ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Population Dynamics of Plant Growth Promoting Microbes on Root Surface and Rhizosphere of Tomato Crop and Their Beneficial Effect as Bioinoculants on Tomato and Chilli Crop

Gyansingh Meena, S. G. Borkar, Nisha M. Patil*

Department of Plant Pathology and Agricultural Microbiology, Mahatma Phule Agricultural University, Rahuri-413 722 Dist. Ahmednagar, Maharashtra, India

Manuscript Info

Manuscript History:

Received: 22 February 2015
Final Accepted: 25 March 2015
Published Online: April 2015

Key words:

PGPM, PGPR's, Tomato, Chilli

Corresponding Author

Gyansingh Meena

Abstract

Population of plant growth promoting microbes (PGPM) were more in tomato rhizosphere as compare to the root surface of tomato plants. *Azotobacter*, *Azospirillium*, Phosphate solubilising microbes and *Actinomycetes* were present as PGPM in the tomato rhizosphere /on root surface. Although, *Actinomycetes* was present in the rhizosphere of tomato crop, it was not there on tomato roots surface. These (PGPM) as bioinoculants stimulated plant growth which resulted in significant yield increase. Bioinoculants effect was maximum with application of nitrogen fixer + PSM + Actinomycetes culture followed by application of nitrogen fixer + PSM culture and Actinomycetes culture over uninoculated control. Due to application of PGPM bioinoculants of tomato the percent increase in yield in tomato was 120 per cent whereas it was 45 per cent in chilli. These results indicated that crop specific culture of plant growth promoting microbes (PGPM) has great potential in increasing yield of that crop as compared to the general culture of PGPR's (plant growth promoting rhizobacteria) used in the crop.

INTRODUCTION

The continuous use of chemical fertilizers to increase soil fertility and crop productivity often resulted in unexpected harmful effects, particularly leaching of nitrate into ground water, rendering soils unsuitable for cultivation, soil salinity, diminishing C: N ratio in soil, degradation of soil microbial ecology and soil health. Soil ecology and soil biota are important factor to produce quality food material. Microbial inoculants are promising components to play a role in soil health management systems.

Beneficial microbial inoculants are known to increase the crop productivity up to 20 percents. However, these are not crop specific and are used on variety of crops. At present there is no literature available, whether the microbial inoculants i.e. N_2 fixer or phosphate solubilizers are specific to the rhizosphere environment, plant root system and the crop. Generally, single inoculants of *Azotobacter*, *Azospirillum*, and phosphate solubilizer are used on various crops without their specificity studies. Present investigation were, therefore, undertaken to isolate the beneficial microbes from tomato root surface as well as tomato rhizosphere and to study their specific effect on tomato and chilli crop, so as to determine whether the same bioinoculants give equal effect on both the crops.

MATERIAL AND METHOD

Isolation and Enumeration of PGPM from tomato root surface and rhizosphere of tomato:

Soil samples from rhizosphere of tomato and root samples of tomato plant from the same rhizosphere were collected from tomato field of Mahatma Phule Agricultural university experimental fields. These samples were

subjected for enumeration and isolation of PGPM on specific medium (*Azotobacter* on-Jensen's medium, *Azospirillum* on nitrogen free semi-solid malic acid medium, *Actinomycetes* on Knight agar medium, phosphate solubilizer on Pikovskaya's medium).

Serial dilution plate technique was used for enumeration of microbial population and the results are expressed as microbial population/gm of soil sample as well as per cm root surface. The cultures of isolated microbes were identified as per routine morphological, physiological and biochemical tests.

Estimation of Phosphorus solubilizing efficiency of isolated phosphate solubilising cultures:

The ability of test isolates to solubilize insoluble inorganic phosphate was studied by growing them on Pikovskaya's broth by incubating at 28 ± 2˚C temperature for 14 days. The amount of phosphate solubilized by isolates was estimated using phosphomolybdic blue colour method (Jackson, 1973). The phosphors solubilised was express a term of percent pi released tricalcium phosphate

Estimation of N_2 fixing efficiency of isolated *Azotobacter* and *Azospirillum* cultures:

The ability of *Azotobacter* and *Azospirillum* to fix atmospheric nitrogen was studied by growing them on Jensen's broth and N_2 free malic acid broth respectively, by incubating at 28 ± 2˚C temperature for 14 days. The amounts of nitrogen fixed by the cultures were estimated by using modified Micro-Kjeldahl's digestion and distillation method (A.O.A.C., 1975).

Effect of isolated PGPM as bioinoculants on tomato and chilli crop.

Seedling root dip treatment of tomato and chilli crop with microbial inoculants of tomato was carried out before transplanting.

For preparation of microbial bioinoculants for seedling root dip treatment, a week old culture of beneficial microbes on slants were suspended in distilled water. Sufficient quantity of microbial inoculum was prepared for root dip treatment. The roots of tomato as well as chilli seedlings were dipped in PGPM bioinoculant suspension for 10 minute as under-

Treatment No.	Tretment details
T_1	Control (uninoculated)
T_2	Nitrogen fixer culture
T_3	PSM culture
T_4	*Actinomycetes* culture
T_5	Nitrogen fixer + PSM culture
T_6	Nitrogen fixer + PSM + *Actinomycetes* culture

These treated seedlings were kept in shed for 15 minutes for establishment of PGPM bioinoculant on root and then were transplanted in respective treatments.

RESULTS AND DISCUSSION

The Plant growth promoting microbes (PGPM) were enumerated from the rhizosphere soil and root surface of Tomato. The results indicated that, rhizosphere soil of tomato crop contained more PGPM population than root surface of tomato. The PGPM found in rhizosphere were N_2 fixer (*Azotobacter*, *Azospirillum*), phosphate solubilising bacteria and fungi (*Bacillus*, *Aspergillus*, *Penicillium*) and *Actinomycetes*. All these PGPM were also found on the root surface of tomato except Actinomycetes (Table 1).

Phosphate solubilising microbes from tomato rhizosphere solublized phosphate in the range of 29.89 to 53.41per cent using tricalcium phosphate as phosphorus source. PSM bacillus isolates solubilise phosphate in the range of 29.89 – 41.25% while PSM– *Aspergillus* isolate solubilise phosphate in the range of 42.63 – 53.41 % and PSM– *Pencillium* solubilise phosphate in the range of 40.42 – 44.10 % (Table 2). These results clearly indicated that, fungal isolates solubilised more phosphorus as compared to bacterial isolates and further *Aspergillus* isolate solubilise more phosphorus than *Penicillum* isolate. Interestingly the root surface isolate of *Aspergillus* solubilised the maximum phosphorus i.e. 53.41 per cent as compare to Rhizosphere isolate of Aspergillus. Similarly, root surface isolate of *Bacillus* recorded the maximum phosphate solubilisation i.e. 41.25 % as compare to rhizosphere isolate of bacillus. Thus the root surface isolate of PSM solubilize more phosphorus as compared to rhizospheric isolates.

Among the N_2 fixing rhizospheric isolates of tomato *Azospirillum sp.* fixed maximum nitrogen i.e. 10.23 mg / g of sucrose consumed, followed by *Azotobacter* isolate-2 (rhizosphere isolate) 7.60 mg/g of sucrose consumed (Table 3).

Effect of PGPM inoculants of tomato on growth and yield parameters of tomato

The results revealed that all the treatments of PGP microbial inoculants were significantly superior over uninoculated control. However treatment T_6 (nitrogen fixing culture + PSM + *Actinomycetes* culture), exhibited more plant height, root length, shoot biomass and root biomass, no. of flowers, fruit and fruit yields and this treatment was at par with treatment T_5 (nitrogenous culture + PSM culture) but were superior over all other treatments (Table 4).

Effect of PGP microbial inoculants of tomato on growth and yield parameters of chilli

The results revealed that, all the treatment of PGP microbial inoculants was significantly superior over uninoculated control. However the treatment T_6 (nitrogen fixing culture + PSM + Actinomycetes culture), exhibited more plant height, maximum root length, shoot biomass and root biomass, no. of flowers, no. of fruits and fruit yield and this treatment was at par with treatment T_5 (nitrogenous culture + PSM culture) but were superior over all other treatments (Table 5).

The increase in growth parameters and yield parameters due to inoculation with PGPR's (plant growth promoting rhizobacteria) has been reported by several workers (Krishanraj *et. al*, 1992). Bhardwaj and Gaur (1970) reported that *Azospirillum* strains fixes more nitrogen than *Azotobacter* strains while Singh and Kapoor (1992) and Paratey (2001) reported that Phosphate solubilising fungal isolates solubilised more phosphate as compared to Phosphorus solubilising bacteria. The increase in yield of tomato by application of plant growth promoting microbes of tomato crop was to the tune of 120% where as when the same microbes were used for chilli crop the increase in yield was up to 45%. These results clearly indicated that a crop specific plant growth promoting microbes have added advantage over the general plant growth promoting microbes.

Table 1. Population dynamics of PGPM in tomato rhizosphere and on root surface of tomato

Sr. No.	PGP microbes	Microbial Population (10^6 cfu/gm) in tomato rhizosphere	Microbial Population(10^6 cfu/cm root) on root surface of tomato
1.	*Azotobacter*	19	12
2.	*Azospirillum*	21	14
3.	PSM (a) *Aspergillus* (b) *Penicillium* (c) *Bacillus*	(18) 4 8 6	(10) 2 4 4
4.	*Actinomycetes*	81	Colony not occurred
5.	Other bacteria	147	79

Note: PSM = Phosphorus solubilising Microorganism

Table 2. Phosphorus solubilising efficiency of rhizosphere and root surface PSM of tomato crop

Sr. No.	Phosphate solubilizing microbe	Phosphate solubilizing efficiency (% PI released from tricalcium phosphate)	
		Root surface isolate	Rhizosphere isolate
I.	*Bacillus sp*	41.25	29.89
II.	*Aspergillus sp*	53.41	42.63
III.	*Penicillium sp*	44.10	40.42

Table 3. N_2 fixing efficiency of rhizosphere and root surface *Azotobacter* and *Azospirillum* of tomato crop

Sr. No.	N_2 fixing microbes	Nitrogen fixing ability (mg/gm of sucrose consumed)	
		Root surface isolate	Rhizosphere isolate
I.	*Azotobacter*	7.60	6.56
II.	*Azospirillium*	10.23	8.96

Table 4. Effect of beneficial microbial inoculants of tomato on growth and yield parameters of tomato crop

Microbial inoculants treatment	**Plant height (cm)**	**Root length (cm)**	**Shoot weight (gm)**	**Root weight (gm)**	**No. of fruit/plant**	**No. of flower/plant**	**Yield/ plant (Kg/plant)**	**Yield (q/ha.)**	**% yield increase over control**
T_1 Uninoculated control	64.50	13.80	50.32	3.50	29.00	35.50	1.16	38.50	-
T_2 Nitrogen fixer culture	70.60	20.10	61.72	6.53	40.75	46.50	1.83	64.05	66.36
T_3 PSM culture	72.40	22.80	63.43	6.83	43.00	49.25	1.93	67.55	75.45
T_4 *Actinomycetes* culture	67.40	16.32	54.50	4.63	34.00	40.50	1.44	50.40	30.90
T_5 Nitrogen fixer + PSM culture	72.80	25.18	65.82	7.29	46.25	52.25	2.12	74.20	92.72
T_6 Nitrogen fixer + PSM + *Actinomycetes* culture	74.80	26.30	68.32	8.19	48.75	54.50	2.43	85.05	120.9
S.E. ±	1.256	1.045	1.339	0.390	1.684	2.316	0.2683	0.278	
CD. at 5%	3.732	3.105	3.978	1.159	5.003	6.881	0.797	0.826	

Table 5. Effect of beneficial microbial inoculants of tomato on growth and yield parameters of chilli crop

Microbial inoculants treatments	**Plant height (cm)**	**Root length (cm)**	**Shoot weight (gm)**	**Root weight (gm)**	**No. of fruit/plant**	**No. of flower/plant**	**Yield/ plant (gm/plant)**	**Yield (q/ha.)**	**% yield increase over control**
T_1 Uninoculated control	54.40	15.42	23.15	3.67	38.25	44.75	86.50	34.60	-
T_2 Nitrogen fixer culture	61.60	19.15	27.48	5.74	54.50	60.50	118.65	47.46	37.16
T_3 PSM culture	61.80	21.81	27.88	5.89	57.25	64.50	120.18	48.07	38.93
T_4 *Actinomycetes* culture	57.20	17.28	24.15	4.89	52.25	59.75	108.50	43.40	24.85
T_5 Nitrogen fixer + PSM culture	61.28	24.06	28.17	6.14	58.75	66.50	124.24	49.69	43.61
T_6 Nitrogen fixer + PSM + *Actinomycetes* culture	61.80	27.65	30.27	6.44	59.25	66.75	126.14	50.45	45.80
S.E. ±	1.396	1.241	1.278	0.680	1.692	2.199	1.056	1.142	
CD. at 5%	4.148	3.687	3.797	2.020	5.927	6.534	3.138	3.393	

REFERENCES

A.O.A.C, (1975): Official methods of analysis of the Association of official Analytical Chemist. 12th Edn. Washington DC: 927.

Bhardwaj and Gaur A.C. (1970): Nitrogen fixation in phyllosphere of *Graminae*. Agril. Res. Report. Center for Agril. Publishing and Documentation. Wgeningen, 786.

Jackson, M. L. (1973): Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp: 370-387.

Paratey, P.R. (2001): Isolation and characterization of phosphate solubilizing microorganisms from soybean *(Glycine max* (L.) Merill.). M.Sc. (Agri), Thesis, M.P.K.V., Rahuri.

Singh, C.P., M.M. Mishra, and K.K. Kapoor, (1982): Solubilization of insoluble phosphate by mesophillic fungi. Rev. Ecol. Biol. Soil. 19(1): 17-25.