Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 1218-1221

Received: 04-11-2019
Accepted: 08-12-2019

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Bioefficacy of botanicals against *Fusarium solani* isolate, causing root rot of papaya under pot condition

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Abstract
Fusarium solani has been reported as a major constraint in the successful cultivation of Papaya, as it caused root rot disease which reduced the yield up to 60-95 percent. The present paper depicts the antifungal activity of some plant extracts on the progress of *Fusarium solani*. The five different botanicals *viz;* Garlic creeper (*Adenocalymma alliaceum*), Neem (*Azadirachta indica*), Garlic (*Allium sativum)*, Tulsi (*Ocimum sanctum*) and Makoi (*Solanum nigrum*) at 10% concentration were evaluated against a different isolate of *Fusarium solani* (Fs-I to Fs-V) under pot condition. The results revealed that all the plant extracts significantly inhibit root rot incidence on papaya in comparison to the control. Across the aqueous plant extract, garlic creeper was seen most cogent against all the isolates of *Fusarium solani* as it shows maximum inhibition percent (53.00%) and minimum inhibition percent (45.70%) over control followed by Neem, Garlic, and Tulsi. The maximum inhibition percent of (24.20%) and minimum inhibition percent of (16.40%) over control was recorded by Makoi and considered as the least effective botanicals against the pathogen.

Keywords: *Fusarium solani* isolates, variability, fungi static and botanicals, root rot of papaya

Introduction
Papaya (*Carica papaya* L.) "Fruit of the angels" belonging to the family caricaceae is one of the five major fruit crops of the tropical world. Papaya, a very wholesome fruit, is high in nutritive and medicinal value. As a consequence of increasing demand for fruits, papain and high returns, the area and production of papaya have increased during the last few decades. India is the largest producer of papaya in the world. The present area under this fruit crop is about 138(000) ha and production is 5989(000 MT) with 42.3 tones/ha productivity [5]. Maharashtra is the leading state of papaya production where it is grown mainly for papain extraction. Other states are Karnataka, Madhya Pradesh, Uttar Pradesh, Bihar, Gujarat, West Bengal, Tamil nadu, Andhra Pradesh, Kerala, and Assam. In Bihar, its production was 42.72 (000 MT) from an area of 1.90 (000) ha [5]. Regarding the nutritional important, papaya is considered as a rich source of carbohydrates, minerals, vitamins, and ascorbic acid. Papaya fruits are rich in proteolytic enzyme, papain, which helps in the digestion of protein-rich foods. Pests are the major confining component in the cultivation of papaya. There are several damaging insects *viz;* whitefly (*Bemesia tabaci*), Papaya spider mites (*Brevipalus phoencis*), Fruit fly (*Dacus dorsalis*), Papaya mealy bug (*Paracoccus marginatus*), Ash weevil (*Myllocerus* spp.), and Scale insect (*Aonidiella comperei*), Etc. which decrease the quality and yield of papaya fruit [4, 8, 13]. Despite of some pests, over 17 diseases caused by fungi, viruses, bacteria, mycoplasmal and nematodes, which affect the papaya plants all over the world of these, about 5-6 diseases like papaya ring spot (PRSV), leaf curl, collar rot, damping off, and anthracnose are serious problems in many papaya growing areas of the world [11]. They can reduce yield greatly and impair the marketability of fruits. But over the last four years; a new disease of papaya with the symptom of root rot has emerged as a serious threat to the crop in Bihar causing 90-95 percent crop failure and thus inflicting a heavy loss to the growers. The disease has been found to affect the crop round the year at all growth stages of the plants and all the varieties have found to be susceptible. However, the development of disease becomes fast after rain occurring in any month. The first time the etiology of Papaya root rot in agro-ecological conditions of Bihar was determined and reported that the root rot was caused by *Fusarium solani* (Mart.) Sacc [12]. An experiment was conducted in the greenhouse at

DRPCAU, Pusa to find out the efficacy of different plant extracts against *Fusarium solani* isolate causing root rot of papaya under pot condition.

Materials and Methods

The standard laboratory techniques were used for the preparation of media, cleaning of glassware's, isolation, inoculation, sterilization of soil/ plastic pot/ glassware and maintenance of fungal cultures, with modifications whenever necessary.

Preparation of aqueous plant extract

Fresh leaves of five plants *viz*. Garlic creeper (*Adenocalymma alliaceum*), Neem (*Azardirachta indica*), Garlic (*Allium sativum*), Tulsi (*Ocimum sanctum*) and Makoi (*Solanum nigrum*) were collected from the nearby local area of DRPCAU, Pusa. Collected plant materials were surface sterilized with 0.1% sodium hypochlorite and repeatedly washed in sterile water and cut into small pieces. A 50% w/v stock solution of the extract was prepared by soaking the crushed plant materials in sterilized water for 24 hrs at room temperature, passing through a muslin cloth and finally through Whatman filter paper No.1. The concentrations of 10% w/v were prepared by adding an appropriate quantity of sterile water into the stock solution. The diluted plant extracts were heated to 40-50 ºC for 10 min. to avoid contamination. The extract was stored at 4 ºC to avoid contamination and prospective chemical alteration [6].

Mass multiplication of *Fusarium solani* isolates

In this study we had collected different isolates of *Fusarium solani* from different districts of Bihar and the five isolates of *Fusarium solani* were selected on the basis of cultural, morphological and disease potential in department laboratory by following standard technique and the further mass multiplication was done using protocol given by [3]. For mass multiplication of different isolates of *Fusarium solani*, 50 g sorghum grain flour with 25 ml tap water (adjusted level to the 50 percent (w/v)) was taken in 500ml conical flasks and autoclaved at 15 psi for 20 minutes for three successive days for each isolate. Then seven-day-old culture of the pathogen was added under aseptic conditions and incubated at room temperature at 28±2 ºC for development and mass multiplication.

Efficacy of botanicals against the pathogen in pot condition

The antifungal activity of Garlic creeper (*Adenocalymma alliaceum*), Neem (*Azardirachta indica*), Garlic (*Allium sativum*), Tulsi (*Ocimum sanctum*) and Makoi (*Solanum nigrum*) extract was tested at 10 percent concentration in the greenhouse under artificial pot condition against different isolates *F. solani*. The mass culture of *F. solani* isolates was prepared as per the method [3]. The mass culture of *F. solani* isolates was mixed in steam-sterilized soil separately @50 g/kg soil having 10 kg sterile loamy soil / plastic pots (50cm diameter). Each plant extract @10% was applied in pathogen inoculated pots after 15 days of transplanting. Inoculation of a pot with sterilized distilled water was served as control. Each treatment was replicated three times with three papaya seedling (cv. Pusa dwarf) / pot. The disease incidence (%) was calculated by dividing the total number of transplanted plants showing root rot disease symptoms by the total plant transplanted and then multiplied by a hundred. The data was recorded up to 90 days after transplanting. The data was analyzed by CRD design.

Results and Discussion

During the studies, an aqueous extract of plants *viz;* Garlic creeper (*Adenocalymma alliaceum*), Neem (*Azadirachta indica*), Garlic (*Allium sativum*), Tulsi (*Ocimum sanctum*) and Makoi (*Solanum nigrum*) at 10% concentration were tested against root rot incidence on papaya under artificial pot condition. It was evident from the data presented in Table 1 and illustrated in fig 1 that all the botanicals significantly inhibited root rot incidence on papaya caused by *Fusarium solani* at 5% level of significance in comparison to the control. In a uninoculated pot (control) highest incidence of 85.3% was recorded in Fs-II followed by Fs-III (80.3%), Fs-IV (77.0%), Fs-I (75.0%) and isolates Fs-V shows 73.3% root rot disease respectively. The garlic creeper reduced the disease incidence to 34.3% in isolate Fs-V followed by Fs-I (36.0%), Fs-IV (39.6%), and Fs-III (41.0%). The highest root rot incidence was recorded in Fs-II *i.e.* 46.35% at 10% concentration respectively. Among the aqueous plant extract, garlic creeper was identified as the most effective plant extract against all the *Fusarium solani* isolates where root rot disease symptom was not observed up to 69 days in isolate Fs-V; while in the control (Where no treatment was given) the disease appeared earlier in plant within 32 days of transplanting in case of isolate Fs-II followed by Fs-III (35 DAT), Fs- IV (36 DAT), Fs-I (38 DAT) and the late appearance of root rot disease symptoms were observed in plant inoculated with *Fusarium solani* isolate V *i.e.* 40 DAT. These findings of the present investigation are in favor of work done by Dwivedi and Shukla (2000) [2] reported that leaf extracts of *Allium sativum* and *Azadirachta indica* on spore germination of *Fusarium solani*, *F. oxysporum* and *F. equisetti* under lab condition. They observed that *Azardirachta indica* leaf extract at cent percent concentration completely inhibited spore germination of *Fusarium* spp. The five different plant leaf extract were tested against *Terminalia catappa* blight pathogen *(F. solani)*, the result reveals that *Lantana camara* extracts have high antifungal activity and was founded best against the pathogen followed by *Azardirachta indica*, *Acalypha indica* and *Bacopa monnieri* were found to be equally effective in inhibiting the growth of *Fusarium solani* at 5 percent concentration [7]. Neem leaf extracts (1mg/1ml) were most effective against soil-born fungus *Fusarium* in Common bean [9]. The antifungal activity of four plant extracts *viz;* Bitter guard, Turmeric, Garlic And Black pepper at different concentration *viz;* 5%, 10%, and 15% respectively were evaluated against *Fusarium udum* and *Fusarium oxysporum* f. sp. *Ciceri* and found that the growth of both pathogens was significantly reduced by garlic and turmeric at 10% concentration followed by black pepper while bitter guard extract was found to be the less effective against both pathogen [10]. The present results are also in conformity with the findings of others where different plants having antifungal activity were tested against *Fusarium solani* the causal of dry rot of potato and found that combined leaf extract of *Lawsonia alba* and stem extract of *Acacia* showed a better result than individual against mycelium growth. The seed extract of *Dedonia viscosa* showed strong inhibition. The petal extracts of *Mimosa hamartia* and leaf extract of *Acacia arabicae, Jacranda mimosaefolia and Ocimum sanctum* were found to be a good inhibitor against *Fusarium solani* [1].The efficacy of botanicals was screened by testing five different

botanicals against the root rot of Papaya incited by *Fusarium solani* and found that out of five botanicals Garlic creeper was identified as most effective in controlling the disease [6].

Table 1: Effect of botanicals against *Fusarium solani* causing root rot of Papaya under Pot condition

Plant Extracts (10%)	Fs-I			Fs-II			Fs-III			Fs-IV			Fs-V		
	First appearance of disease *(DAT)	Root rot incidence (%)	Inhibition over Control (%)	First appearance of disease (DAT)	Root rot incidence (%)	Inhibition over Control (%)	First appearance of disease (DAT)	Root rot incidence (%)	Inhibition over Control (%)	First appearance of disease (DAT)	Root rot incidence (%))	Inhibition over Control (%)	First appearance of disease (DAT)	Root rot incidence (%)	Inhibition over Control (%)
Garlic creeper (*Adenocalymma alliaceum*)	66	36.0	52.0	58	46.3	45.7	61	41.0	48.9	64	39.6	48.5	69	34.3	53.0
Neem (*Azadirachta indica*)	63	39.6	47.2	55	55.6	34.7	58	47.0	41.4	62	44.3	42.4	65	42.3	42.0
Garlic (*Allium sativum*)	52	42.0	44.0	46	61.6	27.7	48	51.3	36.1	50	51.6	32.9	52	45.6	37.5
Tulsi (*Ocimum sanctum*)	45	55.0	26.6	38	64.6	24.2	42	57.3	28.6	44	56.3	26.8	48	52.0	28.7
Makoi (*Solanum nigrum*)	40	60.6	19.2	35	69.3	18.7	39	65.6	18.3	39	64.3	16.4	44	55.3	24.2
Control	38	75.0	-	32	85.3		35	80.3	-	36	77.0	-	40	73.0	-
CD at 5%		7.99			12.33			8.96			7.51			9.04	
CV (%)		8.71			10.74			8.81			7.56			9.73	

* Mean of three replications. Root rot incidence was recorded up to 90 days, * DAT- Days after transplant

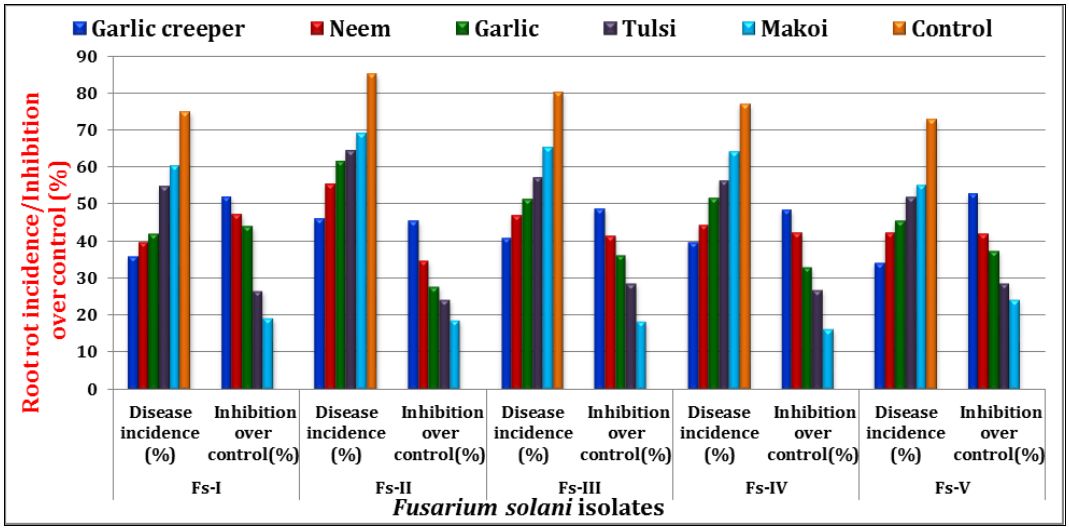

Fig 1: Effect of botanicals against *Fusarium solani* causing root rot of Papaya under Pot condition

Conclusion

All the five botanicals significantly inhibited root rot incidence on papaya incited by *Fusarium solani*. Among the five botanicals, garlic creeper was found best showed maximum inhibition against *Fusarium solani* isolate followed by Neem, Garlic, and Tulsi. Based on the antifungal efficacy, Makoi was considered as the least effective botanicals against the pathogen.

Acknowledgment

The authors are grateful to the Chairman, Department of Plant Pathology and Dean Agriculture DRPCAU, Samastipur, Bihar for providing advance facilities to conduct the research.

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