The Bioscan 5 (1) : 19-20, 2010
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

COMPATIBILITY OF NATIVE POTENTIAL BIOAGENTS WITH DIFFERENT FUNGICIDES AGAINST *COLLETOTRICHUM GLOEOSPORIOIDES* PENZ. CAUSING MANGO ANTHRACNOSE

S. THAHIR BASHA*, J. SUVARNA, T. M. HEMALATHA AND N. P. ESWARA REDDY
Department of Plant Pathology, S.V. Agricultural College, Tirupati - 517 502, A. P. INDIA
E-mail: thahirbashas@yahoo.com

KEY WORDS
Mango
Anthracnose
Colletotrichum gloeosporioides
Bioagents
Fungicidal
Compatibility

Received on :
24.08.2009
Accepted on :
17.12.2009

***Corresponding author**

ABSTRACT
Managing the anthracnose through chemicals alone is not satisfactory in view of the development of resistance, environmental concerns and cost benefit ratio. Some reports are available regarding the resistance of *C. gloeosporioides* to fungicides in mango and as well as in other crops. Keeping this in view, ninety six native potential antagonists were isolated from phylloplane and leaf endophytes during the roving survey conducted in different regions of Andhra Pradesh. Of the 96 antagonists screened by dual culture technique, four fungal and six bacterial antagonists identified as fungicidal tolerant potential bioagents. Further these antagonists were evaluated for their compatibility with commonly used four systemic fungicides viz., carbendazim (50 ppm), thiophanate-methyl (50 ppm), propioconazole (25 ppm), hexaconazole (25 ppm) and two non-systemic fungicides viz., mancozeb (1000 ppm) and copper oxychloride (1000 ppm) to manage the disease through an integrated approach by combining bioagents and economic use of chemicals.

INTRODUCTION

Mango (*Mangifera indica* L.) is one the world's most important and esteemed fruits and described by some as the "king of all fruits". India is the world's largest producer and Andhra Pradesh ranks first in production (45.89 lakh tonnes). Because of diverse production conditions and the vast area grown, mango suffers from a number of diseases, some of them taking heavy toll on the crop and representing limiting factors for production and productivity. Anthracnose caused by *Colletotrichum gloeosporioides* Penz., is the most destructive disease of mango causing substantial yield losses which can reach 60% or higher during the heavy rainy season (Ann *et al*., 1997). The indiscriminate use of different fungicides causes potential threat to human health, increase in pathogen resistance, mutation and cause environmental hazards. Due to extensive cultivation of mango, this pathogen has emerged as a major constraint in its successful cultivation. Although biocontrol is rarely used for foliar diseases, numerous organisms capable of antagonizing fruit and leaf pathogens have been reported in recent years. Formerly, less attention was paid to biocontrol of foliar microflora was known to consist of relatively a few organisms whose populations fluctuate dramatically according to environmental conditions. The rapid growth of foliage provides better opportunities for pathogen growth rather than organisms in the phyllosphere (Fry, 1982). However, it is presumed that the survival ability of endophytes may be better when compared to phylloplane microflora. Therefore, in the present study an attempt has also been made to isolate fungicide tolerant antagonists against *C. gloeosporioides* from leaf endophytes. We opted for using a combination of biocontrol agents against foliar pathogen C. *gloeosporioides* from phylloplane and leaf endophytes with specific fungicides that will enhance the efficacy and duration of active disease control which is crucial for an effective disease management. Information is available on the compatibility of biocontrol agents with chemicals (Gupta and Sharma, 2004; Veena *et al*., 2006). The efficiency of the biocontrol agent could further be improved when it was applied with the recommended fungicide, used at a lower concentration (Korsten *et al*., 1992; Silimela and Korsten, 2001). Fungicide resistance problems, concerns regarding pesticide residues and revocation of registration of certain widely used fungicides have led to increased activity in the development of bioagents against plant pathogens. It is therefore, aimed to identify the compatible potential bioagents with commonly used systemic and non-systemic fungicides for the eco-friendly management of anthracnose fungus *Colletotrichum gloeosporioides* obtained from different regions of Andhra Pradesh.

MATERIALS AND METHODS

Isolation and screening of potential bioagents

Roving survey was conducted for the collection of healthy and diseased leaf samples to isolate the potential antagonists and pathogen respectively from major mango growing regions

of Rayalaseema, Telangana, Godavari and Krishna districts of Andhra Pradesh, India. Pathogen isolates were collected in order to identify the virulent isolate by conducting pathogenicity test on baneshan mango variety. The highly virulent isolate will be used for screening of potential bioagents.

Isolation from phylloplane

Isolation of native biocontrol agents was made from washings of healthy mango leaves (Zenichi *et al.,* 2003). Leaves were washed with sterile distilled water and serial dilution is prepared. One ml of this suspension was transferred to sterile petriplates containing solidified potato dextrose agar (PDA) and nutrient agar (NA) for the isolation of fungi and bacteria respectively. The plates were incubated at $28 \pm 2°C$ for the development of colonies.

Isolation of leaf endophytes

Five grams of healthy leaves were surface sterilized for five minutes with 70 per cent ethanol and homogenized in 20 ml of sterilized phosphate buffer using a mortar and pestle. Appropriate dilutions of these suspensions were plated on PDA and one fourth of nutrient agar. The plates were incubated for 72 hrs at $28 \pm 2°C$ (Kishore *et al*., 2005a). In each sample, single colonies of predominant strains with distinct morphologies and well separated from other were subcultured and used for further studies.

Identification of native potential bioagents by dual culture technique

Dual culture technique was used to identify the potential antagonistic isolates of microflora obtained from phylloplane and leaf endophytes. The antagonistic activity of microflora isolates against *C. gloeosporioides* was determined by dual culture technique under *in vitro* condition (Bhuvaneswari and Rao, 2001).

In case of fungi, mycelial discs of 6 mm diameter from seven day old cultures of both fungal antagonist and the test pathogen were placed at equidistant on sterile petriplates containing PDA medium. Whereas in bacteria, one day old cultures were streaked on opposite side of the pathogen on NA medium. The petriplates were then incubated at $28 \pm 2°C$. Three replications were maintained in each treatment. Suitable controls were kept without antagonist. Growth of the pathogen was measured at 7^{th} day after inoculation of antagonist. Inhibition percentage of mycelial growth of test pathogen was calculated by the formula:

$$1 = \frac{C - T}{C} x100$$

Where,

I = Per cent reduction in growth of test pathogen

C = Radial growth (mm) in control

T = Radial growth (mm) in treatment

Compatibility of native potential antagonists with different fungicides by poisoned food technique

Fungicides that were found effective viz., four systemic fungicides viz., carbendazim (50 ppm), thiophanate-methyl (50 ppm), propioconazole (25 ppm), hexaconazole (25 ppm) and two non-systemic fungicides viz., mancozeb (1000 ppm) and copper oxychloride (1000 ppm) were evaluated for fungicidal resistance / sensitivity (Sampath *et al*., 2007) against *C. gloeosporioides* for their compatibility with potential antagonists by poisoned food technique for fungal isolates (Nene and Thapliyal, 1993). Hundred milliliters of double strength PDA was mixed with 100 mL of double concentrated fungicidal solution so as to get required final concentration of the fungicides. Twenty ml of poisoned media was plated in 9 cm sterile petriplates. A 5 mm mycelial disc of seven days old culture was inoculated at the centre of the petriplates and incubated at $28 \pm 2°C$ for ten days. A control was maintained without fungicide. Three replications were maintained for each treatment. Per cent reduction in radial growth over control was calculated by using the following formula:

$$I = \frac{C - T}{C} x100$$

Where,

I = Per cent reduction in growth of test pathogen

C = Radial growth (mm) in control

T = Radial growth (mm) in treatment

Based on radial growth, the isolates were classified as highly sensitive, sensitive, moderately resistant, resistant and highly resistant.

Spectrophotometric method

This method was followed to study the compatibility of potential bacterial isolates with commonly used fungicides against *C. gloeosporioides*. Five hundred microliters of antagonistic bacterial cultures grown in Nutrient Broth (NB) for over night at $28 \pm 2°C$ and 180 rpm were added to 50 mL of NB in 250 mL flasks containing different fungicides. Inoculated flasks were incubated at $28 \pm 2°C$ and 180 rpm. Bacterial growth was determined by measuring optical density (OD) at 600 nm after 24 hours of incubation. Each treatment consisted of three flasks as individual replications. The nutrient broth without bacteria served as control.

Statistical analysis

Wherever necessary the data was statistically analyzed (Gomez and Gomez, 1984). Completely Randomized Design (CRD) was used for radial growth, per cent disease incidence, poisoned food technique and dual cultural technique. Two-way CRD was used for spectrophotometric method.

RESULTS

During the survey, thirty six isolates of *C. gloeosporioides* were collected and subjected to pathogenic variability on Baneshan mango grafts and classified as highly virulent, moderately virulent and less virulent. The results revealed that isolate Cg23 was found to be highly virulent and the same was used to test against the antagonistic activity of microflora isolated from phylloplane and leaf endophytes (Data not shown).

A total of 96 antagonistic microflora were isolated from phylloplane and leaf endophytic regions of healthy mango leaves against *Colletotrichum gloeosporioides*. The bacterial antagonists isolated from phylloplane were designated as PB_1 to PB_{28} and endophytes as EB_1 to EB_{39} whereas, fungal antagonists from phylloplane were named as T_1 to $T_{29.}$ The

Table 1: Compatibility of potential fungal antagonists with different fungicides in poisoned food technique

Fungicides	Concentration	Mycelial growth (mm)				Percent compatibility			
		T3	T17	T23	T26	T3	T17	T23	T26
Carbendazim	50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thiophanate-methyl	50	12.00	10.00	38.50	13.55	13.33	11.11	42.78	15.06
Propioconazole	25	15.50	11.00	0.00	0.00	17.22	12.22	0.00	0.00
Hexaconazole	25	12.50	32.50	13.30	11.10	13.89	36.11	14.78	12.33
Mancozeb	1000	86.00	85.00	88.50	88.50	95.37	94.44	98.33	98.33
Copper oxychloride	1000	56.00	31.50	69.50	24.55	62.22	35.00	77.22	27.28
Control	—-	90.00	90.00	90.00	90.00	—-	—-	—-	—-

*Mean of three replications

	CD (5%)	SEM
Concentrations	1.5896	1.3574
Fungicides	0.5789	1.9546
Interaction	0.2398	0.5879

fungal antagonists T_3, T_{17}, T_{23} and T_{26} identified as *Trichoderma* spp. were found to be superior compared to other isolates in inhibiting the growth of *C. gloeosporioides*. In case of thirty nine endophytic bacterial antagonists EB_7, EB_9, EB_{35} and EB_{39} completely inhibited (100%) the growth of the pathogen and among the twenty eight phylloplane bacterial isolates tested, complete inhibition (100%) of the pathogen was recorded by PB_{18} and PB_{28} antagonists (Data not shown).

The potential fungal and bacterial antagonistic isolates *viz.*, T_3, T_{17}, T_{23}, T_{26}, EB_7, EB_9, EB_{35}, EB_{39}, PB_{18} and PB_{28} were selected for fungicidal compatibility studies against highly virulent isolate Cg23. The compatibility of the potential fungal antagonistic isolates with different fungicides tested by poisoned food technique revealed the complete inhibition of T_3, T_{17}, T_{23} and T_{26} isolates was observed with carbendazim (50 ppm), T_{23} and T_{26} in the case of propioconazole (25 ppm). Mancozeb (1000 ppm) was found to be least effective about 94.44 to 98.33 per cent compatibility with all the fungal antagonists (Table 1).

Spectrophotometric method was used to test the compatibility of the above six potential bacterial isolates. These results revealed that PB_{18} was more compatible with thiophanate-methyl (96.07%) at 50 ppm followed by mancozeb, carbendazim, copper oxychloride and propioconazole. The compatibility was less (16.09%) with hexaconazole at 25 ppm compared to other fungicides. Higher compatibility of PB_{28} was recorded with propioconazole (88.05%) at 25 ppm followed by copper oxychloride, carbendazim, thiophanate-methyl and mancozeb and the least compatible with hexaconazole (01.07%) at 25 ppm. All the isolates were significantly differing with each other statistically (Table 2).

The endophytic bacterial isolate EB_7 was highly compatible with the fungicide, copper oxychloride (98.07%) at 1000 ppm followed by thiophanate-methyl, carbendazim, mancozeb and propioconazole. The least compatibility (31.12%) was recorded in case of hexaconazole at 25 ppm. EB_9 was highly compatible with the fungicide hexaconazole at 25 ppm (85.89%) followed by thiophanate-methyl, carbendazim, mancozeb and copper oxychloride and the least compatibility (07.29%) was recorded in case of propioconazole at 25 ppm concentrations.

The bacterial antagonist EB_{35} was found to be more compatible with thiophanate-methyl (97.02%) at 50 ppm followed by copper oxychloride, carbendazim, mancozeb and propioconazole. Hexaconazole was found less compatible with EB_{35}. Highest fungicidal compatibility was recorded with mancozeb (87.02%) in EB_{39} at 1000 ppm. This isolate was compatible with all fungicides but the compatibility was least with hexaconazole (10.03%).

The mean compatibility of bacterial antagonists with different fungicides was highest in EB_7 followed by EB_{35}, PB_{18}, PB_{28}, EB_{39} and EB_9. Among the fungicides, mancozeb was found to highly compatible with all the six bacterial antagonists followed by thiophanate-methyl, carbendazim, copper oxychloride and propioconazole whereas hexaconazole at 25 ppm exhibited less compatibility with all the isolates.

DISCUSSION

Table 2: Compatibility of potential bacterial antagonists with different fungicides by spectrophotometry

Fungicides	Optical density at 600nm						Percent compatibility					
	PB18	PB 28	EB 7	EB 9	EB35	EB39	PB18	PB 28	EB 7	EB 9	EB35	EB39
Carbendazim(50 ppm)	0.903	0.619	0.815	0.736	0.923	0.828	87.03	60.03	78.29	71.59	89.00	72.00
Thiophanate-methyl(50 ppm)	1.000	0.605	0.955	0.835	1.008	0.721	96.07	59.00	91.73	81.22	97.02	62.07
Propioconazole(25 ppm)	0.335	0.908	0.645	0.075	0.667	0.426	32.04	88.05	61.95	07.29	64.03	37.01
Hexaconazole(25 ppm)	0.174	0.017	0.324	0.883	0.038	0.118	16.09	01.07	31.12	85.89	03.07	10.03
Mancozeb(1000 ppm)	0.969	0.577	0.696	0.623	0.866	1.003	93.07	56.02	66.85	60.60	83.05	87.02
Copper oxychloride (1000 ppm)	0.612	0.733	1.021	0.497	1.002	0.708	59.02	71.04	98.07	48.34	96.06	61.06
Control	1.035	1.027	1.041	1.028	1.038	1.151	—-	—-	—-	—-	—-	—-
Mean	0.666	0.576	1.041	1.028	0.751	0.639	—-	—-	—-	—-	—-	—-

*Mean of three replications

	CD (5%)	SEM
Concentrations	1.2544	1.9874
Fungicides	1.5860	1.9786
Interaction	1.3680	1.2879

The term "anthracnose" literally means "like coal" and was first used by Fabre and Dunal to describe a disease of grapes in which blackening of a tissue was a characteristic feature. Anthracnose caused by *Colletotrichum gloeosporioides* is an

important disease of mango and prevalent in tropical regions of the world. *C. gloeosporioides* can cause fruit set reduction and quiescent infection results in post harvest losses (Dodd *et al*., 1991; Donkin and Oosthuyse, 1996). The genus *Colletotrichum* includes more than 900 species, of which 100 species have been recorded in India (Wijesekara and Agarwal, 2006). *C. gloeosporioides* produces conidia on lesions on leaves, twigs, panicles, and mummified fruit. Conidia can be rain-splashed to other leaves or flowers and cause secondary infections; thus the disease is polycyclic in these organs. Usually, mango is infected by the pathogen during rainy season and survives in infected leaf debris during off season and serve as a primary source. Under favourable conditions, the pathogen spreads from leaves to inflorescence stalk, flowers and fruits by water borne conidia (Fitzell and Peak, 1984).

During the early phase of fungicidal usage (1950s and 1960s) the benefits of fungicides became increasingly apparent and resulted in significant increase in yield. Development of resistance to these fungicides was not a problem even after many years of their regular use (Russell, 1999). Unfortunately, due to the site-specific action, many brought with them the problem of resistance development soon after their introduction and the experience were sometimes painful as resistance could lead to total loss of effective control of the target pathogen (Davidse *et al*., 1981). Due to the development of resistance in pathogen and the adverse effects of synthetic chemical residues on human health (Lichtenberg and Zilberman, 1987) and on environment (Weaver *et al*., 1990) used in plant disease management has diverted the plant pathologist to intensify world-wide research efforts to develop alternative control strategies with little or no adverse effect on environment. Hence, search for effective, simple, inexpensive and nonhazardous methods of managing plant pathogens globally is gaining attention. Nonchemical and eco-friendly fungal and bacterial bioagents have been found to provide an answer to the nondiscriminatory and broad spectrum fungicides.

The use of biological control methods to reduce disease incidence caused by plant pathogens is continually being developed and is being used in a variety of crops (Soytong *et al*., 2001). The efficiency of the biocontrol agent could further be improved when it was applied with the recommended fungicide, used at a lower concentration (Korsten *et al*., 1992; Silimela and Korsten, 2001). The incorporation of eco-friendly biocontrol agents for the control of *C. gloeosporioides* as a part of integrated disease management will help in managing the disease as well as in delaying the development of tolerance/ resistance to fungicides. In the present study, the native potential fungicidal tolerant biocontrol agents were identified from phylloplane and leaf endophytes against *Colletotrichum gloeosporioides*. Fungal antagonists, T_3, T_{17}, T_{23} and T_{26} which were identified as *Trichoderma* spp. in inhibiting the growth of *C. gloeosporioides*. Uses of *Trichoderma* has long been known as effective antagonists against wide range of plant pathogens with capability of attacking through mycoparasitism. The results evident that fungicidal tolerant potential antagonists from leaf endophytes viz., EB_7, EB_9, EB_{35} and EB_{39} that play beneficial role has been recorded. Our study also revealed that the leaf endophytes that act as a potential source of metabolites against foliar pathogen *C. gloeosporioides*. The effectiveness of native potential antagonists from phylloplane and leaf endophytes warrants a further exploration of other products as alternatives to the fungicides.

Thus, these fungal and bacterial biocontrol agents which would benefit the industry where use of biological products to replace or supplement chemical use is extremely important. It is therefore clear that standardization of material preparation for fungicidal tolerant bioagents are urgently required. This approach might presumably become good and effective for integrated disease management strategies. Research is in progress to evaluate the viability and efficacy of some of the potential biocontrol agents identified during the present study. The main emphasis will be given to endophytes to test on a large scale under field conditions keeps the feasibility for commercialization. Simultaneously, molecular characterization of fungicidal tolerant potential biocontrol agents will be carried out to develop SCAR markers. These nucleic acid based fungal and bacterial biocontrol markers will be highly useful for mapping the distribution of biocontrol populations in production environments.

ACKNOWLEDGEMENT

The authors gratefully acknowledge financial grant and support provided by the Department of Science and Technology, Government of India, New Delhi.

REFERENCES

Ann, P. J., Chen, M. F. and Hwang, R. C. 1997. Effects of environmental factors on disease incidence of mango anthracnose and bacterial black spot. In: *Proceedings of the Symposium on Climatic Effects on the Occurrence of Plant Diseases and Insects*. pp. 29-40 (Tu,. C.C. and Yang, C.M., Eds.), Society of Agrometereology, Wufeng, Taichung, Taiwan, R.O.C.

Bhuvaneswari, V. and Rao, M. S. 2001. Evaluation of *Trichoderma viride* antagonistic to post harvest pathogens on mango. *Indian Phytopathology*. **54:** 493-494.

Davidse, L. C., Looijen, D., Turkensteen, I. J. and Van DerWal, D. 1981. Occurrence of metalaxyl resistant strains of *Phytophthora infestans* in Dutch potato fields. *Neth J. Pl. Pathol*. **87:** 65-68.

Dodd, J. C., Estrada A. B., Matcha, m. J., Jeffries, P. and Jeger, M. J. 1991. The effect of climatic factors on *Colletotrichum gloeosporioides* casual agent of mango anthracnose in the Philippines. *Plant Pathology*. **40:** 568-575.

Donkin, D. J. and Oosthuyse, S.A. 1996. Quality evaluations of sea-exported South African mangos in Europe during the 1995/96 season. South African Mango Growers' Association Yearbook. **16:** 1-5.

Fitzell, R. D. and Peak, C. M. 1984. The epidemiology of anthracnose disease of mango: inoculum sources, spore production and dispersal. *Annal. Appl. Biol*. **104:** 53-59.

Fry, W. E. 1982. *Principles of Plant Management*. Academic Press Inc. USA. p. 378.

Gupta, V. K. and Sharma, K. 2004. Integration of chemicals and biocontrol agents for managing white rot of apple. *Acta Hort*. **635:** 141-149.

Gomez, K. A. and Gomez, A. A. 1984. *Statistical procedures for agricultural research* 2nd Ed., John Wiely and Sons, New York.

Kishore, G. K., Pande, S. and Podile, A. R. 2005a. Phylloplane bacteria increase seedling emergence, growth and yield of field grown groundnut

(*Arachis hypogea* L.). *Letters in Appl. Microbiol.* **40:** 260-268.

Kishore, K. G., Pande, S. and Podile, A. R. 2005b. Biological control of collar rot disease with broad spectrum antifungal bacteria associated groundnut. *Canadian J. Microbiol.* **51:** 123-132.

Korsten, L., Lonsdale, J. H., De Villiers, E. and De Jager, E. S. 1992. Preharvest biological control of mango diseases. S.A. Mango Growers' Assoc. *Yearbook.* **12:** 72–74.

Lichtenberg, E. and Zilberman, D. 1987. Regulating environmental and human health risk from agricultural residuals. *Appl. Agric. Res.* **2:** 56–64.

Nene, Y. L. and Thapliyal, P. N. 1993. Fungicides in plant disease control, 3rd edition. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi pp.526-531.

Russell, P. 1999. Fungicide resistance management: into the next millennium. *Pesticide Outlook*. Oct 1999. pp. 213-216.

Sampath Kumar, A., Eswara Reddy, N. P., Hariprasad Reddy, K. and Charitha Devi, M. 2007. Evaluation of fungicidal resistance among *Colletotrichum gloeosporioides* isolates causing mango anthracnose in Agri Export Zone (AEZ) of Andhra Pradesh, India. *Plant Pathol. Bulletin.* **16:** 157-160.

Soytong, K., Kanokmedhakul, S., Kukongviriyapan, V., and Isobe, M. 2001. Application of *Chaetomium* species as new broad spectrum biological fungicide for plant diseases control. *Fungal Diversity.* **7:** 1-15.

Silimela, M. and Korsten, L. 2001. Alternative methods for preventing pre and post-harvest diseases and sunburn on mango fruits. S.A. Mango Growers' Assoc. *Yearbook.* **21:** 39–43.

Veena, S. S. Anandraj, M. and Sharma, Y. R. 2006. Compatibility of potassium phosphonate with *Trichoderma harzianum*. *J. Mycol. Pl. Pathol.* **36(2):** 171-174.

Weaver, J. E., Hogmire, H. W., Brooks, J. L. and Sencindiver, J. C. 1990. Assessment of pesticide residues in surface and soil water from a commercial apple orchard. *Appl. Agric. Res.* **5:** 37–43.

Wijesekara, H. T. R. and Agarwal, D. K. 2006. Taxonomic studies on five species of the genus *Colletotrichum*. *Indian Phytopathol.* **59:** 203-207.

Zenichi, M., Tetsuya, T., Satoshi, T., Shinichi, A. and Keiji, M. 2003. The study on the biological control of mango anthracnose (I) microflora on mango leaves and screening of antagonists. *Jap. J. Trop. Agri.* **47:** 34-41.

NATIONAL ENVIRONMENTALISTS ASSOCIATION

AND ITS OFFICIAL ORGAN

The Bioscan

An International Quarterly Journal of Life Science

Started in 1988, the National Environmentalists Association has been reorganized in 2006 and now is an association functioning with full vigour and new impetus to meet its objectives with the co-operation of like minded environment conscious academicians from different parts of the nation.

MEMBERSHIP OF THE ASSOCIATION

Any graduate having interest in environmental conservation and protection of nature and natural resources can be the member of the association.

To be the member of the association the application form given below should be duly filled up and sent to the Secretary of the association along with a demand draft of Rs. 500/- for annual membership and Rs. 5000/- for life membership.

FELLOWSHIP OF THE ASSOCIATION

The Association is awarding FELLOWSHIP to deserving academicians / researchers /scientists who are LIFE MEMBERS of the Association after reviewing their bio-data by the Fellows and the Executive Members of the association. The Fellows are privileged to write **F.N.E.A.** after their names **.**The prestigious Fellowship also includes a citation in recognition of their contribution to society in general and the endeavour for the noble cause of environment in particular.

AWARDS OF THE ASSOCIATION

The Association in its Seminars and Conferences provides the following category of awards on annual basis.

1. **The young scientists award** : It is given to the researchers below the age of 35 years.
2. **The senior scientists award** : It is awarded to the academicians above the age of 35 years.
3. **The best paper award**: It is awarded to the contributor of the Journal **The Bioscan** during the year.
4. **The best paper presentation award** : It is awarded to the scholar whose presentation is the best other than the young scientist category.
5. **The best oration award** : It is awarded to the scholar who delivered invited speech.
6. **The recognition award** : It is awarded to those senior scholars who have contributed to the subject through their continued research .
7. **The environmental awareness award** : It is awarded to those who, apart from their research contribution, have done commendable extension work for environmental betterment.

The number of recipients of award in each category will vary depending upon the recommendation of the panel of judges and the executive committee. The association has the provision to institute awards in the name of persons for whom a with desired sum is donated in consultation with the executive body.

PUBLICATION OF THE ASSOCIATION

In order to provide a platform to a vast group of researchers to express their views and finding of research as well as to promote the attitude of quality research among the scholars of younger generation the association publishes an international quarterly journal – **THE BIOSCAN (ISSN:0973-7049).** For the benefit of the potential contributors **instructions to authors** is given separately in this journal. However, the details regarding the journal and also the association can be seen on our website *www.thebioscan.in.*

Cont. ..... P. 30