

Response of Indian mustard (*Brassica juncea*) to biofertilizers and nitrogen

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ABSTRACT

An experiment was conducted during 1991–93 to study the effect of *Azotobacter* and *Azospirillum* inoculation at graded levels of nitrogen on Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] at Gurgaon. *Azospirillum* inoculation markedly increased pods/plant, pod length and seed yield over no inoculation. Growth and yield attributes and seed yield increased significantly with increasing doses of N up to 60 kg/ha. *Azospirillum* in combination with 60 kg N/ha recorded the highest seed yield, being significantly higher than 60 kg N/ha alone.

Inoculation of various crops by *Azotobacter* or *Azospirillum* has been found to improve yields both quantitatively and qualitatively. Bangar and Sharma (1993) observed that *Azotobacter* and *Azospirillum* increased the yield of sugarcane, wheat, tomato, potato, onion and brinjal, etc. and *Azospirillum* improved the seedling emergence, growth and productivity in pearl millet (Sangwan *et al.*, 1993). Mishustin and Shilnikova (1969), on the contrary, reported that inoculation by *Azotobacter* had little effect on crop under unmanured or mineral fertilized conditions.

The results available so far on the response of *Azotobacter* and *Azospirillum* under field conditions are not consistent and show wide variations under different situations. In view of this, it was considered imperative to study the effect of *Azotobacter* and *Azospirillum* inoculation on Indian mustard [*Brassica juncea* (L.) Czernj. &

Cosson] under graded levels of nitrogen.

MATERIALS AND METHODS

The experiment was conducted during winter season of 1991–92 and 1992–93 at Gurgaon. The soil of the experimental field was sandy loam and low in organic matter. The experiment was laid out in randomized block design with 9 combinations involving 3 inoculation treatments (I_0 , no inoculation; I_1 , *Azotobacter* and I_2 , *Azospirillum*) and 3 levels of N (N_1 , 40; N_2 , 60; and N_3 , 80 kg/ha). The culture was obtained from Department of Microbiology, CCS HAU, Hisar. Indian mustard cv 'RH 30' was sown at 30 cm x 15 cm spacing on 24 and 20 October in 1991 and 1992, respectively. Total rainfall during the crop season was 61 and 71 mm in 1991–92 and 1992–93, respectively. The inoculated seeds were dried in shade for half an hour before sowing. Half of nitrogen was drilled 5 cm below the seed as per treatment at the time

Table 1. Growth and yield attributes of Indian mustard as affected by biofertilizers and nitrogen

Treatment	Plant height (cm)		Primary branches/plant		Pods/plant		Pod length (cm)		Seeds/pod		1,000-seed weight (g)	
	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93	1991-92	1992-93
Biofertilizer												
None	157	171	4.5	5.3	220	237	3.53	3.87	13.6	13.8	6.55	6.32
<i>Azotobacter</i>	155	169	4.6	5.5	233	247	3.67	4.15	13.9	14.1	6.78	6.65
<i>Azospirillum</i>	155	167	4.7	5.5	256	254	3.76	4.21	13.9	14.3	7.03	6.74
CD (P = 0.05)	NS	NS	NS	NS	16	15	0.08	0.05	NS	0.4	NS	NS
N (kg/ha)												
40	152	162	4.4	5.1	216	229	3.55	3.68	13.7	13.7	6.49	6.26
60	155	170	4.8	5.5	240	241	3.69	4.25	13.9	14.3	6.88	6.69
80	161	175	4.9	5.7	253	269	3.72	3.41	13.8	14.3	6.79	6.72
CD (P = 0.05)	9	7	0.3	0.6	21	22	0.09	0.07	NS	NS	0.30	0.41

of sowing. Remaining half of the nitrogen was applied at the time of first irrigation.

Similar behaviour of this inoculation was also observed by Sangwan *et al.* (1973).

RESULTS AND DISCUSSION

Effect of bacterial inoculation

Azospirillum inoculation markedly increased pods/plant and pod length over no inoculation in both the seasons and seeds/pod in 1992–93 (Table 1). *Azospirillum* inoculation also proved superior to *Azotobacter* inoculation in respect of pod length in both the seasons and pods/plant in 1992–92. *Azotobacter* inoculation was effective in increasing the pod length only.

Azospirillum inoculation significantly increased the seed yield of Indian mustard over no inoculation in both the seasons (Table 2). However, the differences between *Azospirillum* and *Azotobacter* inoculation were not marked. *Azospirillum* inoculation increased the yield by 8.7 and 8.4 % over the control in 1991–92 and 1992–93 respectively. The increase in yield by *Azospirillum* inoculation could be attributed to the favourable effect on yield attributes due to nitrogen fixation ability of these bacteria.

Effect of nitrogen

Growth and yield attributes (plant height, primary branches/plant, pods/plant, pod length, 1,000-seed weight) and seed yield of Indian mustard significantly increased by N application in both the seasons (Tables 1 and 2). Application of 60 kg N/ha resulted in marked increase in plant attributes and seed yield over 40 kg N/ha. The differences between 60 and 80 kg N/ha were, however, not marked. An increase of 8.4 and 10.5 % in seed yield was obtained with 60 kg N/ha over 40 kg N/ha in 1991–92 and 1992–93, respectively. This might be attributed to the fact that applied N tended to improve plant growth and development of yield attributes which in turn resulted in increased seed yield. Padmani *et al.* (1994) also reported favourable response of Indian mustard to the application of 60 kg N/ha. This indicated the N requirement of this crop for proper growth and development.

Table 2. Seed yield and oil content of Indian mustard as affected by biofertilizer and nitrogen

Treatment	Seed yield (q/ha)		Oil content (%)	
	1991–92	1992–93	1991–92	1992–93
<i>Biofertilizer</i>				
None	19.5	17.4	41.2	41.1
<i>Azotobacter</i>	20.6	18.2	41.0	41.3
<i>Azospirillum</i>	21.3	19.0	41.5	41.3
CD (P = 0.05)	1.3	1.5	NS	NS
<i>N (kg/ha)</i>				
40	19.1	16.7	41.1	41.0
60	20.8	18.7	41.2	41.3
80	21.4	19.2	41.4	41.3
CD (P = 0.05)	1.2	1.1	NS	NS

Table 3. Plant attributes and seed yield as affected by interaction of biofertilizer and nitrogen

Year	Biofertilizer x nitrogen									CD (P = 0.05)
	I ₀ N ₁	I ₀ N ₂	I ₀ N ₃	I ₁ N ₁	I ₁ N ₂	I ₁ N ₃	I ₂ N ₁	I ₂ N ₂	I ₂ N ₃	
	<i>Plant height (cm)</i>									
1991-92	154	155	166	149	156	160	152	155	159	14
1992-93	166	171	174	167	170	172	159	169	171	12
	<i>Primary branches/plant</i>									
1991-92	4.1	4.7	4.6	4.7	4.5	4.9	4.3	4.8	5.1	0.6
	<i>Pods/plant</i>									
1991-92	199	227	235	211	231	257	274	262	268	37
1992-93	219	234	259	231	239	271	236	250	276	38
	<i>Pod length (cm)</i>									
1991-92	3.46	3.54	3.60	3.57	3.72	3.72	3.63	3.81	3.84	0.15
1992-93	3.38	4.02	4.20	3.77	4.28	4.41	3.89	4.44	4.31	0.11
	<i>1,000-seed weight (g)</i>									
1991-92	6.40	6.43	6.83	6.75	6.98	6.60	6.91	7.23	6.93	0.52
1992-93	6.13	6.41	6.42	6.34	6.59	7.03	6.42	7.08	6.72	0.69
	<i>Seed yield (q/ha)</i>									
1991-92	18.2	19.6	20.7	19.1	20.9	21.7	19.9	22.1	21.9	2.1
1992-93	16.7	17.1	18.4	16.7	18.8	19.6	16.9	20.2	18.9	1.4

Details of treatments are given in text

Interaction effects of bacterial inoculation and nitrogen

Interactions between bacterial cultures and applied nitrogen with respect to growth and yield attributes and seed yield were significant (Table 3). In general, it was observed that at the same level of N, *Azospirillum* had favourable effect on plant attributes. The effect was, however, pronounced at lower (40 kg N/ha) or moderate (60 kg N/ha) level of N supply. *Azospirillum* inoculation in combination with 60 kg N/ha gave the highest seed yield, being significantly higher over the same dose with no inoculation. *Azospirillum* is reported to perform better than *Azotobacter* under optimum moisture-supply conditions. In the present investigation, crop was never

allowed to suffer from moisture stress and hence the *Azospirillum* inoculation showed better performance. Similar observations were also made by Bangar and Sharma (1993):

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