The Bioscan 9(1): 277-281, 2014 (Supplement on Plant Pathology)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

# ANTIFUNGAL ACTIVITY OF SOME PLANT EXTRACTS AGAINST *GANODERMA LUCIDUM* (CURTIS EX. FR.) KARST., CAUSING BASAL STEM ROT DISEASE IN ARECANUT

**RANJANA CHAKRABARTY*, G. C. ACHARYA AND T. C. SARMA**[1]
Central Plantation Crops Research Institute, Kahikuchi, Guwahati -781 017, Assam
[1]Department of Botany, Gauhati University, Ghy - 781 014, Assam
e-mail: ranjana74@yahoo.co.in

**KEYWORDS**
Arecanut
*Ganoderma lucidum*
Plant species
Aqueous extract

**Received on :**
09.10.2013

**Accepted on :**
06.02.2014

***Corresponding author**

**ABSTRACT**
Basal stem rot disease caused by the fungus, *Ganoderma lucidum* (Curtis Ex. Fr.) Karst, is the most dreaded disease of arecanut in Assam. The experiment was carried out to test the antifungal activity of aqueous extract of thirty locally available plant species against the test fungus. Pure culture of *Ganoderma* sp. was isolated from fruiting body of infected arecanut palm. Among the plant species tested, *Allium sativum* corm extract exerted maximum inhibition with 90.89, 100 and 100 per cent inhibition over control at 5, 10 and 20 per cent conc. respectively, followed by extract of *Solanum nigrum* with 77.00. 84.11 and 100 per cent inhibition over control at 5, 10 and 20 per cent conc. respectively after 144h of incubation. Leaf extract of *Clerodendron infortunatum, Bidens pilosa, Leucas aspera, Spilanthes paniculata, Lawsonia inermis* and *Cinnamomum verum* showed strong inhibitory effect at 20 per cent conc. with 84.00, 83.88, 79.22, 77.22, 76.11 and 72.78 per cent inhibition over control respectively.

## INTRODUCTION

The arecanut palm (*Areca catechu* L.) is one of the most important plantation crop in Assam grown in an area of 70,000 ha with an annual production of 62.7 thousand tonnes and a productivity of 896 kg chali/ha (India Horticulture Database, 2010). In recent years, arecanut cultivation is beset with recurring problems due to reduced productivity, delayed commercial yield, soil fertility depletion, small holding size, price fluctuation and pests and diseases. Among the various diseases, basal stem rot, a slow decline disease, caused by the fungus, *Ganoderma lucidum* (Curtis ex. Fr.) Karst is the most dreaded that has not only affected productivity but has also wiped out arecanut plantation in certain localities. It is a polyporoid fungus of the order Polyporales, family *Ganodermataceae*. The fungus has attracted the attention of many mycologist since they are considered both as plant pathogen (Hepting, 1971; Adaskaveg and Ogawa, 1990; Adaskaveg *et al.,* 1993) and also as useful medicinal herb (Mizuno *et al.,* 1995). The fungus, *Ganoderma* is cosmopolitan and causes white rot of woody plants by decomposing lignin, cellulose and related polysaccharides. The occurrence of the disease was recorded as early as 1807 from Karnataka (Buchanan, 1807). Butler, 1906 & 1909 reported the disease on cash crops such as coconut, betelnut and other plantation crops like *Casuarina, Acacia, Dalbergia sisso* and *Toona ciliate* in the North Eastern States. Venkatarayan, 1936 recorded and studied the biology of *Ganoderma* in arecanut and coconut. The disease is also reported from Kerala, Assam, West Bengal (Sharples, 1928), Nicobar Islands (Sangal *et al.,* 1961), the present Karnataka (Coleman, 1911) and Mettupalayam areas of Tamil Nadu (Anonymous, 1960). It is a soil borne disease but secondary spread occurs through air borne spores formed on matured fruiting bodies, through irrigation water, repeated ploughing and other cultural operations. The disease is severe in neglected, ill drained and over-crowded gardens.

Crop loss due to the disease is not systematically documented. It is found to be a devastating disease in the North Eastern Region of India affecting arecanut plantation, with high incidence in Goalpara district (78%) followed by Kamrup (11%) and Morigaon (2.8%). Incidence is also reported in the palms of Bongaigaon district (CPCRI Annual Report, 2012-13). Despite extensive damage caused by the pathogen, scanty works has been done for its management. Although control measures using fungicides are reported to be effective (Nambiar and Nair, 1973; Kumar and Nambiar, 1990), it becomes very difficult for large scale adoption. Also, the indiscriminate use of synthetic chemicals for the control of pests and diseases of crops has resulted in serious threat to human health and environment leading to disturbed biodiversity, outbreak of secondary pests, reappearance of resistance in the pathogens and contamination of food chain in the ecosystem. But the present scientists are optimistic in developing alternatives to chemical fungicides. Currently studies pertaining to the use of botanicals in management of diseases are highly emphasized (Koche, 2013; Toppo, 2013; Mathad, 2013; Mahapatra, 2013; Bisht, 2013). However, actual use of plant extracts in managing soil borne diseases in particular is still limited. Keeping in

view the destructive nature of the disease and economic loss, the present investigation was undertaken to evaluate the efficacy of aqueous plant extracts, against *G. lucidum* under *in vitro* conditions.

## MATERIALS AND METHODS

### Isolation of the fungus

The fungus, *Ganoderma lucidum* was isolated from the fruiting body of basal stem rot affected arecanut palm. The samples were cut into small convenient pieces, sterilized in 0.1% $HgCl_2$ for one minute, then washed thrice in sterile distilled water and plated on Ganoderma Selective Media (Ariffin and Idris, 1991). Pure cultures were transferred into slants and maintained on Potato Dextrose Agar media for further study.

### *In-vitro* assay of botanicals

Thirty locally available botanicals were tested for their antifungal property against *G. lucidum* by poisoned food technique (Nene and Thapliyal, 1982) under *in vitro* condition. Fresh leaves of test plants were taken for preparing crude extracts. The leaves were thoroughly washed with water and fine slurry was prepared by taking 100g leaves with 100 ml of sterilized distilled water (1:1w/v). The resultant slurry was filtered through three layer of muslin cloth and then through Whatman No.1 filter paper. Finally the filtrate thus obtained was used as stock solution. From the stock solution, 5, 10 and 20mL extract were added to 95, 90 and 80 mL of PDA medium, respectively, to make 5, 10 and 20 per cent concentration. The medium was thoroughly shaken for uniform mixing of extract. Twenty ml of each medium was poured into 90 mm sterile Petri plates. Mycelium of seven mm size discs from periphery of actively growing culture were cut out by sterilized cork borer and one such disc was placed at the centre of each agar plate. Control was also maintained by growing the pathogen on only PDA. Plates were incubated at $28 \pm 2^{o}C$ for 144h and radial growth was measured. The efficacy of plant products or botanicals was expressed as per cent of radial growth over the control, which was calculated by using the formula (Vincent, 1927).

$$I = \frac{(C-T)}{C} \times 100$$

Where,

I = Per cent inhibition over control

C = Radial growth in control

T = Radial growth in treatment

The values obtained in different categories are transformed, wherever necessary and subjected to statistical analysis (Panse and Sukhatme, 1995) for treatment comparison.

Compatibility study of botanicals with bio-agent, *Trichoderma viride* T16 (CPCRI, RC, Kahikuchi) was carried out by poisoned food technique with same procedure as above.

## RESULTS AND DISCUSSION

### Efficacy of botanicals on mycelial growth of *G. lucidum*

**Table1: List of plant species used in the experiment**

| Sl. No. | Plant species | Family | English name |
|---|---|---|---|
| 1 | *Ageratum haustonianum* Mill. | Asteraceae | Floss flower, blue mink, blueweed, pussy foot |
| 2 | *Allium cepa* L. | Amaryllidaceae | Onion |
| 3 | *Allium sativum* L. | Amaryllidaceae | Garlic |
| 4 | *Amaranthus viridis* L. | Amaranthaceae | Amaranth or pigweed |
| 5 | *Azadirachta indica A.Juss* | Meliaceae | Neem |
| 6 | *Bidens pilosa* L. | Asteraceae | Cobbler's pegs or Spanish needle |
| 7 | *Carica papaya* L | Caricaceae | Papaya |
| 8 | *Catharanthus roseus* ( L.) G.Don | Asteraceae | Toothache plant |
| 9 | *Centella asiatica* (L.) Urban | Mackinlayaceae | Indian pennywort |
| 10 | *Chromolaena odorata* (L.) King & H E. Robins | Asteraceae | Siam weed |
| 11 | *Cinnamomum verum* J.Presl | Lauraceae | Cinnamon |
| 12 | *Clerodendron infortunatum* L. | Lamiaceae | Hill glory bower |
| 13 | *Lantana camara* L. | Verbenaceae | Lantana |
| 14 | *Lawsonia inermis L.* | Lythraceae | Henna |
| 15 | *Leucas aspera* (Willd)L. | Lamiaceae | Thumbai |
| 16 | *Lippia alba* (Mill.)N.E.ex Britton & P.Wilson | Verbenaceae | Bushy matgrass/Bushy lippia |
| 17 | *Melastoma malabathricum* L. | Melastomataceae | Indian rhododendron |
| 18 | *Mimosa pudica* L. | Fabaceae | Shy, bashfull or shrinking or Touch me not |
| 19 | *Ocimum tenuiflorum L.* | Lamiaceae | Tulsi, Holy basil |
| 20 | *Oxalis corniculata* L. | Oxalidaceae | Creeping wood sorel |
| 21 | *Pavonia odorata* Willd | Malvaceae | Fragrant swamp mallow, Pavonia, Fragrant pavonia |
| 22 | *Peperomia pellucida* Kunth. | Piperaceae | Shiny Bush, Slate pencil plant, silverbush |
| 23 | *Piper betle* L. | Piperaceae | Betelvine |
| 24 | *Psidium guajava* L. | Myrtaceae | Guava |
| 25 | *Rauvolfia serpentina* (L.) Benth ex. Kurz | Apocynaceae | Snakeroot |
| 26 | *Senna tora* ( L.)Roxb. | Caeselpinaceae | Sickle pod senna |
| 27 | *Solanum nigrum* L. | Solanaceae | Black night shade |
| 28 | *Spilanthes paniculata* Wall.ex.DC | Apocynaceae | Periwinkle |
| 29 | *Vitex negundo* L. | Lamiaceae | Five leaved chaste tree |
| 30 | *Zingiber officinalis* Roscoe. | Zingeberaceae | Ginger |

**Table 2: Efficacy of aqueous plant extracts on radial growth of *Ganoderma lucidum*.**

| S. No. | Botanicals | Plant part used | 5% Mycelial growth (mm) | Per cent inhibition over control | 10% Mycelial growth (mm) | Per cent inhibition over control | 20% Mycelial growth (mm) | Per cent inhibition over control |
|---|---|---|---|---|---|---|---|---|
| 1 | *Ageratum haustonianum* Mill. | Leaf | 44.5 | 50.55(45.32) | 41.0 | 54.44(47.55) | 32.2 | 64.22(53.26) |
| 2 | *Allium cepa* L. | Bulb | 61.9 | 31.22(33.97) | 55.4 | 38.44(38.32) | 50.4 | 44.00(41.55) |
| 3 | *Allium sativum* L. | Corm | 8.2 | 90.89(72.43) | 00.0 | 100.00(89.48) | 00.0 | 100.00(89.48) |
| 4 | *Amaranthus viridis* L. | Leaf | 39.7 | 55.89(48.38) | 34.6 | 61.55(51.68) | 30.3 | 66.33(54.53) |
| 5 | *Azadirachta indica A.Juss* | Leaf | 39.5 | 56.11(48.51) | 34.6 | 61.55(51.68) | 34.2 | 62.00(51.94) |
| 6 | *Bidens pilosa* L. | Leaf | 69.6 | 22.67(28.43) | 33.5 | 62.78(52.41) | 14.5 | 83.88(66.33) |
| 7 | *Carica papaya* L | Leaf | 39.4 | 56.22(48.57) | 34.9 | 61.22(51.48) | 30.5 | 66.11(54.40) |
| 8 | *Catharanthus roseus* (L.) Don | Leaf | 41.8 | 53.55(47.04) | 39.4 | 56.22(48.57) | 33.7 | 62.55(52.27) |
| 9 | *Centella asiatica* (L.)Urban | Leaf | 49.5 | 45.00(42.13) | 45.5 | 49.44(44.68) | 45.3 | 49.67(44.81) |
| 10 | *Chromolaena odorata* (L.) King & H E. Robins | Leaf | 60.5 | 32.78(34.93) | 57.3 | 36.33(37.07) | 53.5 | 40.55(39.55) |
| 11 | *Cinnamomum verum* J.Presl | Leaf | 40.7 | 54.78(47.74) | 34.7 | 61.44(51.61) | 24.5 | 72.78(58.55) |
| 12 | *Clerodendron infortunatum* L. | Leaf | 31.0 | 65.55(54.06) | 20.6 | 77.11(61.42) | 14.4 | 84.00(66.42) |
| 13 | *Lantana camara* L. | Leaf | 61.8 | 31.33(34.04) | 59.7 | 33.67(35.47) | 50.5 | 43.89(41.49) |
| 14 | *Lawsonia inermis L.* | Leaf | 30.5 | 66.11(54.40) | 24.5 | 72.78(58.55) | 21.5 | 76.11(60.94) |
| 15 | *Leucas aspera* (Willd) L. | Leaf | 19 | 78.89(62.65) | 18.7 | 79.22(62.88) | 18.7 | 79.22(62.88) |
| 16 | *Lippia alba* (Mill.)N.E.ex Britton & P.Wilson | Leaf | 54.4 | 39.55(38.97) | 51.6 | 42.67(40.79) | 51.5 | 42.78(40.85) |
| 17 | *Melastoma malabathricum* L. | Leaf | 50.7 | 43.67(41.36) | 48.0 | 46.67(43.09) | 46.4 | 48.44(44.11) |
| 18 | *Mimosa pudica* L. | Leaf | 43.5 | 51.67(45.96) | 39.5 | 56.11(48.51) | 32.4 | 64.00(53.13) |
| 19 | *Ocimum tenuiflorum L.* | Leaf | 70.1 | 22.11(28.05) | 69.5 | 22.78(28.51) | 34.7 | 61.44(51.61) |
| 20 | *Oxalis corniculata* L. | Leaf | 43.5 | 51.67(45.96) | 42.6 | 52.67(46.53) | 40.6 | 54.89(47.81) |
| 21 | *Pavonia odorata* Willd | Leaf | 58.5 | 35.00(36.27) | 55.2 | 38.67(38.45) | 52.6 | 41.55(40.14) |
| 22 | *Peperomia pellucida* Kunth. | Leaf | 55.4 | 38.44(38.32) | 54.4 | 39.55(38.97) | 53.3 | 40.78(39.69) |
| 23 | *Piper betle* L. | Leaf | 38.2 | 57.55(49.34) | 35.2 | 60.89(51.29) | 30.7 | 65.89(54.27) |
| 24 | *Psidium guajava* L. | Leaf | 87.5 | 2.78(1.60) | 84.5 | 6.11(14.31) | 80.5 | 10.55(18.95) |
| 25 | *Rauvolfia serpentina* (L.) Benth ex. Kurz | Leaf | 39.5 | 56.11(48.51) | 29.5 | 67.22(55.01) | 29.5 | 67.22(55.07) |
| 26 | *Senna tora* ( L.) Roxb. | Leaf | 51.4 | 42.89(40.91) | 49.6 | 44.89(42.07) | 32.7 | 63.67(52.93) |
| 27 | *Solanum nigrum* L. | Leaf | 20.7 | 77.00(61.34) | 14.3 | 84.11(66.51) | 00.0 | 100.00(89.48) |
| 28 | *Spilanthes paniculata* Wall.ex.DC | Leaf | 22.6 | 74.89(59.93) | 21.5 | 76.11(60.74) | 20.5 | 77.22(61.49) |
| 29 | *Vitex negundo* L. | Leaf | 43.6 | 51.55(45.89) | 47.5 | 47.22(43.41) | 48.5 | 46.11(42.77) |
| 30 | *Zingiber officinalis* Roscoe. | Rhizome | 64.7 | 28.11(32.02) | 59.7 | 33.67(35.47) | 44.7 | 50.33(45.19) |
| 31 | *Control* | | 90.00 | 0.00 | 90.00 | 0.00 | 90.00 | 0.00 |
| | SEd(±) | | - | 0.26 | - | 0.20 | - | 0.19 |
| | CD(0.05) | | - | 0.52 | - | 0.40 | - | 0.38 |

The data are the mean of 3 replications; Data within parentheses are the angular transformed values

Efficacy of botanicals on mycelial growth of *G. lucidum* varied with different botanicals at different concentrations *viz.,* 5, 10 and 20 per cent (Table 2). At 5 per cent concentration, *Allium sativum* recorded maximum inhibition (90.89%) in mycelial growth, followed by *Solanum nigrum* (77.00%) and *Leucas aspera* (78.89%) and minimum inhibition was recorded in *Psidium guajava* (2.78%). Similar trend was recorded at 10 per cent concentration. *A. sativum* recorded maximum inhibition (100.00%) in mycelial growth, followed by *S. nigrum* (84.11%) and *L. aspera* (79.22%) and minimum inhibition was recorded in *P. guajava* (6.11%). At 20 per cent concentration, *A. sativum* and *S. nigrum* recorded maximum inhibition (100 %) in mycelial growth, followed by *Clerodendron infortunatum* (84.00%) and minimum inhibition was recorded in *P. guajava* (10.55%). At all the concentration, there is significant difference between the treatments. However, there is no significant difference between *A. sativum* and *S. nigrum* at 20 per cent concentration. As a whole, extract of *A. sativum* and *S. nigrum* at all the concentration were highly effective in inhibiting the mycelial growth of the test fungus. Garlic was found to be fungitoxic to a number of plant pathogen (Iyer *et al.,* 2004, Gowda and Nambiar, 2006, Chakrabarty *et al.,* 2013). Crude extract of different plant parts of *Solanum nigrum* obtained using solvents *viz*., petroleum ether, chloroform, acetone, ethanol and methanol showed that leaf aqueous extract was more active against all the microbes tested (Ramya *et al.,* 2012).

The plants and its derivatives are of great use in agriculture, public health, medicines, cosmetics, etc. Plant extracts are effective against plant pathogens as they have unique antimicrobial properties that act in a holistic manure due to presence of certain secondary metabolites, *viz*., alkaloids, terpenoids, glycocides and phenolic acids (Srivastava *et al.,* 1994; Singh *et al.,* 1999). Kharkwal *et al*. (2012) determined the antifungal activity of the dealcoholized extract of the leaves of *Clerodendron infortunatum* Retz. against four fungal organisms *i.e. A.niger, P. frequentance, P. notataum* and *B. cinera*. Bhardwaj (2012) carried out test of aqueous extract of twenty plants for their antifungal activity against *Fusarium solani,* the causal organism of dry rot disease of potato. The combined leaf extracts of *Lawsonia alba* and stem extracts of *Acacia catechu* in general showed a strong enhancement in activities over the individual extract of each against the mycelial growth of the fungus.

The compatibility study of *Trichoderma viride* with plant extracts showed that except the extract of *Allium sativum,* all the tested plant extracts are compatible with *T. viride*. Thus, except *A. sativum* all the plant extracts that were tested can be integrated in IDM package.

## ACKNOWLEDGEMENT

The authors are grateful to the Director, CPCRI, Kasaragod for the guidance and facilities provided to carry out the work. Financial support of the Central Sector Scheme on Horticulture Mission for North East and Himalayan States is gratefully acknowledged.

## REFERENCES

**Adaskaveg, J. E. and Ogawa, J. M. 1990**. Wood decay pathology of fruit and nut trees in California. *Plant Disease.* **74:** 341-352.

**Adaskaveg, J. E., Miller, R. W. and Gilbertson, R. L. 1993**. Wood decay, lignicolous fungi, and decline of peach trees in South Carolina. *Plant Disease.* **77**: 707-711.

**Anonymous 1960.** *Annual Progress Report for 1959-1960.* Central Arecanut Research Station, Vittal, India p. 92.

**Anonymous 2013.** *Annual Progress Report for 2012-2013. Central Plantation Crops Research*, Kasaragod, kerela India. p. 142.

**Ariffin, D. and Idris, A. S. 1991**. A selective medium for isolation of *Ganoderma* from diseased tissues. *Proc. Of the 1991 International Palm Oil Conference: Progress, Prospects and challenges Towards the 21st century (Module 1: Agriculture)* (Yusof, B; Jalani, S; Chang, K. C; Cheah, S. C; Henson, I. E; Norman, K; Paranjyothy, K; Rajanaidu, N; Tayeb, D and Ariffin, D, eds). pp. 517-519.

**Bhardwaj Surender, K. 2012**. Evaluation of plant extracts as antifungal agents against *Fusarium solani* (Mart.) Sacc. *World J. Agricultural Sciances.* **8(4):** 385-388.

**Bisht, S. and Kumar, P., Srinivasan Raghavan, A. and Purohit, J. 2013.** *In vitro* management of Curvularia leaf spot of maize using botanicals, essential oils and bio-control agents. *The Bioscan. Supplement on Medicinal Plants.* **8(3):** 731-733.

**Buchanan, F. 1807**. A journey through the countries of Mysore, Canara, Malabar and London.

**Butler, E. J. 1906.** Some diseases of palms. *Agric. J. India* 1906; **1**: 299-310.

**Butler, E. J. 1909**. *Fomes lucidus* (Leys.) Fr.- a suspected parasite. *Indian Forester.* **35**: 514-518.

**Chakrabarty, R., Acharya, G. C and Sarma, T. C. 2013**. Effect of fungicides, *Trichoderma* and plant extracts on mycelial growth of *Thielaviopsis paradoxa* under *in vitro* condition. *The Bioscan.* **8(1):** 55-58.

**Coleman, L. C. 1911**. 'Anabe roga' of supari. Annual Report for 1909-1910. *Agric. Chemist Mysore, Dept. of Agric.* Bangalore. p. 32.

**Gowda, P. V. and Nambiar, K. K. N. 2006**. Antifungal activity of garlic (*Allium sativum* Linn.) extracts on *Thielaviopsis paradoxa* (de Seynes) von Hohnel, the pathogen of stem bleeding disease of coconut. **34(3):** 472-475.

**Hepting, G. H. 1971**. *Diseases of forest and shade trees in the United States.* US Department of Agriculture, Agriculture Handbook, 386, pp. 1-658.

**Iyer, Rohini, Parvathy, Meera, Lekha, G., Hegde, Vinayak and Gunasekharan, M. 2004.** Management of basal stem rot disease of *Areca catechu* L. in India. *J. Plantn Crops.* **32(1):** 25-27.

**Kharkwal, H., joshi, D. D., Kharkwal, A. C. and Prasad, R. 2012.** Antifungal activity of the leaf extract of *Clerodendron infortunatum* Retz. *World Applied Science J.* **20(11):** 1538-1540.

**Koche, M. D., Gade, R. M. and Deshmukh, A. G. 2013**. Antifugal activity of secondary metabolites produced by *Pseudomonas fluorescens*. *The Bioscan. Supplement on Medicinal Plants.* **8(2):** 723-726.

**Kumar, S. N. S. and Nambiar, K. K. N. 1990**. *Ganoderma* disease of areca palms: Isolation, pathogenicity and control. *J. Plantn Crops.* **18(1):** 14-18.

**Mahapatra, S. and Das, S. 2013**. Bioefficacy of botanicals against alternaria leaf blight of mustard under field condition. *The Bioscan.* **8(2):** *Supplement on Medicinal Plants.* 675-679.

**Mathad, R. C., Shakuntala, N. M., Vasudevan, S. N., Naik, M. N. and Patil, S. B. 2013.** The anti-fungal properties of aqueous extracts from *Psorolea corylifolia* Linn. seeds in controlling grain smut and seed quality enhancement of sorghum. *The Bioscan. Supplement on Medicinal Plants.* **8(2):** 685-687.

**Mizuno, T., Wang, G. Y., Zhang, J., Kawagishi, H., Nishitoba, T. and Li, J. X. 1995**. Reishi, *Ganoderma lucidum* and *Ganoderma tsugae*: Bioactive substances and medicinal effects. *Food Reviews internationals*. **11**: 151-166.

**Nambiar, K. K. N. and Nair, R. R. 1973**. Investigations on Anabe disease of arecanut caused by *Ganoderma lucidum* (Leys.) Karst. *J. Plantn Crops* **1** (Suppl.): pp. 119-123

**Nene, Y. L. and Thapliyal, P. N. 1982.** Fungicides in plant disease control. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp.163.

**Panse, V.G. and Sukhatme, P. V. 1961.** Statistical Methods for Agricultural Workers. ICAR, New Delhi, p. 328.

**Ramya, S., Krishnasamy, G., Jayakumararaj, R., Periathambi, N. and Devaraj, A. 2012**. Bioprospecting *Solanum nigrum* Linn. (Solanaceae) as a potential source of Anti-Microbial agents against selected bacterial strains. *Asian J. Biomedical and Pharmaceutical Sciences*. **2(12):** 65-68.

**Sangal, P. M., Mukerji, S. K. and Singh, B. 1961.** A short note on the fungus flora of Nicobar Islands. *Indian Forester* **87**: 766-767.

**Sharples, A. 1928**. Palm diseases in Malaya. *Malaya Agric. J.* **16**: 313-360.

**Singh, S. K., Sarma, B. K., Srivastava, J. S., Singh, U. P. and Ray, A. B. 1999.** Antifungal activity of ¢3-Alstovenine, a plant alkaloid isolated from *Alstonia venenata*. *Folia Microbiol*. **44**: 510-512.

**Srivastava, B. P., Singh, K. P., Singh, U. P. and Pandey, V. B. 1994**. Effect of some naturally occuring alkaloids on conidial germination of *Botrytis cinerea*. *Bioved*. **5**: 69-72.

**Toppo, K. I., Gupta, S., Karkun, D., Agrawal, S. and Kumar, A. 2013.** Antimicrobial activity of *Sphagneticola trilobata* (L.) Pruski, against some human pathogenic bacteria and fungi. *The Bioscan*. **8(2):** *Supplement on Medicinal Plants*. 695-700.

**Venkatarayan, S. V. 1936**. The biology of *Ganoderma lucidum* on arecanut and coconut palms. *Phytopathol*. **22**: 153-175.

**Vincent, J. M. 1927.** Distortion of fungal hyphae in presence of certain inhibitors. *Nature*. **15(9):** 850.