

Effects of Plant Growth-Promoting Rhizobacteria on Organic Tomato Seedling Production

Hatice Ozaktan, M.Can Malkoclu, **Yuksel Tuzel**,
Golgen B. Oztekin, Lalehan Yolageldi



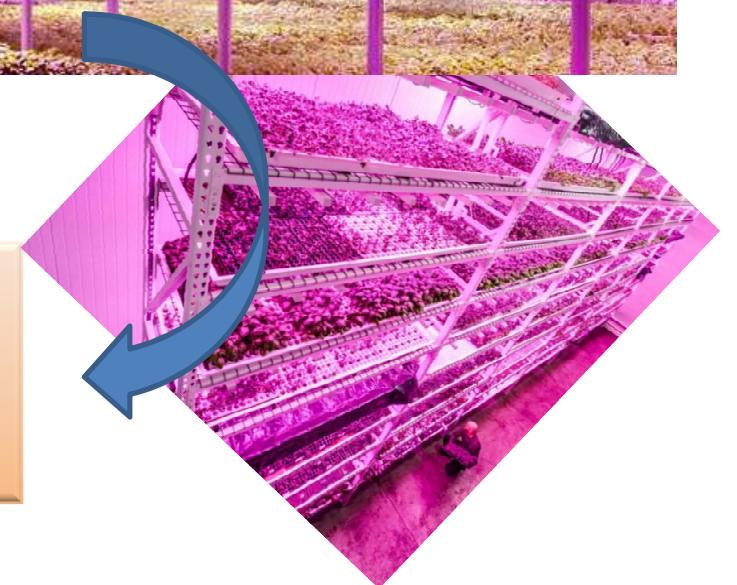
**Ege University Faculty of Agriculture
Departments of Plant Protection & Horticulture
Bornova-Izmir, Turkey
yuksel.tuzel@ege.edu.tr**

INTRODUCTION

The **major factor** affecting optimum crop production is the quality of the transplants raised, either in situ, or through transplanting techniques.



provides homogenous germination,
improves plant survival
resulting in higher and stable yield



Organic seedling production



- Restrictions for propagation material.
- Should have been produced according to Regulations (EU No 834/2007 & 839/2008) and be certified.
- Inputs are used only if they have been authorised for use in organic production under that Regulation.
- Production needs different protocols in terms of input use due to the limitations such as substrates, fertilizers, pesticides etc.
- In Turkey, mostly raised by the farmers.



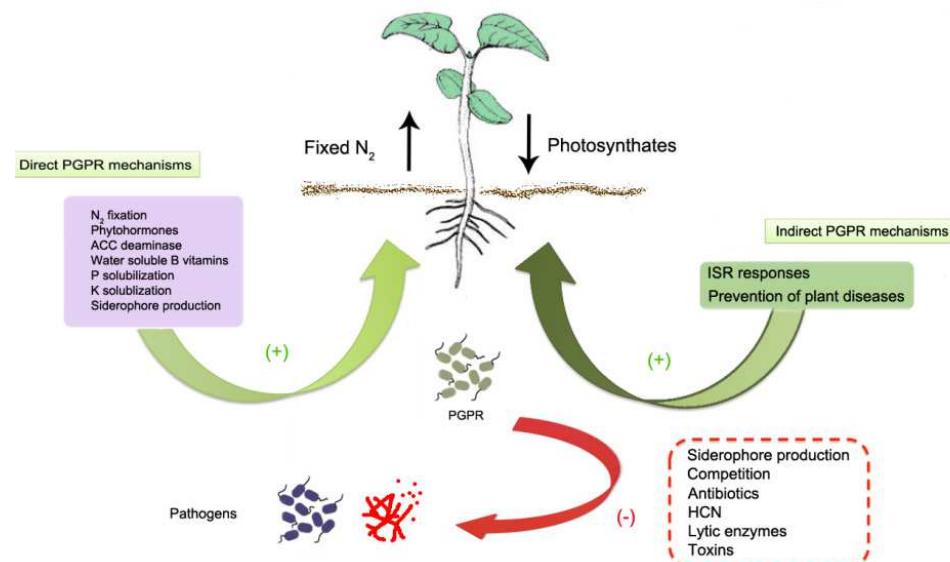
PGPRs

Important tool in organic seedling production due to their promotion of plant growth quantified as an increase in seedling emergence, vigor, biomass, proliferation of root system and yield in various plant species (Podile and Kishore, 2006).



Influence mechanism

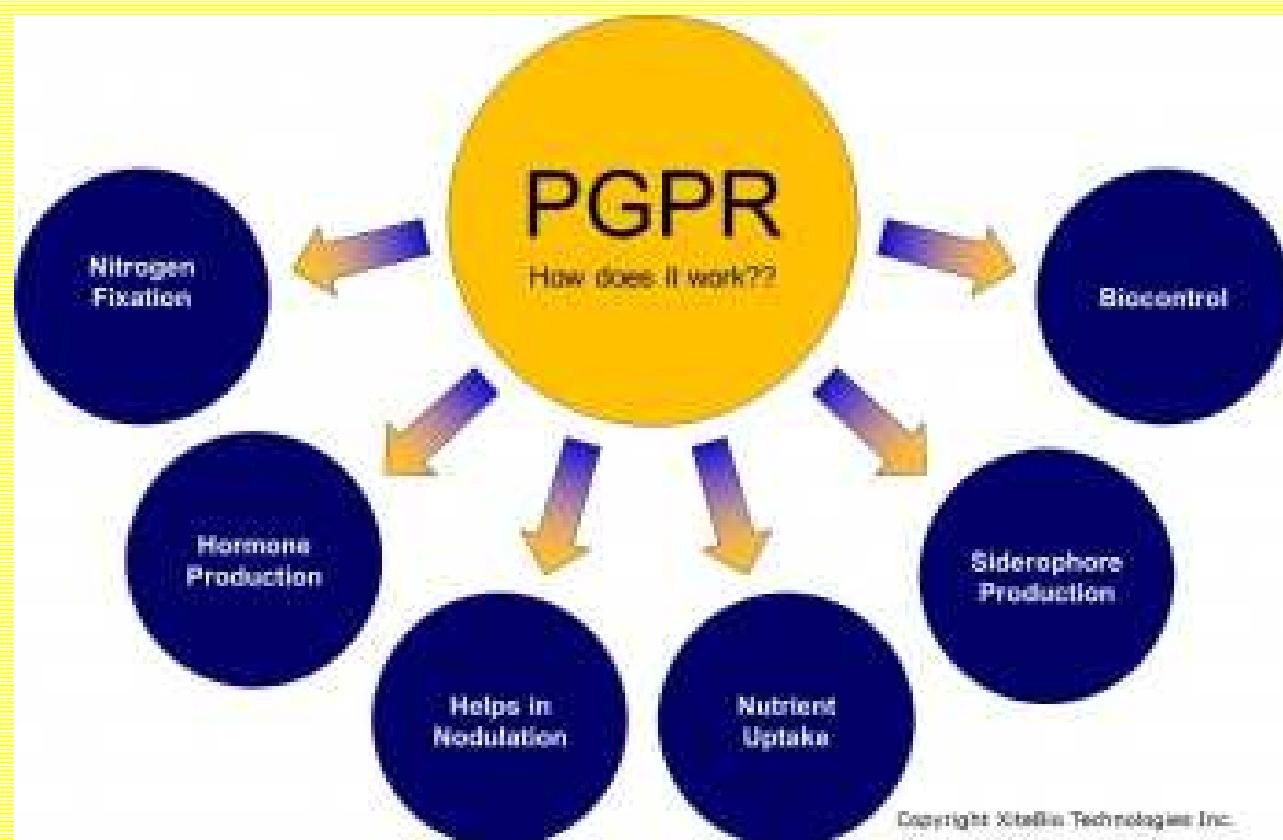
- production of phytohormones such as indole-3-acetic acid (IAA),
- solubilization of phosphate, potassium, oxidation of sulphur, fixation of nitrogen, production of siderophores enhancing iron uptake,
- suppression of soil borne pathogens by the production of hydrogen cyanide, siderophores, antibiotics
- improvement of abiotic stress (i.e. salinity, drought) tolerance and metal toxicity



Garcia-Fraile et al., 2013

AIM

to determine the effects of different Plant Growth Promoting Rhizobacteria on organic tomato seedling growth in different growing media.



MATERIAL and METHODS

Where: Nursery of Ege University Agriculture Faculty Department of Horticulture, Izmir-Turkey



Seedlings were fertilized with liquid composted farmyard manure (**Botanica**, Camli Yem Besicilik, Izmir-Turkey) (30 L ha^{-1}) every day with boom system.

PE greenhouse specialized for seedling growing

Treatments 1: GROWING MEDIA

- (1) Peat (P),
- (2) Local peat + clinoptilolite + vermicompost (**LP+CLI+VC**) (1:1:1; v:v),
- (3) Local peat + perlite + vermicompost (**LP+PER+VC**) (1:1:1; v:v),
- (4) Local peat+ vermicompost (**LP+VC**) (1.5:1, v/v)

Some physical and chemical properties of growing media.

Parameters	P (Control)	LP+CLI+VC	LP +PER+VC	LP +VC
pH	6.37	6.4	6.43	6.10
EC (dS m ⁻¹)	1.21	3.37	3.64	3.67
CaCO ₃ (%)	0.40	1.60	2.41	1.62
Org. Matter (%)	38.8	11.4	16.1	22.1
N (%)	0.92	0.57	0.80	1.10
P (mg kg ⁻¹)	190.8	274	373	270
K (mg kg ⁻¹)	3097	21390	7883	5622
Ca (mg kg ⁻¹)	4570	4231	4408	5227
Mg (mg kg ⁻¹)	1005	1338	1538	954.4
Fe (mg kg ⁻¹)	28	19	35	76
Cu (mg kg ⁻¹)	3.30	2.01	3.14	8.69
Zn (mg kg ⁻¹)	3.10	6.06	8.31	32.60
Mn (mg kg ⁻¹)	3.98	6.13	9.89	113.10

Treatments 2: PGPRs

The properties of tested PGPRs

Treatments	Isolate	Property	Gram test
<i>Pseudomonas punonensis</i>	37	Endophytic	Gram (-)
<i>Pseudomonas putida</i>	18/1K	Epiphytic	Gram (-)
<i>Ochrobactrum pseudintermedium</i>	80	Endophytic	Gram (-)
<i>Pantoea agglomerans</i>	83	Endophytic	Gram (-)
<i>Bacillus subtilis</i>	63/3	Epiphytic	Gram (+)
<i>Bacillus thuringiensis</i>	99	Endophytic	Gram (+)
<i>Pseudomonas fluorescens</i>	S5/4	Epiphytic	Gram (-)
<i>Pseudomonas fluorescens</i>	30	Epiphytic	Gram (-)
<i>Pseudomonas fluorescens</i>	TR21/1	Epiphytic	Gram (-)
<i>Pseudomonas fluorescens</i>	112	Endophytic	Gram (-)
<i>Pseudomonas punonensis</i>	56	Endophytic	Gram (-)
Control	-	-	-

- PGPR inoculation took place once; before sowing as seed coating.
- For seed coating, bacterial inoculants were suspended with carboxyl methyl cellulose (CMC, 1.5%) to obtain the population density with $10^8\text{--}10^9$ CFU ml⁻¹. In control treatment, seeds were treated only CMC (1.5%) suspension.
- Tomato seeds were treated with the bacterial suspensions in erlenmeyer flasks by shaking for 30 min at 120 rpm, and the seeds were air-dried before sowing. It was determined that isolates of endophytic and epiphytic bacteria colonized in seed tissues at the rate of 10^6 CFU seed g⁻¹ after bacterization (Callan et al., 1990).

RESULT: Germination Period

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVERAGE _{PGPR}
<i>Pseudomonas punonensis</i> (37)	1.00	1.75	2.00	2.00	1.69 AB
<i>Pseudomonas fluorescens</i> (30)	1.25	2.00	2.00	2.00	1.81 A
<i>Ochrobactrum pseudointermedium</i> (80)	1.00	1.25	2.00	1.75	1.50 B
<i>Pantoea agglomerans</i> (83)	1.50	1.75	2.00	2.00	1.81 A
<i>Bacillus subtilis</i> (66/3)	1.00	1.50	2.00	2.00	1.63 AB
<i>Bacillus thuringiensis</i> (99)	1.50	1.75	2.00	2.00	1.81 A
<i>Pseudomonas putida</i> (18/1K)	1.00	2.00	2.00	2.00	1.75 A
<i>Pseudomonas fluorescens</i> (112)	1.00	1.75	2.00	2.00	1.69 AB
<i>Pseudomonas fluorescens</i> (S5/4)	1.50	1.50	2.00	2.00	1.75 A
<i>Pseudomonas fluorescens</i> (TR21/1)	1.00	1.75	2.00	2.00	1.69 AB
<i>Pseudomonas punonensis</i> (56)	1.00	1.00	1.50	1.00	1.13 C
Control	1.00	1.75	2.00	2.00	1.69 AB
AVERAGE_{Growing medium}	1.15 C	1.65 B	1.96 A	1.90 A	

Complete germination (100%) was achieved in all treatments.

Germination period changed between 1 and 2 days.

Germination period was the lowest when seeds were coated with *Pseudomonas punonensis* strain 56 in all growing medium.



RESULT: Shoot Fresh Weight

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVE. _{PGPR}
<i>Psedomonas punonensis</i> (37)	1.366 df	1.113 os	1.306 ei	1.267 fk	1.263 B
<i>Pseudomonas fluorescens</i> (30)	1.163 kq	0.940 uw	0.999 sv	1.207 ho	1.077 D
<i>Ochrobactrum pseudointermedium</i> (80)	1.043 ru	1.067 qt	0.952 tw	1.261 fl	1.081 D
<i>Pantoea agglomerans</i> (83)	1.146 lr	0.878 w	1.035 ru	1.959 a	1.254 B
<i>Bacillus subtilis</i> (66/3)	0.930 uw	0.847 w	0.916 vw	1.415 ce	1.027 D
<i>Bacillus thuringiensis</i> (99)	1.041 ru	1.124 nr	1.102 os	1.348 dg	1.154 C
<i>Pseudomonas putida</i> (18/1K)	1.364 df	1.089 ps	1.132 mr	1.363 df	1.237 B
<i>Pseudomonas fluorescens</i> (112)	1.314 eh	1.242 gm	1.211 ho	1.183 jq	1.238 B
<i>Pseudomonas fluorescens</i> (S5/4)	1.256 fl	1.211 ho	1.299 ej	1.196 ip	1.240 B
<i>Pseudomonas fluorescens</i> (TR21/1)	1.462 bd	1.237 gn	0.934 uw	1.320 eh	1.238 B
<i>Psedomonas punonensis</i> (56)	1.498 bc	1.255 fl	1.250 fl	1.547 b	1.388 A
Control	1.415 ce	1.335 eg	1.364 df	1.483 bc	1.399 A
AVERAGE_{Growing medium}	1.250 B	1.112 C	1.125 C	1.379 A	



Shoot fresh weight changed between 0.093 and 0.196 g.

The highest fresh weight was in LP+VC when the seeds were treated with *P. agglomerans* strain 83.

RESULT: Shoot Dry Weight

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVE. _{PGPR}
<i>Pseudomonas punonensis</i> (37)	0.140 bf	0.107 qv	0.118 kq	0.118 kq	0.121 BC
<i>Pseudomonas fluorescens</i> (30)	0.116 ns	0.094 wz	0.096 vz	0.115 ns	0.105 E
<i>Ochrobactrum pseudintermedium</i> (80)	0.106 rv	0.106 rv	0.089 yz	0.112 os	0.103 E
<i>Pantoea agglomerans</i> (83)	0.115 ns	0.091 xz	0.101 tx	0.164 a	0.118 CD
<i>Bacillus subtilis</i> (66/3)	0.099 uy	0.082 z	0.087 yz	0.138 bg	0.102 E
<i>Bacillus thuringiensis</i> (99)	0.110 ou	0.111 ot	0.105 sw	0.128 gm	0.113 D
<i>Pseudomonas putida</i> (18/1K)	0.139 bg	0.117 mr	0.108 ou	0.134 di	0.124 B
<i>Pseudomonas fluorescens</i> (112)	0.137 ch	0.124 in	0.108 pu	0.119 kp	0.122 BC
<i>Pseudomonas fluorescens</i> (S5/4)	0.131 ej	0.124 in	0.118 lq	0.120 jo	0.123 BC
<i>Pseudomonas fluorescens</i> (TR21/1)	0.134 di	0.129 gl	0.089 yz	0.129 fk	0.120 BC
<i>Pseudomonas punonensis</i> (56)	0.161 a	0.138 bg	0.126 hn	0.149 b	0.143 A
Control	0.149 bc	0.134 di	0.144 bd	0.142 be	0.142 A
AVERAGE_{Growing medium}	0.128 A	0.113 B	0.107 C	0.131 A	



Shoot dry weight was also the highest in LP+VC when the seeds were treated with *P. agglomerans* strain 83 and in peat with *P. punonensis* strain 56.

The mean dry matter content was higher in peat and LP+VC.

RESULT: Root Fresh Weight

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVE. _{PGPR}
<i>Psedomonas punonensis</i> (37)	0.150 in	0.175 ck	0.154 in	0.113 qu	0.148 EF
<i>Pseudomonas fluorescens</i> (30)	0.127 mt	0.111 ru	0.139 ls	0.094 u	0.118 H
<i>Ochrobactrum pseudintermedium</i> (80)	0.142 lr	0.127 mt	0.144 kq	0.186 ch	0.150 EF
<i>Pantoea agglomerans</i> (83)	0.178 cj	0.116 ou	0.149 jn	0.199 cd	0.160 CE
<i>Bacillus subtilis</i> (66/3)	0.115 ou	0.159 gl	0.149 jn	0.099 tu	0.131 GH
<i>Bacillus thuringiensis</i> (99)	0.126 mt	0.178 cj	0.110 su	0.162 fl	0.144 FG
<i>Pseudomonas putida</i> (18/1K)	0.190 cg	0.123 nu	0.160 fl	0.145 kp	0.154 DF
<i>Pseudomonas fluorescens</i> (112)	0.191 cf	0.186 ch	0.191 cf	0.114 pu	0.171 BC
<i>Pseudomonas fluorescens</i> (S5/4)	0.163 el	0.170 dl	0.198 cd	0.139 ls	0.168 CD
<i>Pseudomonas fluorescens</i> (TR21/1)	0.283 a	0.157 hm	0.115 ou	0.181 ci	0.184 B
<i>Psedomonas punonensis</i> (56)	0.195 ce	0.170 dl	0.203 c	0.252 ab	0.205 A
Control	0.267 ab	0.179 cj	0.245 b	0.147 ko	0.209 A
AVERAGE _{Growing medium}	0.177 A	0.154 BC	0.163 B	0.152 C	



Root fresh weight was the highest in peat x *P. fluorescens* strain TR21/1 and followed by LP+VC x *P. punonensis* strain 56.

RESULT: Root Dry Weight

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVE. _{PGPR}
<i>Pseudomonas punonensis</i> (37)	0.020 dm	0.022 ce	0.018 ip	0.017 kq	0.019 CD
<i>Pseudomonas fluorescens</i> (30)	0.018 ho	0.017 mq	0.015 os	0.015 ps	0.016 E
<i>Ochrobactrum pseudointermedium</i> (80)	0.018 ip	0.017 mq	0.015 ps	0.022 cd	0.018 D
<i>Pantoea agglomerans</i> (83)	0.019 fn	0.017 mq	0.017 mq	0.026 b	0.020 BC
<i>Bacillus subtilis</i> (66/3)	0.014 rs	0.016 nr	0.017 jq	0.015 qs	0.016 E
<i>Bacillus thuringiensis</i> (99)	0.017 mq	0.020 dk	0.013 s	0.022 cg	0.018 D
<i>Pseudomonas putida</i> (18/1K)	0.020 dj	0.019 gn	0.018 ip	0.020 dl	0.019 CD
<i>Pseudomonas fluorescens</i> (112)	0.020 dl	0.022 cf	0.020 dm	0.017 lq	0.020 BC
<i>Pseudomonas fluorescens</i> (S5/4)	0.021 ch	0.020 dm	0.019 dm	0.021 cg	0.020 BC
<i>Pseudomonas fluorescens</i> (TR21/1)	0.026 b	0.020 di	0.013 s	0.023 c	0.021 B
<i>Pseudomonas punonensis</i> (56)	0.026 b	0.021 cg	0.021 ch	0.028 ab	0.024 A
Control	0.030 a	0.022 ce	0.027 b	0.019 em	0.025 A
AVERAGE _{Growing medium}	0.021 A	0.019 B	0.018 C	0.021 A	



The dry matter content of roots were higher in LP+VC (1.5:1, v/v) and Peat.

Root dry weight was the highest in peat x control and followed by LP+VC x *P. punonensis* strain 56.

RESULT: Shoot N Content

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	Average PGPR
<i>Psedomonas punonensis</i> (37)	1.13 or	1.57 dk	1.66 ch	1.75 bg	1.53 BC
<i>Pseudomonas fluorescens</i> (30)	0.90 rt	1.27 jq	1.37 hp	1.59 dj	1.28 E
<i>Ochrobactrum pseudointermedium</i> (80)	1.23 kr	1.39 hp	1.91 bd	1.59 dj	1.53 BC
<i>Pantoea agglomerans</i> (83)	1.08 pr	1.26 jq	1.74 cg	1.99 ac	1.52 BC
<i>Bacillus subtilis</i> (66/3)	1.17 nr	1.42 gp	1.89 bd	1.89 bd	1.59 B
<i>Bacillus thuringiensis</i> (99)	1.02 qs	1.47 go	1.69 ch	1.73 cg	1.48 BD
<i>Pseudomonas putida</i> (18/1K)	0.63 tu	1.17 mr	1.89 bd	1.48 en	1.29 E
<i>Pseudomonas fluorescens</i> (112)	0.69 su	1.35 hq	1.83 be	1.45 go	1.33 DE
<i>Pseudomonas fluorescens</i> (S5/4)	0.54 u	1.64 di	1.48 fn	1.30 iq	1.24 E
<i>Pseudomonas fluorescens</i> (TR21/1)	0.72 su	1.26 jq	1.82 bf	1.54 ek	1.33 DE
<i>Psedomonas punonensis</i> (56)	1.32 iq	1.18 lr	1.57 dj	1.52 em	1.40 CE
Control	1.52 el	2.09 ab	1.35 hq	2.26 a	1.80 A
AVERAGE Growing medium	0.99 C	1.42 B	1.68 A	1.68 A	

Among the tested treatments, LP+VC had the highest N in control.

RESULT: Shoot P Content

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVERAGE PGPR
<i>Psedomonas punonensis</i> (37)	0.35 fg	0.56 ac	0.54 bd	0.58 ab	0.50
<i>Pseudomonas fluorescens</i> (30)	0.33 fg	0.61 a	0.59 ab	0.58 ab	0.53
<i>Ochrobactrum pseudintermedium</i> (80)	0.33 fg	0.54 bd	0.56 ac	0.61 a	0.51
<i>Pantoea agglomerans</i> (83)	0.35 f	0.58 ab	0.59 ab	0.57 ac	0.52
<i>Bacillus subtilis</i> (66/3)	0.29 g	0.54 bd	0.56 ac	0.56 ac	0.49
<i>Bacillus thuringiensis</i> (99)	0.34 fg	0.57 ac	0.59 ab	0.59 ab	0.52
<i>Pseudomonas putida</i> (18/1K)	0.35 fg	0.59 ab	0.58 ab	0.59 ab	0.53
<i>Pseudomonas fluorescens</i> (112)	0.33 fg	0.51 ce	0.59 ab	0.58 ab	0.50
<i>Pseudomonas fluorescens</i> (S5/4)	0.38 f	0.56 ac	0.55 bc	0.58 ab	0.52
<i>Pseudomonas fluorescens</i> (TR21/1)	0.38 f	0.56 ac	0.53 be	0.48 de	0.49
<i>Psedomonas punonensis</i> (56)	0.38 f	0.56 ac	0.58 ab	0.47 e	0.50
Control	0.39 f	0.54 bc	0.57 ac	0.53 be	0.51
AVERAGE Growing medium	0.35 B	0.56 A	0.57 A	0.56 A	

Among the tested treatments, LP+VC had the highest P content in *O. pseudintermedium* strain 80.

RESULT: Shoot K Content

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVERAGE PGPR
<i>Psedomonas punonensis</i> (37)	1.535hi	5.94 ac	5.69 ae	5.63 af	4.70
<i>Pseudomonas fluorescens</i> (30)	1.348hi	5.58 af	5.72 ae	6.08 ac	4.68
<i>Ochrobactrum pseudintermedium</i> (80)	1.67 gi	6.11 ab	6.40 a	5.06 bf	4.81
<i>Pantoea agglomerans</i> (83)	2.53 gh	4.44 f	5.63 af	6.14 ab	4.69
<i>Bacillus subtilis</i> (66/3)	1.30 i	5.86 ad	5.70 ae	5.49 af	4.59
<i>Bacillus thuringiensis</i> (99)	2.34 gi	4.87 cf	5.66 ae	5.06 bf	4.48
<i>Pseudomonas putida</i> (18/1K)	1.93 gi	5.66 ae	5.25 af	5.26 af	4.52
<i>Pseudomonas fluorescens</i> (112)	1.94 gi	5.25 af	4.66 df	5.46 af	4.33
<i>Pseudomonas fluorescens</i> (S5/4)	1.40 hi	5.38 af	5.54 af	4.94 bf	4.32
<i>Pseudomonas fluorescens</i> (TR21/1)	1.51 hi	5.38 af	6.07 ac	4.70 df	4.41
<i>Psedomonas punonensis</i> (56)	1.88 gi	4.44 f	4.63 ef	5.82 ae	4.19
Control	2.75 g	6.07 ac	5.48 af	4.73 df	4.76
AVERAGE Growing medium	1.85 B	5.42 A	5.54 A	5.37A	

Among the tested treatments, LP+VC had the highest and K content in *O. Pseudintermedium* strain 80.

RESULT: Root N Content

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVERAGE PGPR
<i>Pseudomonas punonensis</i> (37)	1.14	1.55	1.37	1.13	1.30 A
<i>Pseudomonas fluorescens</i> (30)	0.99	1.32	1.14	1.18	1.16 AC
<i>Ochrobactrum pseudintermedium</i> (80)	1.02	1.19	1.10	1.12	1.11 AC
<i>Pantoea agglomerans</i> (83)	0.93	0.70	1.02	1.29	0.98 C
<i>Bacillus subtilis</i> (66/3)	0.72	1.08	1.20	1.09	1.02 BC
<i>Bacillus thuringiensis</i> (99)	1.15	1.12	1.11	1.18	1.14 AC
<i>Pseudomonas putida</i> (18/1K)	1.10	1.24	0.90	1.01	1.06 BC
<i>Pseudomonas fluorescens</i> (112)	0.92	1.20	1.16	1.19	1.12 AC
<i>Pseudomonas fluorescens</i> (S5/4)	1.23	1.20	1.26	1.07	1.19 AB
<i>Pseudomonas fluorescens</i> (TR21/1)	1.19	1.07	1.51	1.09	1.21 AB
<i>Pseudomonas punonensis</i> (56)	0.96	0.99	1.14	1.18	1.07 BC
Control	1.29	1.49	1.11	1.17	1.27 A
AVERAGE Growing medium	1.05	1.18	1.17	1.14	

In roots nitrogen content was affected by PGPRs and *P. punonensis* strain 37 and control gave the highest values.

RESULT: Root P Content

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVERAGE PGPR
<i>Pseudomonas punonensis</i> (37)	0.24 k	0.95 bf	0.82 ci	0.79 di	0.70
<i>Pseudomonas fluorescens</i> (30)	0.26 k	0.84 bi	0.77 di	1.00 bd	0.72
<i>Ochrobactrum pseudintermedium</i> (80)	0.37 k	0.78 di	0.83 ci	0.83 ci	0.70
<i>Pantoea agglomerans</i> (83)	0.45 jk	0.84 bi	0.76 di	0.92 bf	0.74
<i>Bacillus subtilis</i> (66/3)	0.26 k	0.75 ei	0.76 di	0.62 ij	0.60
<i>Bacillus thuringiensis</i> (99)	0.33 k	0.92 bf	0.79 di	0.95 bf	0.74
<i>Pseudomonas putida</i> (18/1K)	0.26 k	0.94 bf	0.81 ci	1.08 ab	0.77
<i>Pseudomonas fluorescens</i> (112)	0.28 k	0.86 bi	0.63 hj	1.04 ac	0.70
<i>Pseudomonas fluorescens</i> (S5/4)	0.22 k	0.98 be	0.84 bi	0.98 be	0.75
<i>Pseudomonas fluorescens</i> (TR21/1)	0.28 k	0.98 be	0.86 bh	0.98 be	0.77
<i>Pseudomonas punonensis</i> (56)	0.30 k	0.72 fi	0.62 ij	1.27 a	0.73
Control	0.42 jk	0.89 bg	0.79 di	0.65 gj	0.69
AVERAGE Growing medium	0.31 C	0.87 A	0.77 B	0.92 A	

In roots P content was affected significantly. The highest P content was in *P. punonensis* strain 56 x LP+VC.

RESULT: Root K Content

Treatments	P	LP+CLI+VC	LP+PER+VC	LP+VC	AVERAGE PGPR
<i>Pseudomonas punonensis</i> (37)	1.53 hi	5.94 ac	5.69 ae	5.63 af	4.70
<i>Pseudomonas fluorescens</i> (30)	1.34 hi	5.58 af	5.72 ae	6.08 ac	4.68
<i>Ochrobactrum pseudintermedium</i> (80)	1.67 gi	6.11 ab	6.40 a	5.06 bf	4.81
<i>Pantoea agglomerans</i> (83)	2.53 gh	4.44 f	5.63 af	6.14 ab	4.69
<i>Bacillus subtilis</i> (66/3)	1.30 i	5.86 ad	5.70 ae	5.49 af	4.59
<i>Bacillus thuringiensis</i> (99)	2.34 gi	4.87 cf	5.66 ae	5.06 bf	4.48
<i>Pseudomonas putida</i> (18/1K)	1.93 gi	5.66 ae	5.25 af	5.26 af	4.52
<i>Pseudomonas fluorescens</i> (112)	1.94 gi	5.25 af	4.66 df	5.46 af	4.33
<i>Pseudomonas fluorescens</i> (S5/4)	1.40 hi	5.38 af	5.54 af	4.94 bf	4.32
<i>Pseudomonas fluorescens</i> (TR21/1)	1.51 hi	5.38 af	6.07 ac	4.70 df	4.41
<i>Pseudomonas punonensis</i> (56)	1.88 gi	4.44 f	4.63 ef	5.82 ae	4.19
Control	2.75 g	6.07 ac	5.48 af	4.73 df	4.76
AVERAGE Growing medium	1.84 B	5.41 A	5.54 A	5.36 A	

In roots K content was affected significantly. The highest K content was in *O. pseudintermedium* strain 80 x LP+PER+VC.

CONCLUSION

Among the tested media **LP+VC (1.5:1, v/v)** was found promising for commercial use considering its effects on plant fresh weight, availability and cost.

Bacteria showed different results in different growing media however some strains of *Bacillus subtilis*, *Pseudomonas putida*, *P. fluorescens* and *P. punonensis* were found as promising on plant growth in organic tomato seedling production.

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