

IXX08498 UTILIZATION OF PLANT GROWTH PROMOTING BACTERIA (PGPB) FOR ENHANCING CROP PRODUCTIVITY IN HILL AGRICULTURE

Evaluation of PGP Pseudomonad on nutrient uptake, growth and yield of Finger millet

Table 1: Rhizospheric colonization of Pseudomonad strains at 30 and 60DAS in Finger millet

TREATMENT	Colony Forming Units (cfu/g soil)	
	30 DAS	60 DAS
T 1→ Control	3.00E+06 d	2.00E+06 e
T 2→ <i>Pseudomonas</i> sp. strain PGERs17	4.00E+06 c	3.00E+06 d
T 3→ <i>Pseudomonas</i> sp. strain PPERs23	4.00E+06 c	9.00E+06 a
T 4→ <i>Pseudomonas putida</i> strain PBRs5	2.00E+06 e	4.00E+06 c
T 5→ <i>Pseudomonas putida</i> strain PGRs4	3.00E+07 a	2.00E+06 f
T 6→ <i>Pseudomonas lurida</i> strain NPRp15	2.00E+06 e	1.00E+06 g
T 7→ <i>Pseudomonas lurida</i> strain NPRs3	1.00E+06 f	3.00E+06 d
T 8→ <i>Pseudomonas</i> sp. strain NARs9	5.00E+06 b	5.00E+06 b
T9 → <i>Pseudomonas fluorescens</i> strain PPRs4	4.00E+06 c	3.00E+06 d

Table 2: Effect of PGP Pseudomonad on physiological parameters of Finger millet under field conditions

Treatment	Physiological parameters							
	30DAS				60DAS			
	Chlorophyll (mg/ g in FLT)			Phy. Av. Iron	Chlorophyll (mg/ g in FLT)			Av. Iron
	Chl a	Chl b	Total		Chl a	Chl b	Total	
T1- Control	1.66 e	0.31 a	1.97 e	9.8 e	0.94 e	0.17 b	1.11 d	11.3 e
T2- PGERs17	1.89 cd	0.35 a	2.24 cd	12.2 d	1.10 de	0.23 b	1.33 cd	13.3 de
T3- PPERs23	2.42 a	0.39 a	2.80 a	10.6 e	2.17 a	0.38 a	2.54 a	19.3 a
T4- PBRs5	1.79 d	0.32 a	2.12 de	11.8 d	1.51 b	0.25 b	1.76 b	14.1 cd
T5- PGR4	2.15 b	0.33 a	2.48 b	13.8 ab	1.50 b	0.26 ab	1.75 b	13.4 de
T6- NPRp15	1.86 cd	0.34 a	2.20 cd	12.6 bcd	1.31 bcd	0.23 b	1.54 bc	16.1 bc
T7- NPRs3	1.78 d	0.36 a	2.14 de	12.5 cd	1.37 bc	0.22 b	1.59 bc	16.3 bc
T8- NARs9	2.18 b	0.35 a	2.52 b	14.1 a	1.54 b	0.24 b	1.78 b	17.8 ab
T9- PPRs4	1.97 c	0.38 a	2.35 bc	13.5 abc	1.21 cde	0.25	1.46 bcd	15.8 bcd

Table 3: Enzyme activity of PGP *Pseudomonas* in Finger millet

Treatments	fluorecein ($\mu\text{g/g}$ dry soil/ hr)		Phosphomonoesterase ($\mu\text{g NP/g dm. 1hr}$)				Total Phosphomonoesterase ($\mu\text{g NP/g dm. 1hr}$)	
	30DAS	60DAS	30DAS		60DAS		30DAS	60DAS
			Acidic	Alkaline	Acidic	Alkaline		
T1- Control	5.218 d	5.238 e	99.5 e	35.3 g	127.2 f	58.2 e	134.8 f	185.4 g
T2- PGERs17	5.952 bc	5.847 c	118.2 d	54.2 e	173.4 d	81.4 d	172.4 e	254.8de
T3- PPERs23	5.697 c	5.827 c	146.9 b	69.2 d	159.4 e	81.4 d	216.1 b	240.8 f
T4- PBRs5	6.012 bc	6.204 a	158.5 a	77.0 c	154.5 e	91.4 c	235.4 a	245.9 ef
T5- PGR4	5.933 bc	5.285 e	150.1 b	88.3 b	179.6 c	103.0 b	238.4 a	282.6 bc
T6- NPRp15	5.799 bc	5.856 c	133.8 c	47.3 ef	183.1 c	107.4 b	181.1 de	290.5 b
T7- NPRs3	6.167 ab	6.054 b	146.3 b	41.9 fg	179.6 c	101.2 b	188.1 d	280.9 c
T8- NARs9	5.829 bc	5.585 d	137.6 c	75.6 cd	199.1 b	61.2 e	213.3 bc	260.3 d
T9- PPRs4	6.430 a	5.973 b	105.6 e	98.1 a	222.2 a	122.4 a	203.7 c	344.7 a

Table 4: Effect of PGP *Pseudomonad* on Microbial biomass parameters in Finger millet at 30 and 60 DAS

Treatment	Microbial biomass Parameter ($\mu\text{g/g}$)												$C_{mic}:N_{mic}$ ratio	
	30DAS						60DAS						30DAS	60DAS
	C	N	P	Na	K	Na:K	C	N	P	Na	K	Na:K		
T1- Control	282i	36.08h	10.29g	16.70i	19.384f	0.86	168i	19.90i	6.71i	10.95h	5.00i	2.190	7.82	8.442
T2- PGERs17	339d	53.38a	15.14b	25.20e	28.182b	0.89	210g	26.41d	10.57b	15.05g	5.70g	2.640	6.35	7.952
T3- PPERs23	381b	41.48g	13.57c	31.55b	9.928i	3.18	285b	21.95f	9.57d	18.20e	7.50b	2.427	9.19	12.984
T4- PBRs5	309h	43.15f	15.14b	23.10f	20.052 e	1.15	258c	29.57c	11.14a	20.40b	7.35c	2.776	7.16	8.725
T5- PGR4	312g	49.29b	16.29a	28.10c	21.190d	1.33	234d	33.67a	7.71g	19.10d	5.90f	3.237	6.33	6.950
T6- NPRp15	315f	48.36c	15.14b	17.05h	31.310a	0.54	288a	20.27h	7.29h	20.30c	7.25d	2.800	6.51	14.208
T7- NPRs3	351c	47.24d	11.71e	27.95d	19.294g	1.45	222e	21.02g	8.14f	24.30a	7.00e	3.471	7.43	10.561
T8- NARs9	336e	47.24d	12.00d	32.65a	14.594h	2.24	213f	30.50b	8.71e	17.65f	5.60h	3.152	7.11	6.984
T9- PPRs4	393a	44.6e	11.4f	21.1g	23.590c	0.89	201h	24.55e	9.71c	10.85i	8.20a	1.323	8.81	8.187

Table 5: Plant growth parameters and nutrient analysis at 60 DAS

Treatment	Plant growth parameters						Shoot nutrient content (%)						
	Length (cm)		Weight / plant (g)				N	P	K	Na	Na:K	Zn	Fe
	SL	RL	SFW	RFW	SDW	RDW							
T1- Control	92.7ab	16.0a	82.95c	7.17b	37.16d	3.70c	0.844b	0.92i	3.34h	0.03i	0.00898	0.76g	3.72i
T2- PGERs17	96.0ab	16.7a	82.30d	6.37d	40.00c	3.85b	0.874a	0.98h	4.08d	0.13h	0.03186	0.80f	3.98h
T3- PPERs23	98.0a	15.7a	55.78g	6.16e	33.00h	3.50d	0.797c	1.24e	3.65g	0.33d	0.09041	0.69i	4.41f
T4- PBRs5	96.0ab	18.3a	75.81e	5.25f	34.71f	3.35e	0.648d	1.15g	5.93a	0.43a	0.07251	0.74h	4.52d
T5- PGR4	100.0a	12.7a	107.60b	3.08i	55.69a	1.89i	0.554h	1.40a	5.39b	0.24g	0.04453	0.92d	4.74a
T6- NPRp15	80.7b	16.0a	54.83h	6.78c	35.81e	3.20f	0.574f	1.33c	3.73f	0.29f	0.07775	0.88e	4.47e
T7- NPRs3	101.7a	13.3a	109.83a	4.46g	51.96b	2.58h	0.557g	1.29d	2.94i	0.36c	0.12245	0.98a	4.69b
T8- NARs9	100.3a	16.0a	71.90f	8.88a	33.98g	4.30a	0.594e	1.37b	3.90e	0.40b	0.10256	0.94c	4.29g
T9- PPRs4	85.7ab	18.0a	34.22i	4.25h	16.08i	2.56h	0.528i	1.23f	4.45c	0.31e	0.06966	0.97b	4.67c

Table 6: Macro and micro nutrient analysis of Finger millet at final harvesting

Treatment	Per cent Nutrient content											
	Grain						Straw					
	N	P	K	Na	Zn	Fe	N	P	K	Na	Zn	Fe
T1- Control	1.0213h	0.83i	0.39h	0.023i	0.74i	0.91i	0.6990i	1.20i	0.55i	0.054g	0.39i	2.75i
T2- PGERs17	1.0325e	0.92g	0.50d	0.026h	0.93d	0.92h	0.7182h	1.60a	0.81f	0.061d	0.42h	3.08h
T3- PPERs23	1.0652d	1.15d	0.50e	0.031g	0.95c	1.17d	0.7532d	1.44d	0.77g	0.056f	0.43g	3.19g
T4- PBRs5	1.0783c	1.05e	0.41f	0.038e	0.83h	1.12e	0.7237g	1.37f	1.31d	0.059e	0.43f	3.43e
T5- PGR4	1.0816b	1.00f	0.37i	0.036f	0.95b	1.03g	0.7313f	1.41e	0.89e	0.074c	0.45e	3.70b
T6- NPRp15	1.0922a	0.92h	0.55b	0.051a	1.01a	1.05f	0.8126b	1.36g	1.40b	0.061d	0.46c	3.58d
T7- NPRs3	1.0285g	1.16c	0.44e	0.048b	0.86f	1.21c	0.7924c	1.45c	1.48a	0.077b	0.45d	3.74a
T8- NARs9	1.0298f	1.23b	0.54c	0.046d	0.85g	1.22b	0.7336e	1.55b	1.33c	0.061d	0.49b	3.67c
T9- PPRs4	1.0075i	1.30a	0.64a	0.048c	0.90e	1.26a	0.8170a	1.26h	0.60h	0.082a	0.51a	3.40f

Table7: Effect of PGP bacterial strains on per cent nutrient contents and yield of Finger millet at final harvesting

Treatment	Yield (q/ha)							
	2014	% Increase	2015	% Increase	2016	% Increase	Average (Three yrs)	% Increase
T1- Control	32.92		24.4 ab		23.48 a		26.93	
T2- PGERs17	39.75	20.7	27.2 ab	11.5	27.15 a	15.63	31.37	16.47
T3- PPERs23	39.67	20.5	27.9 a	14.2	25.55 a	8.82	31.04	15.26
T4- PBRs5	31.58	-4.1	22.0 b	-9.9	25.33 a	7.88	26.30	-2.33
T5- PGRs4	32.33	-1.8	25.9 ab	6.2	25.93 a	10.43	28.05	4.17
T6- NPRp15	31.83	-3.3	20.9 ab	-14.6	23.83 a	1.49	25.52	-5.24
T7- NPRs3	35.00	6.3	24.5 ab	0.4	26.15 a	11.37	28.55	6.02
T8- NARs9	37.75	14.7	26.2 ab	7.3	26.28 a	11.93	30.08	11.68
T9- PPRs4	28.50	-13.4	22.2 ab	-9.1	21.53 a	-8.30	24.08	-10.60