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Early Blight Disease Management of Tomato through Use of Native Bioresources in Mid Hills of Himachal Pradesh

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Abstract

Early blight of tomato also known as target leaf spot disease caused by *Alternaria solani* (Ellis and Martin) Jones and Grout is important disease of tomato. To manage the disease, six plant origin pesticides and cow urine based bioresource were assessed under *in vitro* and field conditions. The results of present investigations revealed that cow urine and *Roylea elegans* (kadu) showed cent per cent mycelial growth inhibition followed by *Justicia adhatoda, Vitex negundo* and *Allium sativum* which resulted in 88.15, 84.44 and 80.00% growth inhibition at 15% concentration. To study the effect of these bioresources under field conditions five foliar sprays were given at ten days interval after commencement of disease. It was revealed that foliar application of bioresources, significantly reduced the disease severity and increased the yield. Five foliar sprays of *Allium satium* (garlic) at ten days interval was found most effective in decreasing the severity of disease to 56.12% followed by *Justicia adhatoda* (basunti), *Melia azedarach* (darek) and cow urine which resulted in 44.24, 38.71 and 37.92% reduction of disease respectively, whereas, leaf water extract of *Vitex negundo* (banah) was least significantly effective and resulted in 28.50% reduction of disease. Five successive sprays of *Allium sativum* (garlic) also resulted in maximum yield of fruits (18.40 kg plot^{-1}) followed by *Justicia adhatoda* (basunti) (13.52 kg plot^{-1}), cow urine (13.00 kg plot^{-1}) and *Nerium indicum* (12.70 kg plot^{-1})

Keywords: Early blight, bioresources, *Alternaria solani*

1. Introduction

Tomato *(Solanum lycopersicum* L.), (2n = 24) belongs to the family solanaceae is one of the most popular vegetable crop grown all over the world and occupies a prominent position in the world vegetable economy. It is the second most consumed vegetable after potato, ranking first among the processing crops. In Himachal Pradesh, cultivation of tomato as an off-season crop has gained popularity, being most remunerative cash crop. Tomato is highly sensitive to abiotic stresses especially extreme temperature, salinity, drought, excessive moisture, environmental pollution and biotic stresses and suffered from large number of biotic stresses including insect pests and diseases from the time of emergence to harvest. Many factors contribute in successful cultivation as well as marketing of quality tomato, of which diseases play an important role. More than two hundred diseases have been reported to infect tomato in the world which destroy the quality and reduce the yield of crop (Atherton and Rudich, 1986). Among fungal diseases early blight caused by an ascomycetous fungus *Alternaria solani* is of

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major importance and cause heavy losses during cultivation (Foolad et al., 2002).

In India, the disease was first reported from Delhi by Chona et al. (1958), while in Himachal Pradesh, occurrence of this disease has been reported by Sahi and Shyam (1993). Ramgiry et al. (1997) observed *A. solani* as the most frequent causal agent of tomato decay in fields and vegetable markets in Madhya Pradesh. Bhatt *et al*. (2000) recorded *A. alternata* as the causal agent of leaf blight disease of tomato, which was the first confirmed record of this fungus from Kumaon hills of Uttar Pradesh. Occurrence of this disease has been reported from many states of India which resulted in crop losses running from 70-100 per cent (Kanjilal et al., 2000). The disease produces a wide range of symptoms and manifestations on foliage named as early blight and symptoms on stems, seedlings and fruits are termed as stem lesions, collar rot and fruit rot, respectively, (Walker, 1952; Mc Carter et al., 1976; Basu, 1974; Ramakrishnan et al., 1971; Chaerani *et al*., 2006). Initial symptoms of disease appeared as small, dark necrotic lesions on the older leaves which subsequently spread upward as the plants become older (Sherf and MacNab, 1986). In later stages, the lesions enlarge and they generally resulted in concentric rings giving a target board like appearance which are often surrounded by a yellowing zone (Mayee and Datar, 1986). Seedling, stem, blossom blight and fruit drop symptoms also produced by this pathogen (Agrios, 2005). Prsently, many systemic as well as non-systemic fungicides have been recommended to manage this disease (Patil et al., 2002). High dose and continuously use of the systemic fungicides set off the environmental hazards as well as fungicidal resistance against *A. solani*. Various plant species has been reported by different researchers which possess natural substances that are hazardous to plant pathogenic fungi (Goussous et al., 2010). Enormous investigations have been completed to reflect about the impact of plant extracts on microscopic organisms, as they were found to contain phytochemicals for example, alkaloids, tannins, saponins, flavonoids, diterpenes, glucosinolates, acetylenes and thienyls (Goswani et al., 1986; Chitwood, 2002). Products got from plants are significant wellsprings of new agrochemicals for the control of plants ailments (Kagale et al., 2004). Beside this, these products are non-phytotoxic, efficient and effectively biodegradable (Qasem and Abu-Blan, 1996). Thus the availability of many locally bioresources which have shown antifungal activity may reduce the dependency on fungicides and can be an effective component of integrated disease management strategy. Among the various recognized methods of plant disease control, the use of bioresources is considered to be cheapest and the best way to manage plant disease. Therefore, in present studies locally available bioresources in mid hills of Himachal Pradesh were evaluated under *in vitro* and field conditions to find out their efficacy and to evolve an effective non chemical disease management strategy.

2. Materials and Methods

The experiment was conducted in the Department of Plant Pathology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2018-2019. To isolate the pathogen, infected tissues from leaves, stems and fruits of tomato plants showing typical symptoms of early blight were collected and isolation was done by following standard isolation method under aseptic condition. Isolated fungus was identified with the help of identification manual of *Alternaria*, given by (Simmons, 2007).

2.1. Preparation of plant extracts

Used plant parts of various bioresources weighing about 500 g were grinded for five minutes in blender by adding small quantity of distilled water. Thereafter, 500 ml of distilled water was added and homogenized in orbital shaker at the rate of 2000 rpm for half an hour to get an extract of 100 per cent concentration. The plant material was then filtered through double-layered muslin cloth. Tyndallisation of plant extracts were done in autoclave at 5 psi pressure for one hour for three consecutive days and tested at 5, 10 and 15% concentrations.

2.2. In vitro evaluation of bioresources

Seven bioresources (Table 1) were evaluated under *in vitro* conditions at 5, 10 and 15% concentrations against *A. solani* by poison food technique (Falck, 1907). Experiment was conducted in Completely Randomized Design (CRD) and each treatment was replicated thrice. Inhibition percent in each treatment was calculated as described by Vincent (1947).

$$I=(C - T)/C\times 100$$

where,

I = Per cent inhibition

C = Growth of test pathogen in absence of fungicide (cm),

T = Growth of test pathogen in presence of fungicide (cm)

2.3. Evaluation of bioresources against A. solani under field conditions

Bioresources evaluated under *in vitro* conditions were further evaluated by spraying at 5% concentration under field conditions at the experimental farm of department of Plant Pathology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. Field experiments were laid out in Randomized Block Design (RBD) during two consecutive crop seasons of 2018 and 2019. Each treatment was repeated thrice using the susceptible variety 'Heem Sohna'. Plot size was 3.0×2.0 meter, having four rows 90 cm apart. Five plants were transplanted in each row at a distance of 45cm. Five foliar sprays of bioresources were applied at 10 days interval starting from first appearance of symptoms. The severity of disease was recorded periodically and calculated by using the formula given by McKinney (1923).

Disease severity (%) =(Sum of all disease ratings/(Total number of ratings × maximum grade) × 100

Table 1: *In vitro* efficacy of different bioresources against *A. solani* causing early blight of tomato

Bioresources		Average mycelial growth (mm)			Mean	Mycelial growth inhibition (%)			Mean
		Concentration (%)				Concentration (%)			
Common Name	Scientific Name	5	10	15		5	10	15	
Banah	*Vitex negundo*	4.57	2.63	1.40	2.87	49.26 (44.56)	70.74 (57.24)	84.44 (67.19)	68.15
Kadu	*Roylea elegans*	2.60	1.40	0.00	1.33	71.11 (57.47)	84.44 (66.76)	100.00 (90)	85.19
Kaner	*Nerium indicum*	5.37	4.07	2.90	4.11	40.37 (39.43)	54.81 (47.75)	67.78 (55.06)	54.32
Darek	*Melia azedarach*	3.40	3.03	2.50	2.98	62.22 (52.09)	66.30 (54.51)	72.22 (58.18)	66.91
Garlic	*Allium sativum*	4.13	3.27	1.80	3.07	54.07 (47.32)	63.70 (52.96)	80.00 (62.63)	65.93
Cow Urine	-	0.00	0.00	0.00	0.00	100.00 (90)	100.00 (90)	100.00 (90)	100.0
Basunti	*Justicia adhatoda*	2.63	1.33	1.07	1.68	70.74 (57.24)	85.19 (67.36)	88.15 (71.02)	81.36
SEm±			0.11				0.66		
CD (*p*=0.05)			0.29				1.89		

Figures in the parenthesis are arc sine transformed value

2.4. Statistical analysis

Data obtained of various experiments were analyzed statistically by using OPSTAT software and their means were separated by the test of CRD and RBD at the 0.05% of the probability level.

3. Results and Discussion

The fungus associated with the early blight disease of tomato was isolated in pure culture and identified as *Alternaria solani* on the basis of morphological i.e. conidiophores, size, shape, septation and beak length of conidia and cultural characteristics i.e. colour and type of colony of the pathogen (Simmons, 2007).

3.1. In vitro evaluation of bioresources

All the bioresources evaluated under *in vitro* conditions significantly inhibited the growth of fungus at various concentrations tested as compared to control (Plate 1). Among all the bio resources tested, cow urine was highly effective at all the concentrations against the fungus and resulted in cent per cent average mycelial growth inhibition followed by leaf extract of *Roylea elegans* (kadu) (85.19), *Justicia adhatoda* (basunti) (81.36%) and *Vitex negundo*(banah) (68.15). At 15% level of concentration *Roylea elegans* and cow urine showed cent per cent mycelial growth inhibition followed by *Justicia adhatoda, Vitex negundo* and *Allium sativum* which resulted in 88.18, 84.44 and 80.00% growth inhibition respectively.

Products derived from plants are important sources of new biopesticides for the control of many plant diseases (Kagale et al., 2004). Beside this, these products derived from plant origin are non-phytotoxic, systematic and easily biodegradable (Qasem and Abu-Blan, 1996). Various workers studied the efficacy of many plant origin fungicides to manage early blight of tomato. The results obtained in present investigations are also in consonance with the findings of earlier workers (Maya and Thippanna, 2015); Sadana and Didwania, 2015; Kumar and Singh, 2017; Royet et al., 2019) who, reported the inhibitory activity of many plant originated bio-pesticides against *Alternaria* spp. Ghosh et al. (2018) and Sharma et al. (2010) demonstrated the antifungal and inhibitory activity of cow urine against various plant pathogens and concluded that among various concentrations tested, cow urine at 100% concentration was most effective to inhibit the growth of *Alternaria* spp (Plate 2 and Table 2).

B1- *Roylea elegans*; B2- *Allium sativum*; B3- *Vitex negundo* B4- *Justicia adhatoda*; B5- *Nerium indicum*; B6- *Melia azedarach*; B7- Cow urine

Plate 1: Various bio-resources extracted from different plants

3.2. Evaluation of bio resources under field conditions

All the bioresources tested under field conditions at 5% concentration significantly reduced the severity of disease and increased the yield as compared to the untreated check. Data obtained from the two year experiments under field conditions (pooled data) showed that foliar sprays of *Allium satium* (garlic) was found significantly more effective in reducing the disease severity to 56.12% followed by *Justicia adhatoda* (basunti), *Melia azedarach* (darek) and cow urine which resulted in 44.24, 38.71 and 37.92% , reduction of disease. The *Melia azedarach* (darek) and cow urine treatments were statistically at par and there were no significant difference between them.

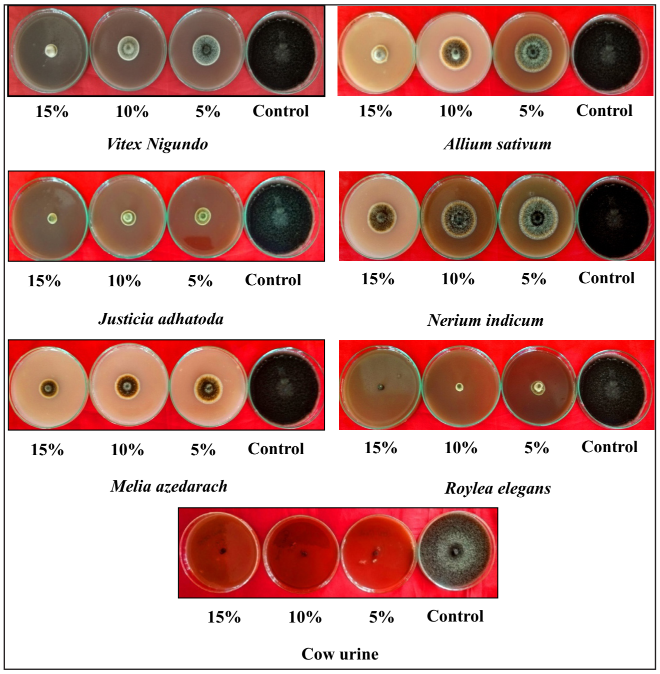

Plate 2: *In vitro* efficacy of different bio-resources against *A. solani*

The data pertaining to the yield of fruits also revealed that, maximum yield of fruits (18.40 kg plot^{-1}) and potential yield of 30.25 tonne ha^{-1} was recorded in five consecutive spray treatment of *Allium sativum* (garlic) followed by *Justicia adhatoda* (basunti) (13.52 kg plot^{-1}), cow urine (13.00 kg plot^{-1}) and *Nerium indicum* (12.70 kg plot^{-1}) which were statistically at par with each other, whereas, minimum yield of fruits 9.40 kg plot^{-1} was observed in *Vitex negundo* (banah) treatment. The results of present studies are in consonance with the findings of various earlier workers who reported that garlic extract was highly effective against the disease under field conditions and recorded highest reduction of disease severity in addition increased the fruit yield by 76.2% compared to the infected control (Nashwa and Abo-Elyousr, 2012; Mahapatra and Das, 2013; Debbarma et al., 2017). In many plants, the compounds like saponins, sterol, aromatic hydrocarbon, alkaloids and unsaturated fatty acids are present which showed inhibitory effects against several pathogens. Shekhawat and Prasad (1971) reported that garlic extract was effective against *Alternaria* and concluded that allicin in garlic was responsible for bursting in young hyphae of fungus. Singh et al., (1990) reported ajoene a compound derived from garlic inhibited the spore germination of *A. solani.*

Table 2: Effect of different bioresources on severity of early blight disease and yield of tomato fruits under field conditions

Bioresources		Dose (%)	Disease severity (%)			Disease reduction (%)			Yield (kg plot^{-1})			Yield (t ha^{-1})		
			2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
Banah	Vitex negundo	5	56.18 (48.53)	50.68 (45.37)	53.43 (46.95)	23.29 (28.76)	33.79 (35.52)	28.50 (32.14)	9.8	9	9.40	16.33	15.00	15.67
Kadu	Roylea elegans	5	45.31 (42.28)	53.24 (46.84)	49.27 (44.56)	38.15 (38.15)	30.49 (33.46)	34.35 (35.80)	11.5	9.5	10.50	19.17	16.67	17.92
Kaner	Nerium indicum	5	48.84 (44.32)	47.14 (43.34)	47.99 (43.83)	33.32 (35.09)	38.41 (38.28)	35.78 (36.6)	13.5	11.9	12.70	22.50	19.83	21.17
Darek	Melia azedarach	5	49.61 (44.76)	41.87 (40.30)	45.74 (42.53)	32.27 (34.51)	45.27 (42.27)	38.71 (38.39)	10	12.1	11.07	16.67	20.06	18.36
Garlic	Allium sativum	5	31.75 (34.27)	33.90 (35.56)	32.82 (34.92)	56.69 (48.13)	55.74 (48.29)	56.12 (48.51)	17.8	19	18.40	29.67	30.83	30.25
Cow urine	-	5	44.16 (41.63)	48.80 (44.29)	46.48 (42.96)	39.72 (38.99)	36.21 (36.98)	37.92 (37.99)	12	14	13.00	20.00	25.56	22.78
Basunti	Justicia adhatoda	5	39.72 (39.05)	43.78 (41.41)	41.75 (40.23)	45.80 (42.53)	42.75 (40.81)	44.24 (41.67)	12.2	14.8	13.52	20.33	25.17	22.75
Control	-	-	73.21 (58.83)	76.52 (61.00)	74.87 (59.91)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	8	7.5	7.75	13.33	12.67	13.00
SEm±			0.90	0.81	0.88	1.18	1.07	1.21	0.85	1.23	0.78	1.42	1.60	1.20
CD (p=0.05)			2.76	2.48	2.55	3.62	3.29	3.51	2.63	3.77	2.26	4.38	4.92	3.48

Figures in the parentheses are arc sine transformed value

4. Conclusion

In order to manage the disease studies were conducted under invitro and field conditions. Garlic extract at 5% concentration reduced the severity of disease and increased the yield. Cow urine and basunti *(Justicia adhatoda)* also showed inhibitory activity under invitro and found effective under field conditions. Results of present studies concluded that foliar spray of garlic extract or cow urine and *Justicia adhatoda* could be utilized as effective non chemical measure to manage early blight of tomato.

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