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Effect of plant growth promoting rhizobacteria on plant nutrient content and uptake in *Clitorea ternatea* L

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Abstract
A field experiment was conducted to assess the Effect of plant growth promoting rhizobacteria on plant nutrient content and uptake in *Clitorea ternate a* L. at College of Horticulture, UHS campus, GKVK, Bengaluru, during 2016-2017. The experiments were comprised of ten treatments and they were replicated thrice in RCBD. The significant maximum plant uptake of NPK (31.17, 2.24, 25.12, kg ha^{-1} respectively) was obtained with seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescence* with application of full dose of RDF under rainfed condition and the higher nitrogen, phosphorous and potasium uptake of the plant (54.74, 4.24, 39.62 kg ha^{-1} respectively) were found with seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescence* with application of full dose of RDF under irrigated situation. However, there is no significant difference among the treatments with respect nitrogen, phosphorus and potassium content in leaves of shankapushpi under both rainfed and irrigated condition.

Keywords: Shankapushpi, *Bradyrhizobium japonicum* and *Pseudomonas fluorescence*

Introduction
India with a rich biodiversity supports many systems of medicines by producing and exporting various medicinal plants approximately, one third of pharmaceutical are plant origin and are used for reliving and curing ailments. Plants are the important source of medicine ever since the dawn of human civilization and in spite of tremendous developments in the field of allopathy during the 20th century, plants still remain as one of the major source of drugs in modern as well as traditional systems of medicine across the world (Ghosh., 1998) [3]. Approximately, one third of pharmaceuticals are of plant origin and are used for relieving and curing ailments (Dubey *et al*., 2004) [2]. According to World Health Organization, the global market for plant based medicines will hit 5 trillion US dollar by 2030 (Anon., 2013) [1].
Shankapushpi also known as butterfly pea is one of the important medicinal plants used for boosting memory and improving intellect and also to cure mental illness (Gupta *et al*., 2010) [4]. It is a perennial leguminous twiner, botanically known as *Clitoria ternatea* L. belonging to the family Fabaceae. The plant originated from tropical Asia and distributed widely in South and Central America. The genus *Clitoria* comprises of about 60 species distributed mostly within the tropical belt with a few species found in temperate areas. The most frequently reported species is *Clitoria ternatea* L, which is mainly used as a forage as it is highly palatable for live-stock apart from its various medicinal usage.
Butterfly pea is vigorous, strongly persistent and it is long-lived perennial herb with an erect growth habit. The stem is fine twining and sparsely pubescent at base, leaves are pinnate with 5-7 leaflets, petioles 1.5-3cm long, flowers are axillary, whitish blue to dark blue in colour resemble a conch shell. The pods are linear oblong, flattened 4-13 cm long the tap root which may grow to more than 2m deep, bears one to several purplish lateral roots. The plant is adaptable to a wide range of temperature, rainfall and altitude, but susceptible to frost and does not grow well during cold spells in winter. The rainfall requirements ranges from 400 mm to 1500 mm per annum, sensitive to water logging and flooding and it is claimed to have some tolerance to salinity. The shankapushpi is considered as Madhya-Rasayana in *Ayurveda* and reported as nervine tonic and laxative. The leaves of shankapushpi conatains glycosides *viz*., kaempferol-3-glucoside, kaempferol-3-rutinoide and kaempferol-3-neohesperidoside.

The root contains ternatins, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins, starch, taraxerol and taraxerone. The seeds have nucleoprotein with its aminoacid sequence similar to insulin, delphinidin-3, 3, 5-triglucoside, essential amino-acids, pentosan and water soluble mucilage (Zingare *et al.*, 2013) [8].The root powder of *clitorea* is used as one of the ingredients in the preparation of the drug "SULAK" and its ointment to treat leprosy. The flower had been used to dye rice cake in Malaysia and being eaten as vegetable in India and Philippines. The flower is also being used traditionally as diuretic, anthelmintic, purgative, demulcent and remedy for rheumatism, bronchitis, urinogenital disorder and cancer (Subramanian and Prathyusha, 2011) [6]. The application of PGPR strains can provides an effective, economical and practical way of plant protection via disease suppression, P-solubilization, phytohormone production *etc.* The PGPR strain mixtures often show synergistic action in plant protection and growth promotion involving many mechanisms (Zahir and Arshad, 2004) [7].

Materials and Methods

The field experiment was conducted at College of Horticulture, University of Horticultural Sciences Campus, Gandhi Krishi Vignana Kendra (Post), Bengaluru during June to November 2016-17. Shankapushpi seeds (Local type) were collected from Sanjeevini vatika, Division of Horticulture, University of Agricultural Science, Gandhi Krishi Vignana Kendra, Bengaluru.

The native *Rhizobium* stain was collected from root nodules of shankapushpi and *Pseudomonas fluorescence* was collected from the Department of Agricultural Microbiology, University of Agricultural sciences, Gandhi krishi Vignana Kendra, Bengaluru and used for seed treatment of shankapushpi with three replication by using RCBD design and treatments *viz*. T_1 -Recommended dose of fertilizers (control) T_2 -Recommended dose of fertilizers + *Bradyrhizobium japonicum* T_3 -Recommended dose of fertilizers + *Pseudomonas fluorescens* T_4- Recommended dose of fertilizers +*Bradyrhizobium japonicum*+ *Pseudomonas fluorescens* T_5 -75% Recommended dose of fertilizers + *Bradyrhizobium japonicum* T_6 -75% Recommended dose of fertilizers + *Pseudomonas fluorescens* T_7 -75% Recommended dose of fertilizers + *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* T_8 - 50% Recommended dose of fertilizers + *Bradyrhizobium japonicum* T_9 -50% Recommended dose of fertilizers +*Pseudomonas fluorescens* T_{10} -50% Recommended dose of fertilizers+ *Bradyrhizobium japonicum* +*Pseudomonas fluorescens.*

Result and Discusion

With regard to nitrogen content (%), phosphorus content (%) and potassium content (%) didn't expressed any significant difference among the treatments under both rainfed and irrigated condition (Fig 1).

The nitrogen uptake of the plants was found maximum (31.17 kg ha^{-1}) with seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* and application of full dose RDF and was followed by seed treatment of *Bradyrhizobium japonicum* and application of full dose of RDF (28.13 kg ha^{-1}). While, the lowest nitrogen uptake by the plants (22.51 kg ha^{-1}) was found in control under rainfed condition. Similarly, under irrigated condition, the seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* and application of full dose of RDF has recorded maximum nitrogen uptake (54.74 kg ha^{-1}) of the plant and was on par with seed treatment of *Bradyrhizobium japonicum* and application of full dose of RDF(51.53 kg ha^{-1}). While, the seed treatment of *Pseudomonas fluorescens* and application of 50 per cent RDF has recorded lowest uptake of nitrogen by the plant (39.14 kg ha^{-1}) under irrigated condition.

The seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* with full dose of RDF has recorded maximum phosphorus uptake of the plant (2.24 kg ha^{-1}) and was on par with seed treatment of *Bradyrhizobium japonicum* and application of full dose of RDF (2.05 kg ha^{-1}). While, the lowest phosphorus uptake by the plant was recorded with seed treatment of *Bradyrhizobium japonicum* and application of 50 per cent RDF (1.48 kg ha^{-1}) under rainfed condition. The seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* and application of full dose of RDF has recorded significantly maximum P uptake of the plants (4.24 kg ha^{-1}) under irrigated condition.

There was significant difference among different treatments with respect to potassium uptake of the plant. The seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* with full dose of RDF has recorded maximum Potassium uptake of the plant (25.12 kg ha^{-1}). While, the minimum potassium uptake of the plant was recorded with seed treatment of *Pseudomonas fluorescens* + 50 per cent RDF (19.22 kg ha^{-1}) under rainfed condition. Similarly, under irrigated condition, seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* + full dose of NPK has recorded significant maximum Potassium uptake of the plant (39.62 kg ha^{-1}) and was on par with application of full dose of RDF, seed treatment of *Bradyrhizobium japonicum* + full dose of RDF, seed treatment of *Pseudomonas fluorescens*+ full dose of RDF and seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* + 75 per cent of NPK (36.37, 38.24, 36.76 and 36.63 kg ha^{-1}, respectively). While, the seed treatment of *Pseudomonas fluorescens* + 50 per cent RDF has recorded minimum potassium uptake of the plant (33.29 kg ha^{-1}) under irrigated condition. The seed treatment of *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* and application of full dose RDF has recorded the maximum nitrogen, phosphorus and potassium uptake by the plants similar trend was found under irrigated condition with respect to N, P and K uptake by the plants. It might be due to application of inorganics along with combination of bio-fertilizers lead to subsequent deposition due to increased yield which in turn resulted in gradual buildup of nutrients. Activity of soil microorganisms also increased with FYM, which in turn increases the mineralization of organically bound nutrients to inorganic form. These results are in conformity with those obtained by Kalita *et al*. (2010) in Bhringaraj (Table 1).

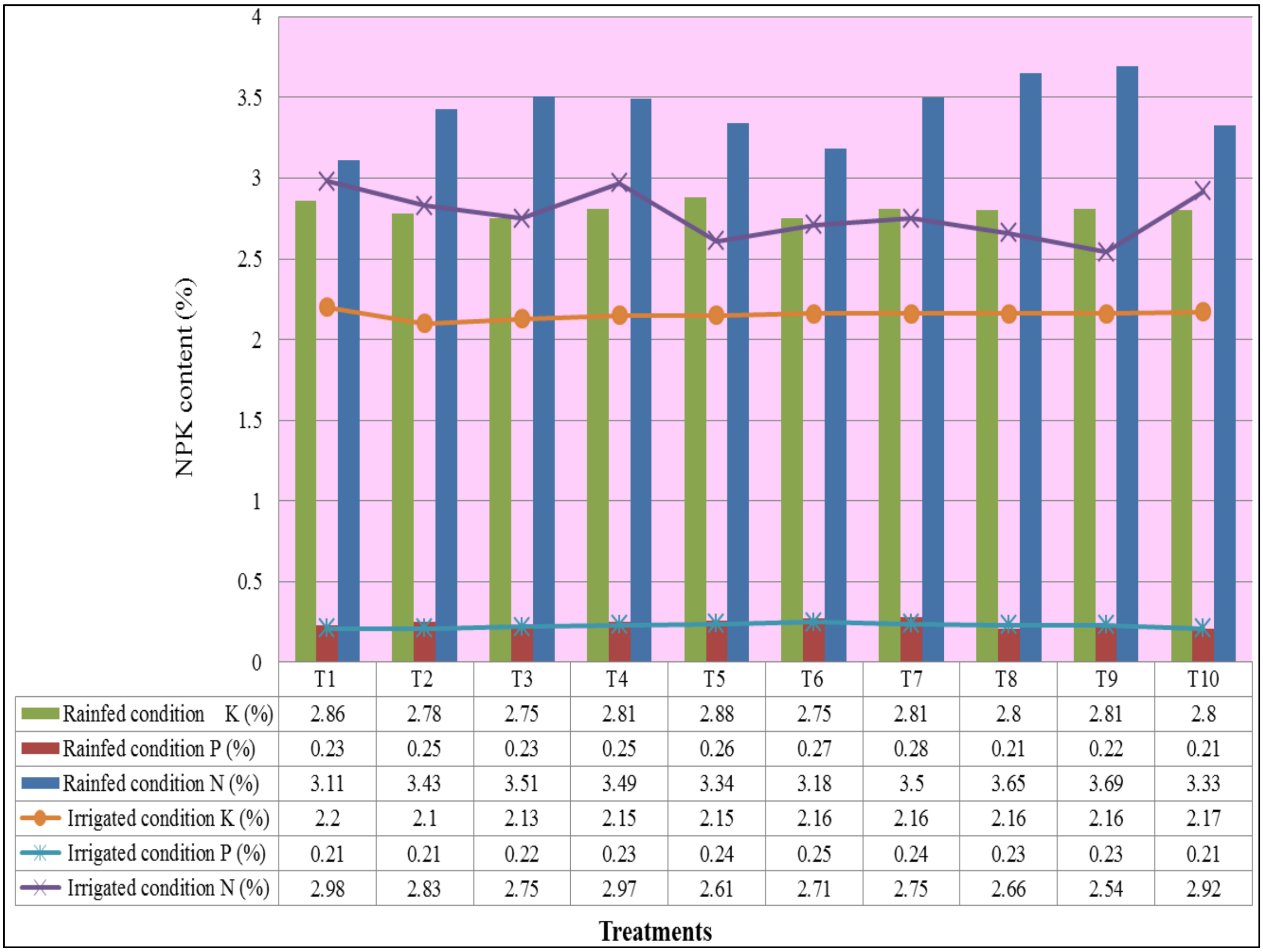

Fig 1: Influence of plant growth promoting rhizobacteria on NPK content in plants of *Clitorea ternatea* L

Table 1: Effect of plant growth promoting rhizobacteria on plant uptake of NPK (kg ha^{-1}) in *Clitorea ternatea* L

Treatments	Rainfed condition			Irrigated condition		
	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T_1 - RDF (control)	22.51	1.66	20.68	49.26	3.47	36.37
T_2 - RDF + *Bradyrhizobium japonicum*	28.13	2.05	22.80	51.53	3.82	38.24
T_3 - RDF + *Pseudomonas fluorescens*	27.12	1.78	21.23	47.47	3.80	36.76
T_4 - RDF + *Bradyrhizobium japonicum* + *Pseudomonas fluorescens*	31.17	2.24	25.12	54.74	4.24	39.62
T_5 - 75% RDF + *Bradyrhizobium japonicum*	25.41	1.98	21.89	43.64	4.01	35.95
T_6 - 75% RDF + *Pseudomonas fluorescens*	23.62	2.00	20.41	44.99	4.15	35.86
T_7 - 75% RDF + *Bradyrhizobium japonicum* + *Pseudomonas fluorescens*	26.71	2.14	21.44	46.64	4.07	36.63
T_8 - 50% RDF + *Bradyrhizobium japonicum*	25.77	1.48	19.77	42.51	3.68	34.52
T_9 - 50% RDF + *Pseudomonas fluorescens*	25.24	1.50	19.22	39.14	3.54	33.29
T_{10} - 50% RDF + *Bradyrhizobium japonicum* + *Pseudomonas fluorescens*	23.99	1.51	20.19	48.59	3.49	36.11
F test	*	*	*	*	*	*
S.Em±	0.88	0.07	0.64	1.66	0.14	1.21
CD at 5%	2.45	0.21	1.89	4.76	0.40	3.54

Conclusion

The present investigation reveals that, the seed treatment with *Bradyrhizobium japonicum* + *Pseudomonas fluorescens* and application of full dose of RDF has resulted in significantly found maximum NPK uptake in leaves of shankapushpi under both rainfed and irrigated conditions condition.

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