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RESEARCH PAPER

Influence of *Azotobacter chroococcum* on seedling parameters of rice (*Oryza sativa* L.)

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Abstract : The effect of plant growth promoting Rhizobacteria, *Azatobacter chroococcum* on rice seedling was investigated in this endeavour. Influence of *Azotobacter chroococcum* was significant creating variation for almost all seedling characters. The genotype Kumargore (M) performed better for almost all the seedling characters, but it failed to exhibit higher incremental change (%) for the same after inoculation. The higher incremental change was exhibited by genotypes Nigersail, Daharnagra and Kumargore.

Key Words : Rice, seedling vigour, *Azotobacter chroococcum,* Tropical environment

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INTRODUCTION

Bio-fertlizer can be defined as microbial inoculants which contain live or latent cells of selected strains of microorganisms. They are used as a supply of nitrogen and phosphorus to agricultural crops (Shehata and El-Khawas, 2003, Yadav *et al*. 2011). Bio-fertilizer also reduces the use of inorganic fertilizer and prevents pollution (Narula *et al*., 1991; Lakshminarayana, 1993). Dinitrogen (N_2)-fixation in the rhizosphere of rice has attracted a wide interest in biological and agricultural research, because rice is the staple or major food crop of different countries of the world (App *et al*., 1980; Watanable and Roger, 1984). Several N_2-fixing in rice-bacteria association under flooded condition. Each bacterium may be considered for sustaining and promoting N_2- fixing in association with rice plant (Yoo *et al*., 1986; Nagananda *et al*., 2010, Woyessa, and Assefa, 2011). Among dizotrophs, *A. chroococcum* is a soil inhabiting N_2-fixing bacterium, which is also known to secrete growth promoting factors as well as antifungal antibiotics. For this attributes, pretreatment of seeds with a suspension of *A. chroococcum* has generally shown improvement is seed germination and seedling vigour. Seedling growth is closely related with the root system, root length, its branching pattern, root geometry etc. (Bhaduri and Bairagi, 1968). Besides agricultural use of bio-fertilizers, Ali *et al*. (2011) demonstrated the beneficial effects of bio-fertilizers in aquacultures. In the present endeavour the effect bio-inoculum, *Azotobacter chroococcum* on seeding vigour in rice was studied.

MATERIALS AND METHODS

The experiment was conducted at District Seed Farm, Kalyani, Bidhan Chandra Krishi Viswavidyalaya during *Kharif* (wet) season of two consecutive years in a Randomized Block Design design with three replications. To study the seedling growth pattern of 16 indigenous and folk cultivars of rice as influenced by the bioinoculums *A. chroococcum* were selected. In addition to those indigenous folk varieties, four stable mutants and three high yielding recommended varieties suitable for varying agro-climate conditions were included for having a comparative idea with regard to its responsiveness toward the inoculums for seeding production.

Seeds of all 23 rice genotypes were thoroughly mixed

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with the paste of carrier based inoculums-slurry of *A. chroococcum* for 15 minutes and spread in shade for drying. Seeds, both treated and untreated of different genotypes were sown in nursery beds in plots of 1m x 1m with three replications at spacing of 50 cm in both between plots and replications. Randomly selected 10 seedlings per replication were uprooted at 21 days after germination for taking observations on seeding length, fresh and dry weight of roots and shoots separately.

The mean performance of individual genotypes over three years was pooled and employed for statistical analysis. Analysis of variance was worked out using AGRES software package.

RESULTS AND DISCUSSION

Significant variation was observed in per se performance after seed inoculation with *A. chroococcum* for all the seedling characters studies (Table 1). The genotypes also significantly varied amongst themselves for their average performance for all those parameters. But, culture and genotype interaction

Table 1 : ANOVA for different seedling characters of rice

Source	d.f.	Mean sum of square					
		Shoot length	Shoot fresh weight	Shoot dry weight	Root length	Root fresh weight	Root dry weight
Replication	2	6.402	403.668	52.408	0.910	36.065	3.417
Culture(C)	1	157.953*	5908.761**	555.606**	29.960*	781.973*	69.879*
Error(1)	22	2.010	41.866	5.225	0.894	12.543	0.899
Genotype (G)	22	47.487**	2376.333**	136.068**	4.867**	289.081**	26.592**
C x G	22	1.304	36.780	5.907	0.284	6.435	0.640
Error	22	1.418	104.533	7.878	0.317	10.079	0.894

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Average performance of genotypes for seedling shoot characters

Genotypes	Shoot length			Shoot fresh weight			Shoot dry weight		
	C_0	C_1	Mean	C_0	C_1	Mean	C_0	C_1	Mean
NC-1281 (M)	24.24	26.23	25.24	109.00	128.66	118.83	20.00	24.03	22.01
Kalamkati (L)	23.10	24.54	23.82	111.00	125.00	118.00	21.73	24.60	23.16
Patnai-23 (L)	25.42	26.54	25.98	111.66	127.00	119.33	24.03	26.73	25.38
Kumargore (L)	25.06	28.60	26.83	169.00	188.33	178.66	26.46	34.58	30.52
Suakalam (L)	24.96	25.75	25.35	121.00	130.66	125.83	30.80	31.96	31.38
Dudkalam (L)	23.47	26.06	24.77	120.00	135.66	127.83	21.13	34.36	32.75
Nagra (L)	22.86	25.45	24.16	111.16	123.66	117.41	27.53	30.16	28.85
Daharnagar (L)	23.92	27.96	25.94	110.00	127.66	118.83	27.86	32.66	30.26
Nigersail (L)	25.62	28.33	26.97	129.00	155.66	142.33	27.73	36.36	32.05
Hatipongar (L)	24.22	25.61	24.91	111.00	121.00	116.00	27.96	30.32	29.10
B.U.-3(M)	21.42	24.23	22.83	110.33	120.33	115.33	26.26	29.20	27.73
Chapakushi (L)	25.18	26.82	6.00	116.33	128.00	122.16	31.58	36.58	34.08
Gobindabhog (L)	16.61	18.01	17.31	100.00	110.00	105.00	24.00	30.33	27.16
Nuna aus (L)	19.91	22.23	21.07	101.66	116.66	109.16	19.76	23.03	21.40
Lankagore (L)	24.81	27.74	26.28	126.83	141.66	134.25	28.03	26.20	30.43
Mirgibalam (L)	21.59	23.91	22.75	99.00	109.16	104.08	22.40	26.60	24.30
Pankaj (HYV)	23.79	26.65	25.22	124.00	130.66	127.33	24.50	28.96	25.50
Matla (HYV)	22.31	25.33	23.82	111.33	119.83	115.58	26.36	26.33	27.65
Jaladhi-1 (HYV)	18.70	19.83	19.26	113.50	118.00	115.75	24.00	25.56	25.16
Kalmunia (L)	22.28	23.26	22.77	110.00	123.00	116.50	22.60	44.16	24.08
Kumargore:M (M)	28.73	32.02	30.88	172.66	189.16	180.91	40.26	35.83	42.21
Lathisail (L)	23.73	24.95	24.34	117.00	129.33	123.16	28.26	25.45	32.05
Jhingasail:M (M)	19.73	20.82	20.28	97.00	104.33	100.16	21.16	23.03	23.30
Range	16.61-	18.01-	24.19	97.00-	104.33-	124.84	19.76-	44.16	28.28
	28.73	32.02	-	172.66	189.16	-	40.26	30.29	-
Mean	23.11	25.25	-	117.50	130.58	-	26.28	3.226	-
C.D. (P=-0.05)	1.034	1.369	-	4.741	11.751	-	1.670	2.112	-

effect (C × G) played insignificant role in creating variation in their performance (Table 1).

The genotype, Komargore (M) produced with highest vigour in both seedlings inoculated and un-inoculated conditions as could be revealed through its performance for all the characters under study. Other better performing genotypes were Nigersail, for both shoot and root characters; Kumargore, Lankagore and Suakalma for shoot characters; Daharnargore, NC-1281, Hatipongar, B. U. -3 for root characters only.

Longest seedlings were recorded for Kumargore (M) followed by Nigersail, Kumargore, Lankagore (Table 2). As responsiveness of genotype towards bioinoculums (*A. chroococcum*) can be assessed through the change in performance (%) of individual genotype after inoculation over control, the highest responsiveness for this character was recorded for genotype Daharnagra (17.03%) followed by the genotype Matla and B.U.-3 (Table 3) the higher responsiveness in local genotypes, *viz*., Daharnagra, Nagra and others indicated its genetic potentialities suited for inter action with *Azotobacter* culture.

The maximum shoot fresh weight was again observed for the genotype Kumargore (M) when the seeds were inoculated with *A. chroococcum* (Table 2). Whereas, maximum change over control after inoculation was 21.30 per cent for Nigersail, followed by NC-1281 (M) and Patnai-23. The higher percentage of increase was noted for all the local genotypes excepting Suakalma, which may be clarified as they have the potentiality of not only producing plant characters with higher values in comparison to high yielding and mutants, but also for having better interaction with *A. chroococcum*. The erratic fashion with regard to the change in magnitude as well as in terms of percentage after seed inoculation may be due to variable genetic architecture of different genotype. Accordingly their responsiveness varied due to their specificity in interaction effect with both inoculums and environment.

Shoot dry weight ranged from 19.76-40.26 in in-

Table 3 : Average performance of genotypes for seedling root characters

Genotypes	Root length			Root fresh weight			Root dry weight		
	C_0	C_1	Mean	C_0	C_1	Mean	C_0	C_1	Mean
NC-1281 (M)	8.20	8.81	8.50	36.50	37.66	37.08	12.20	12.50	12.35
Kalamkati (L)	7.15	8.73	7.94	32.00	37.33	34.66	9.76	12.26	11.01
Patnai-23 (L)	7.98	9.33	8.65	36.33	43.83	40.08	11.65	14.00	12.82
Kumargore (L)	8.22	9.44	8.83	37.50	46.33	41.91	9.50	11.50	10.50
Suakalam (L)	8.03	8.59	8.31	26.33	31.16	28.75	8.65	10.16	9.40
Dudkalam (L)	7.21	8.56	7.88	25.00	32.33	28.66	8.16	10.31	9.24
Nagra (L)	9.96	8.20	7.58	36.50	43.50	40.00	11.81	13.66	12.74
Daharnagar(L)	8.01	10.01	9.01	41.66	50.00	45.83	13.15	15.56	14.35
Nigersail (L)	8.49	8.89	9.19	42.66	46.83	44.75	13.56	14.95	14.25
Hatipongar (L)	7.89	8.37	8.13	39.50	41.33	40.41	13.83	13.26	13.05
B.U.-3(M)	7.42	8.01	7.71	36.66	40.66	38.66	11.66	13.00	12.33
Chapakushi(L)	8.13	8.77	8.45	32.33	35.16	33.75	10.30	10.83	10.56
Gobindabhog (L)	5.37	5.94	5.55	2 2.50	25.16	23.83	7.30	7.93	7.61
Nuna aus (L)	6.96	7.51	7.23	28.33	31.50	30.16	9.55	10.43	9.99
Lankagore(L)	8.20	9.17	8.68	28.33	32.50	30.41	9.18	10.60	9.89
Mirgibalam(L)	7.11	7.83	7.47	34.00	38.16	36.08	11.06	12.43	11.75
Pankaj (HYV)	7.55	8.82	8.18	32.33	38.50	35.41	10.38	12.16	11.27
Matla (HYV)	6.93	8.10	7.51	26.66	32.16	29.41	8.66	10.70	9.68
Jaladhi-1 (HYV)	7.34	7.98	7.66	34.50	38.33	36.41	11.01	12.35	11.68
Kalmunia(L)	7.12	7.86	7.49	34.00	38.33	36.16	10.96	12.25	11.60
Kumargore:M (M)	9.60	10.53	10.06	52. 16	57.50	54.83	16.55	17.76	17.15
Lathisail(L)	7.57	8.22	7.89	33.50	38.66	36.08	10.73	12.21	11.47
Jhingasail:M (M)	6.71	7.08	6.89	26.66	29.00	27.83	8.46	9.00	8.73
Range	5.37-	5.94-	8.04	22.50-	25.16-	36.14	7.30-	7.93	11.45
	9.60	10.53	-	52.16	57.50	-	16.55	17.76	-
Mean	7.57	8.50	-	33.76	38.50	-	10.74	12.16	-
C.D. (P=0.05)	0.693	0.648	-	2.595	3.649	-	0.694	1.087	-

inoculated and 23.03 to 44.16 in inoculated condition, Kumargore (M) and Nuna Aus being the best and lowest performer in both the situations for this character. The maximum responsiveness was observed in genotype Nigersail, followed by Kumargore (Table 3). Biari *et al*. (2008) also reported increase in plant height and shoot dry weight on application of *A. chroococcum* in maize (*Zea mays* L.). The lower increment in shoot dry weight after seed inoculation in high yielding genotypes, *viz*., Pankaj, Maita and Jaladhi-1 in comparison to the better performing local genotypes indicated that the local genotypes were more responsive to that specific inoculum than the HYV.

Significantly average longest root was observed for the genotypes Nagra and Kumargore (M) in control and bio-inoculated conditions. But, maximum changeover control was recorded for cultivar Daharnagra followed by Kalamkati, Dudkalam and Nagra. The high root length and high responsiveness towards bioinoculums for the traditional indigenous genotype may be due to their inherent potentiality for the expression of this character in comparison to high yielding genotypes. The similar trend was noted for the local genotypes, which has been supported by the reports of IRRI (1980) and observation of Ichii and Ishikawa (1997) in this respect.

Highest root fresh weight also reported for Kumargore (M) followed by Daharnagra and Nigersail. Maximum change (%) over control for this character was noted for the genotype Dudhkalma followed by Kumargore and Matla.

Kumargore (M) showed maximum root dry weight under both inoculated and controlled conditions (Table 4). The cultivars Daharnagra and Nigersail were also recorded as constantly higher performing genotypes. Whereas, maximum response over control was noted in Kalamkati, Dudhkalam and Matla. Though Kumargore (M) recorded as best performer under inoculated condition, its responsiveness to seed inoculation with *A. chroococcum* for this character, could not be recognized well. This genotype performed best for all root characters, which clearly indicates its genetic architecture suitable for vigourous root, but its increment for those parameters were not so remarkable under inculcated condition, on the other hand, the remarkable change due to bioinoculants was observed for local genotypes for all the parameters.

The trend in responsiveness for genotypes was almost similar for all the root characters, which also indicated the specificity of rice genotypes towards *A. chroococcum*. In the study on role of nitrogen fixing bacteria on the phyllosphere of wheat seedlings, Patil *et al*. (1995) observed from an *in vitro* study a higher percentage in seedling dry weight due to

Table 4 : Change (%) over control after seed inoculation for seedling

Sr. No.	Genotypes	Shoot length	Shoot fresh weight	Shoot dry weight	Root length	Root fresh weight	Root dry weight
1.	NC-1281 (M)	8.23	19.09	21.49	9.55	3.84	2.87
2.	Kalamkati (L)	6.37	14.67	14.63	22.99	17.62	27.68
3.	patnai-23 (L)	4.58	16.55	13.17	17.58	20.73	20.34
4.	Kumargore (L)	14.20	11.67	31.23	15.24	25.83	22.65
5.	Suakalam (L)	3.34	8.21	3.69	7.51	19.36	18.83
6.	Dudkalam (L)	11.31	13.86	11.22	18.86	29.41	26.66
7.	Nagra (L)	11.36	10.92	10.01	18.14	20.05	14.46
8.	Daharnagar(L)	17.09	16.03	17.62	25.53	20.96	19.57
9.	Nigersail (L)	10.97	21.30	32.36	16.32	10.05	10.37
10.	Hatipongar (L)	6.11	11.41	11.37	6.79	5.56	4.13
11.	B.U.-3(M)	13.15	9.06	11.12	8.04	11.25	11.64
12.	Chapakushi(L)	7.34	10.22	16.60	8.99	9.63	5.67
13.	Gobindabhog (L)	8.44	10.08	26.32	6.75	12.07	8.74
14.	Nuna aus (L)	11.73	14.63	16.15	8.04	9.29	9.29
15.	Lankagore(L)	12.02	11.85	17.79	12.30	15.52	16.47
16.	Mirgibalam(L)	11.16	10.20	16.40	10.68	12.80	12.99
17.	Pankaj (HYV)	12.14	5.78	10.21	16.93	19.37	17.38
18.	Matla (HYV)	13.74	7.80	10.36	17.42	21.96	24.69
19.	Jaladhi-1 (HYV)	6.01	3.96	9.89	8.91	11.23	12.37
20.	Kalmunia(L)	4.39	11.82	13.04	10.30	12.76	11.77
21.	Kumargore:M (M)	11.47	9.63	9.89	10.33	10.90	7.90
22.	Lathisail(L)	5.13	10.50	27.18	8.66	15.51	13.93
23.	Jhingasail:M (M)	5.54	7.55	20.33	5.52	8.69	6.39

inoculation with *A. chroococcum* and *Corynebacterium* sp. Significantly higher seeding height and root dry matter production in nusery plant of rice were recorded after seed treatment with *Azospirillum* and phosphorus-solubilizing bacteria along with diammonium phosphate than application of DAP alone (Natrajan and Kuppusamy, 1998). Yasari *et al*. (2009) reported enhanced growth and nutrient uptake by rapseed (*Brassica napus* L.) by applying *A. chroococcum* along with other bio-fertilizers.

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