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# EFFECT OF *AZOTOBACTER* AND *AZOSPIRILLUM* ON YIELD PERFORMANCE OF MAIZE IN HILLY REGIONS OF MIZORAM

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**Maize is the second most important crop next to paddy in *jhum* (shifting cultivation) areas of Mizoram occupying an area of 8,681 ha with a production of 16,589 metric tonnes. Maize is sown in Mizoram with the onset of monsoon rains in the *jhum* areas using chemical fertilizers at meager quantities. Since no information is available on the efficacy of biofertilizers under upland conditions of Mizoram, the present investigation was carried out to study th effect of *Azotobacter* and *Azospirillum* with and without fertilizer N on yield performance and N uptake by maize.**

A field experiment was conductd in upland terraces at ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib during *kharif* 2000. Initial soil sample was collected, processed and analyzed for textural components (Piper 1966), organic C (Walkley & Black 1934) and other chemical constituents (Jackson 1973). The experiment was laid out in a randomized block design in three replications with 10 treatments *viz.*, control, 40 kg N/ha, 60 kg N/ha, 80 kg N/ha, *Azotobacter,* 40 kg N/ha + *Azotobacter,* 60 kg N/ha + *Azotobacter, Azospirillum,* 40 kg N/ha + *Azospirillum* and 60 kg N/ha + *Azospirillum.* The experimental soil (Typic Hapludult) is sandy loam in texture, acidic in reaction (pH 4.9), medium in organic C (0.52%), low in available N (220 kg/ha), available P (7.86 kg/ha) and high in available K (160 kg/ha).

An uniform dose of P @ 60 kg $P_2O_5$/ha and K @ 40 kg $K_2O$/ha were applied at basal in the form of single super phosphate and muriate of potash, respectively. Half of the N at basal, each $^1/_4$ of N at crown root initiation and flowering stages, respectively was applied as per the treatments in the form of urea. Lime was applied uniformly @ 1 t/ha to all the plots in the last puddle. Maize (*cv* RCM 1-3) seeds were inoculated with *Azotobacter* and *Azospirillum* separately in the jaggery slurry. The inoculated dry seeds dibbled at a spacing of 45x30 cm in the respective treatments. The crop was harvested at maturity and the yield parameters like number of cobs/plant, number of rows/cob, number of grains/row, 100 grain weight, grain yield and stover yield were recorded. The plant samples were analyzed for N content by $H_2O_2$ digestion followed by steam distillation (Piper 1996) and uptake of N was computed based on yield and N concentration of the plant sample.

Per cent yield response was calculated by :

$$\frac{\text{Treatment yield (kg/ha)} - \text{control yield (kg/ha)}}{\text{Control yield (kg/ha)}} \times 100$$

Per cent uptake response :

$$\frac{\text{N uptake in treatment (kg/ha)} - \text{N uptake in control (kg/ha)}}{\text{N uptake in control (kg/ha)}} \times 100$$

Yield response per kg of applied N:

$$\frac{\text{Treatment yield (kg/ha)} - \text{control yield (kg/ha)}}{\text{Amount of applied N (kg/ha)}}$$

## RESULTS AND DISCUSSION

Grain yield and stover yield were increased significantly with the increased doses of N application up to 80 kg/ha (Table 1). All the yield attributes like number of cobs/ plant, number of rows/cob, number of grains/row, 100 grain weight were increased significantly with the application of N up to 60 kg/ha and non significantly with the further application of N up to 80 kg/ha. Among the treatments highest and significant yield (13.58 q/ha) was observed with the applicaitonof 60 kg/ha + *Azotobacter* inoculation followed by 80 kg N/ha (12.80 q/ha). It was found that higher dose of N application along with inoculation of seed with *Azotobacter* and *Azospirillum* produced highest grain and stover yields in comparison with the corresponding fertilizer N alone. This may be due to bacterization with *Azotobacter* culture helping in fixation of atmospheric nitrogen, secretion of growth promoting substances, resulting in better seed germination and expanded root system for nutrient uptake. The results of the present study are in accordance with the findings of Tomar *et al* (1995).

It was observed that seed inoculatin of *Azospirillum* along with application of N showed a marginal increase of grain yield and other yield parameters as compared to application of fertilizer N alone. *Azopirillum* inoculation have been attributed to fixation of atmospheric nitrogen by these organisms and production of indoleacetic acid, gibberellin and cytokinine like substances provided by the bacterium enhances the crop production and nutrient uptake. These results are in conformity with the findings of Yadav *et al* (1992) and Ganguly *et al* (1997). Seed inoculation with *Azotobacter* showed highest grain and stover yields than *Azospirillum* inoculation. An increase of 24 and 19% grain yield was observed with the bacterization of *Azotobacter* along with the application of 40 and 60 kg N/ha, respectively, while it was 11 and 3% with *Azospirillum* inoculation.

The uptake of N by grains and stover recorded highest (36.12 and 43.84 kg/ha, respectively) with the combined application of 60 kg N/ha + *Azotobacter,* which was higher than the application of 80 kg N/ha (34.56 and 40.74 kg/ha, respectively). An increase of 32 and 25% N uptake by grains was noticed with the inoculation of *Azotobacter* along with the application of 40 and 60 kg N/ha, respectively, while it was 17 and 4% with the inoculation of *Azospirillum* in comparison with the corresponding fertilizer N alone. Uptake of N by stover also showed similar trend.

Highest per cent yield response in respect of grains and stover (190.2 and 160.4, respectively) was recorded with the inoculation of *Azotobacter* and application of 60 kg N/ha (Table 2) followed by application 80 kg N/ha (173.5 and 155.3) and 60 kg N/ ha + *Azospirillum* (150.9 and 137.3). However, it was observed that both the biofertilizers showed lesser response with the increased doses of fertilizer N application. Significant response to inoculation of *Azotobacter* and *Azospirillum* in the presence of a limited supply of N and lesser response at higher doses of fertilizer N application was also observed in maize by Tomar *et al* (1995) and Ganguly *et al* (1997). An increase of 55 and 33% and 26 and 13% yield response was observed with the inoculationof *Azotobacter* and *Azospirillum* in comparison with the application of 40 and 60 kg N/ha. However, the uptake response by grains and stover positively increased with the application of graded doses of N in conjunction with the biofertilizers.

It was also found that highest yield response per kg of applied N (14.83) with the application of 60 kg N/ha + *Azotobacter* followed b 40 kg N/ha + *Azotobacter* (13.73) and 60 kg N/ha + *Azospirillum* (11.77). However, the yield response per kg of applied N in terms of stover yield was highest (23.15) with the application of 40 kg N/ha + *Azotobacter* and decreased with the increased doses of fertilizer N application.The increase in efficiency of fertilizers along with the application of biofertilizers depends on soil type, environmental factors, initial N status of the soil and crop genotype (Yadav *et al* 1992).

Maize showed significant response in terms of yield and N uptake with the inoculation of biofertilizers like *Azotobacter* and *Azospirillum* and limited supply of fertilizer N under upland hilly conditions of Mizoram. Application of different levels of N in conjunction with *Azotobacter* and *Azospirillum* brought about a significant response of grain yield and N uptake over its corresponding control of fertilizer N alone. Usage of N fixing biofertilizers in maize enhances the crop production improves the efficiency of fertilizers and saves the fertilizer cost to a tune of 20-30 kg N/ha.

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**Table 1. Effect *Azotobacter* and *Azospirillum* on yield parameters and uptake of N by maize**

| Treatment | No. of cobs/ plant | No. of rows/ cob | No. of grains/ row | 100 grain weight (g) | Grain yield (q/ha) | Stover yield (q/ha) | N uptake | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Grain | Stover |
| | | | | | | | ..... kg/ha ..... | |
| Control | 1.06 | 7.62 | 13.76 | 16.88 | 4.68 | 7.32 | 8.05 | 7.61 |
| 40 kg N/ha | 1.58 | 10.40 | 18.20 | 21.12 | 8.22 | 13.90 | 18.58 | 25.58 |
| 60 kg N/ha | 1.94 | 11.14 | 21.45 | 23.91 | 11.38 | 16.68 | 28.91 | 35.03 |
| 80 kg N/ha | 1.85 | 11.80 | 22.88 | 24.22 | 12.80 | 18.69 | 34.56 | 40.74 |
| *Azotobacter* | 1.22 | 8.56 | 15.50 | 19.30 | 6.75 | 9.04 | 12.83 | 13.74 |
| 40 kg N/ha + *Azotobacter* | 1.86 | 10.92 | 19.24 | 22.86 | 10.17 | 16.58 | 24.61 | 37.14 |
| 60 kg N/ha + *Azotobacter* | 2.04 | 11.84 | 23.36 | 24.52 | 13.58 | 19.06 | 36.12 | 43.84 |
| *Azospirillum* | 1.30 | 8.43 | 15.32 | 19.16 | 6.09 | 8.96 | 11.33 | 13.62 |
| 40 kg N/ha + *Azospirillum* | 1.75 | 9.97 | 18.90 | 22.24 | 9.14 | 14.62 | 21.75 | 31.58 |
| 60 kg N/ha + *Azospirillum* | 1.70 | 11.31 | 22.18 | 23.73 | 11.74 | 17.37 | 30.05 | 38.21 |
| CD (P = 0.05) | 0.27 | 0.92 | 1.07 | 0.80 | 1.41 | 1.26 | 5.77 | 5.47 |



**Table 2. Response of *Azotobacter* and *Azospirillum* on maize**

| Treatment | Per cent yield response | | Per cent uptake response | | Yield response per kg of applied N | |
|---|---|---|---|---|---|---|
| | Grain | Stover | Grain | Stover | Gran | Stover |
| 40 kg N/ha | 75.6 | 89.9 | 130.8 | 236.1 | 8.85 | 16.45 |
| 60 kg N/ha | 143.2 | 127.9 | 259.1 | 360.3 | 11.17 | 15.60 |
| 80 kg N/ha | 173.5 | 155.3 | 329.3 | 435.3 | 10.25 | 14.21 |
| *Azotobacter* | 44.2 | 23.5 | 59.4 | 80.6 | - | - |
| 40 kg N/ha +*Azotoacter* | 117.3 | 126.5 | 205.7 | 388.0 | 13.73 | 23.15 |
| 60 kg N/ha + *Azotobacter* | 190.2 | 160.4 | 348.7 | 476.1 | 14.83 | 19.57 |
| *Azospirillum* | 30.1 | 22.4 | 40.7 | 79.0 | - | - |
| 40 kg N/ha + *Azospirillum* | 95.3 | 99.7 | 170.2 | 315.0 | 11.15 | 18.25 |
| 60 kg N/ha +*Azospirillum* | 150.9 | 137.3 | 273.3 | 402.1 | 11.77 | 16.75 |