are in line with Chaterjee *et al* (2005) [1], Ekta *et al.* (2017) [4] in broccoli and Manisha and Korla (2009) [10], Kumar and Devi (2016) [9], Sable *et al.* (2016) [11] in cauliflower reported highest annual net returns and benefit cost ratio through application of bio fertilizers in combination with inorganic fertilizers.

Table 1: Effect of biofertilizers in combination with inorganic nutrients on yield and Benefit cost ratio of sprouting broccoli (*Brassica oleracea* var. *italica* L.)

T. No	Treatments	Head yield (qt/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio
1	100% RDF + *Azotobacter*	101.07	202140.00	71320.00	130820.00	2.83
2	100% RDF + PSB	98.02	196040.00	71320.00	124720.00	2.75
3	100%RDF + KSB	88.98	177960.00	71320.00	106640.00	2.50
4	100% RDF + *Azotobacter* + PSB + KSB	111.83	223660.00	71680.00	151980.00	3.12
5	75% RDF + *Azotobacter*	73.82	147640.00	70788.00	76852.00	2.09
6	75% RDF + PSB	68.93	137860.00	70788.00	67072.00	1.95
7	75% RDF + KSB	66.73	133460.00	70788.00	62672.00	1.89
8	75% RDF + *Azotobacter* + PSB + KSB	104.74	209480.00	71148.00	138332.00	2.94
9	50% RDF + *Azotobacter*	63.8	127600.00	70072.00	57528.00	1.82
10	50% RDF + PSB	61.6	123200.00	70072.00	53128.00	1.76
11	50% RDF + KSB	58.3	116600.00	70072.00	46528.00	1.66
12	50% RDF + *Azotobacter* + PSB + KSB	77.61	155220.00	70432.00	84788.00	2.20
13	*Azotobacter* + PSB + KSB	53.53	107060.00	69385.00	37675.00	1.54
14	100% RDF (100:60:40 NPK kg ha^{-1})	82.62	165240.00	71140.00	94100.00	2.32

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 BC ratio is due to the combined effect of biofertilizers and inorganic fertilizers.

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