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Effect of Bioinoculants on morphological characters and yield of French bean

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ABSTRACT: *The aim of the study is to assess the effect of bioinoculants viz., Rhizobium, TagTeam, CellTech on morphological characters like shoot length, root length, RS ratio, number of nodules, TDMA and yield of French bean. Among the different treatments, seed treatment with TagTeam @ 8.1g/kg excelled all other treatments in shoot length, RS ratio, TDMA and number of nodules of French bean. In root length, CellTech @ 2.8ml/kg was found to be significantly influenced over all other treatments followed by Rhizobium @ 60g/kg and TagTeam @ 8.1g/kg. The vegetable pod yield of French bean was found higher in seed treatment with TagTeam @ 8.1g/kg significantly influenced over control with 13.36% increase over control.*

Keywords: *Cowpea, Rhizobium, Penicillium, TagTeam, CellTech*

INTRODUCTION

French bean, leguminous plant is one of the important sources of protein rich staple food for population in hilly region. Beans are cultivated in an area of 1.38 lakh ha with the production around 13.7 lakh MT. The productivity of French bean is very low due to the suppression of microorganism's effect on plants by heavy application of fertilizers in the soil which causes toxic effect. French bean has the advantage of fixing atmospheric nitrogen through symbiosis with *Rhizobium* through its root nodules. This attribute ensures that, it will enhance yield in an era of increasing food demand and concern for sustainable agricultural production system.

TagTeam is a multiaction legume fertility inoculant, a combination of the naturally occurring soil fungus *Penicillium bilaii* and the bacterial strain *Rhizobium leguminosarum*. It makes better use of phosphate and provides more fixed nitrogen to the plant. The fungus, *Penicillium* forms a symbiotic relationship with plant roots that makes more phosphate available to the plants, while *Rhizobium* provides better nodule development for more nitrogen fixation. *Cell-Tech* contains *Rhizobium leguminosarum* which works in symbiotic relationship with the plant to fix nitrogen. The improvement in the plant nodule number improves the growth and development of French bean. The aim of the present study was to assess the effect of *TagTeam*, a bioinoculant, on morphological, physiological characters and yield in French bean.

MATERIALS AND METHODS

The field experiment was conducted in French bean (var. AFA 10) at Kothagiri district of Tamil Nadu during winter season with four replications in Randomized Block Design using *Rhizobium*, *TagTeam* and *CellTech* as treatments. The treatments include T_1- control, T_2- *Rhizobium* @ 30g/kg, T_3- *TagTeam* @ 2.7g/kg, T_4- *TagTeam* @ 5.4g/kg, T_5- *TagTeam* @ 8.1g/kg, T_6- *TagTeam* @ 10.8g/kg and T_7- *CellTech* @ 2.8ml/kg.

Morphological observations like plant height (cm plant^{-1}), root length (cm plant^{-1}), root shoot ratio and total dry matter accumulation (g plant^{-1}) were recorded in five plants per replication and the observation were taken during maturity stage of French bean. Number of nodules was observed during vegetative stage of French bean.Vegetable pod yield of French bean was calculated and expressed in tonnes ha^{-1}.The data collected were subjected to statistical analysis in randomized block design following the method of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Shoot length: Shoot length plays a major role in growth and development of a plant. Seed treatment

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with bioinoculants like *Rhizobium, TagTeam* and *CellTech* showed a significant influence on shoot length of French bean. In French bean, maximum shoot length was observed in T_5 (45.18cm plant^{-1}) which was on par with T_2 (44.69cm plant^{-1}) and the minimum shoot length was observed in control (38.16cm plant^{-1}). *Rhizobium* in *TagTeam* plays a major role in synthesis of plant growth promoting hormones like auxin, cytokinin and gibberellin (Madhavan *et al.,* 2012). These growth promoting substances improved the shoot length in French bean. Plant growth promoting fungi (PGPF) improve plant growth indirectly by altering the structure of soil rhizosphere, producing certain metabolites and providing nutrients to plants (Murali *et al.,* 2012). The increase in shoot length may also be attributed to increase in cell division, elongation and the improvement in metabolite activity due to enhanced phosphorous uptake by *P. bilaii* and nitrogen uptake by *Rhizobium* leads to increased vegetative growth of plant.

Root length: Seed treatment with *Rhizobium*, *TagTeam* and *Cell*-Tech has direct impact on root characters of French bean. The maximum length of root was observed in T_7 (18.57 cm) followed by T_2 (18.37 cm) and the minimum root length was found in control (15.68 cm). The root development was due to the production of auxin and mineralization of nutrients by PGPR (Steenhoudt and Vanderleyden, 2000). The colonization of *Rhizobium* helps in hormonal synthesis which has direct role in root development with lateral root formation (Bhattacharyya and Pati, 2000). Thus increase in root length was observed in inoculated plants when compared to uninoculated plants (Sharma and Gour, 2011).

Root shoot ratio: Root shoot ratio of leguminous plants is a balance between nitrogen productivity and photosynthesis. The highest root shoot ratio was observed in *TagTeam* @ 8.1g/kg (0.479) followed by *Rhizobium* @ 60g/kg (0.440) and the lowest ratio were recorded in control (0.366). *Rhizobium* inoculation increases the root growth than shoot growth. Inoculation of *P. bilaii* increased the volume of root hairs and phosphorous solubilization. Thus, dual inoculation of *Rhizobium* and *P. bilaii* enhanced the root shoot ratio than single inoculation of bioinoculant. The results were in accordance with Downey and Kessel, (1990) in peas.

Number of nodules: Nodules occur on the roots of French bean, associated with biological nitrogen fixation which converts atmospheric nitrogen to ammonia, which is then assimilated into amino acids, nucleotides and other cellular constituents like vitamins, flavones and hormones. On comparing the number of nodules in different treatments, T_5 (23.43) excelled other treatments. The lowest number was observed in T_1 (19.33). *P. bilaii* as fungi enhance more root hairs directly. More number of root hairs helps in easy penetration of *Rhizobium* into the plant through their deformation and cause more colonization through transference of bacterial cells to root cortex. Bacteria were released into cortical cells cause formation of nodule meristem and their expansion by cellular division of infected cortex cells. Thus, *P. bilaii* indirectly enhances the nodule number and weight by enhancing more root hairs and providing more P available to the plants. P is required for energy production. Thus energy required for nodule formation was supported by *P. bilaii* (Heisinger, 1998). More number of nodules in seed treatment with *TagTeam* is due to the presence of both *Rhizobium* and *Penicillium* which causes higher energy production from *Penicillium* andare effectively utilized by the *Rhizobium* for their multiplication to obtain more number of nodules in the roots (Guo *et al.,* 2010).

Total dry matter accumulation: It has direct relationship with photosynthesis and yield. Dry matters are resulted from carbon dioxide accumulation and source for yield. It has direct relationship with photosynthesis and yield. Seed treatment with *TagTeam* @ 8.1g/kg has enhanced total dry matter production (41.48 g plant^{-1}) compared to all other treatments followed by seed treatment with *Rhizobium* @ 60g/kg (39.86g plant^{-1}). The lowest total dry matter production was observed in T_1 (30.28g plant^{-1}). Crop specific *Rhizobium* inoculation enhances the nitrogen fixation and directly correlates with improved vegetative growth through metabolic activities like assimilate production and their translocation to different parts of the plant. Thus reduce the source limitation and enrich the dry matter production (Yadegari and Ashadi, 2010). Co-inoculation of *Rhizobium* and *Penicillium* enriches the nutrient uptake mainly phosphorous (*P. bilaii* solubilisation) and nitrogen (*Rhizobium* -– BNF) and enhance photosynthetic efficiency, chloroplast content, leaf area by assimilate partition, vegetative growth of plant and dry matter accumulation. Similar increase was observed with dual inoculation of *Rhizobium* and *Trichoderma* and *Pseudomonas* on mungbean (Gangwar *et al.,* 2013).

Fertility co-efficient and Vegetable pod yield: Yield is the manifestation of morphological,

physiological and biochemical characters put together to move the efficiency of trapping and conversion of solar energy (Fig. 1). Fertility coefficient was found maximum with T_5 (82.64) and the minimum was observed in T_1 (74.13). The total sugar accumulation in plants could increase the osmotic concentration and therefore had the capability to absorb water and maintain turgidity, thereby inhibiting flower abscission (Upadhayay *et al.*, 1993). The vegetable yield of French bean as influenced by multiaction bioinoculant (*TagTeam*) treatments is presented in Fig 1. Significantly higher vegetable pod yield (15.50t ha^{-1}) was recorded in T_5, followed by T_2(15.24). Control recorded lower yield of 12.60t ha^{-1} compared to other treatments. The increase of 11.48 per cent for fertility co-efficient and 23.02 per cent in French bean with dual inoculation of *Rhizobium* and *P.bilaii*. The fungi present in the *TagTeam P. bilaii* helps in enhancing nutrient uptake with increasing root hairs. It was also observed that, this convert unavailable form of phosphorous to available form (Gulden and Vessey, 2000). *Rhizobium* has the potentialities to produce plant growth promoting substances which might create favourable conditions for improving mineral uptake by plants. The increase in growth and yield of French bean might be due to the nutrient supplementation by inoculated organisms, as they might have enhanced the efficiency of N_2 fixation by *Rhizobium,* P-solubilization by *P. bilaii*. Christy Kala (2011) found thatseed inoculation significantly increased biological yield and biochemical constituents as compared to control. Pandey *et al.* (1981) stated that senescence and abscission of the older leaves might cause the depletion of LAI at the later stages of growth. Delaying of abscission by enhancing LAD reflects their increase in translocation from source to sink leads to increase in yield. Better effects of co-inoculation with *Rhizobium* and vesicular arbuscular mycorrhizal fungi on pod yield of Cowpea were shown by Thiyagarajan *et al.,* (1992). Tajini and Drevon, 2012 observed that dual inoculation of *Rhizobium* and arbuscular mycorrhiza fungi in French bean.

Table 1
Effect of multiaction bioinoculant on morphological parameters of French bean

Treatments	*Shoot length (cm plant^{-1})*	*Root length (cm plant^{-1})*	*Root Shoot ratio*	*Number of nodules*	*Total dry matter accumulation (g plant^{-1})*
T_1	38.16	15.68	0.366	19.33	30.28
T_2	44.69	18.37	0.440	23.06	39.86
T_3	42.48	17.46	0.426	21.98	37.68
T_4	39.81	16.35	0.408	20.27	33.21
T_5	45.18	17.10	0.479	23.43	41.48
T_6	39.30	16.17	0.384	20.03	31.98
T_7	41.61	18.57	0.419	21.41	35.61
Mean	41.60	17.10	0.418	21.36	35.73
SEd	0.38	0.17	0.005	0.13	0.26
CD (P:0.05)	**0.76**	**0.34**	**0.010**	**0.27**	**0.53**

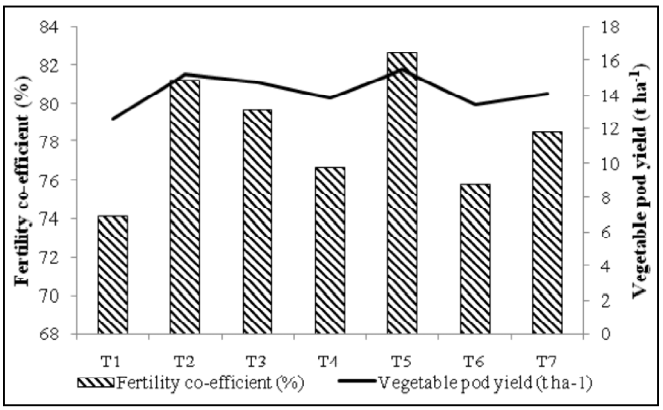

Figure 1: Effect of multiaction bioinoculants on fertility coefficient and vegetable pod yield of French bean

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