Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 7, Issue, 08, pp.19821-19825, August, 2015

ISSN: 0975-833X

RESEARCH ARTICLE

ROLE OF INDIGENOUS PGPR IN INTEGRATED NUTRIENT MANAGEMENT OF GROWTH AND DEVELOPMENT IN TEA NURSERY

***Princy, T., Raj Kumar, R., Radhakrishnan, B., Mareeswaran, J., Jayanthi, R. and Nepoloean, P.**

India

ARTICLE INFO

Article History:
Received 14th May, 2015
Received in revised form
03rd June, 2015
Accepted 15th July, 2015
Published online 31st August, 2015

Key words:
Tea,
INM,
Growth promotion,
Biofertilizers.

ABSTRACT

Plant Growth Promoting Rhizobacteria (PGPR) that colonize plant roots and promote plant growth and development. The plant growth is being enhanced by wide variety of mechanisms adapted by rhizobacteria. Hence the use of PGPR is steadily increasing in the field of agriculture. Six indigenous PGPR strains were isolated from tea soils and different environment and characterized for the enhancement of plant growth and to improve soil health. To investigate the growth inducing ability of PGPR in tea plants. A nursery trial was conducted using three popular clones namely CR-6017, UPASI-9 and graft CR-6017/UPASI-9. The plants were uprooted after 6 months of treatment implementation and studied their biometric parameters. During observation, the morphometric parameters *viz*., leaf count, shoot height, root length, biomass of shoot, root and secondary roots were monitored and found significantly higher in clones CR-6017 and Graft CR-6017/UPASI-9 treated with 50% NPK + VC + BF followed by 50% NPK+ BF. UPASI- 9 treated with either 50% NPK+ BF or 50% NPK + VC + BF registered significantly higher values of biometric parameters. While studying the NPK content in all three clones and graft combination, significantly higher nitrogen content was noticed in the plants treated with BF alone. In the case of phosphorous and potassium, higher values were recorded in the plants treated with 50% NPK + VC + BF. CR-6017 showed higher values of chlorophyll in BF alone treated plants, when Graft CR-6017/UPASI-9 and UPASI- 9 had recorded higher chlorophyll in 50% NPK+ BF. Integrated Nutrient Management practice by exploiting indigenous beneficial microorganisms with partial withdrawal of synthetic fertilizers will definitely provide sustainable yield and productivity in tea and the tea planters will be immensely benefited.

***Citation*:** Princy, T., Raj Kumar, R., Radhakrishnan, B., Mareeswaran, J., Jayanthi, R. and Nepoloean, P. 2015. Role of indigenous PGPR in integrated nutrient management of growth and development in tea nursery", *International Journal of Current Research*, 7, (8), 19821-19825.

INTRODUCTION

An inexpensive and popularly known beverage throughout the world is tea (*Camellia* sp.) Tea plantation requires relatively higher quantum of nutrients like N,P,K. Constant uptake of nutrients will leach in the soil and the residues that remain in plant or soil limits the crop productivity, these threats can fragile the soil ecosystem (Chadhuri, 2006). Soil fertility status depends on organic matter, macro and micro nutrients, and beneficial microorganisms (Jayathilake *et al*., 2006). Nitrogen is the major constituent that plays a vital role in plant physiology (Verma, 1997). Potassium and magnesium are involved in all biological reactions, so plant requires in large quantities (Verma, 1993, 1997). Deficiencies in potassium and magnesium are due to higher demands, precipitation and leaching.

But continuous use of these chemical fertilizers resulted in the decline of organic matter content of tea soil, leading to depletion of beneficial microorganisms. This can be overcome by reducing chemical fertilizers by underlying on integrated nutrient management (INM) strategy. In this regard, balanced chemical nutrients and biological source of nutrients is the way to secure good soil health and plant growth. These naturally occurring, PGPR bacterial species that can protect and promote plant growth are collectively termed as Plant Growth Promoting Rhizobacteria (PGPRs) (Mishra *et al*., 2005). PGPR and their interactions with plants are exploited commercially and hold great promise for sustainable agriculture (Podile and Kishore, 2006). Applications PGPR have been investigated in maize, wheat, oat, barley, peas, canola and cucumber (Gray and Smith, 2005). Even though the manmade fertilizers containing nitrogen, phosphorous and potassium increase the output and agricultural products but resulted in infertile soil health. Therefore, the strategy for improving soil health and yield is by

****corresponding Author: Princy, T.***
India.

supplementing organic manure and biofertilizers. Preparation and application of these rhizosphere organisms are cost effective, pollution free, a potential renewable source of plant nutrients and an excellent supplement for chemical fertilizers. This study was conducted to investigate the possibility of reducing inorganic fertilizer requirement by exploiting PGPR in nursery tea.

MATERIALS AND METHODS

Treatment details

Experiment was conducted using two popular clones namely, CR-6017, UPASI- 9 and their graft combination (CR-6017 and UPASI-9).Each treatment had four replicates and each replicate had 50 numbers of plants. Treatment details are as follows,

T1 - Recommended practice (100% NPK)
T2 - Bioinoculants alone (*Azospirillum,* PSB, KSB and AMF)
T3 - 50% N, P & K fertilizers + Vermicompost + Bioinoculants
T4 - 50% N, P & K fertilizers + Bioinoculants
T5 - Untreated control.

Preparation of composted coir pith based bioformulation of PGPR

Efficient and native biofertilizer strains *Azospirillum brasiliensis* (AB), *Azospirillum lipofereum* (CT8), *Pseudomonas fluorescence* (PF), *Pseudomonas putida* (PB), *Burkholderia cepacia* (KSB1), *Pseudomonas fluorescence* (KSB 2) of southern Indian tea ecosystem and phosphate mobilizer Arbuscular Mycorrhizae fungus (AMF) obtained from Cadila Pharmaceuticals Limited, Gujarat was used in the study. A loopfull of bacterial strains were inoculated separately into LB broth and incubated in a rotary shaker at 150 rpm for 72 h. The broth containing $7x10^9$cfu ml^{-1} was used for the preparation of formulation. Sterilized coirpith was mixed aseptically with culture broth at the ratio 1:2. The product was shade dried to reduce the moisture content below 20%. The formulation is now ready for the application.

Treatment design

Nursery sleeves of 200 gauge and 10 x 30 cm size were filled with soil and sand mixture (1:1) approximately 2 kg. Each before filling the soil into the sleeves, the soil pH (4.8) and EC (0.03) were adjusted to the optimum level. The bottom layer of the sleeve was filled with jungle soil-sand mixture and the top layer with red soil-sand mixture. Initial dose of bioinoculants (3 g each) was incorporated by mixing them with soil prior to filling the sleeves.

Nursery practice

Foliar application of nutrients (diammonium phosphate, $MgSO_4$ and muriate of potash) was applied as per the all treatments. Except the nutrient application, all other nursery practices/plant protection measures were followed uniformly.

NPK analysis

Finally plants were dried and finely ground for nutrient analysis; NP and K were quantified using the methods by Murphy and Riely (1962) Bray and Kurtz (1945), Bremner (1965) and Jackson (1962), respectively.

Observations

Biometric parameters and chlorophyll analysis were carried out after three months after treatment imposement. After six months the plants were uprooted and morphometric, biochemical and microbial parameters were studied. Morphometric parameters such as diameter of stem (mm), number of leaves, height of the shoot (cm), total biomass (fresh and dry weight of shoot and root) and number of secondary roots were documented adopting standard procedures. Total nitrogen, available phosphorous and potassium also estimated. Incorporated biofertilizers were enumerated by serial dilution method. Data were statistically tested using analysis of variances (ANNOVA) at probability level 0.05 (Gomez and Gomez, 1984).

RESULTS

Morphometric parameters

At the end of 10 months, CR-6017 plants were recorded higher values on leaf count (11.00), root length (32.08 cm), shoot height(30.5 cm), shoot (8.5 g) and root fresh (3.7 g) weight, shoot (1.9 g) and root dry (1.6 g) weight followed by the plants treated with 50% NPK +vermicompost+ bioinoculants followed by 50%NPK+ bioinoculants (Table 1). Higher root fresh weight (8.28 g) was scored on treatment 50% NPK + bioinoculants followed by 100 % NPK and 50% NPK + vermicompost+ bioinoculants. In general when compared to control that of all the treatment registered better results. UPASI-9 plants were recorded good results on treatment 50%NPK+vermicompost+ bioinoculants for shoot height(30.5 cm), root length (31.7 cm), root fresh weigh(4.1 g), shoot fresh (8.5 g) and shoot dry weight (2.0 g) (Table 2). Higher leaf count (13.00) and root dry (1.2 g) weight was recorded on treatment 50% NPK + bioinoculants followed by Bioinoculants alone and 50%NPK+vermicompost+ bioinoculants. Grafted plants were showed higher leaf count (8.00), root length (31.5cm) and shoot fresh weight (8.8 g) and dry weight (2.1 g) when treated with 50% NPK + vermicompost + bioinoculants. NPK 50% + bioinoculants treated plants were recorded higher shoot height (19.7 cm) followed by other treatments (Table 3). Root fresh (4.5 g) and dry weight (1.18 g) was higher on bioinoculants alone treated plants followed by recommended and 50% NPK + vermicompost + bioinoculants.

Nutrient status of shoot and root of nursery cuttings

Nutrient status of shoot and root collected from nursery grown plants treated with differents were documented. At the end of 10 months, it was observed that the shoot and root N, P and K of CR-6017was significantly higher in 50% NPK+ vermicompost + bioinoculants followed by 100% NPK and 50% NPK + bioinoculants (Table 4). UPASI – 9 plants were showed higher shoot NPK and root N content where the plants recorded 50% NPK + vermicompost + bioinoculants followed by 100% NPK and other treatments. However, root P and K content was higher in the treatment 50% NPK + bioinoculants followed by 100 NPK (Table 5).

Morphometric parameters

Table 1. Morphometric parameters of nursery growth CR-6017

S.No.	Treatment details	Leaf count (no)	Shoot height (cm)	Root length (cm)	Shoot fresh weight (g)	Root fresh weight(g)	Shoot dry weight (g)	Root dry weight (g)
1	Recommended practice (100% NPK)	7	20.5	29.7	5.8	2.5	1.2	0.3
2	Bioinoculants alone	8	26.4	24.9	7.3	2.4	1.4	0.4
3	50% NPK + Bioinoculants	8	22.3	32.6	5.8	3.7	1.5	0.8
4	50%NPK+Vermicompost + Bioinoculants	11	30.5	32.8	8.5	2.6	1.9	1.6
5	Control	8	18.5	29.1	4.8	1.6	1.1	0.3
CD 5% at P=0.05.		0.33	0.44	0.56	0.09	0.03	0.03	0.02

Table 2. Morphometric parameters of nursery growth UPASI- 9

S.No.	Treatment details	Leaf count (no)	Shoot height (cm)	Root length (cm)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)
1	Recommended practice (100% NPK)	11	28.4	27.5	7.0	2.7	1.5	0.7
2	Bioinoculants alone	10	29.3	29.8	7.5	3.5	1.7	1.0
3	50% NPK + Bioinoculants	13	29.8	30.8	7.3	3.9	1.7	1.2
4	50%NPK+Vermicompost + Bioinoculants	11	30.5	31.7	8.5	4.1	2.0	1.1
5	Control	8	28.2	24.3	7.0	2.3	1.0	0.7
CD 5% at P=0.05.		0.58	0.44	0.33	0.07	0.03	0.04	0.03

Table 3. Morphometric parameters of nursery growth graft CR- 6017/UPASI-9

S.No.	Treatment details	Leaf count (no)	Shoot height (cm)	Root length (cm)	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)
1	Recommended practice (100% NPK)	7	18.3	27.5	7.2	2.8	1.9	1.15
2	Bioinoculants alone	6	18.5	31.3	8.4	4.5	2.0	1.18
3	50% NPK + Bioinoculants	7	19.7	31.3	8.7	2.8	2.1	0.73
4	50%NPK+Vermicompost + Bioinoculants	8	18.6	31.5	8.8	3.8	2.1	1.02
5	Control	5	11.4	27.3	7.5	1.8	1.8	0.59
CD 5% at P=0.05.		0.17	0.16	0.28	0.18	0.03	0.04	0.09

Table 4. Nutrient status of shoot and root of CR-6017 clone

S.No	Treatment details	Shoot			Root		
		N	P	K	N	P	K
1	Recommended practice (100% NPK)	0.88	0.125	1.225	0.78	0.098	1.225
2	Bioinoculants alone	0.76	0.113	1.074	0.26	0.095	1.160
3	50% NPK + Bioinoculants	1.83	0.115	1.160	0.63	0.097	1.163
4	50%NPK+Vermicompost + Bioinoculants	1.86	0.145	1.264	1.09	0.107	1.264
5	Control	0.85	0.103	1.163	0.23	0.094	1.074
CD 5% at P=0.05.		0.01	0.057	0.029	0.029	0.040	0.029

Table 5. Nutrient status of shoot and root of UPASI – 9 clone

S.No	Treatment details	Shoot			Root		
		N	P	K	N	P	K
1	Recommended practice (100% NPK)	2.42	0.137	0.907	0.91	0.085	1.220
2	Bioinoculants alone	2.01	0.114	1.009	0.78	0.072	0.803
3	50% NPK + Bioinoculants	2.04	0.136	1.008	0.94	0.296	1.312
4	50%NPK+Vermicompost + Bioinoculants	2.43	0.155	1.214	1.20	0.116	1.106
5	Control	1.97	0.103	0.880	0.65	0.061	0.503
CD 5% at P=0.05.		0.03	0.032	0.008	0.010	0.040	0.010

Table 6. Nutrient status of shoot and root of graft

S.No	Treatment details	Shoot			Root		
		N	P	K	N	P	K
1	Recommended practice (100% NPK)	1.87	0.126	0.977	0.76	0.084	0.906
2	Bioinoculants alone	2.05	0.146	1.009	0.70	0.084	0.906
3	50% NPK + Bioinoculants	2.42	0.144	1.062	0.91	0.118	0.803
4	50%NPK+Vermicompost + Bioinoculants	2.20	0.139	1.112	0.73	0.091	0.956
5	Control	1.75	0.113	0.806	0.45	0.082	0.247
CD 5% at P=0.05.		0.04	0.041	0.020	0.001	0.040	0.001

Table 7. Microbial population in tea nursery soil – CR-6017

S.No	Treatment details	Total Bacteria 10^7	Total fungi 10^5	PSB 10^7	KSB 10^7	N2 fixers 10^6
1	Recommended practice (100% NPK)	3.40	1.1	1.20	nil	0.04
2	Bioinoculants alone	5.60	3.6	3.10	1.10	16.00
3	50% NPK + Bioinoculants	4.70	1.2	1.40	1.60	0.45
4	50%NPK+Vermicompost + Bioinoculants	4.90	2.10	2.10	1.80	9.20
5	Control	3.30	1.1	1.10	0.45	nil

Table 8. Microbial population in tea nursery soil – graft

S.No	Treatment details	Total Bacteria 10^7	Total fungi 10^5	PSB10^7	KSB 10^7	N2 fixers10^6
1	Recommended practice (100% NPK)	2.2	1.1	1.19	1.2	0.16
2	Bioinoculants alone	8.2	8.3	4.7	2.4	19
3	50% NPK + Bioinoculants	4.7	3.6	3.5	1.8	0.53
4	50%NPK+Vermicompost + Bioinoculants	5.6	1.2	1.2	2.5	1.75
5	Control	1.2	1.2	0.1	1.0	0.08

Table 9. Microbial population in tea nursery soil – UPASI- 9

S.No	Treatment details	Total Bacteria 10^7	Total fungi 10^5	PSB 10^7	KSB 10^7	N2 fixers 10^6
1	Recommended practice (100% NPK)	5.2	4.3	0.2	0.4	0.16
2	Bioinoculants alone	12.4	4.6	5.7	3.2	19
3	50% NPK + Bioinoculants	14.7	4.8	3.5	8.8	0.53
4	50%NPK+Vermicompost + Bioinoculants	8.5	5.2	5.1	2.5	19
5	Control	1.2	1.2	0.2	1 .1	0.08

The Grafted plants were treated with 50% NPK + bioinoculants showed higher shoot and root nitrogen, root phosphorus followed by 100% NPK and 50% NPK + vermicompost + bioinoculants. Shoot and root potassium contents were significantly higher on treatment 50% NPK + vermicompost + bioinoculants than 50% NPK + bioinoculants and 100% NPK (Table 6). However, shoot phosphorus content was high on the plants treated with bioinoculants alone followed by other treatments.

Microbial population in tea nursery soil

Significant improvement was observed in soil fertility due to imposition of different bioinoculants and chemical fertilizers (Table 7 to 9). The availability of soil N, P, K, in the tea nursery was increased due to combined application of inorganic and bioinoculants. The bioinoculants alone treated soil resulted higher population of total bacteria, fungi, PSB and KSB followed by 50% NPK + Bioinoculants. Population of KSB resulted on treatment 50% NPK + Bioinoculants followed by bioinoculants alone (Table 9). In the case of CR6017 clone and graft treated with 50%NPK+vermicompost + bioinoculants resulted higher population level of KSB (Table 7 & 8).

DISCUSSION

The present study investigated the response of tea crop at two clone (CR6017, UPASI-9 and graft combination of CR-6017/UPASI-9) on growth parameters morphobiometric, nutrientstatus and microbial population in soil against various doses and/or combinations of inorganic fertilizers and organic manures incorporated with bioinoculants so as to achieve maximum results have noticed different treatment. These results are in line with the findings of several workers (Vikram, 2001 and Afzal *et al.,* 2005). It has been supported that, it might be helped to improve and increasing various growth parameters (Ramanandan *et al*., 2008). Finely ground, dried shoot and root samples collected from nursery grown plants. The experimental results showed that, UPASI-9 and CR-6017 clones were observed that the shoot and root N, P and K was significantly improved. Combination of organic fertilizers and biofertilizers were showed good results. Jayathilake *et al*., (2006) indicated that integrated nutrient management with biofertilizer (*Azotobacter* and *Azospirillum*) in combination with 50% inorganic N through organic manure (VC or FYM) and rest of the N, P and K through chemical fertilizer was considered most useful for obtaining maximum yield with higher fertility status in soil for onion cultivation. Reports of Ranganathan and Natesan (1985) explained that N and potassium are required for the sustained yield of tea crop. Verma (1997) also suggested that NK is mostly recommended for tea. Many researchers reported higher potassium application resulted in improved plant health and lesser disease incidence (Goodman *et al.,* 1967; Stack *et al*., 1986; Sinha,1998). Naturally soil containing more bacterial and fungal population, the present findings revealed that (T-2) bioinoculants alone recorded higher rate of total bacteria and fungi, followed by (T-3) 50% NPK + bioinoculants. These could be due to rapid multiplication of bacteria applied through seedling root dip and soil application in preferable medium of organic manure, particularly vermicompost. In addition, vermicompost is inherently rich in microflora such as *Azotobacter, Azospirillium* and actinomycetes Jambelkhar, (1994). Kalyani *et al.* (1996) studied the interaction of *Azospirillum* and fertilizer nitrogen on cauliflower. Integrated nutrient management could be helpful to reduced chemical fertilizers and increased biofertilizers levels for improved young tea growth and development and ecofriendly manual system.

Acknowledgement

The authers are grateful to Dr.B.Radhakrishnan, Director and UPASI Tea Research Foundation for facilities and encouragements. The financial assistance provided by NTRF-Funded Project Govt. of India. Kolkotta.

REFERENCES

Afzal, A., M. Ashraf, S.A. Asad and M. Farooq, 2005. Effect of phosphate solubilizing microorganisms on phosphorus uptake, yield and yield traits of wheat (*Triticum aestivum* L.) in rainfed area. *Int. J. Agric. Biol.,* 7: 207–209.

Bray.R.H and Kurtz,L.T.1945.Determination of total organic and available form of phosphorus in soil.*Soil Sci*.59:39-45

Bremner,J.M.1965.Total nitrogen.In:*Methods of Soil Analysis*.Part 2.pp.1149-1178(ed) C.A.Black.American Society of Agronomy, Madison,WI.

Chadhuri, S.2006. Brain storming meeting on biological nutrient management in plantation and other cash crops organized by Department of Biotechnology, Govt of India, New Delhi on 10th August. at Kerala forest research institute, Peechi, Trichur, Kerala 680 653.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research. John Wiley and sons, Inc. London, UK (2nd edtn) 13-175.

Goodman, R.N., Kirlay. Z. and Zatlin, M. 1967. The Biochemistry and Physiology of Infectious Plant Diseases. Van Nosrand co., London. 354 p.

Grey EJ and Smith DL (2005) Intracellular and extracellular PGPR: Commonalities and distinctions in the plant-bacterium signaling processes. Soil Biol. Biochem 37:395-412.

Jambelkhar, H., 1994. Bio organic farming, paper presented in the seminar on Development of Agriculture in Andhra Pradesh held on 4th –5th September of Hyderabad, pp. 1-6.

Jayathilake, P.K.S., Reddy, I.P., Srihari, D. and Reddy, K.R. 2006. Productivity and soil fertility status as influenced by integrated use of N-fixing biofertilizers, organic manures and inorganic fertilizers in onion. *J. of Agricultural Sciences* 2 (1): 46-58.

Kalyani, D. P., Ravishankar, C. and Manohar, P. D., 1996. Studies on the effect of nitrogen and *Azospirillum* on growth and yield of cauliflower. *S. Indian Hortic.,* 44 (5&6) : 147-149.

Mishra, A. K., Dutta, S. and Dileep Kumar, B. S., 2005, Effect of fluorescent Pseudomonads strains on crop enhancement and suppression of root diseases of tea. *Proc. Asian Conf. on Emerging Trends in Pl. Microbe Interactions*, Ed. S.S. Gnanamanickam, R. Balasubramanian and N. Anand, Dec. 08-10, Chennai, pp. 26-30.

Murphy,J and Riley,J.L1962.A modified single solution method for determination of phosphate in natural waters. *Anal,Chem.Acta*., 27:31-36.

Podile AR and Kishore GK (2006) Plant Growth Promoting Rhizobacteria. In: SS (ed) Plant – Associated Bacteria. Springer, Netherlands, pp 195-230.

Ramanandan, G. Ravisankar, C. and Srihari, D. 2008. Integrated Nutrient Management for Cassava Under Rainfed Conditions of Andhra Pradesh. *J. of Root Crops*, 34 (2): 129-136.

Ranganathan, V. and Natesan, S. 1985. Pottassium nutrition of tea. In: *Pottassium in Agriculture. Munsoon,R.D.(ed).* American Society of Agronomy, Madison, Wisconsin, USA. pp. 981-1022.

Sinha, A.P. 1998. Effect of potash and nitrogenous fertilizers on brown rust of wheat. *Indian Phytopath*. 51: 100-101.

Stack, R.W., Herst, R.W. 1986. Effects of nitrogen and potassium fertilization on infection of florist's carnations by *Gibberlla zeae*. *Plant Dis.*70:29-31.

Verma D. P., 1993. Fertilizer management in tea. In: H.L.S. Tandon (ed.). Fertilizer Management in Commercial Crops. FDCO. Pp 148-175

Verma D. P., 1997. Balanced fertilization for sustainable productivity of tea. Fertilizer News. 42(4):113-125.

Vikram. A, 2001. Studies on mineral phosphate solubilizing bacteria in the vertisols of Northern Karnataka. *Ph. D. Thesis*, Univ. Agric. Sci. Dharwad (India).

****