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REVIEW

Present scenario of research on diseases of medicinal plants with special emphasis on leaf spot disease of Aswagandha [*Withania somnifera* (L.) Dunal] caused by *Colletotrichum gloeosporioides*

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In spite of the tremendous progress in the development of modern medicine, plants continue to be an important source of drugs throughout the world, particularly in the developing countries. The last two decades registered significant revival in the use of higher plants for healthcare and treatment of several diseases for which modern medicines are not found effective. In this article, attempts had been made to highlight the present Scenario of Researches on Diseases of Medicinal plants with special emphasis on leaf spot disease of Aswagandha [*Withania somnifera* (L.) Dunal] caused by *Colletotrichum gloeosporioides*. Fixed plot survey was conducted on leaf spot diseases of some medicinal plants viz. *Withania somnifera, Ocimum sanctum, Pandanus foetida,* caused by three fungi *Colletotrichum gloeosporioides, Curvularia lunata, Alternaria brassicicola* respectively and another two medicinal plants *Curcuma caesia, Aristolochia indica* caused by *Rhizoctonia* sp. at Kalyani "C" block farm of West Bengal during January, 2015 – September 2016. The results showed that except Iswarimul and Aloevera, the leaf spot disease incidence occurred during winter months and in case of Iswarimul highest disease occurred during summer months and in Aloevera the disease is observed throughout the year. For the management of leaf spot disease of Aswagandha caused by *Colletotrichum gloeosporioides*, a field trial was conducted at "C" Block Farm, BCKV, Kalyani to find out the best botanical against the disease. Highest disease (30.61%) was recorded in control treatment and application of Carbendazim recorded the lowest percent disease incidence (14.75%) and recorded 74.99 % control of the disease over control and it was statistically at par with the treatment where *Polyalthia longifolia* (0.2%) was sprayed and 67.63 % control of the disease over control recorded. The highest plant wt (315 g/plant) and root wt (94 g/plant) were recorded where *Polyalthia* is sprayed and lowest plant wt (163 g/plant) and root wt (44 g/plant) were recorded where carbendazim is sprayed. Integrated disease management of leaf spot disease of Aswagandha was conducted at "C" Block Farm, BCKV, Kalyani to find out the suitable combination for the control of the disease. Lowest percent disease incidence (15.25%) and highest inhibition of disease incidence (80.86 %) and highest yield were obtained in treatment of Mancozeb (0.2%) as root treatemt + Organic manure (.3 kg/plot) + Polyalthia (0.01%) + *Trichoderma* (10^9 2g/lit of water) in root treatment+ Foliar *Trichoderma* (10^9). Highest percent disease incidence (36.94 %) was obtained in control treatment and it is inferior to all the treatments.

Key words: Medicinal plants, *Withania somnifera*, *Colletotrichum gloeosporioides*

INTRODUCTION

Medicinal plants belong to a big plant group with a great interest due to its pharmaceutical, cosmetic and nutritional application. In addition, they are also an alternative to traditional crop with species in high demand at the current international market. It has been in use since ancient time mostly to heal and cure human and animal diseases. The wide spread use of medicinal herbs for health care dates back particularly to the early existence of human civilization. The largest group of pharmaceutically important preparation for living organisms has come from plants which are continuously being exploited even today. Considering the adverse effect of synthetic drugs, the western world is

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looking for natural remedies which are effective as well as safe. More than 30,000 plant species of medicinally important are grown all over the world. Extensive cultivation of these plants has increased the pathological problems. The diseases of these plants and their intensity have increased to a great extent. An attempt to conserve and protect these plants presents a formidable challenge. Increasing demand for herbal medicines has resulted in "slaughter harvesting" of medicinal plants from wild sources particularly in India. At present 90% of the medicinal plants come from wild sources. This trend does not promise sustainable use of medicinal plants, which fulfil health care needs for majority of population.

In India, medicinal plants comprise approximately 8000 plant species A large number of the country's rural population depends on medicinal plants for treating various illnesses. About 1.5 million practitioners of the Indian Systems of Medicine and Homeopathy (ISM&H) use medicinal plants for preventive, primitive and curative applications. Furthermore, there are 7843 registered ISM pharmacies and 851 of homoeopathy as well as a number of unlicensed small-scale units. Besides meeting national demands, India caters to 12% of the global herbal trade. In recent years, trade in herbal-based products has quantum leaped, particularly in the volume of plant material traded within and outside the country. Estimates by the EXIM Bank put medicinal plants related international trade at US$ 60 billion per year and still growing at a rate of 7% annually (Maiti, 2014).

Currently in India Mints (1,50,000 ha), Senna (20,000 ha), Tulsi (5,000 ha), Safed Musli (5,000 ha) etc. are grown commercially and providing employments in terms of man-days by cultivation and post harvest processing in Mint (4.0 Cr), Tulsi (4.0 Cr), Safed Musli (1.3 Cr) and several others (Khanuja *et al*., 2006). So the challenge before country is not only preparation of a model GAP documents but also its implementation in its true spirit. It is documented that 80% of world population has faith in traditional medicine, particularly plant drugs for their primary health care as suggested by World Health Organization (WHO).

West Bengal exhibits a varied range of topography and agro climatic conditions, which enormously contribute on its vegetation and floristic consumption. In spite of this, information on area under medicinal plants and production are not available (Das, 2002). Cultivation of medicinal plants in West Bengal is yet to take a noble shape. West Bengal government has recommended some medicinal plants like Aswagandha (*Withania somnifera* Dunal), Sarpagandha, Senna, Tulsi, Bach (*Acorus calamas*), Punarnaba (*Boerhaavia diffusa*) and Arrowroot (*Maranta arundinacea*) etc. for commercial cultivation in different zones. However, several biotic and abiotic factors limit the production of these crops. The pathogenic diseases cause significant damage of the crops as well as reduce the quality of the produces and acceptability to the market. The diseases may reduce the active chemicals components in the plant parts used for medicinal purpose (Mukherjee, 2009).

MEDICINAL PLANTS AND THEIR IMPORTANCE

The term of medicinal plants include a various types of plants used in herbalism and some of these plants have a medicinal activities. These medicinal plants consider as a rich resources of ingredients which can be used in drug development and synthesis. Besides that these plants play a critical role in the development of human cultures around the whole world. Moreover, some plants consider as important source of nutrition and as a result of that these plants recommended for their therapeutic values (Hassan, 2012).

In India, earliest references of use of plants as medicine appear in Rig-Veda, which is said to be written between 1600 - 3500 B.C. Later the properties and therapeutic uses of medicinal plants were studied in detail and recorded empirically by the ancient physicians (an indigenous system of medicine) which are a basic foundation of ancient medical science in India. In many developing countries, a large proportion of the population relies on traditional practitioners and their armamentarium of medicinal plants in order to meet health care needs. Although modern medicine may exist side-by-side with such traditional practice, herbal medicines have often maintained their popularity for historical and cultural reasons (Hosseinzadeh *et.al.* 2015). Mukerjee (2009) reported some medicinal herbs/shrubs found in West Bengal, their uses and medicinal constituents (Table 1).

SURVEY ON DISEAES OF MEDICINAL PLANTS

Survey was carried out in various Talukas of Osmanabad District, Maharastra, India during the years 2008 & 2009 on commonly found and

Table 1: List of some most common medicinal herbs/ shrubs found in West Bengal, their uses and medicinal constituents

Common name in Bengali	Botanical name	Planting time	Plant part use	Medicinal use	Medicinal constituent
Sarpagandha	*Rauvolfia serpentina*	October	Root	Use in nervous disorder, mania, epilepsy, skin disorder, gynecological ointment for menopause, uterine construction trouble during child birth etc.	Ajmalicin, Ajmaline, Ajmalinine, Reserpine, Serpentine, Reserpine, Serpentinine,
Senna	*Cassia angustifolia*	Oct-Nov/ Feb-March	Green leaf and green pods.	Useful in habitual constipation, abdominal disorder, leprosy, leucoderma, hepatopathy, jaundice, dyspepsia, cough, bronchitis, typhoid fever, anemia, tumors, liver complaints and splenic enlargement etc.	Sennoside A,B,C,D
Aswagandha	*Withania somnifera*	July - August	Roots and leaves.	Useful in insomnia, tissue building, nervous breakdown, carbuncles, ulcer and scabies etc.	Withasomnine, Withaferin A, Withanolides, Withanol.
Ghritkumari	*Aloe indica*	March-June	Leaves	Useful as cooling balm on inflammatory joints, in headache, as purgative and athelmintic etc.	Aloin, Ale-emodin, Isoberbaloin, Resin
Nayantara	*Catharanthus roseus*	June-July	Leaves, seed and root	Useful in leukemia, diabetes, menorrhagia etc	Vinblastine, Vincristine, Raubasine
Stevia	*Stevia rebaudiana*	Nursery: Feb-March Transplanting : march-April/ june-july	Green leaves and stems	Source of natural sweeteners, useful for diabetic patient etc.	Stevioside, Rebaudioside
Safed musli	*Chlorophytum borivilianum*	June-July	Roots	Useful in fatigueness, blood purification, leucorrhoea, lactation, energetic to heart.	Sapogenin
Satamuli	*Asparagus racemosus*	July	Roots	Useful in nervous disorder, dyspepsia, diarrhea, dysentery, burning sensation, scalding of urine, throat infection, tuberculosis, cough, gonorrhea, leprosy, epilepsy, hyperacidity, hypertension and cardiac debility etc.	Guanostin, Rutin and Hyperoside, Sistosterol, Stigmasterol,
Bach	*Acorus calamus*	April-May	Underground rhizome	Useful in bronchitis and asthma, headache, chronic diarrhea and dysentery etc.	Acorin
Kalmegh	*Andrographis paniculata*	June-July	Leaves and roots.	Useful for liver complaints, types of fever, constipation, colic, dysentery and dyspepsia, strangulation of intestine and spleen complaints etc.	Kalmeghin, Andrographin and Paniculin, β setosterol.

economically important three medicinal plants viz. *Aloe vera* (L.) *Burm.* F*, Datura metel* L. and *Withania somnifera* (L.) *Dunal.* Plants were examined *In situ* for disease symptoms as well as samples being collected for laboratory analyses. Fungi were identified using morphological characteristics, and where necessary with molecular techniques. The survey resulted in a range of fungi identified and causing different diseases from the target plants have been summarized in Table 2.

Common diseases on all the three plants were leaf spots, leaf blight and leaf rust which cause harmful effects on medicinal value of the plant parts. *Alternaria* spp. attacked on *Aloe* and *Datura* leaf while *Cercospora withaniae* causes leaf spot diseases of *Withania*. Other fungi observed were *Fusarium solani, Aspergillus niger, Penicillium* spp., etc. These were found to be very harmful for the medicinal uses of the plant parts and may be adversely affect to the body. Gupta *et al*., (2007) conducted a periodic survey in different places (Chitrakoot, Seoni, Narsinghpur and Bilashpur) of Madhya Pradesh, India and in the neighborhood of Jabalpur, within a radius of approximately 50 km, correctly identify some medicinal plants infected by different fungi. Among the observations *Colletotrichum gleosporioides* (*Glomerella cingulata*) on *Ipomoea obscura*, *Colletotrichum caudatum* on *Cymbopogon martini*, *Colletotrichum chlorophytumie* on *Chlorophytum borivillianum* (*Chlorophytum borivilianum*), *Colletotrichum dematium* on *Acorus calamus* and *Jatropha curcas, Macrophoma* (*Sphaeropsis*) sp. on *Croton tiglium*, *Pestalotiopsis dichaeta* on *Madhuca indica* (*Madhuca longifolia*), *Pestalotiopsis versicolor* on *Buchanania lanzan*, *Pestalotiopsis disseminata* on *Ampelocissus latifolia*, *Phoma putaminum* on *Emblica officinalis* (*Phyllanthus emblica), Phoma sp.* on *Terminalia belerica* (*Terminalia bellirica*), and *Septoria sp*. on *Callicarpa macrophylla* were reported.

Acorus calamus is known as sweet flag (Family: Acoraceae) is a perennial medicinal plant found in both temperate and sub temparate zones. Roots and rhizomes are stimulants, emetic, nauseant, stomachic, aromatic, expectorant, carminative, antispasmodic and nervine sedative. Gas chromatography revealed the presence of two components isolated in pure state i.e. á-asarone and â- asarone. Diseases or pathogens cause

(*Contd. Table 1*)

Vasaka	*Adhatoda vasaka*	..	Leaves, shoot and root.	Useful in cough and cold, bronchitis, respiratory disorders, chronic rheumatism, cephalagia, hemiplegia , facial paralysis, otalgia, hemicranias, dysmenorrhoea, internal haemorrhages, intermittent fevers, exudes and debility etc.	Quinazole, Vasicolin, Adhatoda inc, Anisotine.
Bringaraj	*Eclipta alba*	June-July/ Oct-Nov	Leaves and root.	Useful in hepatotoxicity, uterine pains after delivery, to prevent abortion, miscarriages. Useful in expulsion of worms and inflammatory affect, insect bites, stings, swelling and skin disease.	Wedelolactone, Coumarin, Norwedelolactone, Phytosterol, Hentriacontanol, Heptacosanol.
Coleus	*Coleus forskohlii*	June-July	Root	Useful in cardiovascular problem, asthma, carminative.	Forskolin, Deoxyforskolin, 9-deoxyforskolin.

Table 2: Fungal diseases of medicinal plants

Medicinal plants	Common name	Diseases	Causal organism
Pandanus foetidus	Annagandha	Leaf blight	*Alternaria alternata)*
Ocimum sp	Sweet basil	Leaf blight	*Alternaria alternata)*
Boerhavia diffusa	Punarnaba	Leaf spot	*Colletotrichum capsici*
		White rust	*Albugo candida*
Maranta arundinacea	Arrowroot	Leaf spot	*Rhizoctonia solani*
Rauvolfia serpentine	Sarpagandha	Wilt	*Fusarium oxysporium f.sp rauvolfii*
		Leaf spot	*Cercospora rauvolfiae*
Cassia anguistifolia	Senna	Leaf blight	*Alternaria alternata*
		Leaf spot	*Colletotrichum gloeosporioides*
Acorus calamus	Bach	Rust	*Uromyces acori*
		Leaf spot	*Ramularia aromatici*
Piper longum[a]	Pipul	Leaf blight	*Fusarium* sp
Tylophora indica[b]	Antomul	Leaf blight	*Sclerotium rolfsii*
Aloe indica[c]	Allovera	leaf spot	*Phomopsis* sp
Curcuma caesia	Kalo haldi	Rhizome rot	*Pythium graminicolum*
		Leaf bloch	*Taphrina maculans*
		Leaf spot	*Colletotrichum capsici*
Gloriosa superb[d]	Bishangali	leaf blight	*Alternaria alternata*
Plumbago zeylanica	Shwet chita	Leaf spot	*Phoma exigua*
Withania somnifera[e]	Aswagandha	Leaf spot	*Colletotrichum gloeosporioides*

[[a] Momin, 2009; [b] Sarkar et al, 2016; [c] Avasthi et al, 2016; [d] Maiti et al, 2007; [e] Sarkar and Dasgupta , 2017]

deterioration of the active chemicals of the plants which affect the quantitative and qualitative loss of medicinal plants. During a study in the year 2010-2012 at three different locations of West Bengal, India, a new tip blight and leaf spot disease was observed in *Acorus calamus* caused by *Nigrospora oryzae*. A survey was conducted and the result showed that maximum disease incidence and disease index are recorded during November to February and minimum disease incidence and index of leaf spot or blight by *Nigrospora oryzae* during May - July, thereafter gradually increased and again reached to the peak during December – January (Paul and Dasgupta, 2014).

During survey in the year 2010-2012 at three different locations of West Bengal, India, a new tip blight and leaf spot disease was observed in *Acorus calamus* caused by *Nigrospora oryzae* and the maximum disease incidence and disease index were recorded during November to February and minimum disease incidence and index of leaf spot or blight by *Nigrospora oryzae* during May - July, thereafter gradually increased and again reached to the peak during December – January (Paul and Dasgupta, 2014). A fixed plot survey was conducted on leaf spot disease of *Boerhaavia diffusa* (Punarnaba) caused by *Colletotrichum capsici* in three different locations (Kalyani and Krishnanagar of Nadia districts and Narendrapur, Kolkata) of West Bengal during January, 2010 – December, 2011 by Paul (2013). Two years pooled data on leaf spot or anthracnose of *Boerhaavia diffusa* indicated that maximum disease incidence and severity was during November to February and minimum during March – August and gradual increase were recorded from August onwards for Kalyani location but the disease scenario of Krishnanagar for different species of same plant was quite different. Maximum disease incidence was observed in the month of November to February and minimum disease incidence was observed in the month of April to September, whereas the maximum index was during April to November and

minimum was during December to February (Paul, 2013).

Sarkar (2018) conducted fixed plot survey on leaf spot diseases of some medicinal plants viz. *Withania somnifera, Ocimum sanctum, Pandanus foetida,* caused by three fungi *Colletotrichum gloeosporioides, Curvularia lunata, Alternaria brassicicola* respectively and another two medicinal plants *Curcuma caesia, Aristolochia indica* caused by *Rhizoctonia* sp. at Kalyani "C" block farm of West Bengal during January, 2015 – September 2016. The results (Table 3) showed that in *Withania somnifera,* maximum disease incidence and disease index were recorded during October - January and minimum disease incidence and index of leaf spot or blight caused by *Colletotrichum gloeosporioides during* April – July, thereafter disease incidence gradually increased and again reached to the peak during December – January. In *Ocimum sanctum,* maximum disease incidence was recorded during November - February and minimum disease incidence during May – August. During June no leaf spot caused by *Curvularia lunata* var. *aeria* was recorded. Maximum and minimum disease index was observed during November – March and May – August respectively. In *Pandanus foetida*, maximum disease incidence and disease index were recorded during October – March and minimum disease incidence and index of leaf spot by *Alternaria brassicicola* during May –August, thereafter gradually both disease incidence and index increased and reached to peak during February – March. In *Aristolochia indica*, maximum disease incidence caused by *Rhizoctonia* sp. was found during April – August and minimum during December – February, there after gradually increased to reached the peak during July – August. Minimum disease index was recorded during May – December and minimum during January – March. The leaf spot disease of *Aristolochia indica* was affected adversely throughout the year. *Curcuma caesia* is a nine months (April – December) medicinal crop. Maximum disease incidence and disease index were recorded during September – December and minimum disease incidence and index of leaf spot by *Rhizoctonia* sp. during July - August. During April and May no leaf spot disease of *Curcuma caesia* causes by *Rhizoctonia* sp. was recorded.

SYMPTOMS OF LEAF SPOT DISEASES OF IMPORTANT MEDICINAL PLANTS OF WEST BENGAL

Leaf spot of Aswagandha (*Withania somnifera*) caused by *Colletotrichum gloeosporioides*

Symptom was studied very carefully on the leaves. At first small and irregular yellowish to brown spots were appeared on the leaves and gradually spots become enlarge. Concentric ring was appeared on the spot. Spots coalesced with each other and appeared as a large spot. Some times in severe case whole leaf become blighted. This type of symptoms had not yet been reported in any literature. So, this might be a record of new disease of *Withania somnifera* (Fig 1).

Leaf spot of Tulsi (*Ocimum sanctum*) caused by *Curvularia lunata* var. *aeria*

Ocimum sanctum was found infected with leaf spot disease. Symptom was studied very carefully on the leaves. At first small dark black color spots were appeared on the leaf surface and the spots gradually become expanded. At latter stage several spots were coalesced and become large irregular shaped dark black spots on the leaves. There are several shaped irregular spots on the leaf. This also might be a record of new disease of *Ocimum sanctum* (Fig 2).

Leaf spot of Annagandha (*Pandanus foetida*) caused by *Alternaria brassicicola*

The first symptoms appeared as small yellowish to brown spots on leaf and gradually the spots expanded to oblong shaped lesion. Several spots were appeared on the leaf as scatteredly. At severe cases the spots were coalesced and give a blighting appearance. Sometimes whole leaf became brown and dried also. This is also newly reported symptom of *Pandanus foetida* (Fig 3).

Leaf spot of black turmeric (*Curcuma caesia*) caused by *Rhizoctonia solani*

At first light brown color spots were appeared on the leaf. In maximum times spots were appeared from the edged of the leaf. Gradually spots become enlarged and give a water soak lesion. In severe case spots spread from the edge to downward of the leaf and cover the whole leaf. At latter stages

Table 3: Fixed plot survey on Percent disease incidence and Percent disease index of leaf spot diseases of Iswarimul (*Aristolochia indica*), Kalo Haldi (*Curcuma caesia*), Aswagandha (*Withania somnifera*), Tulsi (*Ocimum sanctum*) and Annagandha (*Pandanus foetida*)

Year	Month	Leaf spot of Iswarimul caused by. *Rhizoctonia* sp.		Leaf spot of Kalo Haldi caused by. *Rhizoctonia* sp.		Leaf spot of Aswagandha caused by. *Colletotrichum gloeosporioides*		Leaf spot of Tulsi caused by *Curvularia lunata* var. *aeria*		Leaf spot of Annagandha caused by . *Alternaria brassicola*	
		PDI	PDX	PDI	PDX	PDI	PDX	PDI	PDX	PDI	PDX
2015	January	2.99[1]	5.50[1]								
	February	8.24	11.66								
	March	23.33	42.00								
	April	42.08	60.00	0.01	0.00						
	May	49.08	75.00	0.01	0.00						
	June	50.05	75.50	0.50	7.00						
	July	51.33	78.00	3.08	12.00	6.91	8.50	2.17	0.00		
	August	52.0	79.66	11.66	33.50	17.05	14.32	4.71	7.34		
	September	34.75	80.33	26.82	53.50	45.39	32.66	8.66	11.66		
	October	22.74	81.66	40.08	55.50	58.40	41.66	17.16	15.66	34.99	48.50
	November	16.33	81.99	47.33	58.00	74.75	52.33	29.39	20.33	38.65	50.00
	December	11.99	82.00	58.24	58.35	83.81	62.33	38.41	22.33	39.18	52.00
2016	January					86.09	65.66	40.47	23.66	44.82	53.00
	February					76.81	30.66	34.24	25.33	49.64	53.50
	March					28.33	16.33	22.33	30.33	51.06	55.50
	April					1.16	0.33	8.49	12.33	26.19	37.50
	May					5.54	3.33	1.25	4.33	0.50	7.00
	June					6.08	5.66	0.1	0.00	2.17	10.50
	July									3.83	27.50
	August									6.66	37.00
	September									24.33	47.50

[1]Average of 4 weekly observations PDI= Percent disease incidence PDX= Percent disease index

Table 4: Diseases management of leaf spot of Aswagandha caused by *Colletotrichum gloeosporioides* by using botanicals and fungicides

Treatments	Percent Disease Incidence	% inhibition	Plant wt (Gm/plant)	Plant wt (kg/ha)	Root wt Gm/plant)	Root wt (kg/ha)	Dry plant wt (Gm/plant)	Dry plant wt (kg/ha)	Dry root wt (Gm/plant)	Dry root wt (kg/ha)
T_1	13.06 (21.19)*	49.61	268	10720	87	3480	52	2080	29	1160
T_2	12.19 (20.78)	51.44	214	8560	67	2680	38	1520	20	800
T_3	8.39 (16.86)	67.63	315	12600	94	3760	59	2360	33	1320
T_4	12.01 (20.28)	53.66	210	8400	58	2320	35	1400	19	760
T_5	6.48 (14.75)	74.99	163	6520	44	1760	29	1160	14	560
T_6	8.50 (16.95)	67.22	170	6800	54	2160	33	1320	17	680
T_7	25.92 (30.61)		167	6680	50	2000	30	1200	15	600
SEm±	0.97		24.71	388.54	5.89	235.60	5.12	204.97	2.91	116.54
CD at 5%	3.01		76.15	3046	18.14	725.96	15.78	631.59	8.97	359.11

T_1= Spraying of Ginger extract (20% EC) @0.2% concentration
T_2= Spraying of *Clerodendron* extract (20%EC) @ 0.2 % Concentration
T_3= Spraying of *Polyaithia* extract (20%EC) @ 0.2% Concentration
T_4= Spraying of Fern extract (20%EC) @0.2% Concentration
T_5= Spraying of Carbendazim (50 WP) @0.1%
T_6= Spraying of Mancozeb (75 wp) @0.25%
T_7= Control
*Figures in parentheses are the angular transformed values of percent disease incidence

whole leaf become brown in color and whole plant wilts at end of the season (Fig 4).

Leaf spot of Iswarimul (*Aristolochia indica*) caused by *Rhizoctonia solani*

At first blackish brown colour spots were appeared on the leaf and gradually spots become enlarged and give a dark black colored lesion. Spots were expanded and cover the whole leaf. At latter stage whole leaf becomes dried. Spots were also found on stem. At severe stage whole plant showed damping off symptom. This is very severe disease of Iswarimul and found throughout the year (Fig 5).

MANAGEMENT OF LEAF SPOT DISEASE OF ASWAGANDHA CAUSED BY *COLLETOTRICHUM GLOEOSPORIOIDES* UNDER FIELD CONDITIONS

BY USING NUTRIENTS, SYNTHETIC FUNGICIDE AND BIOCONTROL AGENTS

Management of diseases are important and as medicinal plants are used directly as extract or whole plant dried powder, the management of their diseases by synthetic fungicides cannot be the best option particularly for foliar diseases at late or before harvesting due to residual toxicity of fungicides which in turn causes toxic hazards to human being.

Effects of root inoculations with *Bacillus cereus* (N2-fixing), *Brevibacillus reuszeri* (P-solubilizing), and *Rhizobium rubi* (both N2-fixing and P-solubilizing) on plant growth, nutrient uptake, and crop yield in comparison with manure (control) and mineral fertilizer application under field conditions were conducted by Yildirim et.al (2011). Bacterial inoculations with manure compared with control significantly increased yield, plant weight, head diameter, chlorophyll content, nitrogen (N), potassium (K), calcium (Ca), sulfur (S), phosphorus (P), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) content of the crop tested. The lowest yield per plant, plant weight, steam diameter, and chlorophyll content were recorded in the control, but the manure with *Bacillus cereus* (BC), *Rhizobium rubi* (RR), and *Brevibacillus reuszeri* (BR) inoculations increased yield 17.0%, 20.2%, and 24.3% and chlorophyll content by 14.7%, 14.0%, and 13.7% over control,

Table 5: Integrated disease management of leaf spot of Aswagandha caused by *Colletotrichum gloeosporioides*

Treatments	Percent Disease Incidence	% inhibition	Plant wt (Grn/plant)	Plant wt (kg/ha)	Root wt Grn/plant)	Root wt (kg/ha)	Dry plant wt (Grn/plant)	Dry plant wt (kg/ha)	Dry root wt (Grn/plant)	Dry root wt (kg/ha)
T_1 = Mancozeb (0.2%) as root treatment + Organic manure (3 kg/plot)	9.54 (18.00)*	73.58	292	11680	87	3480	78	3120	58	2320
T_2 = Polyakhia extract @ 0.2%	12.61 (20.80)*	65.09	185	7413	56	2240	48	1920	35	1400
T_3 = *Trichoderma* (10^9 2gm/lit of water) as root treatment + Polyakhia extract 0.2%	12.21 (20.45)*	66.2	201	8026	58	2320	51	2040	36	1440
T_4 = Foliar *Trichoderma* (10^9) @ 5gm / litre	17.58 (24.79)*	51.32	157	6293	51	2040	41	1640	31	1240
T_5 = T_1 + T_2 + T_3 + T_4	6.91 (15.25)*	80.86	345	13800	98	3920	84	3360	60	2400
T_6 = T_2 + T_3 + T_4	11.61 (19.92)*	67.85	234	9373	63	2520	63	2520	41	1640
T_7 = T_2 + T_4	11.93 (20.21)*	66.97	217	8680	62	2480	55	2200	39	1560
T_8 = Control	36.12 (36.94)*	..	139	5560	46	1840	33	1320	28	1120
SEm±	0.59	..	5.65	226.36	2.43	97.41	1.76	70.53	0.81	32.51
CD 5%	1.80	..	17.16	686.50	7.38	295.46	5.35	213.93	2.46	98.62

*Figures in parentheses are the angular transformed values of percent disease incidence

respectively. Bacterial inoculations with manure significantly increased uptake of macronutrients and micronutrients by the plant. In conclusion, seedling inoculation with BR and especially RR may partially substitute costly synthetic fertilizers in this crop plant. Plant growth promoting *Bacillus subtilis* (BS2) was also found effective against wilt disease caused by *Fusarium oxysporum* f sp. *lycopersici* under field conditions. Pretreatment of plants with *B. subtilis* BS2 significantly induced the activities of defense related enzymes *viz*., peroxidase, polyphenol oxidase, chitinase and phenylalanine ammonia lyase and phenolics when challenged with the pathogen. Apart from disease control, BS2 improved the fruit quality with high lycopene (76.30 mg/kg against control, 40.34 mg/kg) and texture (90.5 *F*max against control, 56.35 *F*max) during harvest and even 15 days after harvest, similar trend was maintained unequivocally indicating that plant growth promoting rhizobacteria (PGPR) can improve the nutritional quality as well as shelf life of the fruits (Loganathan *et.al.*,2014).

By using botanicals

Dissanayake and Jayasinghe (2013) tested six medicinal plants i.e. *Oxalis corniculata* (creeping woodsorrel red and green), *Ocimum gratissimum* (wild basil), *Tithonia diversifolia* (wild sunflower*)* and *Chromolaena odorata* (siam weed) and bulbs of *Acorus calamus* (sweet flag) and *Zingiber officinale* (ginger) against plant pathogenic fungi *Rhizoctonia solani*, *Colletotrichum musae* and *Fusarium oxysporum*. Ginger showed moderate level of antifungal activity (75%-42%) against *F.oxysporum,* comparatively very low activity against *R. solani* and moderate level of antifungal activity (61%-34%) against *Colletotrichum musae*. A study was conducted to determine the antimicrobial activity of dried ginger powder, using paper disc diffusion assay, by using chloroform, ethanol, acetone and petroleum ether solvents, against *Fusarium oxysporum* f. sp. *lycopersici* by Rawal and Adhikari (2016). The chloroform extract showed 15.87 mm inhibition zone at 250 mg/ml concentration. 500 mg/ml concentration was moderately effective with 20.25 mm inhibition zone. At 750 mg/ml the zone of inhibition was observed to be as 25.75 mm.

Mogle (2013) tested aqueous leaves extract of *Parthenium hysterophorus, Annona reticulata, Polyalthia longifolia, Ipomea carnea, Tridax procumbens, Argemone mexicana, Cathranthus roseus, Eucalyptus globulus* and *Achyranthus aspera* against fungal pathogens were found to be antifungal during post harvest as these are eco-friendly and do not cause environmental hazard. *Polyalthia longifolia* extracts inhibited the fungi like *Penicillium digitatum* over 50 % followed by *Botrytis cinera* 45 % over control. The extracts of *Polyalthia longifolia, Annona squamosa* and *Tridax procumbens* were found to be inhibitory for the growth of *Alternaria porri, Aspergillus niger, Fusarium oxysporum* and *Cladosporium allii* (Ghangaonkar, 2007). *P. longifolia* leaf extract against *Xanthomonas axonopodis* pv. *citri* was found to be effective in inhibiting the pathogen growth (Harini 2000; Mamin 2009).

A field trial was conducted at “C” Block Farm, BCKV, Kalyani to identify the best botanical against leaf spot disease of Aswagandha. Objective of this experiment was to use the best treatment in integrated management system for management of foliar disease. The result (Table 4) showed that highest disease (30.61%) was recorded in control treatment and application of Carbendazim recorded the lowest per cent disease incidence (14.75%) and recorded 74.99 % control of the disease over control and it was statistically at par with the treatment where *Polyalthia longifolia* (0.2%) was sprayed (16.84%) and recorded 67.63 % control of the disease over control. The treatment was also statistically at par with the treatment where Mancozeb (0.25%) was sprayed and recorded 16.95% disease incidence and 67.22% disease control over control. Application of ginger, which showed 21.19% disease incidence was also statistically at par with the treatments where Clerodendrum and Fern were applied which showed 20.78% and 20.28 % disease incidence respectively and recorded 51.44% and 53.66% control of disease respectively. The treatments could be assigned in the following order Tr_5 e” Tr_3 e” Tr_6 Ã Tr_4 e” Tr_2 e” Tr_1 Ã Tr_7.

The height plant wt (315 g/plant) and root wt (94 g/plant) were recorded where Polyalthia was sprayed and lowest plant wt (163 g/plant) and root wt (44 g/plant) were recorded where carbendazim was sprayed.

Application of carbendazim was statistically superior to all other treatments but as Aswagandha is a medicinal plant and it is use as raw, botanicals would be the best choice for disease management

Fig. 1 : Leaf spot of *Withania somnifera* caused by *Colletotrichum gloeosporioides*

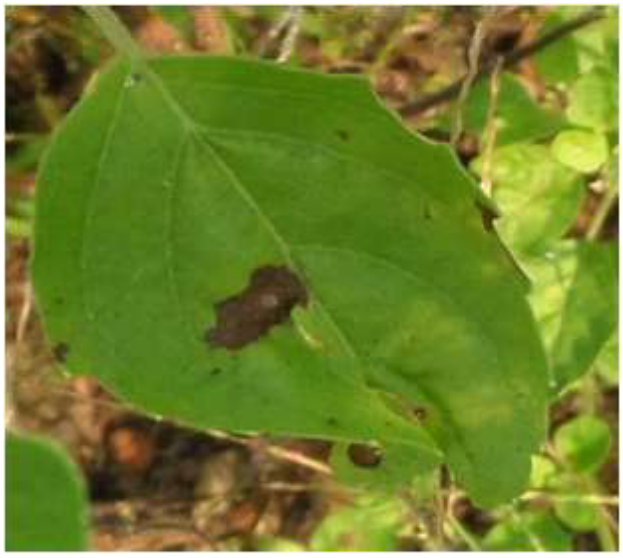

Fig. 2: Leaf spot of *Ocimum sanctum* caused by *Curvularia lunata* var.*aeria*

Fig. 3 : Leaf spot of *Pandanus foetida* caused by *Alternaria brassicicola*

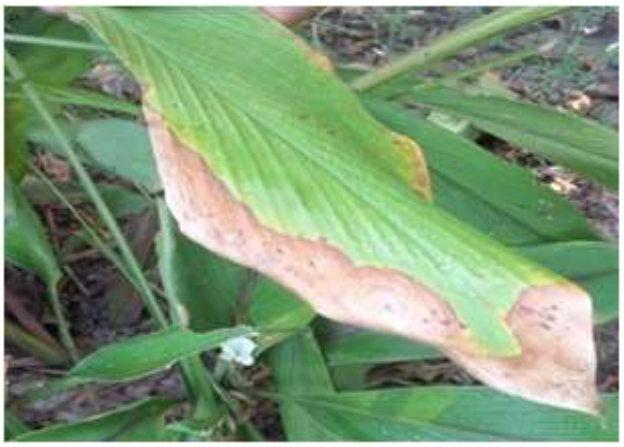

Fig. 4 : Leaf spot of *Curcuma caesia* caused by *Rhizoctonia solani*

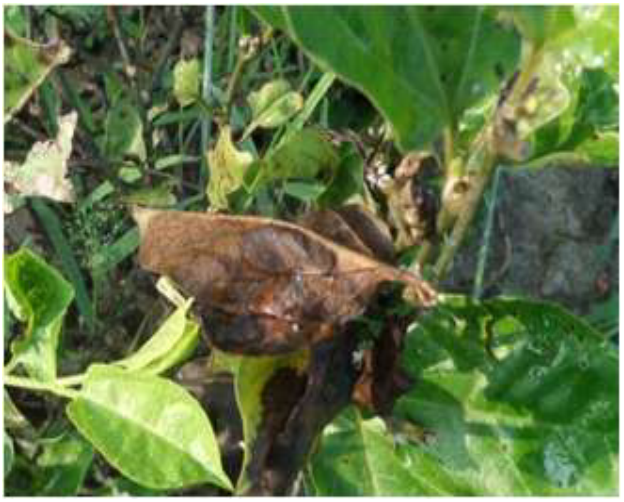

Fig. 5 : Leaf spot of *Aristolochia indica* caused by *Rhizoctonia solani*

practices. So *Polyalthia*, which was at par with carbendazim, was selected for integrated disease management (Sarkar, 2018).

Integrated disease management

Paul (2013) conducted Integrated disease management of leaf spot disease of *Boerhaavia diffusa* (punornaba) caused by *Colletotrichum capsici*. He recorded lowest per cent disease incidence (12.41) and highest inhibition (57.53%) in treatment T4 (*Trichoderma* spp. @ 3.7×10^8 spores/ml + Salicylic acid @ 3mM + *Trichoderma* spp @ 3.7×10^8 spores/ml.) management package was sprayed. Whereas Treatment T7 (*Trichoderma* spp. @ 3.7×10^8 spores/ml + Salicylic acid @ 3mM + *Clerodendron* leaf powder @ 12%) was statistically at par with the T4 in terms of their response against leaf spot disease incidence of *Boerhaavia diffusa*at 5% level of significance.

Highest disease incidence (29.23%) was recorded in control treatment (T8).

Sarkar and Dasgupta (2017) conducted a field trial at "C" Block Farm, BCKV, Kalyani to find out suitable combination of integrated management against leaf spot disease of Aswagandha.

Results of integrated disease management (Table 5) showed that lowest percent disease incidence (15.25) and highest inhibition of disease incidence (80.86 %) was obtained, where treatment T_5 [Mancozeb (0.2%) as root treatment + Organic manure (.3 kg/plot) + Polyalthia (0.01%) + Trichoderma (10^9 2gm/lit of water) as root treatment + Foliar Trichoderma ($10^{9)}$] management practices was applied. T_5 was superior to other treatments at 5% level of significance. Highest percent disease incidence (36.94) was obtained in control treatment (T_8) and it was inferior to all the treatments. All other treatments were in between the above two treatments. The treatments could be assigned in the following order:

T_5Ã T_1Ã T_6e" T_7e" T_3e" T_2ÃT_4ÃT_8

The height plant wt (345 g/plant) and root wt (98 g/plant) were recorded in treatment T_5 [Mancozeb (0.2%) as root treatment + Organic manure (.3 kg/plot) + *Polyalthia* (0.01%) + *Trichoderma* (10^9; 2g/lit of water) as root treatment + Foliar *Trichoderma* (10^9)] management package and lowest plant wt (139 g/plant) and root wt (46 g/plant) were recorded in control treatment(T_8).

CONCLUSIONS

Medicinal plants comprise approximately 8000 plant species in India. A large number of the country's rural population depends on medicinal plants for treating various illnesses. India's export of medicinal plants in the year 2003-2004 dropped by 9.59% over the previous year when the same reached a level of Rs-302.11 Cr as against Rs-334.17 Cr in the previous year. Further the trade shows that five medicinal plants in the year 2003-04 accounted for more than 70% of the trade exports of medicinal plants. These comprise Jajoba seed, Senna leaves and pods, *Phyllium* husk (Isobgul husk), *Phyllium* seed (Isobgul), sandal wood chips and dust, *Vinca rosea* (Herbs), and other leaves, flowers as fresh/ dried/ cut/ crushed/ powdered forms.

Several biotic factors like fungi, viruses, bacteria, phytoplasmas, nematodes and abiotic factors like nutrients deficiencies in soil, lack of proper irrigation, etc. are responsible for the maladies of medicinal plants. There are several kinds of disease affecting the plants and each crop plant can be affected by a number of diseases. Disease conditions in the plants are recognized according to the symptoms produced by the pathogens. The usual disease symptoms are root rots, cankers, wilts, leaf spots, scabs, blights, anthracnose, rusts, mildews, smuts, mosaics, yellows, root knots, etc. Diseases caused by bacteria, fungi, nematodes, viruses, mycoplasmas are characterized by the presence of these pathogens on the tissues of these plants. The presence of such pathogens at an active site on the surface of the plant would indicate that they are probably the cause of the disease. The presence of parasitic nematodes, fungal mycelium and spores or bacteria on the affected areas of the diseased plants must be considered the possibilities of their role in the disease conditions. Diagnosis of such disease is primarily based on symptoms and transmission of the pathogens from diseased to healthy plants. Diseases of plants, thus, can be identified by the symptoms and the presence of the pathogen especially on the site of infection. Biotechnological and biological detection and management of these appears feasible now.

But very little work on Medicinal and Aromatic plants has been made on diseases aspect. There are also several doubts on the causal organisms reported of those medicinal plants because most of them were reported and identified from plant samples. Pathogenecity tests are lacking. Management are also important and as medicinal plants are used directly as extract or whole plant dried powder, the management of their diseases by synthetic fungicides cannot be the best option particularly for foliar diseases at late or before harvesting. So, emphasis should be given on biocontrol of diseases of medicinal plants and integrated management of diseases using botanicals and biocontrol agents.

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