P3TIR/P.94/2002

THE EFFECT OF *AZOSPILLUM* INOCULATION AT TWO SUB-OPTIMAL FERTILIZER N DOSES ON PLAMT PERFOMANCE AND YIELD OF MAIZE

Soertini Gandanegara, Sudono Slamet,
Wayan sabe Ardjasa, Harmastini Sukiman,
Dini Ariani, Sylvia Lekatompessy

THE EFFECT OF *AZOSPILLUM* INOCULATION AT TWO SUB-OPTIMAL FERTILIZER N DOSES ON PLANT PERFOMANCE AND YIELD OF MAIZE

SOERTINI GANDANEGARA[1], SUDONO SLAMET[1], WAYAN SABE ARDJASA[2], HARMASTINI SUKIMAN[3], DINI ARIANI[3], SYLVIA LEKATOMPESSY[3]

[1] *Center for Research and Development for Isotope and Radiation Technology, National Nuclear Energy Agency, P.O. Box 7002, Jakarta 12070,* [2]*Instalation for Research and Agriculture Technology Evaluation, Dept. of Agriculture, Kotak Pos 2, Purbolinggo 34192, East Lampung,* [3]*Research and Development Center for Biotechnology, Indonesian Institute for Sciences, P.O. Box 422, Bogor*

One field experiment has been conducted at Karangrejo, East Lampung to study the effect of inoculation of some selected *Azospirillum* isolates at two sub-optimal N doses on growth and yield in maize cv Bisma. Long drought occurred after the 2nd N fertilizer application affected further plant growth obviously due to water stress. Observation at flowering stage shown that *Azospirillum* inoculation improved drought tolerance as shown in higher plant population, increasing plant dry matter and plant N yield in inoculated plots. At grain maturity, grain yield response to inoculation and N rates were different emphasized further selection of *Azospirillum* isolates.

Key words : N fertilizer rates, *Azospirillum* inoculation, drought tolerance, maize.

Introduction

Among the free living rhizopheric bacteria, *Azospirillum* is getting more attention due to their beneficial effect on plant growth and crop yield of agronomic importance. Various reports indicated that inoculation of *Azospirillum* in forage grass may increased dry matter of *Pennisetum* and *Panicum* (1) as well as grain yield in cereals, such as wheat (2) and maize (3). In Indonesia, Government self sufficiently program in maize resulted the increase of production, from 6,869,000 ton in 1994 to 9,345,000 ton in 2000 (4). To obtain optimum growth and production of maize, considerable amount of N fertilizer is needed with N rates around 120-135 kg N ha^{-1}. Some reports mentioned that *Azospirillum* inoculation could reduce the use of N fertilizer with the increase of grain yield in cereals (5). Furthermore, more success on *Azospirillum* inoculation on grain yield achieved at intermediate rate of fertilizer (6,7). The objective of this experiment was to study the effect

of three selected *Azospirillum* isolates on two sub-optimal N fertilizer rates on the plant perfomance of maize *cv.* Bisma.

Materials and Methods

Bacterial and growth condition

Azospirillum isolates RDCB Az 1, Az 7, and Batan BtJ. No. 08 were used in the study (Table 1). The individual isolates were cultured separately in MPSS broth (8) in a shaker bath in 250 ml flasks at 28°C for 24 hrs. The broth were adjusted to 10^8 cfu ml^{-1} using Spectrophotometer at OD 520 uM. Inoculants were made by injecting each culture into peat which previously sterilized by gamma irradiation of ^{60}Co at 50 kGy.

Field experiment

Field experiment was conducted at Karangrejo, East Lampung, Sumatera during Wet Season 1999/2000. The soil was red yellow podzolic with pH 4.5; organic matter 1.17%; N(Kjeldahl) 0.14 %; P(Bray-1) 10.9 ppm, and Al saturation 68%. The experiment design was in a split plot with four replicates. The treatments consisted of inoculation (control, inoculated with *Azospirillum* isolates RDCB Az 1, Az 7, and Batan BtJ No. 8) assigned as main plot. Two suboptimal dose of N fertilizer (45 and 60 kg N ha^{-1}) assigned as sub-plot.

Maize seeds cv. Bisma were mixed with peat based inoculant at 600 g/ha and grown in sub-plots with size measured 5.00 m long x 4.50 m wide. Rows were spaced 75 cm apart and three seeds were placed in each hill. Ten days after planting (DAP) plants were thinned to 2 plants/hill. Basal fertilization P and K at 90 kg P_2O_5(SP-36) ha^{-1} and 60 kg K_2O(KCl) ha^{-1} applied side banded. N fertilizer (urea) were applied 2 times. First at 30 kgN ha^{-1} at 7 DAP together with basal fertilizer, and the rest at 30 DAP.

Agronomic characters and analyses.

At flowering (FL) stage, 63 DAP, 10 plants were harvested and agronomic characters (plant height to the 3rd internode, length of the inflorescence and the 3rd leaf below) were measured according to Cohen *et al* (6). All plant materials were dried at 70°C for 48 hrs, weighed and ground. Plant samples were then analysed for %N by the Kjeldahl. At grain maturity, yield components (ear weight/plant and grain/plant) were measured.

Result and Discussion

Long drought followed after 2nd N application inhibited further plant growth obviously to water stress. However, the effect of *Azospirillum* inoculation on improving early plant growth still could be observed at FL stage by higher plant population in

inoculated plots. Higher seedling emergence might be due to the improvement of water plant status of inoculated plants as mentioned by Sarig *et al* (9). The effect of the treatments on agronomic characters and %N, and N yield were shown at Table 2. Significant increase on plant growth (99%) and N yield (44%) by inoculation were observed. This condition apparently was the effect of growth hormone and not N fixation activities. Similar results were also reported in maize and *Setaria* (6) and some summer crops (1). While the inhibition of further plant growth shown in the insignificant difference on some agronomic characters.

At grain maturity, the effect of inoculation and N rates was shown in Table 3. At low N rate, inoculation increased grain 44 - 57%, while at higher N rate the grain yield increased only 19% (Table 3). Those different response among *Azospirillum* isolates on yield components emphasized the importance further selection of isolates *Azospirillum.*

Acknowledgement

This research was supported in part by the International Atomic Energy Agency (IAEA) TC Project No. INS. 5/028.

Table 1. Origin of *Azospirillum* isolates

Isolates	Origin
RDCB Az 1	Rice root, root washed, Cugenang, Cianjur, West Jawa
RDCB Az 7	Maize root, root washed, Cugenang, Cianjur, West Jawa
Batan BtJ. No. 08	Maize root, root washed, Subang, West Jawa

Table 2. The effect of *Azospirillum* inoculation and N doses on plant growth and agronomic characters at flowering stage

Treatment		Plant Height, cm	Length of, Infl., 3 rd Leaf ..... cm		Dry Matter, gr	N Percent., %	N yield, mg N/plant
Control	45 N	11.30	22.02	38.28	56.75	1.93	108.0
	60 N	14.56	32.86	38.78	60.25	1.97	116.9
RDCB Az 1	45 N	14.57	31.83	39.43	114.25	1.66	183.6
	60 N	15.25	34.63	41.38	138.00	1.86	254.2
RDCB Az 7	45 N	15.11	32.64	40.90	114.00	1.55	178.0
	60 N	20.03	30.14	41.73	116.25	1.81	212.0
Batan BtJ 08	45 N	12.68	32.63	37.58	97.25	1.83	168.7
	60 N	16.00	32.27	43.43	118.25	1.82	185.4
LSD, 0.05	I	n.s	n.s	n.s	33	n.s	43.8
	N	2.1	n.s	1.51	n.s	n.s	n.s
	I x N	n.s	n.s	n.s	n.s	n.s	n.s
C.V., %		25	16	7	12	12	29

Note : n.s = not significant, ifl. = inflorescensce

Table 3. The effect of *Azospirillum* inoculation and N rates on yield components

Treatment		Grain/plant ... gr ..	Ear weight, ... gr	Ear numbers, .. pcs ..
Control	45 N	8.86	19.96	12.00
	60 N	16.64	31.06	14.25
RDCB Az 1	45 N	13.89	21.24	22.00
	60 N	11.79	21.22	26.00
RDCB Az 7	45 N	12.82	31.34	27.50
	60 N	19.81	36.56	25.75
NNEA BtJ. 08	45 N	13.23	22.87	19.25
	60 N	17.64	30.17	27.00
LSD, 0.05	I	n.s	4.20	n.s
	N	2.69	10.07	n.s
	I x N	5.38	n.s	n.s
C.V., %		24	25	25

References

1. Smith, R. L., Schank, S. C., Bouton, J. R and Quesenberry. K.H.(1978). Yied increase in tropical grasses after inoculation with *Spirillum lipoferum. Ecological Bulletin* Stockholm) **26**: 380-385.
2. Boddey, R. M., Baldani., V. L. D., Baldani, J. I. and Dobereiner. J.(1986). Effect of inoculation of *Azospirillum* spp on nitrogen accumulation by field grown wheat.*Plant and Soil.* **95**: 109-121
3. Vasuyat, Y., Fangcham, B., Siripin, S., Fusang, D. and Chan-a-ram, P. (1986). Yield maximization of feed grain by associative N_2 fixing bacteria. *In* Proc. International Seminar on yield Maximination of Feed Grain Through Soil and Fertilizer Management, Bangkok, Thailand, 12-16 May
4. Central Bureau of Statistics. 2001
5. National Institut of Biotechnology and Genetic Engineering. 1998. Activity Report, Fausalabad, Pakistan.
6. Cohen, E., Okon, Y., Kigel, J., Noor, I. and Henis. Y.(1980). Increase in Dry Matter and Total Content in *Zea mays* and *Setaria italica* Associated with Nitrogen Fixing *Azospirillum* spp. *Plant Physiol.* **66**:746-749
7. Okon, Y. and Labandera Gonzales. C. A. (1994). Review. Agronomical Applications of *Azospirillum* : an evaluation of 20 years worldwide field inoculation. Soil Biol.Biochem. **26**: 1591-1601
8. Krieg, N.R. and Dobereiner. J. (1984). Genus *Azospirillum. In* Krieg, N. R., and Holt, J.E.(Eds). Bergey's Manual of Systematic Bacteriology. Vol. 1.Williams and Wilkins. Baltimore/London. p.94-103
9. Sarig, S., Blum, A. and Okon.Y. 1988. Improvement of the water status and yield of field grown sorghum (*Sorghum bicolor*) by inoculation with *Azospirillum brasilense. J. Agric. Sci. Camb.* **110**:271-277