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N Meena
Department of microbiology
Faculty of agriculture,
Annamalai Universtiy,
Annamalai Nagar, Tamil Nadu,
India

B Karthikeyan
Department of microbiology
Faculty of agriculture,
Annamalai Universtiy,
Annamalai Nagar, Tamil Nadu,
India

Correspondence
N Meena
Department of microbiology
Faculty of agriculture,
Annamalai University,
Annamalai Nagar, Tamil
Nadu, India

Studies on the effects of PGPR on growth and yield of tomato pkm-1 variety

N Meena and B Karthikeyan

Abstract
Tomato (*Lycopersicon esculentum* Mill.) is one of the widely grown and consumed vegetable crops in the world; ranking second in importance next to potato in many countries. The majority of world tomato production is comprised of fresh market (Eating variety) tomatoes, but processing tomatoes also contribute a substantial proportion. Many bacteria are known to be able to stimulate plant growth through direct or indirect interactions with plant roots and these have been classified as Plant growth promoting rhizobacteria (PGPR). Plant growth promoting rhizobacteria (PGPR) are root associated bacteria that colonize the rhizosphere and improve plant growth when introduced onto seeds, seed pieces, roots, or into soil. Indeed, the bacteria lodging around in the plant roots (Rhizobacteria) are more versatile in transforming, mobilizing, solubilizing the nutrients compared to those from bulk soils. PGPR are found in a very wide range *Bacillus subtilis* and *Pseudomonas fluorescens* and *Azotobacter chroococcum.* Eight rhizosphere soil samples were collected from various places were tomato grown in krishnagiri district. The collected rhizosphere soil samples were analysed for microbial populations and PGPR populations and recorded. Further the PGPR strains were screened for IAA production, phosphate solubilizing, and Nitrogen fixation. PGPR *Bacillus subtilis* and *Pseudomonas fluorescens* and *Azotobacter chroococcum* were selected for further studies. The best strains were used for pot culture study. Among the seven Treatments (T_6) the effect of plant growth promoting rhizobacteria (PGPR) inoculation of seedling height 20.15cm, germination percentage 95.20% and Vigour index 1918.28, plant dry matter production 18.00gm/plant, number of fruits-21.20/ Plant, fruit weight -33.15 gm and fruits yield-1350.20 (g/fruit) were recorded the highest in the sixth treatment (T_6-*Bacillus subtilis* and *Pseudomonas fluorscens* and *Azotobacter chroococcum*) for cleared by PKM-1, the third treatment (T_7-control) recorded the lowest yield.

Keywords: PGPR, Rhizosphere soil, seeds, seedlings, microorganisms, fruit yield, pot culture

Introduction
Tomato (*Lycopersicon esculentum* Mill.) is one of the widely grown and consumed vegetable crops in the world, ranking second in importance next to potato in many countries. The majority of world tomato production is comprised of fresh market (Eating variety) tomatoes, but processing tomatoes also contribute a substantial proportion (Seedquest, 2004) [6]. It is rich in vitamins A, B and C and has very high potential for developing value added products like soup, puree, juice, ketchup and powder through processing. It is also economically important for its edible fruits which can be consumed either raw or cooked. Its cultivation has spread throughout the world, it occupying an area of 4.55 million ha with the production of 125.02 million tonnes. In India, it occupies an area of 0.54 million ha with a production of 7.60 million tons with an average yield of 14.07 tons per ha. India's annual producing of tomato accounts for nearly, 7.1 million tones and among the states, Tamil Nadu stands seventh in tomato production (Loganathan *et al.*, 2014) [3]. The use of PGPR has shown potential to be a promising technique in the practice of sustainable agriculture. A group of natural soil microbial flora acquire dwelling in the rhizosphere and on the surface of the plant roots can improve the overall body of the plant growth. (Dweipayan Goswami *et al.*, 2016) [1].The rhizosphere is the region around plant roots where maximum microbial activates occur. In the rhizosphere both beneficial and harmful actives of microorganisms affect plant growth and development. The mutualistic rhizosphere bacteria which improve the plant growth and health are known as plant growth promoting rhizobacteria (PGPR). They are much importance due to their ability to help the plant in diverse manners. PGPR such as *Pseudomonas, Bacillus, Azospirillum, Azotobacter, Arthrobacter, Achromobacter, Micrococcus, Enterobacter, Rhizobium, Agrobacterium, Pantoea* and *Serratia* are now very well known. Application of PGPR as bio inoculants / bio formulations is found to be very effective in enchancing crop productivity in sustainable way (Maya Verma and Jitendra 2019) [4].

Materials and Methods

Survey for the collection of rhizosphere soil sample for enumeration and purification of plants growth promoting Rhizobacteria (PGPR) from the rhizosphere soils of tomato

Survey was conducted at Nearly eight rhizosphere soil samples were carefully collected, from different locations of krishnagiri district in Tamil Nadu were tomato grown. Transported to the laboratory and soil samples were stored in refrigerator at 4ºC for further studies. The rhizosphere soil samples of tomato were used for further isolation and enumeration of *Pseudomonas, Azotobacter* and *Bacillus*. *Pseudomonas* population was enumerated from rhizosphere soil sample of tomato plant by serial dilution plate technique. The soil samples were serially diluted upto 10^{-4} dilution, one ml aliquots of last dilution were plated in king's B agar medium (King's et *al.,* 1954), Waksman's base medium No.77. (Allen, 1953), Pikovskaya's medium (Sperber, 1958).

Screening of plant growth promoting rhizobacteria (PGPR) for plant growth promoting traits

Eight isolates of *Azospirillum* and twenty isolates of *Azotobacter* were screened for their nitrogen fixing efficiency by assaying nitrogenase activity using acetylene reduction assay (ARA) method and fixed nitrogen in culture medium.

Acetylene reduction assay (ARA)

The Acetylene reduction activity (ARA) procedure done According to Bradford (1976) and the ARA was expressed as n moles of C_2H_4 produced h^{-1} mg^{-1} cell protein.

Estimation of fixed nitrogen from culture broth of *Azotobacter* isolates

The quantity of nitrogen fixed *in vitro* by the *Azospirillum* and *Azotobacter* isolates was estimated by Humphries (1956) [12] method.

Screening of phosphate solubilizing bacteria for 'P' solubilization

The efficiency of ten phosphate solubilizing *Bacillus* spp. were determined by estimating the amount of soluble phosphorus released from tricalcium phosphate. The acid phosphatase activity and the Titrable acidity of the medium with concomitant changes in Ph.

Determination of phosphate solublization

The phosphate solubilizing bacterial isolates were grown in 50 mlpikovskaya's broth containing 100 mg of tricalcium phosphate and the amount of soluble phosphorus released was estimated on 7th day after inoculation (DAS). The culture medium was centrifuged at 10,000 rpm for 10 min and the clear supernatant was used for soluble Phosphorus estimation by the method described by Olsen *et al.,* (1954) [13].

Production of phytohormones by plant growth promoting rhizobacteria (PGPR) isolates

Estimation of indole acetic acid (IAA)

The *in vitro* production of phytohormones such as indole acetic acid (IAA) by plant growth promoting rhizobacterial isolates were estimated. A quantity of 100 ml of nitrogen free malate broth (without bromothymol blue indicator) for *Azospirillum,* Waksman's broth for *Azotobacter* and nutrient broth for *Bacillus* isolates were prepared and sterilized. Freshly prepared, filter sterilized solution of L-tryptophan was added to each flask to a final concentration of 100 mg 1^{-1}. One ml of culture broth of plant growth promoting bacterial isolates were inoculated to each flask and incubated at 37ºC in dark for seven days. After incubation, the cultures were centrifuged at 6,000 rpm for 5 min to remove the bacteria cells. The supernatant was brought to pH 2.8 with 1 N HCL. Fifteen ml of the acidified supernatant was taken in 100 ml conical flask and to it equal volume of diethylether was added and incubated in dark for 4 h. IAA extraction was done at 4ºC in a separating funnel using diethylether. The organic phase was discarded and the solvent phase was pooled and evaporated to dryness. To the dried material, 2 ml of methanol was added, pooled and the IAA present in the methanol extract was determined using the method of Gorden and Paleg (1957).

Estimation of siderophore production

Siderophore production by the plant growth promoting bacteria was estimated by the method described by Reeves *et al.,* (1983).

Studies on the effect of inoculation of plant growth promoting rhizobacteria (PGPR) on plant growth and yield of tomato under pot culture condition

A pot culture experiment was conducted during July to November 12, 2018 in the Department of Microbiology, Faculty of Agriculture, Annamalai University, and Annamalai Nagar. The annual mean minimum and maximum temperature of experimental area is 25° and 39°C, respectively and the mean highest and lowest relative humidity was 96 and 78 per cent respectively. The mean annual rainfall of this area is 1500 mm. The physico-chemical properties of the soil were analysed. The plant growth promoting rhizobacterial isolates *B. subitilis* TBSs-2, *A. chroococcum* TAzt-2, *P. fluorescens* TP_S- 7 were prepared as single and contained inoculants The cement pots of size 1'x 2'x 2' filled with land soil and sand in the ratio of 1:1. The seeds of tomato Var. PKM-1 was surface sterilized with 80 percent ethanol and 0.1 per cent mercuric chloride and washed the seeds with sterile distilled water for 3 to 4 times. A control pot without inoculation was also maintained. The experiment was conducted in Randomized Block Design (RBD) with three replications.

Determination of growth parameters of tomato variety Pkm-1 under pot culture condition

Biometric observation

Three replications were chosen for each treatments for recording the biometric observation such as Plant height, Germination percentage, Vigour index, Dry matter production (DMP), Determination of number fruits, fruit weight, Fhruit yield. Plant samples were taken at periodic intervals viz., 35th, 70th, 100th days after sowing and harvest, Plant height was expressed in cm. Vigour index was computed on 7 DAS using the following procedure suggested by Abdul Balli and Anderson (1973) [15].

Vigour Index = Germination percentage × Shoot length

The DMP was recorded on 35th, 70th, 100th DAS and Harvest Harvest expressed in g $plant^{-1}$.The number of fruits were recorded at harvested period. The average fruit weight of five plants selected as randomly recorded and expressed as g/ fruit. The fruit yield five plants were taken from each treatment and expressed as g/plant in pot experiment.

Statistical analysis

The experimental data were analysed by following the methods of Panse and Sukhatme (1985) [16].

Experimental results

Microbiological status in the rhizosphere soil samples from commercially grown area of tomato

In general, the rhizosphere soils of tomato contained higher microbial populations than non-rhizosphere soil in all the ten rhizosphere soil samples were analyzed.

Table 1: Microbial status in the rhizosphere soil samples from commercially grown area of tomato

S. No.	Name of the locations	Bacteria 1x10^{6}cfu g^{-1}			Fungi 1x 10^4 cfu g^{-1}		
		Rhizosphere soil	Non-rhizosphere soil	R:S ratio	Rhizosphere soil	Non-rhizosphere soil	R:S ratio
1.	Pollupalli	8.33	5.44	1.53	6.44	4.33	1.48
2.	Sundagiri	15.44	9.66	1.59	9.33	6.22	1.50
3.	Gangasamuthiram	10.66	7.44	1.43	7.22	4.88	1.47
4.	Melumalai	7.22	5.66	1.27	5.33	3.44	1.54
5.	Bhandharapalli	12.44	8.22	1.51	8.22	5.00	1.64
6.	Maniyandapalli	9.66	6.88	1.40	5.44	3.66	1.48
7.	Hosur	5.00	3.88	1.28	4.88	2.66	1.37
8.	Gumanoor	4.59	2.88	1.59	3.66	1.88	1.94

Relative occurrence of plant growth promoting rhizobacteria (PGPR) in the rhizosphere soil samples of tomato

The rhizosphere soil samples were collected nearly eight locations of Krishnagiri District of Tamil Nadu were tomato field. The plant growth promoting rhizobacteria such as Pseudomonas, Azotobacter and Bacillus were determined from the rhizosphere soils of tomato grown soils collected from eight different locations in krishnagiri district of Tamil Nadu. The plant growth promoting rhizobacterial population was found to be higher in Sundagiri, which recorded 6.88x10^4 cfu g-1 for Pseudomonas, 7.44 x10^4 cfu g-1 for Azotobacter, and 12.88 x10^4 cfu g-1 for Bacillus respectively followed by Bhandharapalli. The lowest PGPR populations was recorded in Gumanoor. 2.80 x10^4 cfu g-1 for Pseudomonas, 3.44 x10^4 cfu g-1 for Azotobacter and 6.22 x10^4 cfu g-1 for Bacillus respectively (Table-1). The early report done by kannaiyan (2000) in tomato the occurrence of *Azotobacter& Pseudomonas* likewise Sakthivel and Karthikeyan, 2012 and Tapasco cabra *et al.*, (2017) also reported the *Bacillus* in tomato.

Screening of Plant Growth Promoting Rhizobacteria (Pgpr) For Plant Growth Promoting Traits

The plant growth promoting bacteria (PGPR) isolates obtained from tomato rhizosphere soil samples collected from different locations of Krishnagiri districts in Tamil Nadu were screened for their efficiency of dinitrogen activity, phytohormone production and phosphate solubilization. Among the eight *Azotobacter* isolates, five isolates produced more than 165 n moles of C_2H_4 mg^{-1} of cell protein hr^{-1}. The results were in accordance with previous reports Furina *et al.*, (2012). The maximum N content of 17.45 mg g^{-1} of cell weight recorded in TAzt-2 followed by TAzt-7 (16.80 mg N g^{-1} of cell weight) and TAzt-3 (15.45 mg N g^{-1} of cell weight).(Table 2).

Table 2: *In vitro* nitrogenase activity and cell nitrogen content of *Azotobacter* isolates obtained from the rhizosphere soils of tomato

S. No.	Name of the Isolates	Nitrogenase activity (n moles of C_2H_4 produced mg^{-1} of cell protein h^{-1})	Cell nitrogen content (mg g^{-1} cell weight)
1.	TAzt-1	165.20	11.10
2.	TAzt-2	246.20	16.80
3.	TAzt-3	200.00	15.45
4.	TAzt-4	120.36	10.80
5.	TAzt-5	118.10	12.45
6.	TAzt-6	105.00	10.05
7.	TAzt-7	260.50	17.45
8.	TAzt-8	96.45	8.35
SED		2.45	0.20
CD (p=0.05)		4.10	0.45

Indole aceticacid (IAA) producing potential of *Pseudomonas Azotobacter, Bacillus* isolates obtained from the rhizosphere of tomato.

All the isolates of *Pseudomonas* produced IAA the quantity ranged from 25.2 to 67.5 µg 25 ml^{-1} broth for IAA. The isolate TPs-7 produced the maximum amount of 67.5 µg of IAA 25 ml^{-1} of nitrogen free malate broth. The isolate TPs-2 produced the minimum amount of 25.2 µg IAA 25 ml^{-1} of the culture broth. All the *Azotobacter* isolates, the isolate TAzt-2 produced the maximum amount of 37. 2 µg IAA 25 ml^{-1}. The isolate TAzt-4 produced the minimum amount of 18.3 µg IAA 25 ml^{-1} of the culture broth. All the eight *Bacillus* isolates, the isolate TB-2 produced the maximum amount of 58.5 µg IAA 25 ml^{-1}. The minimum amount of IAA was produced by TB-4 (25.5 µg IAA 25 ml^{-1}) (Table 3). The IAA production in the plant rhizosphere were reported by many Authores, (Shokri and Emitiazi, 2010). Indole-3-acetic acid is a phytohormone which is known to be involved in root initiation, cell division and cell enlargement (Zafar Maholodar *et al.*, 2018).

Table 3: Indole acetic acid (IAA) producing potential of *Pseudomonas Azotobacter, Bacillus* isolates obtained from the rhizosphere of tomato.

S. No.	Name of the isolates IAA (µg 25 ml^{-1})					
	Pseudomonas		*Azotobacter*		*Bacillus*	
1.	TPs-1	35.6	TAzt-1	25.4	TB-1	42.0
2.	TPs-2	25.2	TAzt-2	37.2	TB-2	58.5

3.	TPs-3	28.3	TAzt-3	28.2	TB-3	29.7
4.	TPs-4	65.2	TAzt-4	18.3	TB-4	25.5
5.	TPs-5	56.5	TAzt-5	26.5	TB-5	40.3
6.	TPs-6	35.0	TAzt-6	30.8	TB-6	26.8
7.	TPs-7	67.5	TAzt-7	34.0	TB-7	44.8
8.	TPs-8	49.6	TAzt-8	23.7	TB-8	38.4
SED	1.90		1.67		0.78	
CD (p=0.05)	1.06		2.15		1.85	

Phosphate solubilizing potential of *Bacillus* isolates obtained from the rhizosphere of tomato

All the eight phosphate solubilizing *Bacillus* isolates which showed clear zones around their growth on Sperber's hydroxyl apatite medium were screened for release of phosphorus from Tricalcium phosphate (TCP) in Pikovskaya's broth, acid phosphatase activity, change in the pH of the medium and Titrable acidity of the culture medium. The results are presented in Table 4.

Solubilization of tricalcium phosphate (TCP)

The isolate TB-2 recorded maximum solubilization of 18.51 mg of phosphorus followed by TB-7 (17.25 mg of phosphorus). The minimum amount of solubilization by the isolate TB-8 (9.27 mg of phosphorus) (Table-4). The acid phosphatase activity of the eight isolates ranged from 22.40 to 47.40 n moles of p-nitrophenol released min^{-1} mg^{-1} of cell protein. The maximum amount of phosphatase activity was recorded by TB-2 (47.40 n moles of p-nitrophenol min^{-1} mg^{-1} of cell protein) followed by TB-7 (45.30 n moles of p-nitrophenol min^{-1} mg^{-1} of cell protein). The acidity level produced in the culture medium was estimated and the results are presented in (Table 4). The Titrable acidity ranged from 2.0 to 4.2 in the culture medium after 7 days growth of *Bacillus* isolates. The maximum titrable acidity of 4.2 was produced by the isolate TB-2 followed by the isolate TB-7 which recorded a titrable acidity of 3.8. The minimum titrable acidity of 2.0 was recorded by the isolate TB-8. Similar report done by pakva kumar Agrawal and shruti Agarwal 2013; Teresa cabra *et al.*, 2017).

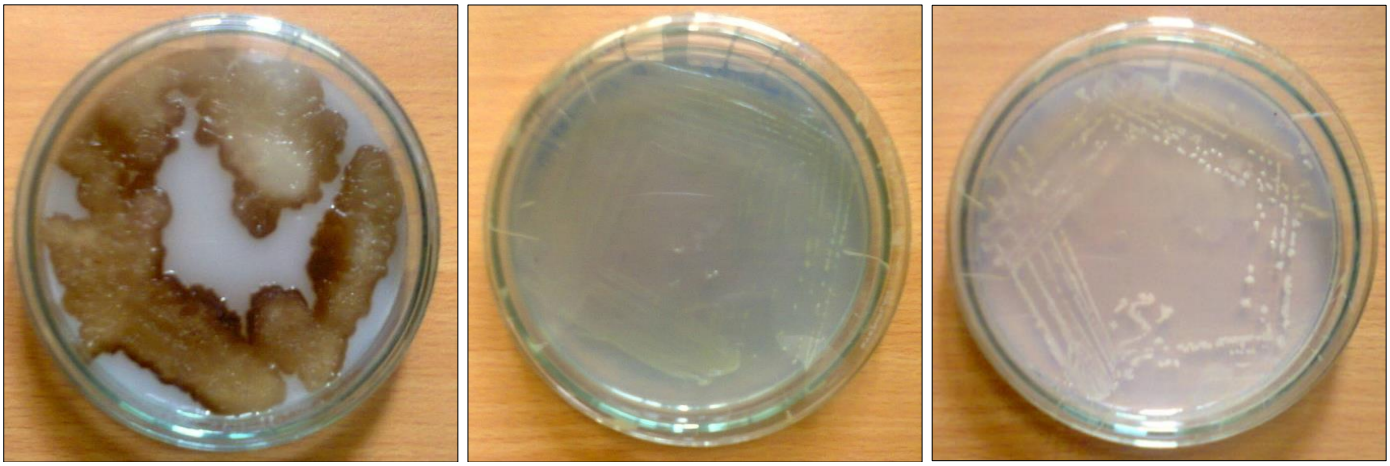

Plate1 (A) *Pseudomonas fluorescens* (TPs-7)

Plate 1 (B) *Azotobacter chroococcum* (TAzt-2)

Plate1(c) *Bacillus subtilis* (TBs-2)

Plate-1. Isolated cultures from Tomato rhizosphere soil 1(a), (b) & 1(c)

Table 4: Phosphate solubilizing potential of *Bacillus* isolates obtained from the rhizosphere soils of tomato

S. No.	Name of the Isolate	Phosphorus solubilization (mg of P released from 100 mg of tricalcium phosphate)	Acid phosphatase activity (n moles of p- nitrophenol released of min^{-1} mg^{-1} of cell protein)	Titrable acidity
1.	TB-1	12.46	28.85	2.8
2.	TB-2	18.51	47.40	4.2
3.	TB-3	16.31	35.50	3.6
4.	TB-4	14.51	30.25	3.2
5.	TB-5	11.15	25.40	3.0
6.	TB-6	13.50	32.20	3.3
7.	TB-7	17.25	45.30	3.8
8.	TB-8	9.27	22.40	2.0
SED		0.90	2.18	0.17
CD (p=0.05)		1.65	4.35	0.28

Siderophore producing potential of Pseudomonas isolates from the rhizosphere of tomato

All the *Pseudomonas* isolates produced both catechol and salicylate type of Siderophores. The catechol type of siderophore produced by *Pseudomonas* isolates ranged from 2.25 to 3.80 µg ml^{-1} of culture broth and salicylate type ranged from 3.00 to 5.25 µg ml^{-1}. The isolate TPs-7 produced the maximum quantity of 3.80 and 5.25 µg ml^{-1} of catechol type and salicylate type of siderophores respectively followed by TAzs-8 which produced 3.50 and 3.95µg ml^{-1} of catechol and salicylate type of siderophores. (Table 5). Siderophore are also known to act as growth factors as phytopathogenic

suppressive agents reported by several works (Shaheedha Begam *et al.,* 2014; Priyanka *et al.,* 2018) [5].

Table 5: Siderophore production by Pseudomonas isolates obtained from the rhizosphere soils of tomato

S. No.	Name of the isolate	Siderophore content (µg ml^{-1})	
		Catechol Type	Salicylate Type
1.	TPs-1	2.50	3.00
2.	TPs-2	3.00	4.50
3.	TPs-3	3.15	4.75
4.	TPs-4	2.25	4.00
5.	TPs-5	3.25	4.90
6.	TPs-6	2.75	4.20
7.	TPs-7	3.80	5.25
8.	TPs-8	3.50	3.95
SED		0.15	0.12
CD (p=0.05)		0.27	0.21

Effect of plant growth promoting rhizobacteria (PGPR) Inoculation on the growth and yield of tomato variety pkm-1 under pot culture condition

A pot culture experiment was conducted to study the inoculation effect of single ands of inoculant preparations of PGPR isolates *viz., P. fluorescens* TPs-7, *A. chroococcum* TAzt-2 and *B. subtilis* TB-2 on the growth and yield of tomato. The seedling height, germination percentage and Vigour index was recorded on one week period and the number of fruits, fruit weight and fruit yield were recorded at harvest period of tomato (Tables 6).

Effect of plant growth promoting rhizobacteria (PGPR) inoculations on the plant height, germination percentage and Vigour index of tomato variety PKM-1

The effect of PGPR inoculation on the seedling height, germination percentage and vigour index of tomato variety PKM-1 was recorded and the results were furnished in Table 6 and Plate -1 (a, b, c).

Among the seven treatments tested, the maximum seedling height, germination percentage and vigour index was recorded in the treatment T_6 (*B. subtilis* + *P. fluorescens* TPs-7 + *A. chroococcum* TAzt-2) of (20.15 cm), (95.20 %) and (1918.28) followed by T_5 of dual inoculant treatment (17.35 cm), (84.20 %) and (1460.87)). The minimum seedling height, germination percentage and vigour index was recorded in the treatment T_7 innoculated (Control) (10.15 cm), (50.21%) and (531.00).

Effect of plant growth promoting rhizobacteria (PGPR) inoculations on the dry matter production of tomato variety PKM-1

The effect of PGPR inoculations on the dry matter production of tomato variety PKM-1 was evaluated and the results are presented in Table 7.

Among the six treatments tested, the maximum plant dry matter production was recorded in the treatment T_6 (*P. fluorescens* TPs-7 + *A. chroococcum* TAzt-2 + *B. subtilis* TB-2) of (46.95 g plant^{-1}) followed by the dual inoculants treatment T_5 (*P. fluorescens* TPs-7 + *A. chroococcum* TAzt-2) (5.60 g plant^{-1}) on harvest period. Minimum dry matter production was recorded in the treatment T_7 (Control) (18.00 g plant^{-1}). The dry matter production was maximum in the treatment T_6 was highly significantly increased over the other treatments. Similar results were reported by ketut widnyana (2019) in tomato plants.

Table 6: Effect of plant growth promoting rhizobacteria (PGPR) inoculation of seedling height, germination percentage and vigour index of tomato variety PKM-l under potculture condition

Treatments	Seedling height (cm)	Germination (%)	Vigour Index
T_1 – *Bacillus subtilis* TB -2	11.20	58.40	654.08
T_2- *P. fluorescens* TPs-7	14.75	75.30	1110.67
T_3- *A. chroococcum* TAzt-2	12.15	65.80	799.47
T_4- *Bacillus subtilis* + *P. fluorescens*	15.20	78.45	1192.44
T_5- *p. fluorescens* + *A. chroococcum*	17.35	84.20	1460.87
T_6- (*P. fluorescens* TPs-7+ *A. chroococcum* TAzt-2+ *B.* subtilis TB-2)	20.15	95.20	1918.28
T_7- Control	10.15	50.21	531.00
SED	1.45	4.74	7.68
CD (P=0.05)	2.50	9.65	13.57

Table 7: Effect of plant growth promoting rhizobacteria (PGPR) inoculation of plant dry matter production of tomato variety PKM-l under potculture condition

Treatments	Plant dry matter production (g plant $^{-1}$)			
	35 DAS	70 DAS	100 DAS	Harvest
T_1 – *Bacillus subtilis* TB -2	8.50	13.50	15.70	19.00
T_2- *P. fluorescens* TPs-7	12.00	14.20	18.15	21.15
T_3- *A. chroococcum* TAzt-2	10.00	12.00	23.85	23.20
T_4- *Bacillus subtilis* + *P. fluorescens*	14.00	17.80	33.50	24.40
T_5- *p. fluorescens* + *A. chroococcum*	16.90	20.00	39.00	25.60
T_6- (*P. fluorescens* TPs-7+ *A. chroococcum* TAzt-2+ *B.* subtilis TB-2)	20.00	23.50	44.45	46.95
T_7- Control	10.15	12.50	15.60	18.00
SED	2.44	3.36	6.30	9.25
CD (P=0.05)	5.25	6.40	15.65	17.50

Effect of Plant growth promoting rhizobacteria (PGPR) inoculation on number of fruits, fruit weight and fruit yield of tomato variety PKM-1

The effect of PGPR inoculations on number of fruits, fruit weight and fruit yield of tomato variety PKM-1 was evaluated and the results were presented in Table 8.

Among the seven treatments tested, the maximum number of fruits, fruit weight and fruit yield was recorded in the treatment T_6 (*P. fluorescens* TPs-7 + *A. chroococcum* TAzt-2+ *B.* subtilis TB-2) of (21.20 plant^{-1}), (33.15 g plant^{-1}) and (1350.20 g plant^{-1}) followed by the dual inoculants treatment

T_5 (*P. fluorescens* TPs-7 + *A. chroococcum* TAzt-2) of (18.40 plant^{-1}), (29.70 g plant^{-1}) and (1040.10 g plant^{-1}). The minimum number of fruits, fruit weight and fruit yield was recorded in the treatment T_7 (Control) (11.30 plant^{-1}), (19.15 g plant^{-1}) and (546.78g plant^{-1}). T_6 was highly significantly increased over the other treatments. Similar results were reported by ketut widnyana (2019) in tomato plants.

Table 8: Effect of plant growth promoting rhizobacteria (PGPR) inoculation of number of fruits, fruit weight and fruits yield (g/fruit) of tomato variety PKM-l under potculture condition

Treatments	No. of fruits (Plant^{-1})	Fruit weight (g) plant^{-1}	Fruits yield (g) (Plant^{-1})
T_1 – *Bacillus subtilis* TB -2	13.50	21.60	645.700
T_2- *P. fluorescens* TPs-7	16.80	25.60	840.20
T_3- *A. chroococcum* TAzt-2	15.65	23.15	726.8
T_4- *Bacillus subtilis* + *P. fluorescens*	17.50	26.70	985.40
T_5- *p. fluorescens* + *A. chroococcum*	18.40	29.70	1040.10
T_6- (*P. fluorescens* TPs-7+ *A. chroococcum* TAzt-2+ *B.* subtilis TB-2)	21.20	33.15	1350.20
T_7- control	11.30	19.15	546.78
SED	0.80	1.35	8.35
CD (p=0.05)	1.45	3.10	18.50

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