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Studies on effect of biofertilizers in combination with inorganic nutrients on NPK uptake by plant and NPK status of soil after harvest in sprouting broccoli (*Brassica oleracea* var. *italica* L.)

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Abstract
The present investigation was conducted to study the "effect of biofertilizers in combination with inorganic nutrients on NPK uptake by plant and NPK status of soil after harvest in 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 N, P and K uptake by plant and N, P and K status of soil.

Keywords: Biofertilizers, sprouting broccoli, NPK uptake and NPK status of soil after harvest

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) [2].

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 NPK uptake by plant and NPK status of soil after harvest was observed. The various nutrient uptake parameters were recorded from five randomly selected tagged plants. Nutrient uptake parameters like N uptake, P uptake and K uptake and NPK status of soil were subjected to statistical analysis as per method suggested by Panse and Sukhatame (1967).

Results and discussion

The data on NPK uptake by plant and NPK status of soil after harvest such as N uptake, P uptake and K uptake and NPK status of soil are presented in the Table 1. The treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) recorded maximum N uptake by plant (122.67 Kg/ha) is due to to expanded root surface area through increased root growth and root hair development. These findings are line with Narayanamma *et al.* (2005) [7], Sable and Bhamare (2007) [11], Kumar and Devi (2016) [4] in cauliflower. The treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) recorded maximum P uptake (50.33 Kg/ha) is due to the growth of bacteria and presence of mycorrhizal fungi around plant rhizosphere dramatically increased the surface area

Table 1: Effect of biofertilizers in combination with inorganic nutrients on NPK uptake and NPK status of soil after harvest in sprouting broccoli (*Brassica oleracea* var. *italica* L.)

T. No	Treatments	NPK status of soil after harvest			N uptake of plant (kg/ha)	P uptake of plant (kg/ha)	K uptake of plant (kg/ha)
		N (kg/ha)	P (kg/ha)	K (kg/ha)			
T_1	100% RDF + *Azotobacter*	145.33	55.67	104.07	121.67	45.66	96.71
T_2	100% RDF + PSB	120.67	61.67	103.26	106.67	49.29	95.33
T_3	100%RDF + KSB	119.33	54.04	123.33	106.81	44.52	107.48
T_4	100% RDF + *Azotobacter* + PSB + KSB	146.11	62.04	124.67	122.67	50.33	108.33
T_5	75% RDF + *Azotobacter*	128.33	45.33	99.05	111.67	30.33	91.75
T_6	75% RDF + PSB	104.04	53.67	98.08	97.33	42.67	90.67
T_7	75% RDF + KSB	104.41	44.03	117.08	96.04	29.05	103.67
T_8	75% RDF + *Azotobacter* + PSB + KSB	130.67	54.33	118.52	113.67	42.33	104.00
T_9	50% RDF + *Azotobacter*	114.67	38.33	96.67	102.33	22.33	88.33
T_{10}	50% RDF + PSB	94.67	49.37	95.15	82.04	31.33	86.35
T_{11}	50% RDF + KSB	93.04	37.04	108.78	81.63	21.04	102.33
T_{12}	50% RDF + *Azotobacter* + PSB + KSB	115.82	50.03	111.15	103.67	32.45	103.37
T_{13}	*Azotobacter* + PSB + KSB	87.67	30.75	94.41	79.67	20.29	85.71
T_{14}	100% RDF (100:60:40 NPK kg ha^{-1})	117.04	51.03	102.19	104.11	39.04	94.71
	S Em ±	2.895	1.414	2.733	2.756	0.976	1.622
	CD at 5%	8.463	4.134	7.989	8.054	2.853	4.742

F roots for exploration of nutrients particularly phosphorus. There are evidences to show that exudation of citrate and malate from roots effectively solubilises unavailable phosphorus sources accompanied by extensive root hair. These bio fertilisers were able to increase mobility and enhance absorption of P which should have increased the uptake of P. These findings are line with Mohandas (1987) [6], Chaudhary *et al.* (2005) [1] in tomato and Narayanamma *et al.* (2005) [7], Kumar and Devi **(**2016) [4] in cauliflower. The treatment T_4 (100% RDF+ *Azotobacter* + PSB + KSB) recorded maximum K uptake (108.33 Kg/ha) is due to the well-developed root system, additional nutrients supplied by FYM, significant improvement in soil physical properties, better absorption of nutrient by the plant due to higher microbial and metabolic activity and higher photosynthesis rate, enhanced the K uptake. These findings are line with Parmar and Sharma (2001) [9], Narayanamma *et al.* (2005) [7], Parmar *et al.* (2006) [10] and Kumar and Devi **(**2016) [4] in cauliflower. The treatment T_4 (100% RDF + *Azotobacter* + PSB + KSB) recorded maximum nitrogen (146.11 kg/ha) is due to the significant buildup of available N in the soil is due to bio fertilizer application especially *azotobacter* which increased the activity of N fixing bacteria and build up inorganic N status of the soil due to biochemical degradation and mineralization, thereby, resulting in higher accumulation of N in soil and fixation of atmospheric nitrogen. The treatment T_4 (100% RDF + *Azotobacter* + PSB + KSB) recorded maximum phosphorus (62.04 kg/ha) is due to the availability of more phosphorus may be due to presence of mycorrhizal fungi which might be possessing P solubilizing activity. They are capable of utilizing P from inositol phosphates and possess phosphatase activity which further affected their ability to release P from soil organic matter and hence increase the available P in soil. The treatment T_4 (100% RDF + *Azotobacter* + PSB + KSB) recorded maximum potassium (124.67 kg/ha) in soil after harvest is due to the increase in available K may be due to the reduction of fixation and release of K due to the interaction of organic matter with soil besides addition of K to the available K pool of the soil. These results are in line with Milosevic *et al.* (1995) [5] in cabbage, Shalini *et al.* (2002) [12] in knol khol, Narayanamma *et al.* (2005) [7] in cauliflower and Kumar *et al.* (2017) [3] in broccoli.

Conclusion

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

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