Original Research Article  
https://doi.org/10.20546/ijcmas.2017.610.349

Effect of Fungicides and Botanicals against Leaf Rot Disease Caused by *Fusarium oxysporum* in *Aloe vera* (*Aloe barbadensis* Miller)

Susheel Kumar¹, S.K. Pande¹, Jay Kumar Yadav¹, Rajesh Saini¹, Sandeep Kumar¹, Santosh Kumar Yadav²,³ and Veer Singh¹

¹Department of Plant Pathology, ²Department of Agriculture Extension, N.D. University of Agriculture and Technology, Kumarganj, Faizabad-224229, U.P., India  
³Chandra Shekhar Azad. University of Agriculture and Technology, Kanpur, (U.P.), India  
*Corresponding author

**A B S T R A C T**

*Aloe vera* is an oldest medicinal plant grown worldwide. The first written record about the use of *Aloe vera* is found on 6,000 years old clay tablets found in Mesopotamia. *Aloe vera* is a stemless succulent plant growing to 80-100 cm tall, spreading by offsets and root sprouts. The result clearly shows that all chemical control the maximum per cent disease control were recorded in treatment T₃ = Propiconazole 25 EC @ 0.25% PDC (65.20, 65.71 and pooled 65.46) followed by T₂ = Mancozeb 75 WP@ 0.25% PDC (61.05, 62.28 and pooled 61.67), and T₁ = Carbendazim 50 WP@ 0.25% PDC (59.36, 60.28 and pooled 59.82) during 2014 and 2015. Among the botanicals maximum per cent disease control were recorded T₄ = Neem leaf extract @ 5% PDC (58.26, 59.16 and pooled 58.71) followed by T₅ = Garlic bulb extract @ 5% PDC 51.81, 51.79 and pooled 51.80) and T₆ = Tulsi leaf extract @ 5% PDC 44.99, 45.84 and pooled 45.41) control leaf rot of *Aloe vera* caused by *Fusarium oxysporum*.

**Keywords**
*Aloe vera*, Leaf rot, *Fusarium oxysporum*, Fungicides and Botanicals.

**Article Info**
Accepted: 23 September 2017  
Available Online: 10 October 2017

**Introduction**

*Aloe vera* (*Aloe barbadensis*) is a perennial, drought resisting succulent plant belong to the family Liliaceae with its believed to have originated in African continent specifically in Egypt (Daodu, 2000). There are over 250 species of *Aloe vera* growing around the world however, only *Aloe barbadensis*, *Aloe ferox* and *Aloe arborescence* are used as herbal drugs. It is distributed to other tropical countries like South Arab, India, and East Asia. *Aloe vera* is grown largely in South America, Central America, Australia and Africa. *Aloe vera* is cultivated in fairly large area in many in parts of India viz. Eastern part of Utter Pradesh Chhattisgarh, Maharashtra, Madhya Pradesh and Gujarat, Tamil Nadu and Andhra Pradesh.

*Aloe vera* is a stemless succulent plant growing to 80-100 cm tall, spreading by offsets and root sprouts. It is a stemless or very short-stemmed plant growing to 80-100 cm tall, spreading by offsets and root sprouts. The leaves are lanceolate, thick and fleshy, green to grey-green, with a serrated margin. The flowers are produced on a spike up to 90 cm tall, each flower pendulous, with a yellow tubular corolla 2-3 cm long. When a leaf is
cut an orange yellow sap drips from the open end. A stabilized product is incorporated in a wild variety of preparation, including juice, gel, ointments, cream, lotion and shampoos (Daodu, 2000). At the rate of 3 or 4 leaves cut from each plant. On an average, the yield per acre annually is about 6000 kg. In the present study, the leaf yield showed significant variation among the accessions and it varied from 0.599 to 2.922 kg per plant per year (Abhila and Jessyeutty, 2010). As medicinal herb Aloe vera has been used externally to treat various skin conditions such as cuts, burns and eczema. Furthermore, Aloe vera gel has been reported to be very effective for the treatment of sore and wounds, skin cancer, skin disease, cold and cough, constipation, pile and fungal infection (Daodu, 2000; Djeraba and Quere, 2000; Olusegun, 2000), while Davis and Moro (1989) reported aloe plants can be used for treatment of asthma, ulcer and diabetes. The ten main area of chemical constituents of Aloe vera include amino acid, anthraquinones, enzymes, minerals, vitamins, lignins, monosaccharide, polysaccharides, salicyclic acid, saponins and steroids (Barcroft and Myskja, 2009). Tha row pulp of Aloe vera contains approximately 98.5% water, while the mucilage or gel consists of about 99.5% water. The remaining 0.5 to 1% solid material consist of a range of compounds including water-soluble and fat soluble vitamins, minerals, enzymes, polysaccharides, phenolic compound and organic acid (Hamman, 2008). The peeled potatoes were cut into 12 mm cubes. Two hundred grams of potato cubes were rinsed in water and boiled for 20 minutes in 500 ml water. Potato broth was filtered through cheese cloth. At the same time, agar was also melted in 500 ml of water by heating. Potato broth was then poured into the melted agar and dextrose was added in it. The final volume was made up 1000 ml by adding distilled water. The pH was adjusted to 7.0; the stock solution was then poured in to sterilized 250 ml Erlenmeyer conical flasks fungus diseases of plant has been also infested. A leaf rot diseases caused by Fusarium oxysporum were reported from the USA. In India, leaf rot is one of the most serious fungal diseases affecting the commercial cultivation of Aloe vera in North India. Among the fungal diseases, leaf spot of Aloe vera caused by Fusarium oxysporum is one of the most wide spread and destructive disease of Aloe vera under field conditions. Severity grade of the leaf rot of Aloe vera caused by Fusarium oxysporum are given in the Table 1.

Materials and Methods

The experiment was conducted during Kharif season 2014 and second 2015, at experimental farm of Medicinal and Aromatic Plants of N.D.U.A.T. Kumarganj, Faizabad. Randomized Blok Design (RBD) was adopted with three replications. The infected leaves collected from infected plants in sterilized poly bags. Thus, collected typical symptom showing parts were kept in rough dry envelopes and marked clearly mentioning location, infected parts, reaction types, date of collection etc. and brought to the laboratory for isolation of the pathogen. The samples were dried for 24 hours in shade in order to remove excess surface moisture. After drying the samples were kept in B.O.D. incubator in paper envelope marked with date of collection maintained at 6-8 °C for isolation and further studies. The peeled potatoes were cut into 12 mm cubes. Two hundred grams of potato cubes were rinsed in water and boiled for 20 minutes in 500 ml water. Potato broth was filtered through cheese cloth. At the same time, agar was also melted in 500 ml of water by heating. Potato broth was then poured into the melted agar and dextrose was added in it. The final volume was made up 1000 ml by adding distilled water. The pH was adjusted to 7.0; the stock solution was then poured in to sterilized 250 ml Erlenmeyer conical flasks
up to 1/3rd only. Then it was plugged with non-absorbent cotton. These poured flasks were kept for sterilization in autoclave at 15psi for 20 minutes.

\[
\text{Per cent disease intensity (\%) = \frac{\text{Sum of total numerical rating}}{\text{Total No. of leaves examined} \times \text{highest rating}} \times 100}
\]

\[
\text{Per cent disease control (\%) = \frac{C - T}{C} \times 100}
\]

Where,
C = Per cent disease incidence in untreated plot
T = Per cent disease plot incidence in treated plot

**Results and Discussion**

**Isolation, purification and identification**

**Isolation**

Isolations were made from infected leaves. The pathogen was isolated on Modified Potato-Dextrose-Agar medium (Singh and Chaube, 1970) in Petri plate by transferring them after surface sterilization. After the mycelial growth, the fungus was purified through hyphal tip culture method. Subsequently, the culture was maintained on PDA slant for further studies. The pathogen under study was identified as *Fusarium oxysporum* on the basis of its cultural and morphological characters described by Booth (1971).

**Purification**

The pure culture of isolated pathogen was done by single spore isolation. A dilute spore suspension was poured on plain agar petriplate to form a very thin layer on it and spores allowed settling down on the agar surface. Settled spores were separated out from each other, selected under the microscope and enriched with the help of dummy culture in petriplates. They were lifted along with agar blocks and transferred to petriplates containing sterilized 2% PDA. After proper growth of fungus obtained by single spore culture regular sub-culturing was done to check contamination till pure cultures were obtained. These cultures were sub-cultured at monthly intervals and maintained on PDA slant under refrigeration at 6 to 8°C temperature for further studies.

**Identification**

White fluffy colony of *Fusarium oxysporum* was seen on PDA and the microscopic studies revealed that the mycelium was septate and hyaline, microconidia were slightly curved and coma shaped and had 0-1 septa while macroconidia were strongly curved or hooked at apex, smooth hyaline and had 1-4 septa. The chlamydospores were oval to globose hyaline and found in solitary or chain form.

**Pathogenicity test**

Pathogenicity test was conducted on *Aloe vera* leaves by inoculation and germination technique in Petri plates. One leaf each was placed in 30 petriplates, inoculated with spore suspension of *Fusarium oxysporum* using moist sterilized filter paper, plates were incubated at 25 ± 2°C and are regularly observed for development of symptoms. The leaf spot symptoms appeared as minute dark brown coloured spots with prominent halo on inoculated leaves in 10 days’ time. The re-isolation was done to confirm the test pathogen from infected portion of the leaves taken for pathogenicity test were taken and cultured in petri plates and incubated at 25 ± 2°C. The whitish velvety growth similar to that of test fungus appeared after 7 days of incubation in petriplates; slides were prepared and examined under microscope. The cultural and morphological behaviour of the pathogen i.e., isolate from naturally infected was similar to the standard pure culture proves its pathogenicity.
Table 1: Effect of fungicides and botanicals on per cent disease incidence of Aloe vera leaf rot

| S.No. | Treatments                          | Per cent Disease Incidence |
|-------|------------------------------------|-----------------------------|
|       |                                    | **2014** | **2015** | **Pooled** |
| 1     | T<sub>1</sub> = Carbendazim 50 WP @ 0.25% | 36.47(37.15) | 36.39(37.10) | 36.43(37.13) |
| 2     | T<sub>2</sub> = Mancozeb 75 WP @ 0.25%    | 33.06(35.08) | 29.26(32.75) | 31.16(33.92) |
| 3     | T<sub>3</sub> = Propiconazole 25 EC @ 0.25% | 28.24(32.10) | 26.61(31.05) | 27.42(31.57) |
| 4     | T<sub>4</sub> = Neem leaf extract @ 5% | 36.19(36.98) | 34.51(35.96) | 35.35(36.47) |
| 5     | T<sub>5</sub> = Garlic bulb extract @ 5% | 39.38(38.86) | 38.66(38.44) | 39.02(38.65) |
| 6     | T<sub>6</sub> = Tulsi leaf extract @ 5%  | 40.91(39.76) | 39.34(38.81) | 40.12(39.29) |
| 7     | Control (Untreated)                 | 82.64(65.38) | 78.71(62.53) | 80.67(63.95) |

SEm±: 0.67 1.01 0.60  
CD at 5%: 2.06 3.11 2.10  
CV: 2.85 4.43 3.70

Table 2: Effect of fungicides and botanicals on Per cent disease Control of Aloe vera leaf rot

| S.No. | Treatments                          | Per cent Disease Control |
|-------|------------------------------------|---------------------------|
|       |                                    | **2014** | **2015** | **Pooled** |
| 1     | T<sub>1</sub> = Carbendazim 50 WP @ 0.25% | 59.36(50.40) | 60.28(50.93) | 59.82(50.67) |
| 2     | T<sub>2</sub> = Mancozeb 75 WP @ 0.25%          | 61.05(51.39) | 62.28(52.11) | 61.67(51.75) |
| 3     | T<sub>3</sub> = Propiconazole 25 EC @ 0.25%    | 65.20(53.88) | 65.71(54.20) | 65.46(54.04) |
| 4     | T<sub>4</sub> = Neem leaf extract @ 5% | 58.26(49.76) | 59.16(50.30) | 58.71(50.03) |
| 5     | T<sub>5</sub> = Garlic bulb extract @ 5%      | 51.81(46.04) | 51.79(46.03) | 51.80(46.03) |
| 6     | T<sub>6</sub> = Tulsi leaf extract @ 5%       | 44.99(42.12) | 45.84(42.61) | 45.41(42.37) |
| 7     | Control (Untreated)                 | 0.00(0.00) | 0.00(0.00) | 0.00(0.00) |

SEm±: 0.79 1.12 0.68  
CD at 5%: 2.43 3.45 2.37  
CV: 3.26 4.58 3.98
Per cent disease incidence

All the treatments delayed the appearance of disease symptoms with respect to per cent disease incidence. Results presented in Table 1, indicated that all treatments were found significantly superior over control during 2014 and 2015 respectively. However, minimum disease incidence were recorded in treatment $T_3 =$ Propiconazole 25 EC @ 0.25% PDI (28.24, 26.61 and pooled 27.42) in years 2014 and 2015, followed by $T_2 =$ Mancozeb 75 WP @ 0.25% PDI (33.06, 29.26 and pooled 31.16) and $T_1 =$ Carbendazim 50 WP@ 0.25% (36.47, 36.39 and pooled 36.43). While among the botanicals $T_4 =$ Neem leaf extract @ 5% (36.19, 34.51 and pooled 35.35), followed by $T_5 =$ Garlic bulb extract @ 5% PDI (39.38, 38.66 and pooled 39.02) and $T_6 =$ Tulsi leaf extract @ 5% (40.91, 39.34 and pooled 40.12). All the treatments were found significantly superior per cent disease intensity during both the years.

Per cent disease control

Data elaborated in Table 2 revealed that in case of chemical control the maximum per cent disease control were recorded in treatment $T_3 =$ Propiconazole 25 EC @ 0.25% PDC (65.20, 65.71 and 65.46) followed by $T_2 =$ Mancozeb 75 WP@ 0.25% PDC (61.05, 62.28 and pooled 61.67), and $T_1 =$ Carbendazim 50 WP@ 0.25% PDC (59.36, 60.28 and pooled 59.82) during 2014 and 2015. Among the botanicals maximum per cent disease control were recorded $T_4 =$ Neem leaf extract @ 5% PDC (58.26, 59.16 and pooled 58.71) followed by $T_5 =$ Garlic bulb extract @ 5% PDC (51.81, 51.79 and pooled 51.80) and $T_6 =$ Tulsi leaf extract @ 5% PDC (44.99, 45.84 and pooled 45.41) during both the years 2014 and 2015, respectively.

The presence of Fusarium oxysporum in Aloe barbadensis plant has great implications on the health of the rural populace that use this plant in multi-purpose herbal preparations and recipes to treat various ailments. This is because the pathogen produces mycotoxin (Trichothecene) in the infected hosts which are hazardous to human health when consumed.

On the basis of results obtained it may be concluded that even though, all the tested fungicides were found slightly more effective over botanicals tried in the present investigation to inhibit the growth of pathogens but seeking the hazardous effects of fungicides, the plant extracts with antifungal activity at given concentration viz, (Neem leaf extract) can be recommended to control the leaf rot disease in Aloe vera at commercial level to maintain the medicinal value of the plant.

Acknowledgements

Thanks are due to Head, Department of Plant Pathology, N. D. University of Agriculture and Technology, Kumarganj and providing essential laboratory facilities and support to conduct this research work successfully.

References

Abhila, S. R., and Jessyeutty, 2010. Morphological characterization of Aloe vera germplasm. Journal of Medicinal and Aromatic Plant Science, 33(3): 289-294.

Adesuyi, A. O., Awosanya, O. A., Adaramola, F. B. and Omeonu, A. I. 2012. Nutritional and phytochemical screening of Aloe vera, Current Research Journal of Biological Science, 4(1): 4-9.

Ahmad, S., and Narain, U. 2007. Symptomatology, etiology and ecofriendly management of Alternaria leaf spots and blight of broccoli.
Ecofriendly management of plant diseases, pp. 461-472.
Anonymous, 2013. Annual progress report of All India Co-ordinated Research Project on Medicinal & Aromatic plants and Betelvine, pp. 342.
Anonymous, 2014. Annual progress report of All India Co-ordinated
Booth, C., 1971. The Genus Fusarium. Commonwealth Agricultural Bureau, Bucks, United Kingdom.
Daodu, T., 2000. Aloe vera, the miracle healing plant. Health Field Corporation, Lagos, Nigeria, p-36.
Hamman, J. H., 2008. Composition and Applications of Aloe vera Leaf Gel, molecules, 13:1599-1616.
Hirat, T., and Suga, T. 1983. The efficiency of Aloe vera plant, chemical constituent and biological activates. Cosmetics and Tolletries, 98:105-108.
Olusegun, A., 2000. One hundred medicinal uses of Aloe vera. Good health Inc. Lagos, pp-76.
Pairashi, M., 2007. Studies on Frog eye leaf spot of bidi tobacco caused by Cercospora nicotianae Ell. & Eve. M. Sc. (Agri) Thesis. Univ. Agric. Sci., Dharwad (India). Pathology. pp. 5-12.
Panwar, V., Gangwar, R.K, Javeria, S. and Yadav, R.S. 2013. Antifungal efficacy of fungicides and bio-control agents against leaf spot pathogens, Alternaria alternate. Current Discovery, 2(2): 128-133.
Research Project on Medicinal & Aromatic plants and Betelvine, pp. 411.
Singh, R.S., and chaube, H.S. 1970. Selective agar media for the isolation of fungi. Indian Journal of Mycol. and Pl. Patho, 3: 67-70 pp.

How to cite this article:
Susheel Kumar, S.K. Pande, Jay Kumar Yadav, Rajesh Saini, Sandeep Kumar, Santosh Kumar Yadav and Veer Singh. 2017. Effect of Fungicides and Botanicals against Leaf Rot Disease Caused by Fusarium oxysporum in Aloe vera (Aloe barbadensis Miller). Int.J.Curr.Microbiol.App.Sci. 6(10): 2957-2962. doi: https://doi.org/10.20546/ijcmas.2017.610.349