J. Hortl. Sci.
Vol. 7(1):104-107, 2012

Short communication

Effect of phosphorus solublizing bacteria (PSB) on growth and yield in tomato

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ABSTRACT

A field experiment was conducted to study the effect of phosphate solublizing bacteria (PSB) on growth and yield of tomato. PSB culture was applied through soil and seedling root dip before transplanting with two levels of phosphorus fertilizers, i.e., 75% and 100% of recommended P, and compared. Results revealed that application of 100% P with seedling dip in PSB 1:10 solution recorded significantly higher plant height (86.30cm), leaf area index (3.52), number of fruits/plant (16.32), fruit weight (77.75g), fruit yield/plant (1125g) and yield (392.26 q/ha) compared to other treatment combinations, except 100% P with 5kg/ha soil application of PSB. The same treatment also recorded the highest (3.41) cost:benefit ratio. However, no significant difference was noticed in 100% recommended P with seedling dip in PSB solution, or soil application.

Key words: Tomato, phosphorus, phosphoros solublizing bacteria, PSB

Tomato (*Lycopersicon esculentum* Mill.) is one of the important vegetable crops grown throughout the year. Alkaline cultivable soil contains less available phosphorus. Due to higher concentration of calcium, whenever phosphatic fertilizers are applied in such soils, a large quantity gets immobilized and becomes unavailable to the crop. Phosphorus is one of the most important mineral nutrients for plant growth and development. It is second only to nitrogen, limiting the growth of crops. Plants acquire P from soil. However, most of the soil phosphorus, approximately 95–99%, is present in the form of insoluble phosphates (Abou El-Yazeid *et al*, 2007). As a result, the amount available to plants is usually a small proportion of the total P. To increase the availability of phosphorus to plants, farmers apply large quantities of phosphoric fertilizer. But, after application, a large proportion of available phosphorus quickly turned into the insoluble form (Rodriquez and Farag, 1999). Hence, a very small percentage of applied phosphorus is used by plants (Abd Alla, 1994). Several scientists (Asea *et al*, 1988; Surange *et al*, 1995; Nahas, 1996; Dutton and Evans,1996; Gull *et al*, 2004) have reported the ability of different bacterial species to solubilize insoluble inorganic phosphate compounds. Phosphate solubilizing bacteria play an important role in supplementing phosphorus to plants, allowing sustainable use of phosphate (Bhatacharya and Jain, 2000). Soil and seed inoculation with phosphate solubilizing bacteria (PSB) improves solubilization of fixed soil phosphorus and of applied phosphates, resulting in higher crop yields (Jones and Darrah, 1994; Toro *et al*, 1997; Bhatacharya and Jain, 2000). In this context, the present study is designed to evaluate the effect of PSB on growth and yield in tomato crop.

A field experiment was carried out at farmers' fields during *Zaid* 2010 (i.e., summer crop) to study the effect of phosphate solubilizing bacterial strain on growth and yield of tomato. Four week old seedlings of tomato were transplanted on ridges in the field toward the end of February with a spacing of 60cm x 45cm. Soil in the experimental field was clay loam in texture, slightly alkaline in reaction (pH 8.10), low in organic carbon content (0.38%), available N (205.4 kg ha^{-1}) and available P (18.1 kg ha^{-1}) but high in available K (350 kg ha^{-1}). This experiment included a control and four treatments (which were a combination of two levels of P:75 and 100% of recommended P_2O_5, i.e., 80 kg ha^{-1} and two modes of PSB inoculation (soil and root inoculation).

Treatments applied were : T_1 – 100 % of recommended P (Control) T_2 - 75 % of recommended P with seedling dip in PSB 1:10 solution (1kg PSB:10 litre water), T_3-100 % of recommended P with seedling dip in PSB 1:10 solution (1kg PSB:10 litre water), T_4 - 75 % of recommended P with soil application of PSB@ 5kg ha^{-1}

and T_5 - 100 % of recommended P with soil application of PSB @ 5kg ha^{-1}. These treatments were arranged in a randomized block design and replicated four times. The N and K fertilizers in all treatments including control were applied as per recommended package of practices for the region and the PSB was supplied by IFFCO. Full amount of P as per treatments was applied just before transplanting through drilling in rows. Observations on growth parameters like plant height, leaf area index and yield attributing characteristics i.e. no. of fruits/plant, fruit weight (g), fruit yield/ plant, fruit yield (q/ ha) were recorded. The experimental data were subjected to statistical analysis of variance and test of significance through the procedure appropriate to the Randomized Block Design (Panse and Sukhatme,1989).

The plant height and leaf area index are considered to be an important factor to judge the efficacy of phosphorus solublizing bacteria and were found to increase to a significant level with the application of phosphorus solublizing bacteria. The results in Table 1 revealed that the application of 100% recommended P with seedling dip in PSB 1:10 solution significantly increased plant height and leaf area index over control as well as other treatments. The treatment T_3 (100% P with seedling dip in PSB 1:10 solution) increased plant height (86.30cm) and leaf area index (3.52). The increase in growth characters might be due to stimulative effect of PSB on P solubilization leading to higher P availability and uptake by plants (Han *et al*, 2006; Kim *et al*,1997; Sharma *et al*,2007 and Turan *et al*,2007). Higher microbial activity in rhizosphere expressed as activity of hydrogenase, phosphates and nitrogenase enzymes was also reported (El-Tantawy and Mohamed, 2009).

The results illustrated in Table 1 indicate that application of 100% of recommended P with seedling dip in PSB 1:10 solution was superior for enhancing number of fruit per plant and fruit size of tomato. This observation may be due to role of PSB inoculation in benefiting plant growth by improving root development, mineral uptake and plant water relationship. In addition to increased P availability, PSB also reported to produce growth promoting substances which might enhance the crop growth. These hormones from PSB might have increased the various endogenous hormonal levels in plant tissue, that may enhance pollen germination and tube growth, which ultimately increased the fruit set. The higher fruit set may also be due to higher percentage of productive flowers.

It is clear from the data presented in Table-1 that application of 100 % of recommended P with seedling dip in PSB 1:10 solution (T_3) treatment was the superior for increasing the total yield (392.26q/ha) which is significantly higher over control and at par with T_5. The highest yield might be due to the high yield contributing characters like number of fruits per plant and average fruit weight. Solubilization of 'P' from insoluble and fixed / adsorbed forms is an important aspect regarding P availability in soils. Microbial biomass assimilates soluble P, and prevents it from adsorption or fixation (Khan and Joergensen, 2009). Microbial community influences soil fertility through soil processes viz. decomposition, mineralization, and storage / release of nutrients. Microorganisms enhance the P availability to plants by mineralizing organic P in soil and by solubilizing precipitated phosphates (Chen *et al,* 2006; Kang *et al*, 2002 and Pradhan and Sukla, 2005). These bacteria in the presence of labile carbon serve as a sink for P by rapidly immobilizing it even in low P soils (Bünemann *et al,* 2004). Subsequently, PSB become a source of P to plants upon its release from their cells. Similar results were reported in tomato (El-Tantawy and Mohamed, 2009 and Shukla *et al*, 2009), Cauliflower (Kachari and Korla, 2009), turmeric (Padmapriya and Chezhiyan, 2009)**,** pea (Chaykovskaya *et al*,2001) and guava (Dutta *et al*, 2009).

Table 2 indicated that the highest net return (Rs. 242607.41) and benefit: cost ratio of 3.41 was recorded with 100% of recommended P with seedling dip in PSB 1:10 solution (T_3). This may be attributed to high yield recorded in this treatment. Similar observation were also reported in

Table 1. Effect of phosphorous solublizing bacteria on the growth and yield attributes of tomato.

Treatments	Plant height (cm)	Leaf area index	No. of fruits / plant	Fruit weight (g)	Fruit yield/ plant	Fruit yield (q/ ha)
T_1	75.88	2.96	14.93	67.18	978.75	344.16
T_2	81.05	3.20	15.49	73.38	1040.00	364.61
T_3	86.30	3.53	16.32	77.75	1125.00	392.26
T_4	80.70	3.21	15.44	72.90	1038.75	362.47
T_5	85.58	3.51	16.24	76.98	1122.50	389.93
CD *(P=0.05)*	1.21	0.076	0.37	1.27	7.19	4.41
SEm$\pm$	0.96	0.060	0.29	1.01	5.70	3.50

Table 2. Effect of phosphorous solublizing bacteria on the economics of tomato crop.

Treatments	Gross return (Rs)	Net return (Rs)	B:C ratio
T_1	275325.19	204825.19	2.91
T_2	291688.89	221288.89	3.14
T_3	313807.41	242607.41	3.41
T_4	289974.07	219674.07	3.12
T_5	311940.00	241040.00	3.40
CD *(P=0.05)*	3529.73	3529.73	0.05
SEm±	2801.23	2801.23	0.04

tomato (Premsekhar and Rajashree, 2009), clusterbean (Dadhich and Gupta 2001) and wheat (Singh *et al,* 2009).

It could be concluded that root inoculation with PSB 1:10 solution (1kg PSB:10 litre water) in the presence of 100% P (full recommended P_2O_5 dose) significantly increased plant height, leaf area index, number and yield of fruits per plant, fruit weight and yield per hectare. The highest net return and cost: benefit ratio were also recorded with the same treatment.

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(MS Received 13 January 2012, Revised 4 May 2012)