The Bioscan 10(4): 1505-1508, 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF BIOSTIMULANT (*NOVOBAC*) ON ROOT CHARACTER SOF CHILLLI (*CAPSICUM ANNUUM L.*)

S. JIDHU VAISHNAVI*, P. JEYAKUMAR AND C. N. CHANDRASEKHAR
Department of Crop Physiology,
Tamil Nadu Agricultural Unversity, Coimbatore, Tamil Nadu, India - 641 003
e-mail: sjvaishnavi@gmail.com

KEYWORDS
Bacillus
Biostimulant
Chilli
NovoBac
Rhizosphere
Root

Received on :
29.07.2015

Accepted on :
20.10.2015

***Corresponding author**

ABSTRACT
The increasing use of chemicals from the stage of germination to harvest of the crop affects the soil condition and productivity of crops. This can be reduced by the application of microorganisms which act as biocontrol agents for pest and disease as well as biostimulants. Combination of several beneficial microorganisms when applied as seed treatments and soil drenching has profound effect on root characters of chilli. It was observed that seed treatment with*NovoBac*@ 2g/kg + soil drenching @ 500 g/ha improved*viz*.,root characters like root length, root volume, root dry weight, root shoot ratio and also transplanting survival rate of chilli.

INTRODUCTION

Chilli is a fascinating crop, grown for vegetables, spices, condiments, sauces and pickles. It is known for the pleasant aromatic flavor, pungency and high colouring substance. Both green and dry chillies are produced all over the world.India is the world leader in chilli production (43%) followed by China and Pakistan. India produced 1.4MT of dry chilli from an area of 0.77 million hectares during 2013-14. Andhra Pradesh stands first in the list of chilli-producing states in India. It alone commands 57.80 per cent of the total production in India, with a production of around 0.76MT of chillies. India stands first in chilli cultivation in the world, but its productivity is very low (0.9 tonnes/ hectare) as compared to the world average (2 tonnes/ hectare). Although, the crop has got great export potential besides huge domestic requirement, a number of limiting factors have been attributed for low productivity. Increasing use of chemical inputs causes several negative effects, *i.e.,* development of pathogen resistance to the applied agents and their non-target environmental impacts (Gerhardson, 2002). A growing awareness that agricultural practices have a great impact on human health and on the environment has spawned research into the development of effective bio-control agents to protect crop plants against diseases. Biostimulants contain neither fertilizer nor pesticide, but possess biologically active substance which when applied to a plant will enhance the health and growth of the plant and are often used as supplements in present agricultural practices in crop production. A biostimulant may increase metabolism, increase chlorophyll efficiency and production, increase antioxidant production, enhance nutrient availability, speed up germination and cell development, or increase the water holding capacity of plant cells, or even the soil.

Novo Bac is a new biostimulant promoted by Novozymes South Asia, Bangalore. It is a natural, soluble, beneficial microbial formulation. The composition of *NovoBac* includes the microorganisms amounting to a minimum of 8.5 x 10^9cfu/ g (*Bacillus licheniformis*- 2.50 x 10^9 cfu/g, *Bacillus amyloliquefaciens*- 2.00 x 10^9 cfu/g, *Bacillus pasteurii*- 0.90 x 10^9 cfu/g, *Bacillus laevolacticus*-2.10 x 10^9 cfu/g and *Bacillus subtilis*- 1.00 x 10^9 cfu/g).It can be applied as seed treatment, soil drenching and drip or direct to soil media and also as fertilizer. *NovoBak* improves root development and transplanting survival rate of crop. With this background, the present investigation was carried out to find out the effect of biostimulant (*NovoBac*) as seed treatment, drenching and their combination on root characters of chilli.

MATERIALS AND METHODS

The experiment was conducted in Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore during the period of November 2010 to May 2011. In this experiment, the biostimulant (*NovoBac*) was given as seed treatment or as soil drenching or in combination tochilli (TNAU chilli hybrid Co1) and observations were recorded from 30 days after transplanting (DAT) till 150 DAT.The experiment had 3 replications and 10 treatments including T_1-Control, T_2-*Trichoderma viride* seed treatment @ 4 g/kg , T_3-*NovoBac* Seed treatment @ 1 g/kg, T_4-*Novo Bac* Seed treatment @ 2 g/

kg, T_5-*NovoBac* Soil drenching @ 250 g/ha on 15 DAT, T_6-*NovoBac* Soil drenching @ 500 g/ha on 15 DAT, T_7-*NovoBac* Seed treatment @ 1 g/kg + Soil drenching @ 250 g/ha on 15 DAT, T_8-*NovoBac* Seed treatment @ 2 g/kg + Soil drenching @ 250 g/ha on 15 DAT, T_9-*NovoBac* Seed treatment @ 1 g/kg + Soil drenching @ 500 g/ha on 15 DAT and T_{10}-*NovoBac* Seed treatment @ 2 g/kg + Soil drenching @ 500 g/ha on 15 DAT. Observations including root length (cm plant^{-1}), root weight (g plant^{-1}), root volume (cc plant^{-1}), root shot ratio and transplanting survival rate were observed at 30DAT, 60 DAT, 90 DAT, 120 DAT and 150 DAT. Seedlings survived after transplanting were counted and compared with number of plants transplanted and expressed in percentage. The data collected were subjected to statistical analysis in randomized block design following the method of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Root length

The root is a site of contention among many microorganisms, where the inoculation of beneficial rhizobacteria can reduce or eliminate the action of pathogens through competition, release of antibiotics or stimulation of defense mechanisms in plants. It has been shown that plants with larger root system and stem diameter are less susceptible to environmental stress after transplanting. Similarly *NovoBac* seed treatment + soil drenching of *NovoBac* showed maximum increase of root length (22.22cm) than control (18.42cm) on 150DAT (Table 1). An increase in root length from 30 DAT to 150 DAT was observed and the mean values on root length in different stages of crop growth ranged between 11.50 and 20.61cm. Among the treatments, T_{10}, T_8 and T_9 showed a significant increase in root length at all stages of plant development. Other treatments showed lesser influence on root length when compared to T_{10}. The effect of the *Bacillus* sp. on enhancing root growth by solubilizing phosphorus and making it available to the rhizosphere increased the root biomass and its ability to absorb nutrients and hence, increased plant growth. PGPR indirectly stimulates root growth by controlling ACC levels or block ethylene biosynthesis in plants. Similar results have been observed by Sundaramoorthy *et al.* (2012) in chilli.

Root weight

Biostimulant (*NovoBac*) as seed treatment @ 2g/kg + soil drenching @ 500 g ha^{-1} increased root weight significantly when compared with control (Table 2). The increase in root weight could be observed as significant with plant development. The root weight ranged between 11.52g in control on 30 DAT and 38.39g in T_{10} on 150 DAT. At all the stages, significant treatmental variation could be seen in T_{10}, T_8 and T_9. However, the control plants recorded the lowest root weight compared to all other treatments.PGPR colonize plant roots and exert beneficial effects on plant growth and development by a wide variety of mechanisms. PGPR is mainly involved in the IAA production and has the ability to solubilize phosphorous. Thus, helps in improving plant growth by higher

Table 1: Effect of biostimulant (*NovoBac*) on root length (cm plant^{-1}) at different growth stages of chilli

Treatment	30DAT	60DAT	90DAT	120DAT	150DAT
T_1 : Control	9.81	12.22	15.42	17.69	18.42
T_2 : *Trichoderma viride* seed treatment @ 4g/kg	11.27	13.35	16.86	19.68	20.82
T_3 :*NovoBac* seed treatment @ 1g/kg	10.97	13.05	16.56	19.08	20.24
T_4 :*NovoBac*seed treatment @ 2g/kg	11.02	13.76	16.65	19.38	20.55
T_5 :*NovoBac*soil drenching @ 250g/ha on 15 DAT	10.39	12.48	15.98	18.23	19.33
T_6 :*NovoBac* soil drenching @ 500g/ha on 15 DAT	10.67	12.75	16.26	18.80	19.93
T_7 :*NovoBac* seed treatment @ 1g/kg + soil drenching @ 250g/ha on 15 DAT	12.12	14.20	17.71	20.53	21.17
T_8 :*NovoBac* seed treatment @ 2g/kg + soil drenching @ 250g/ha on 15 DAT	12.69	14.99	18.14	21.31	21.83
T_9 :*NovoBac*seed treatment @ 1g/kg + soil drenching @ 500g/ha on 15 DAT	12.52	14.60	17.95	20.86	21.55
T_{10} :*NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT	13.58	15.23	18.51	21.94	22.22
Mean	11.50	13.66	17.00	19.75	20.61
SEd	0.05	0.05	0.04	0.06	0.05
CD (p = 0.05)	0.11	0.10	0.10	0.13	0.11

Table 2: Effect of biostimulant (*NovoBac*) on root weight (g plant^{-1}) at different growth stages of chilli

Treatment	30DAT	60DAT	90DAT	120DAT	150DAT
T_1 : Control	11.52	15.18	21.05	24.37	28.74
T_2 : Trichoderma viride seed treatment @ 4g/kg	16.11	19.77	26.24	30.49	32.98
T_3 :NovoBac seed treatment @ 1g/kg	14.19	17.85	24.72	29.18	30.89
T_4 :NovoBacseed treatment @ 2g/kg	15.14	18.80	25.67	29.94	32.21
T_5 :NovoBacsoil drenching @ 250g/ha on 15 DAT	12.88	16.54	23.41	27.67	29.95
T_6 :NovoBac soil drenching @ 500g/ha on 15 DAT	13.33	16.99	23.86	28.31	30.24
T_7 :NovoBac seed treatment @ 1g/kg + soil drenching @ 250g/ha on 15 DAT	16.23	19.89	28.89	32.49	33.27
T_8 :NovoBac seed treatment @ 2g/kg + soil drenching @ 250g/ha on 15 DAT	19.44	23.10	31.86	35.42	36.35
T_9 :NovoBacseed treatment @ 1g/kg + soil drenching @ 500g/ha on 15 DAT	16.34	20.00	30.09	34.54	33.42
T_{10} :NovoBac seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT	21.31	24.97	32.16	36.19	38.36
Mean	15.64	19.31	26.83	30.56	32.64
SEd	1.75	2.13	2.93	3.28	3.53
CD (p = 0.05)	3.67	4.47	6.16	6.91	7.43

Table 3: Effect of biostimulant (*NovoBac*) on root volume (cc plant^{-1}) at different growth stages of chilli

Treatment	30DAT	60DAT	90DAT	120DAT	150DAT
T_1 : Control	20.36	26.82	29.46	39.18	40.79
T_2 : *Trichoderma viride* seed treatment @ 4g/kg	28.47	34.94	47.08	57.29	58.28
T_3 :*NovoBac* seed treatment @ 1g/kg	25.07	31.54	43.69	53.90	54.59
T_4 :*NovoBac*seed treatment @ 2g/kg	26.75	33.22	45.36	55.58	56.92
T_5 :*NovoBac*soil drenching @ 250g/ha on 15 DAT	22.76	29.23	41.37	51.58	52.93
T_6 :*NovoBac* soil drenching @ 500g/ha on 15 DAT	23.56	30.02	42.16	52.38	53.44
T_7 :*NovoBac* seed treatment @ 1g/kg + soil drenching @ 250g/ha on 15 DAT	28.68	35.15	47.29	57.51	58.80
T_8 :*NovoBac* seed treatment @ 2g/kg + soil drenching @ 250g/ha on 15 DAT	34.36	40.82	52.96	63.18	64.24
T_9 :*NovoBac*seed treatment @ 1g/kg + soil drenching @ 500g/ha on 15 DAT	28.88	35.34	47.48	57.71	59.06
T_{10} :*NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT	37.66	44.13	56.27	66.48	67.79
Mean	27.65	34.12	46.26	55.48	56.68
SEd	3.08	3.76	5.04	6.13	6.13
CD (P:0.05)	6.48	7.91	10.63	12.87	12.88

Table 4: Effect of biostimulant (*NovoBac*) on root-shoot ratio at different growth stages of chilli

Treatment	30DAT	60DAT	90DAT	120DAT	150DAT
T_1 : Control	0.102	0.204	0.296	0.363	0.456
T_2 : *Trichoderma viride* seed treatment @ 4g/kg	0.197	0.340	0.432	0.492	0.585
T_3 :*NovoBac* seed treatment @ 1g/kg	0.167	0.335	0.425	0.499	0.592
T_4 :*NovoBac*seed treatment @ 2g/kg	0.178	0.336	0.428	0.495	0.588
T_5 :*NovoBac*soil drenching @ 250g/ha on 15 DAT	0.145	0.325	0.418	0.484	0.578
T_6 :*NovoBac* soil drenching @ 500g/ha on 15 DAT	0.158	0.333	0.427	0.494	0.587
T_7 :*NovoBac* seed treatment @ 1g/kg + soil drenching @ 250g/ha on 15 DAT	0.203	0.374	0.467	0.533	0.627
T_8 :*NovoBac* seed treatment @ 2g/kg + soil drenching @ 250g/ha on 15 DAT	0.237	0.396	0.489	0.555	0.649
T_9 :*NovoBac*seed treatment @ 1g/kg + soil drenching @ 500g/ha on 15 DAT	0.219	0.382	0.474	0.541	0.634
T_{10} :*NovoBac* seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT	0.241	0.397	0.490	0.556	0.650
Mean	0.185	0.344	0.435	0.502	0.595
SEd	0.002	0.003	0.003	0.002	0.002
CD (P:0.05)	0.004	0.006	0.006	0.005	0.005

nutrient uptake from the soil, phytohormones and increased root weight as reported by Meenakshi*et al.*(2010) in chick pea.

Root volume

The time trend of growth in terms of root volume shows a rapid increase till 90 DAT and then a marginal increase could be observed. The root volume of the plant that received *NovoBac*seed treatment @ 2g/kg + soil drenching @ 500 g/ha increased significantly than that of control (Table 3). Presence of *Bacillus* enhances the nutrient uptake which could increase the root length, weight and thereby increasing the root volume and overall growth of the plant and also favouring increased water absorption efficiency. The increase in root volume was observed by Del *et al.* (2008) in chilli. Microbial sideropho resproduced by *Bacillus* enhance plant growth directly by increasing the availability of iron in the soil surrounding the roots. Similar result was observed by Bombiti *et al.* (2011) in tomato and Patel *et al.* (2014) in chilli.

Root-shoot ratio: An increase in root-shoot ratio with increase in number of days could be observed. The effect of biostimulant (*NovoBac*) as seed treatment @ 2g/kg + soil drenching @ 500g/ha on 15 DAT increased the root-shoot ratio significantly when compared with control plants (Table 4). *Trichoderma viride*seed treatment @ 4g/kg also influenced the root-shoot ratio. Comparing the root-shoot ratio of control and inoculated ones with *Bacillus subtilis*, inoculated tef grass shows maximum root shoot ratio (Delelegen and Fassil, 2011).

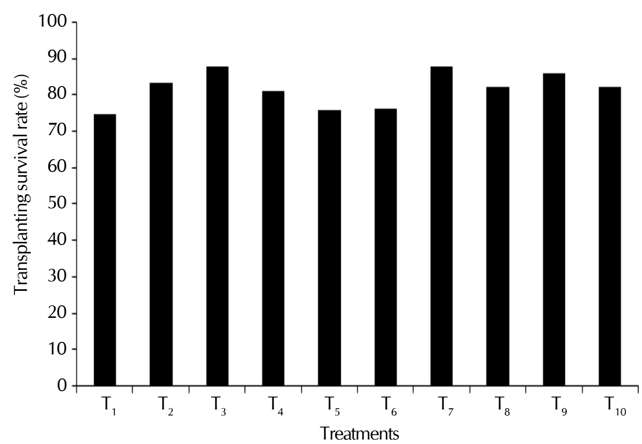

Figure 1: Effect of biostimulant (*NovoBac*) on transplanting survival rate (%) at different growth stages of chilli

The higher root-shoot ratio is a clear indication of root development. Chanway *et al.* (1991) reported that PGPR strains are useful as nursery inoculants for producing seedling with higher root shoot ratio in conifers.The increase in plant growth may be due to increased nutrient availability through a mechanism such as phosphate solubilization as seedlings received supplemental nutrients in a ready available form. Phosphate solubilization is mainly by production of organic acids and chelating acids from sugars of *Bacillus* sp. (Bhattacharya *et al.,* 2014).

Transplanting survival rate

The biostimulant (*NovoBac*) given as seed treatment @ 2g/kg + soil drenching @ 500g/ha increased transplanting survival rate by 26 per cent when compared to control (Fig. 3). The lowest value was observed in control (74.68) and the treatments, T_1 (74.68), T_5 (75.77)and T_6 (76.32) are on par with each other (Fig. 1). The length of time for resumption of rapid growth depends on environmental conditions but is also an inherited feature of each crop. Kokalis *et al.* (2006) observed that the concept of introducing PGPR into the rhizosphere using transplant plug is based on their establishment in the planting media and offer them an opportunity to develop stable populations in the seedling rhizosphere, and that these populations would then persist in the field. It is well recognized that PGPR can positively influence plant growth and resistance to pathogens (Cleyet-Marcel *et al.,* 2001). Similar results were obtained by Sivasakthi*et al.* (2014) in PGPR on transplanted vegetables

REFERENCES

Bhattacharyya, S. K., Sengupta, C., Adhikary, N. K. and Tarafdar, J. 2014. *Bacillus amyloliquefaciens*– A Novel PGPR strain isolated from jute based cropping system. *The Bioscan.* **9(3):** 1263-1268.

BombitiNzanza, Diana Marais and Puffy Soundy. 2011. Tomato (*Solanum lycopersicum*L.) seedling growth and development as influenced by *Trichoderma harzianum*and arbuscular mycorrhizal fungi. *African J. Microbiol. Res.* **5(4):** 425-431.

Chanway, C. P., Radley, R. A. and Holl, F. B. 1991. Innoculation of conifer seed with plant growth promoting *Bacillus* strains causes increased seedling emergence and biomass. *Soil Biol. Biochem.* **23(6):** 575-580.

Cleyet-Marcel, J. C., Larcher, M., Bertrand, H., Rapior, S. and Pinochet, X. 2001. Plant growth enhancement by Rhizobacteria. **In:** Nitrogen assimilation by plants - Physiological, Biochemical and Molecular aspects, Ed J-F Morot-Gaudry. *Science Publishers*, Inc., Enfield. pp. 185-197.

Del Amor, F. M., Serrano-Martý´nez, A., Fortea, I. and Nu´ n˜ez-Delicado, E. 2008a. Differential effect of organic cultivation on the levels of phenolics, peroxidase and capsidiol in sweet peppers. *J. Sci. Food Agric.* **88:** 770-777.

Delelegen Woyessa and Fassil, A. 2011. Effect of plant growth promoting rhizobacteria on growth and yield of Tef (*Erogrostistef*zucc. Trotter) under green house condition. *Microbiologia.* **11:** 121-124.

ErtanYildirim, Metinturan and Mesudefigendonmez 2008. Mitigation of salt stress in radish (*RaphanusSativus*l.) by plant growth promoting rhizobacteria. *Roumanian Biotech. Letters.* **13(5):** 3933-3943.

Gerhardson, B. 2002. Biological substitutes for pesticides.*Trends in Biotech.* **20:** 338-343.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedures for agricultural research. An IRRI book, Wiley Interscience Publication. *J. Wile and Sons*, New York, USA. p. 680.

Meenakshi Mishra, Umesh Kumar, Pankaj Kishor Mishra and Veeru, P. 2010. Efficiency of plant growth promoting *Rhizobacteria*for the enhancement of *Cicer arietinum* L. Growth and germination under Salimity. *Advances in Biol. Res.* **4(2):** 92-96.

Patel, M. D., Lal, A. A. and Singh, P. P. 2014. Efficacy of certain bio agentas and fungicides against root rot of chilli (*Capsicum Annum* L.). *The Bioscan*. **9(3):** 1273-1277.

Sivasakthi, S., Usharani, G. and Saranraj, P. 2014. Biocontrol potentiality of plant growth promoting bacteria (PGPR)-*Pseudomonas fluorescens*and *Bacillus subtillis*: *A review. African J. Agri. Res.* **9(16):** 1265-1277.

Sundaramoorthy, S., Raguchander, T., Ragupathi, N. and Samiyappan, R. 2012. Combinatorial effect of endophytic and plant growth promoting rhizobacteria against wilt disease of Capsicum annum L. caused by *Fusarium solani*. *Biological Control.* **60:** 59-67.