Table 1 *Effect of different concentrations (ppm) of gibberellic acid on seed germination (%) of B. articularis, P. ovata and T. portulacastrum (observations taken at the end of 7 days)*

	B. articularis	*P. ovata*	*T. portulacastrum*
Control	26.6 ± 20.8	0 ± 0	26.6 ± 2.08
Duration of soaking (24 hr)			
10	56.6 ± 5.7	53.3 ± 5.7	46.6 ± 11.7
50	70.0 ± 10.0	80.0 ± 10.0	23.3 ± 5.7
100	46.6 ± 15.2	36.6 ± 11.5	23.3 ± 5.7
200	43.3 ± 5.7	33.3 ± 5.7	16.6 ± 20.8
Duration of soaking (48 hr)			
10	73.3 ± 5.7	23.3 ± 25.1	20.0 ± 17.3
50	100.0 ± 0.0	66.6 ± 5.7	23.3 ± 23.0
100	93.3 ± 5.7	60.0 ± 0.0	33.3 ± 15.2
200	90.0 ± 17.3	26.6 ± 11.5	13.3 ± 15.2

germination. Higher concentration of GA proved detrimental for this species, as the germination percentage did not increase with increase in GA concentration. In *B. articularis*, maximum germination percentage was observed in 50 ppm solution when seeds were soaked for 48 hr. However, seeds of *P. ovata* exhibited maximum percentage of germination after 24 hr soaking in 50 ppm GA. At higher concentrations the decrease in germination percentage was significant in case of *P. ovata*, but this was marginal in *B. articularis*.

Five ppm of GA increased the germination percentage of *Celosia argentea*[3]. Increased germination percentage in seeds of *Farsetia hamiltonii* with increase in GA concentration was also noted[4]. Ten per cent germination in 5 and 10 ppm solutions of GA and 40 and 80% germination in fresh and one year stored seeds, respectively was obtained. Germination of seeds can be promoted in *Chenopodium album* by providing 100 ppm of GA, beyond which decline in germination percentage occurred[5]. Dormancy in seeds of *B. articularis* due to endogenous inhibitor and its removal by gibberellic acid[6], is also supported by the present study. Thus it was recorded that germination percentage of *B. articularis* and *P. ovata* seeds can be improved by providing 50 ppm of GA, and of *T. portulacastrum* by 10 ppm GA.

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1. Chancellor, R. J., *Recherche Agronom. en Suisse* 1984, **23**, 69.
2. Corns, W. O., *Can. J. Pl. Sci.*, 1960, **40**, 47.
3. Ashraf, N., *Ph.D. thesis*, Univ. of Jodhpur, Jodhpur, 1980.
4. Bansal, R. P., *Ph.D. thesis*, Univ. of Jodhpur, Jodhpur, 1978.
5. Jha, P. K., *Ph.D. thesis*, Univ. of Jodhpur, Jodhpur, 1982.
6. Sen, D. N., *US PL-480 Project*, 3rd Annual report, Univ. of Jodhpur, Jodhpur, 1976, p. 72.

CAN THE USE OF *AZOSPIRILLUM* BIOFERTILIZER CONTROL SORGHUM SHOOTFLY?

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THE sorghum shootfly, *Atherigona soccata* Rond is a major pest of sorghum in most areas of Asia, Mediterranean Europe, Africa and India[1]. The flies deposit eggs on the leaves of young plants and the larvae cut the growing point causing 'dead heart'[1]. An effective chemical control measure advocated to farmers is the application of carbofuran 3 G, a systemic insecticide, as seed and seed furrow treatment[1]. However, the use of sorghum cultivars resistant to fly attack appears to be the most promising approach to fly management[2]. Attempts have been made to determine the biochemical basis of resistance with special reference to plant phenolic compounds.

Phenolic compounds have gained considerable interest in the control of insect pests and diseases of crop plants[3]. When phenolics occur in fairly large concentrations, because of their direct toxicity, insect pests are warded off[4]. In plant tissues, these compounds are noted for their age-related changes in concentration especially in *Sorghum bicolor* and their distastefulness to sorghum insects[5]. Any attempt to enhance the level of these distasteful factors in sorghum may eventually help reducing the shootfly incidence. The recently introduced biofertilizer *Azospirillum* (peat soil based preparation containing N_2 fixing live cells of *Azospirillum*) is being enthusiastically used by farmers for sorghum, ragi and cotton crops. It has been a common observation that in *Azospirillum* applied sorghum crop, the incidence of shootfly was strikingly very low[6]. In this paper, we have examined the role of *Azospirillum* inoculation on the incidence of shootfly and also on some biochemical changes induced in sorghum plants which helped warding-off shootfly incidence.

Azospirillum biofertilizer, obtained from this University was used both for seed and soil inoculation with graded levels of nitrogen in the sorghum hybrid CSH9 and the variety, Co 26. Incidence of shootfly was observed on 14th and 28th days after sowing. The effect of *Azospirillum* inoculations on plant growth was also recorded on the 28th day after sowing. For analysing the phenolic compounds, the plant samples collected from each treatment were separated into whole plant and shoot, and 5 g of the representative sample were chopped into small bits, plunged into 20 ml of boiling ethyl alcohol (80%) and extracted for 10 min on a water bath. The clear extract was decanted and the tissues were re-extracted with 10 ml of fresh ethyl alcohol after macerating the tissues in a pestle and mortar. The extracts were pooled and swiftly filtered through layers of cheese cloth. The filtrate was clarified by centrifugation at 2100 × g for 15 min[7]. The total phenolic compounds were estimated colorimetrically[8].

To determine the qualitative changes in the phenolic compounds, the alcoholic extract was extracted with peroxide-free ether after acidification with 1 N HCL. The extract was pooled and after adjusting the pH to 8.5 with 1 N NaOH, it was re-extracted with ether. The extracts were pooled and flash-evaporated to near dryness and finally taken in 2 ml of isopropyl alcohol. An aliquot (100 μl) of this fraction was spotted on a chromatographic paper (27 × 25 cm) and developed ascendingly in a solvent system of isopropyl alcohol:ammonia:water (4 : 5 : 1 v/v). After drying, the paper was examined under UV rays as well as under ammonia vapour. Alcoholic ferric chloride was used as the spray reagent for the detection of phenolic compounds. The R_f values of the dark green spots were then computed[9].

The results showed a statistically significant reduction in the shootfly incidence when treated with *Azospirillum* over the control (table 1). *Azospirillum* inoculation also enhanced the plant growth. An increase in height of about 9.78 cm in CSH 9 and 7.23 cm in Co 26 was noted. The increased plant vigour due to *Azospirillum* inoculation might be responsible for the low incidence of shootfly[6]. It has also been indicated that morphological characters of sorghum seedlings like plant height, and vigour have a definite role in shootfly resistance[10]. The present

Table 1 *Effect of Azospirillum inoculation on the shootfly incidence and phenolic contents in sorghum cultivars*

Treatments	Height[a] (cm)		% incidence of shootfly		Total phenols[b] CSH 9		CO 26	
	CSH9	Co 26	CSH 9	Co 26	WP	Shoot	WP	Shoot
Azospirillum Seed + Soil without N			44.81 (41.95)*	31.64 (34.22)*	3.664	1.589	3.006	1.366
Azospirillum Seed with normal fertilizer	43.36	46.52	41.02 (39.72)*	31.77 (34.21)*	3.771	1.696	3.030	1.360
Azospirillum Soil with normal fertilizer	(41.06)*	(34.64)*	43.23	32.53	3.938	1.678	3.093	1.366
Control with normal fertilizer	33.58	39.23	78.62 (62.58)	58.64 (50.04)	3 087	0.839	3.047	1.232
CD ($P = 0.05$)	9.78[e]	7.23[e]	9.23	8.01	18.69[c] 27.57[d]	89.39[c] 102.15[d]	No difference	10.39[c] 10.88[d]

Figures in parentheses are transformed values. [b] denotes total phenolics mg/g of tissues on dry weight basis in catechol equivalents; * Results are significant at 1% level; [a] Height of the plants observed at random from the three *Azospirillum* treatments and control; [c,d] denotes minimum and maximum increase in phenols in treatment over control; [e] denotes increase in height of the treated plants over control.

study indicates distinct changes in the level of total phenols of the plants due to *Azospirillum* inoculation. More importantly, the shoot portion where the larvae initiate damage recorded larger quantity of phenols in *Azospirillum* inoculated plant in both the cultivars than in the uninoculated control. An increase of 102.15% phenolic compounds in the shoots of CSH 9 and 10.88% in Co 26 was noticed. Since there was an increase in the concentration of phenolics due to *Azospirillum* and again these phenolic compounds would have acted as distasteful factors only in higher concentration[4], in the present investigation, *Azospirillum* inoculation reduced the shootfly incidence. Further, the chromatographic analysis of the phenolic compounds revealed that in both Co 26 and CSH 9 sorghum varieties there were two to three phenol positive spots (R_f 0.86, 0.76, 0.89, 0.81 and 0.68) in the uninoculated plant. However in the *Azospirillum* inoculated varieties there were distinct qualitative changes in the phenolics resulting in greater number of spots. (R_f 0.89, 0.77, 0.84, 0.73 and 0.62). A variety of phenolic compounds was observed in the young sorghum plants by Stafford[11] who found dhurrin, aspigenindin, lutedinidin, cyanidin and lignin as the major phenols occurring in the tissues of young sorghum plants. Further dhurrin in its glycosidal form at higher concentration has been found to deter the feeding of *Locusta migratoria*[5,12].

The enhancement of phenolics by *Azospirillum* treatment may confer some sort of resistance to plants against shootfly feeding and thereby low incidence in the treated plants. Therefore, *Azospirillum* inoculation has greater importance in imparting resistance towards shootfly in sorghum.

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1. Srivastava, K. P. and Jotwani, M. G. *Insect Sci. Application*, 1981, **2**, 117.
2. Jotwani, M. G., *Insect Sci. Application*, 1981, **2**, 93.
3. Panda, N., *Principles of host plant resistance to insect pests*, Hindustan Pub. Corporation, India. 1979.
4. Todd, G. W., Getahun, A. and Cress, P. C., *Ann. Ent. Soc. Am.*, 1971, **64**, 718.
5. Woodheads and Bernays, E. A., *Entomol. Exp. Appl.*, 1978, **24**, 133.
6. Mote, V. N. and Ajri, D. S., *Curr. Res. Rep.*, 1986, **1**, 175.
7. Bieh, M. L., Kue, J. and Williams, G. W., *Phytopathology*, 1968, **58**, 1255.
8. Bray, H. G. and Thorpe, W. W., *Heth. Biochem Anal.*, 1954, **1**, 27.
9. Block, R. J., Durram, E. L. and Szweig, G., *A manual of paper chromatography and paper electrophoresis*, Academic Press, New York, 1986, Vol. 1, p. 175.
10. Singh, S. P. and Jotwani, M. G., *Indian J. Entomol.*, 1980, **42**, 551.
11. Stafford, H. *Phytochemistry*, 1961, **8**, 743.
12. Dabrowski, Z. T. and Patel, N. Y., *Insect Sci. Application.*, 1981, **2**, 73.

LITTLE KNOWN ATTRIBUTES OF SOME MANGROVE PLANTS OF THE KARNATAKA COAST

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DURING a field study of the ecology of mangroves of the Karnataka coast a few unusual or unreported morphological features were observed in *Avicennia alba* Bl., *Bruguiera gymnorrhiza* (L.) Savgny, *B. cylindrica* (L.) Bl. and *Ceriops decandra* (Griff.) Ding Hou, which warranted a study to put on record an overall perspective of their presence in coastal environment.

On the flat and low-lying estuarine banks of the river Mulki in the Udupi taluk are seen the formation of *A. alba* and its root system. Apart from the long cable roots radiating horizontally in all directions from the central basal portion of trees, and producing pencil-like pneumatophores which project above the mud level, the authors observed aerial roots on trunk up to 65 cm above the ground level. They are up to 1.2 cm in diameter and showed regular dichotomous branching system (figure 4). At no stage were they found penetrating the mud or becoming prop-like structures as in other mangrove taxa.

Another instance of aerial roots from the branches was observed in a few sporadic trees of *B. gymnorrhiza* on the saline banks of the river Kali in the vicinity of Karwar. This plant unlike *Rhizophora* species prefers soils with a sandy content and produces moderately buttressed basal portion and geniculate pneumatophores. The aerial roots on the trunk are up to 45 cm long, relatively thick, and protrude *in*