A FIELD TRIAL TO STUDY THE EFFECT OF *AZOSPIRILLUM BRASILENSE* AND *PSEUDOMONAS STRIATA* AS INOCULANTS AND INSECTICIDE CARBOFURAN ON GROWTH PARAMETERS OF SORGHUM CROP

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Abstract: The field trial with inoculants *Azospirillum brasliense* and *Pseudomonas striata* and insecticide carbofuran showed significant increase in grain yield, there was significant decrease in dead heart formation with carbofuran. With application of ammonium sulphate at the rate of 100kg N/ha a yield of 34.75g/ha was obtained and with *Azospirillum* a yield of 32.0g/ha was obtained. The results clearly indicated that inoculation with *A. brasliense* could save about 60kgN/ha since a basal dose of 40kgN/ha as ammonium sulphate was provided.

Keywords: *Azospirillum brasliense, Pseudomonas,* Nitrogen uptake

INTRODUCTION

If biological nitrogen fixation could replace the chemical nitrogen for the crop productivity even in part, food production targets could be obtained without the application of high level of chemical fertilizer the application of *Azospirillum brasliense* a *Pseudomonas striata* have gained importance as a inoculants in the rhizosphare of cereals plants as biological nitrogen fixers. The main reason of their acceptance has been increasing cost of chemical fertilizers, secondly the energy needed for their metabolism is much less as compared to other non symbiotic bacterial inoculants. On the other hand they can survive and resist high soil temperature of tropical and subtropical areas the use of biological nitrogen fixers has been increasing around the world at a steady rate.

MATERIALS AND METHODS

The field experiment was conducted at Indian Agricultural Research Institute Agricultures farm New Delhi with Sorghum crop var. Swarna as test crop. Ten treatments were used in 40 plots (14'x30') as listed in plan layout (Table 1) Effect of inoculation of seeds with *Azospirillum brasliense* strain 251 and *Pseudomonas striata* with two nitrogen levels at the rate of 100 kgN/ha and 40kgN/ha as ammonium sulphate. Insecticide carbofuran was applied to seed furrows. The observations were recorded of the *Azospirillum* population in the rhizosphere at vegetative and harvest stage, nitrogen percentage at vegetative flowering and harvest stage, dead hearts percentage, carbofuran residue grain yield q/ha and Nitrogen uptake by grains. Kg/ha. A uniform basal dose of 40kg N/ha with $60KgP_2O_5$/ha was applied at the time of final field preparation and mixed with the soil but in the last two treatments (T_9 and T_{10}) two split doses of 30 kg N/ha were applied after 25 days and 45 days of sowing *i.e.* (40+30+30=100 kg N/ha). The seeds were soaked in culture solutions of inoculants used as per treatment for two hours and then dried under shade. The seeds were dibbled with hand in rows and covered immediately after applying carbofuran in furrows. Total five irrigations were given and the soil moisture ranged between 17.4 to 20.5% with an average of 19.6% the counts of dead hearts formed due to shoot fly damage were taken on 20^{th} day after germination *Azospirillum brasliense* and *Pseudomonas striata* population in the rhizosphere were estimated by NPN using serial dilution method (Cappuccino and Sherman 1992) at vegetative and harvest stages. Analysis of carbofuran residue in plants was done using the GLC method (Cook *et. al.,* 1969) Nitrogen was estimated by Technicon autonalyser.

RESULTS

The population of *Azospirillum brasliense* and *Psuedomonas striata* is presented in Table 2. The number of *Azospirillum* ranged between $1.1x10^7$ and $20x10^7$/g dry soil in control and *Azospirillum* inoculated soil at 25 days of vegetative growth of sorghum plants. Carbofuran treatment increased their population by about 13 and 3.6 times over control at vegetative and harvest stage

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respectively. The (13.6 x 10^7/g soil) population was observed in carbofuran treated soil where *Azospirillum brasliense* alone showed a population of 20x10^7g and 9.2x10^5g/soil at vegetative and harvest stages respectively.

Nitrogen:

The nitrogen percentage was estimated at vegetative, flowering and harvest stages and are presented in Table 3. The nitrogen percentage increased in all the treatments in comparison to control, but the maximum nitrogen percentage was observed with *Azospirillum brasliense* treatment which was 2.0%, 1.50%, and 0.84% at vegetative flowering and harvest stages. The results of the effects of inoculants and carbofuran on dead heart percentage, carbofuran residue percentage, grain yield q/ha and nitrogen uptake kg/ha have been presented in Table 4.

Table 1. Plan of Layout

R IV	T_3	T_1	T_5	T_8	T_{10}	T_6	T_4	T_2	T_7	T_9
R III	T_6	T_5	T_1	T_{10}	T_9	T_7	T_4	T_3	T_2	T_8
R II	T_5	T_9	T_6	T_4	T_8	T_2	T_7	T_{10}	T_1	T_3
R I	T_1	T_2	T_3	T_5	T_7	T_8	T_4	T_9	T_4	T_{10}

Experiment design : RBD
Number of supplication : 4
Total Number of Plots : 40
Gross Size : 14f x 30f
Distance between replication : 75cm
Distance between Row to Ro : 75cm
Distance between plant to plant : 15 cm

T 1 - N40
T2 - N40 + Carbofuran
T3 - N40 + *A. brasliense*
T4 - N40 + *A. brasliense* + Carbofuran
T5 - N40 + *P. striata*
T6 - N40 + *P. striata* + Carbofuran
T7 - N40 + *P. striata* + *A. brasliense*
T8 - N40 + *P. striata* + *A. brasliense* + *Carbofuran*
T9 - N100
T10 - N110 + Carbofuran

Table 2. Counts of *Azospirillum brasilense* in the rhizosphere of sorghum crop

Treatments	Vegetative Stage g10^7/g soil	Harvest Stage g10^5/g soil
Control (Untreated seeds)	1.1	1.5
Carbofuran	13.6	5.4
Azospirillum brasliense	20.0	9.2
Pseudomonas striata* + *Azospirillum brasilense	15.6	8.0
***P. Striata* + *A. brasilense* + Carbofuran**	2.42	1.7
***Azospirillum brasilense* + Carbofuran**	2.43	0.2
S±em	0.1	0.2
C.D.at 5%	0.36	0.02

Table 3. Nitrogen percentage at vegetative, flowering stage and harvest stage of sorghum crop

Treatments	Vegetative Stage (25 days after) germination	Flowering Stage 60 dyas after germination	Harvest Stage
Control (Untreated seeds)	1.0	1.04	0.60
Azospirillum brasliense	2.00	1.50	0.84
***A. brasliense* + Carbofuran**	1.20	1.07	0.70
Pseudomonas striata	1.65	1.12	0.67
***P. Striata* + Carbofuran**	1.65	1.00	0.70
A. brasliense* + *P. Striata	1.80	1.04	0.65
***A. brasliense* + *P. Striata* + Carbofuran**	1.25	0.97	0.50
S±em	0.63	0.93	0.6
C.D.at 5%	0.08	0.03	0.08

Table 4. Effect of Microbial inoculants and insecticide carbofuran on dead hearts, insecticide residue grain yield and nitrogen uptake by sorghum crop

Treatments	Dead hearts (%)	Carbofuran residue (%)	Grain Yield (q/ha)	Nitrogen uptake in grains (kg/ha)
Control (40kg N/ha)	20.56 (26.36)	-	16.66	26.15
40kg N/ha Carbofuran	2.56 (7.58)	1.84	28.98	42.6
40kg N/ha *Azospirillum brasilense*	17.56 (24.56)	-	27.03	45.95
40 + *A. brasliense* + Carbofuran	2.60 (6.59)	0.60	32.00	50.24
40 + *Pseudomonas striata*	17.15 (24.01)	-	26.11	37.37
40 + *P. Striata* + Carbofuran	2.73 (2.43)	2.86	28.06	42.03
40 + *A. brasliense* + *P. Striata*	12.39 (19.76)	-	24.37	38.26
40 + *A. brasliense* + *P. Striata* + Carbofuran	1.73 (7.38)	1.74	31.29	49.12
100kg N/ha	24.79 (29.61)	-	23.99	33.58
100kg N/ha + Carbofuran	3.48 (10.49)	1.00	34.75	57.33
S±em	2.59	-	1.90	2.88
C.D.at 5%	12.83	-	5.52	11.29

Actual values of death hearts given in the parenthesis.
Values obtained by transformation are outside the parenthesis.

Dead hearts formation:

The effect of carbofuran application on dead heart formation in carbofuran treated plots varied from 1.73% to 3.48% in comparison to non treated plots (20.56%) carbofuran treatment reduced the loss due to dead heart formation significantly. Treatment with full dose of fertilizer 100kg N/ha showed 24.79% and 40kg N/ha 20.56% of dead heart formation. Carbofuran residue percentage varied from 0.60% to2.86% since the level of carbofuran in plant tissues depends upon the amount of carbofuran present in soil, this study indirectly showed that inoculation of sorghum seeds with *Azospirillum* and *Pseudomonas* cultures did not enhance the biological degradation of carbofuran in soil. There was significant increase in grain yield in all the treatments the maximum grain yield was obtained with 100 kg N/ha with carbofuran (34.75g/ha) *Azospirillum brasliense* with carbofuran recorded a yield of 32.0g/ha. This clearly indicated that inoculation with *Azospirillum brasliense* could save about 60kgN/ha since a basal dose of only 40kgN/ha was provided. The maximum nitrogen uptake in grains was observed with 100 kg N/ha + Carbofuran treatment followed by 40kg N/ha + *A. brasliense* + carbofuran which showed a uptake of 50.24kg N/ha which was statistically at par with N100+Carbofuran (57.33 kg/ha). The application of carbofuran controlled the dead heart formation in sorghum crop. The control of dead hearts from carbofuran was earlier reported by Jotwani and Sukhani (1968) The present study has showed that inoculation with *Azospirillum brasliense* or *P. striata* cultures in compatable with carbofuran treatments. The effect on yield was more pronounced with *A. brasliense* which showed a significant increase in yield However there was no further gain due to combined inoculation in grain yield. Kapulnik *et. al.* (2008) have reported the favourable effect of *A. brasliense* on the different growth parameters of wheat Cv. Nirias the maximum nitrogen uptake in grains followed by *A. brasliense* + Carbofuran treatment. Bouton and Zuberer (1979) has studied the nitrogen uptake by *Panicum maximum* in humid sub tropical conditions and have reported an increase in the uptake with fertilzer application. Nayak and Rao (1980) have also observed increased nitrogen fixation in rice fields. Rajeshkharan *et al.* (2007) observed similar results with green gram with inoculants. Recently many reports have appeared suggesting beneficial effect of using *Azospirillum* alone or in association with other free living bacteria. Yeole (1997); Yahalom *et al.* (1990); Sarig and Kapulnik (2006); Richardson (2004); Sivaramariah *et al.* (2007).

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