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In-vitro evaluation of leaf extracts against *Fusarium solani* causing dry rot disease of potato

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Abstract
Fusarium solani is an important disease that causes dry rot disease of potato tubers world over. Management through chemical fungicides cause serious environmental problems and are toxic to non-target organisms as well. Plant metabolites and plant based pesticides appear to be one of the better alternatives as they are known to have minimum environmental impact and danger to consumers in contrast to synthetic pesticides. In an approach towards the development of eco-friendly management, *in-vitro* antifungal leaf extract was conducted against *Fusarium solani*, using seven leaf extracts in three replication. Out of seven leaf extracts, two leaf extracts was proved to be potential in inhibiting the growth of *Fusarium solani*, namely *Sarraca ashoka* (39.63%), Lemon grass (63.52%), *Ocimum sanctum* (71.85%). Antifungal potency was compared with seven treatments each other. The poison food technique was conducted for the evaluation of antifungal activity of the extracts at 10% concentration on mycelial growth of *Fusarium solani*. This study indicates that the leaf extracts could be a good alternative in developing a potent plant based fungicides which can be used in organic farming for the management of *Fusarium solani*.

Keywords: Poison food technique, leaf extract, *Fusarium solani* & potato dry rot disease

Introduction
Potato (*Solanum tuberosum* L.) popularly known as 'The king of vegetables', has emerged as fourth most important food crop in India after rice, wheat and maize. Indian vegetable basket is incomplete without Potato. Because, the dry matter, edible energy and edible protein content of potato makes it nutritionally superior vegetable as well as staple food not only in our country but also throughout the world. Potato is a major food crop, grown more than 100 countries in world. At present, China, Russia, India, Poland and U.S.A. contribute a major share of total world production. It is one of main commercial crop grown in the country. It is cultivated in 23 states in India. Uttar Pradesh, West Bengal, Bihar, Punjab and Gujarat account a lion's share in total production. Country has achieved a tremendous growth in potato production during last four to five decades. (Anonymous, 2015) [1]. The potato (*Solanum tuberosum*) crop is generally harvested during February and March in most regions of India. This is a time when temperature starts increasing to between 30 °C and 40 °C in the month of June followed by rains in July and August. The high temperature and humid conditions during this time favour dry rot and other types of rots of potatoes stored in heaps and country stores. This can lead to huge losses. Therefore, it becomes essential to store potatoes in cold stores for about five to six months. Nevertheless, the potatoes may still develop dry or soft rots if they have been mechanically damaged during a period of high temperatures. Sagar *et al.* (2011) [5]. *Fusarium* dry rot is an important postharvest disease of potato worldwide. *Fusarium* dry rot can be caused by several different *Fusarium* spp, including *F. solani, F. sambucinum, F. avenaceum, F. culmorum,* and *F. oxysporum,* but *F. solani* appears to be the most aggressive and important. Dry rot Fusarium spp. originate from contaminated seed or infested soils, infecting tubers through wounds in the periderm that are common after potato cutting and handling practices. *Fusarium spp.* introduced into soils by contaminated seed can persist for years. Soil borne inoculum can infect tubers through wounds caused by other pathogens, insects, or during harvest and handling. Rotted cavities are often lined with mycelia and spores of various colors from yellow to white to pink. Dry rot diagnosis may be complicated by the presence of other tuber pathogens. Soft rot bacteria (*Pectobacterium spp*.) often colonize dry rot lesions, especially when tubers have been stored under conditions of high relative humidity or tuber surfaces are wet.

Materials and Methods

The following material and method were used in the present investigation entitled, *"In- vitro* evaluation of leaf extracts against *Fusarium solani* causing dry rot disease of potato". The *in-vitro* studies on management dry rot of potato carried out at Department of Plant Pathology, Sam Higginbottom University of Agriculture, and Technology & Science Allahabad. 2016-2017. The experiment was conducted as a completely randomized design with seven treatments and three replications. The treatments were 10% concentrations of leaf extract. The treated plates were then incubated at 26 °C in the dark. The average diameter of the mycelia growth inhibition zone around the paper discs loaded with each treatment was measured seven days post incubation (before the plates were completely covered with mycelia of the fungus). The growth inhibition percent was calculated using the formula: IP=c-t/c×100, where IP was the growth inhibition percent, c and t were the diameter of growth inhibition zone in negative control and each of the other treatments, and follows table 1.

Table 1: Treatments

S. No.	Treatment	Treatments Name	Conc.	References
1	T_1	*Lantana camara*	10.00%	Wadikar and Nimbalkar (2015) [7].
2	T_2	*Mentha spicata*	10.00%	Isam *et al.* (2009) [2]
3	T_3	*Ocimum sanctum*	10.00%	Joseph *et al*. (2008) [3]
4	T_4	*Jatropha curcas*	10.00%	Thakre (2010) [6]
5	T_5	*Cymbopogon citratus* L.	10.00%	M.S. Gurjar, *et al.*(2012) [4]
6	*T_6*	*Saraca asoca*	10.00%	Thakre (2010) [6]
7	T_7	*Aloe sbarbadensis Mill.*	10.00%	M.S. Gurjar, *et al.*(2012) [4]
8	T_0	Control		-

Results

Evaluation of leaf extracts against *Fusarium solani.* Radial growth of mycelium recorded at: 24 hrs, 48 hrs, 72 hrs, 96 hrs.

Table 2: Percent inhibition

Treatments		Conc. 24 hr		48 hr	72 hr	96 hr
T_1	*Lantana camara*	10.00%	81.35	75.56	83.30	72.41
T_2	*Mentha spicata*	10.00%	81.54	79.73	85.98	73.52
T_3	*Ocimum sanctum*	10.00%	81.44	75.14	83.59	71.85
T_4	*Jatropha curcas*	10.00%	79.85	80.55	86.57	75.93
T_5	*Cymbopogon citratus* L.	10.00%	73.91	74.95	81.61	63.52
T_6	*Saraca asoca*	10.00%	88.92	27.65	82.11	39.63
T_7	*Aloe barbadensis* Mill.	10.00%	82.52	76.81	81.69	75.00
T_0			0.00	0.00	0.00	0.00
Mean		71.19		61.30	73.10	58.98
F- test		S		S	S	S
S. Ed. (±)		2.348		13.087	1.514	10.399
C. D. (P = 0.05)		4.977		27.745	3.209	22.045
C.V.		0.168		1.090	0.106	0.900

Saraca asoca leaf extract (10.00%), *Jatropha curcas* leaf extracts (10.00%) *Lantana camara* leaf extract (10.00%), *Mentha spicata* leaf extract (10.00%), *Ocimum sanctum* leaf extract (10.00%), *Cymbopogon citratus L.* leaf extract (10.00%) and *Aloe barbadensis* Mill. leaf extract (10.00%) leaf extract (10.00%) were tested against *Fusarium solani* using poison food technique using Potato Dextrose Agar (PDA) which used as basal medium. Both the treatments tested were significantly effective in inhibiting the growth of pathogen over control. *Saraca asoca* leaf extract (10.00%) showed minimum inhibition percent (39.63%) as compared to *Jatropha curcas* leaf extract (10.00%) showed maximum inhibition percent (75.93%).

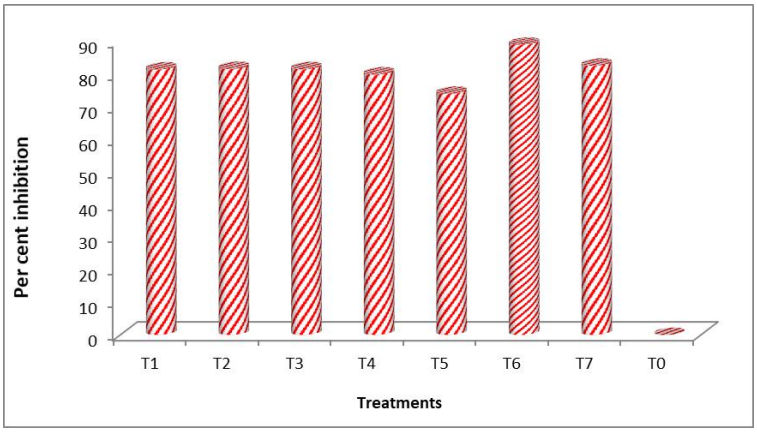

Fig 1: Percent inhibition mycelial growth of *Fusarium solani* as affected by after 24 hrs.

After 48 hours of inoculation minimum average redial mycelial growth(mm) of *Fusarium solani* was observed in T_6 - *Saraca asoca* (27.65) followed by T_5- *Cymbopogon citratus* L (74.95), T_3- *Ocimum sanctum* (75.14), T_1- *Lantana camara* (75.56), T_7- *Aloe barbadensis* (76.81), T_2- *Mentha spicata* (79.73), as compared to the treated chaeck T_4- *Jatropha curcas* (80.55) and untreated check T_0-(0).

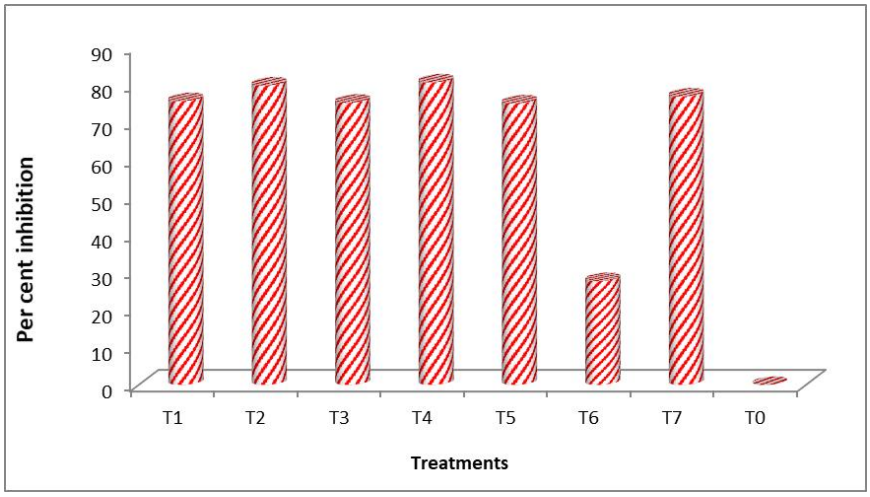

Fig 2: Percent inhibition Mycelial growth of *Fusarium solani* as affected by treatments after 48 hrs.

Table 3: Effect of plant extracts on the radial growth (mm) of *Fusarium solani* at 72 hrs. of the incubation

Treatments		Conc.	R_1	R_2	R_3	72 hr
T_1	*Lantana camara*	10.00%	85.71	82.44	81.74	83.30
T_2	*Mentha spicata*	10.00%	90.18	84.82	82.93	85.98
T_3	*Ocimum sanctum*	10.00%	82.50	85.36	82.90	83.59
T_4	*Jatropha curcas*	10.00%	88.99	87.50	83.23	86.57
T_5	*Cymbopogon citratus* L.	10.00%	83.57	81.31	79.94	81.61
T_6	*Saraca asoca*	10.00%	81.20	81.90	83.23	82.11
T_7	*Aloe sbarbadensis* Mill.	10.00%	80.88	82.74	81.44	81.69
T_0			0.00	0.00	0.00	0.00
Mean						73.10
F- test						S
S. Ed. (±)						1.514
C. D. (P = 0.05)						3.209
C.V.						0.106

After 72 hours of inoculation minimum average redial mycelial growth (mm) of *Fusarium solani* was observed in T_5- *Cymbopogon citratus* L. (81.61) followed by T_7- *Aloe barbadensis* Mill. (81.69), T_6- *Saraca asoca* (82.11), T_1- *Lantana camara* (83.30),T_3- *Ocimum sanctum* (83.59), and T_2- *Mentha spicata* (85.98) as compared to the treated chaeck T_7- *Jatropha curcas* (86.57) and untreated check T_0-(0).

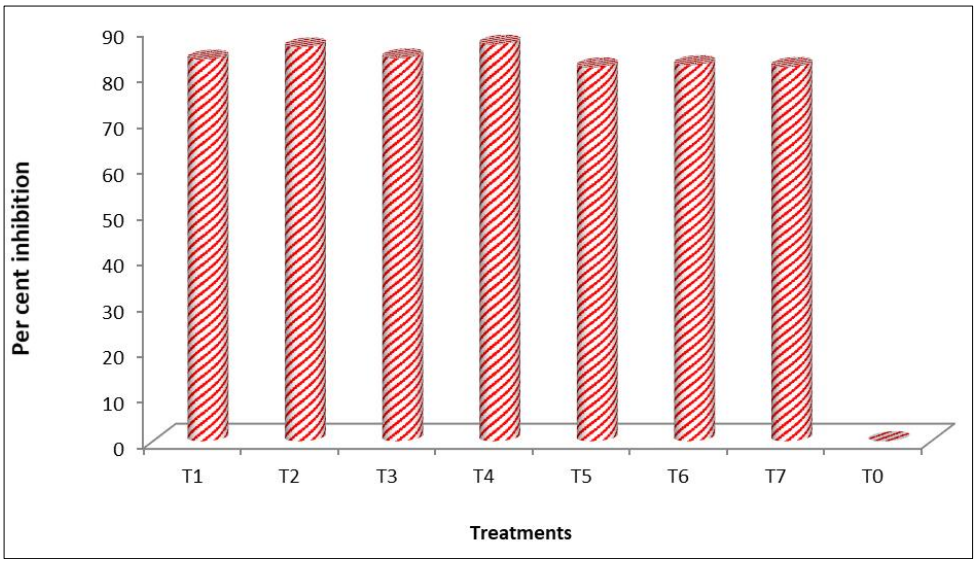

Fig 3: Per cent inhibition Mycelial growth of *Fusarium solani* as affected by after 72 hrs.

Table 4: Effect of plant extracts on the radial growth (mm) *Fusarium solani* at 96 hrs. of the incubation.

Treatments		Conc. R_1	R_2	R_3		96 hr
T_1	*Lantana camara*	10.00%	71.11	74.44	71.67	72.41
T_2	*Mentha spicata*	10.00%	71.11	75.56	73.89	73.52
T_3	*Ocimum sanctum*	10.00%	71.11	71.11	73.33	71.85
T_4	*Jatropha curcas*	10.00%	71.67	81.67	74.44	75.93
T_5	*Cymbopogon citratus* L.	10.00%	61.11	60.00	69.44	63.52
T_6	*Saraca asoca*	10.00%	0.00	45.00	73.89	39.63
T_7	*Aloe barbadensis* Mill.	10.00%	74.44	74.44	76.11	75.00
T_0			0.00	0.00	0.00	0.00
Mean						58.98
F- test						S
S. Ed. (±)						10.399
C. D. (P = 0.05)						22.045
C.V.						0.900

After 96 hours of inoculation minimum average redial mycelial growth(mm) of *Fusarium solani* was observed in T_6- *Saraca asoca* (39.63) followed by T_5- *Cymbopogon citratus* L (63.52), T_3- *Ocimum sanctum* (71.85), T_1- *Lantana camara* (72.41), T_2- *Mentha spicata* (73.52), and T_7- *Aloe barbadensis* (75.00) as compared to the treated check T_4- *Jatropha curcas* (75.93) and untreated check T_0-(0).

Summary

The experiment was conducted as a completely randomized design with seven treatments and three replications. The treatments were 10% concentrations of leaf extract. The treated plates were then incubated at 26 °C in the dark. The average diameter of the mycelia growth inhibition zone around the paper discs loaded with each treatment was measured seven days post incubation (before the plates were completely covered with mycelia of the fungus).The growth inhibition percent was calculated using the formula: IP=c-t/c×100, where IP was the growth inhibition percent, c and t were the diameter of growth inhibition zone in negative control and each of the other treatment. *Saraca asoca* leaf extract (10.00%), *Jatropha curcas* leaf extracts (10.00%) *Lantana camara* leaf extract (10.00%), *Mentha spicata* leaf extract (10.00%), *Ocimum sanctum* leaf extract (10.00%), *Cymbopogon citratus* L. leaf extract(10.00%) and *Aloe barbadensis* Mill. leaf extract (10.00%) leaf extract(10.00%) were tested against *Fusarium solani* using poison food technique using Potato Dextrose Agar (PDA) which used as basal medium. Both the treatments tested were significantly effective in inhibiting the growth of pathogen over control. *Saraca asoca* leaf extract (10.00%) showed minimum inhibition percent (39.63%) as compared to *Jatropha curcas* leaf extract (10.00%) showed maximum inhibition per cent (75.93%).

Conclusion

Ashoka leaf extracts (10%) were found the most effective against *Fusarium solani*, after at 96 hours inoculation. Which were found minimum mycelium growth than Lemon grass leaf extracts (10%) was found effective in mycelium growth as compare to other treatments except lemon grass which was taken as treated control. The results of the present study are in- *vitro* condition as such for validation of the results more such trials should be carried out in future.

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