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STUDIES ON THE ROLE OF *AZOSPIRILLUM* SP., PHOSPHOBACTERIA AND FLY ASH ON THE GROWTH AND YIELD OF BHENDI (*ABELMOSCHUS ESCULENTUS* L.)

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Abstarct

A pot culture experiment was conducted at the Department of Microbiology, Faculty of Agriculture, Annamalai University to study the effect of biofertilizers and lignite Fly ash on the growth and yield of Bhendi. The biofertilizers viz., Azospirillum and Phosphobacteria were isolated from different locations of cuddalore district. The isolates were screened for their efficiency in nitrogen fixation, phosphate solubilization, IAA production, etc. Fly ash, a waste generated from coal mines (lignite) was obtained from Neyveli Lignite Corporation (NLC). The major role of Fly ash are it changes the soil $_{pH}$ thereby increases water holding capacity of soil and increases both uptake of native and applied nutrients by crop. The biofertilizers Azopirillum, Phosphobacteria and Fly ash were applied to Bhendi crop by framing various treatment schedules to study their performance. Among the different treatments studied, the treatment T_{12}(AZS+PB + LFA@40tha^{-1}) showed maximum plant height (47.10), root length (21.63cm), number of flowers per plant (31.66), number of fruits per plant (29.66) and fruit yield was 92.43 gm per plant. The experiment revealed that application of biofertilizers and Fly ash increases soil fertility which in turn increases the fruit yield of Bhendi.

Key words: Azopirillum, Bhendi, Biofertilizers, Fly ash, Phosphobacteria

Introduction

India is the second largest producer of vegetables in the world and accounts for about ten percent of world's production. Bhendi (*Abelmoschus esculentus)* is one major vegetable crop which is grown throughout the year in India. However, bhendi crop produces low yield due to several abiotic and biotic factors. Nowadays, the usage of biofertilizers is increasing among the vegetable crops by replacing the use of chemical fertilizers. The most important macronutrient required for the plant growth is Nitrogen. Among the biofertilizers, *Azospirillum* sp. is known to fix atmospheric nitrogen in crops and also involves in the production of plant growth promoting substances. Inoculating the *Azospirillum* sp. to the crops is known to increase the crop yield by 5-20 percent and also involves in saving chemical nitrogen usage upto 50 per cent from the recommended dose of fertilizer (Dart, 1986).

Next to nitrogen, phosphorus is the second essential macronutrient required for crop production which comprises around 0.2 percent of the plant dry weight. The efficient phosphate solubilizers *were used to* solubilize fixed phosphorus from the soil their by make the availability of phosphorus to crop (Sharma and Bhalla, 1986). Fly ash is one of waste generated from coal mines (lignite)) and contains several elements which are used for the crop growth. Fly ash application at higher rates around 200 to 800 tons per hectare will improve the physical, chemical and biological properties of soil. In agriculture, Fly ash is used as a nutrient source and can also be used as a suitable liming agent in acidic agricultural soils (Adriano *et al.*, 1980) and to correct nutrient deficiency or increase nutrient uptake of crops (Manoharan, 1996). A pot culture experiment was carried out in the Department of Microbiology, Faculty of Agriculture, Annamalai University to study the effect of biofertilizers Azospirillum and Phosphobacteria and Fly ash on the growth of Bhendi

Materials and methods

Isolation of *Azospirillum* and *Phosphobacteria*

The bhendi rhizosphere soil samples were collected from different locations in cuddalore district and the

collected soil samples were used for the isolation of *Azospirillum* and *Phosphobacteria*. NFB and Pikovskaya medium were used to isolate Azospirillum and PHOSPHOBACTERIA respectively. The isolates were studied for their characterization and efficiency. The isolates and lignite fly ash were inoculated to the crop with different treatments. The experimental design was CRD. The treatment details are:

Treatment	Treatment details
T_1	Control
T_2	AZS
T_3	PB
T_4	AZS + PB
T_5	LFA @ 20 t ha^{-1}
T_6	LFA @ 40 t ha^{-1}
T_7	AZS + LFA @ 20 t ha^{-1}
T_8	AZS + LFA @ 40 t ha^{-1}
T_9	PB + LFA @ 20 t ha^{-1}
T_{10}	PB + LFA @ 40 t ha^{-1}
T_{11}	AZS +PB + LFA @ 20 t ha^{-1}
T_{12}	AZS + PB + LFA @ 40 t ha^{-1}

AZS – *Azospirillum,* PB -*Phosphobacteria,* LFA- Lignite Fly Ash

Nitrogen, phosphorus and potassium were applied @ 40: 50: 30kgha^{-1} for all the treatments including control (absolute).

Biometric Observations

The plant growth parameters such as plant height, root length, number of flowers per plant, number of fruits per plant, fruit yield, dry matter production of the crop and also the nutrient uptake such as NPK and NPK content were observed from these treatments at 30, 60 and 90 DAS.

Results

Effect of *Azospirillum* , *P*hosphobacteria and Fly ash on plant height and root length of Bhendi

In the experimental study, among the all treatments, the maximum plant height and root length was recorded maximum on 90th day in the treatment T_{12} (47.10cm) (21.63cm) followed by the treatment T_{11} (45.36cm) (19.66cm). The minimum plant height and root length was recorded in the treatment T_1control (33.20 cm) (15.93cm). The data pertaining to plant height and root length were presented on Table 1.

Effect of *Azospirillum, Phosphobacteria* and Fly ash on number of flowers plant^{-1}, number of fruits plant^{-1} and yield of Bhendi.

In the experimental study, among the treatments, the maximum number of flowers per plant, number of fruits per plant and were recorded on the treatment T_{12} (31.66) (29.66) and (92.43gm/pt) followed by the treatment T_{11} (29.33) (27.33) and (89.70gm/pt). The minimum number of flowers plant^{-1}, number of fruits plant^{-1} and yield on bhendi recorded in the T_1control (17.33) (14.66) and (80.33gm/pt). These data were presented on the Table 2.

Effect of *Azospirillum, Phosphobacteria* and Fly ash on dry matter production plant^{-1} of Bhendi.

In the experimental study, among the treatments, the dry matter production of bhendi was recorded maximum on 90th day for the treatment T_{12} (19.00 gm plant^{-1}) followed by the treatment T_{11} (18.79 gm plant^{-1}). The minimum number of flowers plant^{-1}, number of fruits plant^{-1} and yield on bhendi recorded in the T_1control (10.75 gm plant^{-1}). These data were presented on the Table 3.

Effect of *Azospirillum, Phosphobacteria* and Fly ash on N, P and K uptake of Bhendi.

The nitrogen, phosphorus and potassium uptake by bhendi are presented in Table 4.

The uptake of nitrogen has been ranged from 39.24 to 47.00 kg ha^{-1}. Maximum uptake of N (46.22 kg ha^{-1}) was recorded in the treatment T_{12} -AZS + PB + LFA@40 t ha^{-1} which was followed by T_{11} –AZS + PB + LFA @

Table 1: Plant height and root length

Treatments	Plant height (cm) Days after sowing			Root length (cm) Days after sowing		
	30	60	90	30	60	90
T_1–Control	12.20	22.63	33.20	9.16	12.36	15.93
T_2 - AZS	13.83	28.30	38.23	10.53	13.23	17.43
T_3– PB	13.43	27.33	37.26	10.16	13.06	17.03
T_4 – AZS +PB	14.13	29.26	39.30	11.06	13.53	17.70
T_5 – LFA@20t ha^{-1}	12.83	24.66	35.50	9.36	12.56	16.66
T_6 - LFA @ 40 t ha^{-1}	13.03	26.53	36.13	9.73	12.83	16.89
T_7 – AZS + LFA @20 t ha^{-1}	15.16	32.76	43.26	12.03	14.26	18.33
T_8 – AZS + LFA @ 40 t ha^{-1}	15.60	33.63	44.13	12.43	14.70	18.80
T_9 – PB + LFA @ 20 t ha^{-1}	14.33	30.23	40.46	11.16	13.70	17.96
T_{10} – PB + LFA @ 40 t ha^{-1}	14.66	31.53	41.33	11.66	14.00	18.00
T_{11} –AZS + PB + LFA @ 20 ha^{-1}	16.43	34.26	45.36	12.90	15.26	19.66
T_{12} –AZS + PB + LFA @40 t ha^{-1}	17.33	36.30	47.10	14.40	17.26	21.63
SED	0.15	0.16	0.18	0.16	0.10	0.15
CD (p=0.05)	0.30	0.32	0.36	0.32	0.21	0.31

Table 2: *Azospirillum, Phosphobacteria* and Fly ash on number of flowers plant, number of fruits plant and yield of Bhendi.

Treatments	No. of flowers plant^{-1} 30 DAS	No. of fruits plant^{-1} 60 DAS	Yield (gm/pt) 90 DAS
T_1 – Control	17.00	14.33	80.33
T_2 – AZS	22.66	19.66	85.66
T_3 – PB	21.66	18.66	85.78
T_4 –AZS + PB	24.00	18.00	86.14
T_5 – LFA @ 20 t ha^{-1}	19.33	16.33	83.60
T_6 – LFA @ 40 t ha^{-1}	21.00	18.00	83.65
T_7 – AZS + LFA @20 t ha^{-1}	27.00	25.33	87.06
T_8 - AZS + LFA @40 t ha^{-1}	28.66	26.00	87.70
T_9 - PB + LFA @20 t ha^{-1}	25.66	23.00	86.48
T_{10} - PB + LFA @40 t ha^{-1}	26.33	24.33	86.15
T_{11} - AZS +PB+ LFA @20 t ha^{-1}	29.33	27.33	89.70
T_{12} - AZS +PB+ LFA @40 t ha^{-1}	32.33	30.66	92.17
SED	0.28	0.29	0.13
CD (p = 0.05)	0.56	0.58	0.26

Table 3: Effect of *Azospirillum, Phosphobacteria* and Fly ash on dry matter production plant^{-1}of Bhendi.

Treatments	Dry matter production (gm/pt) Days after sowing		
	30	60	90
T_1 - Control	1.24	3.16	10.75
T_2 - AZS	1.86	4.15	13.43
T_3 - PB	1.60	3.95	12.54
T_4 - AZS +PB	2.07	4.55	15.38
T_5 - LFA@20t ha^{-1}	1.36	3.49	10.32
T_6 - LFA @ 40 t ha^{-1}	1.43	3.72	11.26
T_7 -AZS + LFA@ 20 t ha^{-1}	3.20	5.73	17.03
T_8 - AZS + LFA @ 40 t ha^{-1}	3.80	6.12	17.90
T_9 - PB + LFA @ 20 t ha^{-1}	2.50	4.97	16.58
T_{10} - PB + LFA @ 40 t ha^{-1}	2.85	5.42	16.68
T_{11}-AZS + PB + LFA @ 20 ha^{-1}	4.62	6.51	18.79
T_{12} -AZS + PB + LFA @40 t ha^{-1}	5.37	7.84	19.00
SED	0.11	0.17	0.10
CD (p=0.05)	0.23	0.34	0.32

20 ha^{-1} (45.68 kg ha^{-1}). Minimum uptake of 'N' was recorded in T_1 control (39.24 kg ha^{-1}).

The uptake of phosphorus has been ranged from 9.37 to 15.78 kg ha^{-1}. Maximum uptake of 'P' was recorded in the treatment T_1 -AZS + PB + LFA@40 t ha^{-1} (14.78 kg ha^{-1}) which was followed by T_{11} –AZS + PB + LFA @ 20 ha^{-1} (13.83 kg ha^{-1}). Minimum uptake of 'P' was recorded in T_1 control (9.36 kg ha^{-1}).

The uptake of potassium has been ranged from 42.15 to 52.63 kg ha^{-1}. Maximum uptake of 'K' was recorded in the treatment T_{12} AZS + PB + LFA@40 t ha^{-1} (50.63

Table 4: Effect of *Azospirillum, Phosphobacteria* and Fly ash on N, P and K uptake of Bhendi.

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})
	30	60	90
T_1 – Control	39.24	9.36	42.15
T_2 – AZS	44.12	10.89	48.85
T_3 – PB	42.49	11.99	47.83
T_4 – AZS + PB	42.92	11.54	48.37
T_5 – LFA @ 20 t ha^{-1}	41.14	10.71	46.84
T_6 – LFA @ 40 t ha^{-1}	42.01	10.78	47.17
T_7 – AZS + LFA @20 t ha^{-1}	44.41	11.00	50.05
T_8 - AZS + LFA @40 t ha^{-1}	44.70	11.24	50.80
T_9 - PB + LFA @20 t ha^{-1}	43.31	12.19	49.26
T_{10} - PB + LFA @40 t ha^{-1}	43.84	12.87	49.54
T_{11} - AZS +PB+ LFA @20 t ha^{-1}	44.62	12.44	40.33
T_{12} - AZS +PB+ LFA @40 t ha^{-1}	46.22	14.78	50.72
SED	0.23	0.23	0.23
CD (p = 0.05)	0.47	0.47	0.46

Table 5: Effect of *Azospirillum, Phosphobacteria* and Fly ash on N, P and K content of Bhendi.

Treatments	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
	30	60	90
T_1 – Control	92.11	10.62	137.61
T_2 – AZS	97.95	12.14	141.52
T_3 – PB	94.20	12.24	146.09
T_4 – AZS + PB	96.89	12.78	141.91
T_5 – LFA @ 20 t ha^{-1}	93.48	11.96	139.75
T_6 – LFA @ 40 t ha^{-1}	93.68	12.03	140.61
T_7 – AZS + LFA @20 t ha^{-1}	98.99	12.25	143.01
T_8 - AZS + LFA @40 t ha^{-1}	100.79	12.48	143.30
T_9 - PB + LFA @20 t ha^{-1}	94.91	14.21	142.44
T_{10} - PB + LFA @40 t ha^{-1}	95.91	14.73	142.72
T_{11} - AZS +PB+ LFA @20 t ha^{-1}	101.26	14.86	143.28
T_{12} - AZS +PB+ LFA @40 t ha^{-1}	103.50	18.80	147.60
SED	0.23	0.05	0.03
CD (p = 0.05)	0.47	0.10	0.07

kg ha^{-1}) which was followed by T_{11} –AZS + PB + LFA @ 20 ha^{-1} (51.07 kg ha^{-1}). Minimum uptake of 'K' was recorded in T_1 control (42.15 kg ha^{-1}).

Effect of *Azospirillum, Phosphobacteria* and Fly ash on N, P and K content of Bhendi.

The available nitrogen, phosphorus and potassium in the rhizosphere soil of bhendi are presented in Table 5.

The maximum availability of nitrogen was recorded in the treatment T_{12} AZS + PB + LFA@40 t ha^{-1} (105.50 kg ha^{-1}), which was followed by T_{11} –AZS + PB + LFA

@ 20 ha^{-1} (103.26 kg ha^{-1}) and the minimum availability was recorded in T_1 control (93.11 kg ha^{-1}).

The highest available soil phosphorus was recorded in the treatment T_1 AZS + PB + LFA@40 t ha^{-1} (17.80 kg ha^{-1}) which was followed by T_{11} –AZS + PB + LFA @ 20 ha^{-1} (15.86 kg ha^{-1}). The least available soil phosphorus was recorded in T_1 control (11.62 kg ha^{-1}).

The maximum availability of soil potassium was recorded in the treatment T_{12} AZS + PB + LFA@40 t ha^{-1} (145.60 kg ha^{-1}) which was followed by T_{11} –AZS + PB + LFA @ 20 ha^{-1} (144.28 kg ha^{-1}). Minimum uptake of 'K' was recorded in T_1 control (139.61 kg ha^{-1}).

Discussion

In the present study, interesting results were obtained when an attempt was made to study the effect of *Azospirillum*, *phosphobacteria* and Fly ash for the growth and development on Bhendi. Twelve treatments were fixed to study the growth parameters of Bhendi. In the present investigation, plant height and root length were maximum in the treatment T_{12} (AZS + PB+ LFA @40 t ha^{-1}). Growth parameters increased due to *Azospirillum*, phosphobacterial inoculation as they fix atmospheric nitrogen, solubilize phosphorus and production of growth promoting substances which increased the growth parameters. Fly ash proves to be a better soil conditioner and can also be used as a cheapest source of micronutrient for crops and thereby increase the plant growth. The present observation was supported by various workers (Anajali Deshmukh *et al*., 1999; Amirthaling am, 1988; Deka *et al*., 1992; Parvatham*et al*., 1989; Subbiah, 1991; Bashan and Hvanony, 1990 and Naver*et al*., 1985).

The inoculants of *Azospirillum*, phosphobacteria were used invariably for almost all the crops to boost the yield. In this investigations, higher number of floweres $plant^{-1}$, higher number of fruit $plant^{-1}$, and yield $plant^{-1}$ were recorded in the pot treatment T_{12} (AZS + PB+ LFA @ 40t ha^{-1}). It is well established fact that the enhanced microbial activity with the biofertilizer application and LFA would have contributed to increase the nutrient availability, which resulted in increased yield of crop (Matte and Kene, 1995 and Savitha, 1998).

In the present study, interesting results were obtained in the dry matter production of Bhendi. Maximum amounts of dry matter production was observed in the treatment AZS + PB+ LFA @ 40t ha^{-1}. The increased dry matter production was due to the application of *Azospirillum*. It is well established fact that *Azospirillum* gives nitrogen, solubilizing the insoluble phosphates, thereby plants absorb higher amount of N,P,K and adds possible amounts of micro and macro nutrients which results in the higher dry matter production.

In the present study, the uptake of N, P and K were maximum in the treatment AZS + PB+ LFA@ 40t ha^{-1}.

In the pot culture experiment, the maximum available soil, N, P and K were observed in the treatment receiving AZS + PB+ LFA@ 40t ha^{-1}. The available N, P and K contents were increased with fly ash application (Anjali Deshmukh *et al.*, 2000, Savitha, 1998).

References

Adriano, D.C., T.A. Woodford and T.G. Ciravolo (1980). Utilisation and disposal of fly ash and other coal riduse in terrestrial ecosystem. *A review . J. Environ. Qual.,* **9:** 333-343.

Amirthalingam, S. (1988). Studies on the effect of *Azospirillum*, nitrogen and NAA growth and yield of chilli. *South Indian Horticulture,* **36**: 218.

Bashan, Y. and Hanna Hvanony (1990). Effect of bacterial inoculant on rice. *Can. J. Microbiol.,* **36:**591.

Dart, P.J. (1986). Nitrogen fixation associated with non-legumes in agriculture. *Plant and Soil,* **90**: 303-334.

Deka, B.C., G.C.Bora and A.Shadeque (1992). Effect of Azospirillum on growth and yield of chilli (*Capsicum annum* L.) cultivar Pusajwala. *Haryana J. Hort. Sci.,* **38**: 44-46.

Deshmukh, Anjali, D.B.Matte and Bharti Bhaisare (2000). Soil properties as influenced by fly ash application. *J. Soils and Crops,* **10(1)**: 69-71.

Matte, D.B.and D.R. Kene (1995). Effect of fly ash application on yield performance of *kharif* and rabi crops. *J. Soils and Crops,* **5(2)**:133-136.

Morris, R.O. (1986). Genes specifying auxin and cytokinin biosynthesis in phytopathogens. *An. Rev of Plant. Physiol.,* **37**: 509-538.

Naver, G., A. Kronenberg and H. Bothe (1985). Denitrification and nitrogen fixation by *Azospirillum*. *Arch Microbio.,* **141**: 364-370.

Parvatham, A., K.P. Vijayan and A. Nazar (1989). Effect of *Azospirillum* on growth and nutrient uptake of Pusa Sawani Bhendi. *South Indian Hort.,* **37**: 227-229.

Savitha, V. (1998). Studies on the role of microorganisms in utilization of fly ash in agriculture. *M.Sc.(Ag.) Thesis,* Annamalai Univ., Annamalainagar.

Sharma, N.K. and P.L. Bhalla (1986). Influence of integrated nutrient management on growth, yield and economics of okra (*Abelmoschus esculentus* L. Moench). *Veg. Sci.,* **22(1)**: 1-4.

Subbiah, K. (1991). Studies on the effect of nitrogen and *Azospirillum* on Okra. *South Indian Horticulture,* **39(1)**: 39-47.