J. Mycopathol. Res. 53(2) : 205-213, 2015; (ISSN 0971-3719)

Eco-friendly management strategy of Alternaria blight through plant extracts

JASKARAN SINGH, S.K. BISWAS*, DEVESH NAGAR AND RAVINDRA SINGH
Department of Plant Pathology, C.S.A. University of Agriculture & Technology, Kanpur 208002. U.P.

Received : 10.11.2014 Accepted : 27.04.2015 Published : 27.10.2015

Eight plant extracts like *Melilotus albus, Solanum nigrum, Physallis minima, Salix* sp., *Datura fastusa, Convolvulus arvensis, Achyranthus aspera* and *Parthenium hysterophorus* have been exploited against Early blight of tomato and their effect on physiological and biochemical activities in tomato also evaluated. Seed treatment with plant extracts stimulated the germination of the tomato seeds. The maximum germination percentage was noted in case of *Datura* extract treatment. The growth promoting effect of plant extracts was also perceived with *Datura* extract treatment showing maximum shoot length which was 8.7% increase over control 7.9%. Fresh and dry shoot and root weight were also found maximum in *Datura* and *Parthenium* extract treated plants representing 40.60 to 39.70 g respectively. The maximum yield with 580 gm/plant was also obtained from *Datura* extract treated plants. Biochemichal changes like total soluble protein and phenol content in tomato plants were also examined. Total soluble protein content was found maximum in case of *Datura* extract treated plants. Total phenol content also showed significant increase in treated plants which was 2.76 mg/g, 2.55 mg/g, 2.18 mg/g and 1.98 mg/g in *Datura*, *Parthenium*, *Physallis* and *Achyranthus*, respectively at 10 days after spraying. The correlation coefficient between disease severity with total phenol and soluble protein contents revealed that there was a negative correlation.

Key words: Alternaria blight, management, plant extracts

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill). is one of the most remunerable and widely grown vegetables in the world. The worldwide production of tomato is about 130 million tones in the year 2008. Tomato is also well known as protective food. In India production of tomato during 2012-13 was 182.27 lakh tones and total area under tomato production was 879.6 ha. which constitutes 9.6 per cent of total vegetable area and 11.2 per cent of total vegetable production. The productivity of tomato in India is 20.7 MT/ha during 2021-13 which is very low as compare to other country of the world like USA, 81.0 tones /ha. One of main reason of low productivity of tomato in India is diseases which are caused by fungi, bacteria, virus, nematode and abiotic factors (Balanchard, 1992). Among the fungal diseases, Early Blight also known as target spot disease incited by *Alternaria solani* (Ellis and Mar-

*E-mail: samirkrbiswas@rediffmail.com

tin) Jones and Grout is one of the world's most catastrophic disease. The disease is causing loss from 50-86% in fruit yield (Mathur and Sekhawat, 1986). The pathogen survives for a long time in the diseased plant parts, soil and on alternative or collateral hosts in the absence of main host, determine the wide ability of the pathogen to perpetuate (Moore and Thomas, 1942; Basu, 1971 and Rands, 1917). Therefore management of the disease is quite difficult. Spraying of broad spectrum fungicides like Mancozeb, Captan and Paraclostrobin (25%), Copper oxychloride, Chlorothalonil has been recommended for the control of Early Blight of tomato by several workers (Ramakrishnan *et al.*, 1971; Stevenson, 1977; Ganeshan and Chethana, 2009; Sahu *et. al.,* 2013). Cultural practices like field sanitation, deep summer ploughing, soil solarization, soil amendment, crop rotation etc. can minimize the possibility of disease but can not completely control the disease on standing crop. Biological control is another important method of plant disease management. However, slight fluctuation of temperature, relative humidity, pH, moisture largely affect the efficacy of bio-agents. Therefore, the use of chemicals is one of the best method of plant disease management. Several fungicides like Paraclostrobin, Mancozeb, Propineb, Metalaxyl, Fosetyl-Al, Aureofungin, Streptocycline, Phosphonic acid, and Chlorthanil @ 0.2% and Iprovalicarb + Propineb as seed treatment have been used for management of Alternaria blight of tomato (Chaudhari *et al.,* 2002; Andreu and Coldiz, 2006; Saha *et al.,* 2013). But excessive use of chemicals has caused soil, air surface and ground water pollution besides affecting the crop produce. It also enter in our food chain. Botanicals can serve as an alternative approach in this situation. (Arzoo and Biswas, 2013) reported that use of plant extracts of neem, dhatura, zinger, garlic, motha etc. as seed treatment increases plant growth and decreases seedling mortality of tomato caused by Fusarium wilt. Zarina *et al.* (2003) have also found that soil amendment with extract of neem and datura increases the growth of brinjal plant and also controls infestation of root knot nematodes. Similarly, Biswas *et al.* (2003) have reported increased shoot and root length of rice plants when treated with leaf extracts of neem and *datura*. Therefore the study has been undertaken in the present investigation.

MATERIALS AND METHODS

Preparation of plant extract

The fresh and mature leaves of collected plant materials were thoroughly washed under running clean tap water to remove dust and other surface contaminant. The extract was obtained from individual plant material by electric mixie in distilled water 1:1 (w/v). The resultant slurry was strained through a double layered muslin cloth to remove the uncrushed fibrous tissue of plant material. The procedure repeated twice and each time, the resultant slurry was filtered through two fold muslin cloth. The final volume of the filtrate thus obtained was made up to one liter by adding water to maintain at 10 per cent concentration on fresh weight basis of plant material (w/v).

Effect of plant extracts on growth parameter of tomato plants

The experiment was conducted at Glass house complex Department of Plant Pathology, C.S.A. University of Agriculture and Technology, Kanpur. The seedlings of tomato variety RT- 6 were placed in a jar containing 10% solution of each extract for five hrs. It was then transplanted in the glasshouse in 30 cm earthen pots, which were previously filled with a mixture of sterilized sandy loam and farm yard manure in the ratio of 2:1. One seedling was transplanted in each pot and watered regularly. Three replications were kept for each treatment and three pots were sown with untreated seedling served as control. Observations pertaining to effect of different treatments on the seed germination, growth parameter of seedlings like, fresh shoot and root length and weight, dry matter were recorded at 30, 45, 60 and 75 days age of plants.

Effect of plant extracts on severity of disease

At 45 days age, the plants were artificially inoculated with homogenized spore suspension of pathogen. Then covered with polythene bags for 48 hrs to provide suitable moisture and humidity for growth and development of the pathogen. The concentration of conidia was maintained at 10,00,000 conidia/ml. The spore suspension was prepared from seven days old culture of the pathogen. After 48 hrs of pathogen inoculation of plants were sprayed with plant extracts separately. All the plants were then kept on the bench of glass house.

In one case, plant were sprayed with pathogen only served as control. Three replications were kept for each treatment. Observations on disease severity were recorded at 5, 10 and 15 days of final spraying.

Measurement of disease severity

Observations for measuring the disease severity were taken after 5, 10 and 15 days of pathogen inoculation. The disease severity was recorded on a 0-4 scale, where zero representing no infection and 4 denoting plants completely infected. The 0-4 scale of the disease severity was classified as follows:-

The disease severity of individual plants was calculated by following formula:-

$$\text{Disease severity PDI} = \frac{\text{Sum of numerical rating}}{\text{Total number of leaves examined x maximum rating}} \times 100$$

Effect of plant extracts on biomolecules during pathogenesis

Tomato leaves were collected from different treatments and the changes in the content of soluble protein and phenol in leaves were estimated at 5, 10 and 15 days after inoculation of the pathogen.

Soluble protein estimation

The method developed earlier was used with slight modification to determine the total soluble protein content. The estimation of protein was calculated as 5, 10 and 15 days of pathogen inoculation.Tomato leaves from different treatments were harvested, washed with distilled water several times and blotter dried before protein extraction. A quantity of 1.0 g of each leaf sample was cut into small pieces and ground in pre-chilled pestle and mortar using 1:5 ratio of leaves : extraction buffer. Extraction buffer consists of 120 mM Tris-HCl, pH 7.5, 20 mM Dithiothretol, 20% glycerol, 2% SDS, 1 mM phenyl sulpheryl floride. The suspension was centrifuged at 10,000 rpm for 30 minutes at 4^0C. The supernatant was collected. A quantity of 7.5 ml of the supernatant was transferred in a tube and mixed with 2.5 ml of sample buffer and used for protein estimation. The working standard solution was pipetted out and 0.2, 0.6 and 1.0 ml of the solution was put into series of test tubes. A quantity of 0.2 ml, 0.6 ml and 1.0 of the sample extract was also pipetted out and kept into other test tubes separately. Then volume in all the tubes was made upto 1 ml with water. A tube with 1 ml of water served as a blank. Later on, 5 ml of solution C was added in each test tube and incubated at room temperature for 10 min. Thereafter, 0.5 ml of FCR was mixed well immediately and incubated at room temperature for 30 min in dark place. The absorbance at 660 nm against the blank was read and standard graph was drawn to calculate the amount of soluble protein in sample and represented as mg/ g of fresh sample.

Total phenol estimation

The accumulation of phenols in tomato plants after treatment with different plant extracts followed by inoculation of pathogen was estimated. In this method, the total phenol estimation was carried out with FCR, which was measured at 650 nm radiation colorimetrically. The total phenol content was calculated as 5, 10 and 15 days of pathogen inoculation. For estimations, 1.0 g of leaf sample of potato was ground in a pestle and mortar in 10 times volume of 80% ethanol. It was then centrifuged to homogenate the suspension at 10,000 rpm for 30 minutes at room temperature. Supernatant was separated and re-extracted for 5 times with required volume of 80% ethanol, centrifuged and the supernatant were pooled. It was then evaporated to dryness and residues were dissolved in 5 ml of distilled water. Different aliquots (0.2, 0.6 and 1.0 ml) were pipetted out into test tubes and the volume in each tube was made to 3 ml with water. Subsequently 0.5 ml of FCR was added and after three minutes, 2 ml of 20% Na_2CO_3 solution in each tube was thoroughly mixed. Then absorbance at 650 nm against blank was measured using Ultra Violet Visible (UV-VIS) spectrophotometer and the standard curve using different concentration of phenols was prepared. From the standard curve the concentration of phenols in the test sample was determined and expressed as mg phenols per g of sample materials.

Correlation coefficient and Regression equation

Correlation coefficients (r) between soluble protein and disease severity as well as between total phenol and disease severity were calculated by stan-

dard statistical calculation. Simple regression equations (Y = a + bx) were also developed for both the variables (protein and phenol) separately to understand their relation with disease severity.

RESULTS AND DISCUSSION

The present study was undertaken for comparative evaluation of the effect of different plant extracts or *Alternaria solani,* to find the effect of seed treatment with plant extracts on seed germination, growth parameters, yield and severity of disease. The possible biochemical changes in plant extracts due to application of tomato was also noticed in the present investigation.

Effect of plant extracts on germination and growth parameter of tomato seedling. Seed germination

The result presented in Table 1 indicated that the seed treatment with plant extract significantly increased the germination percentage of tomato seed. The maximum germination was recorded in case seed treatment with extract of *Datura* and *Parthenium* (90.0), followed by *Physallis* (87.5). From the Table, it is also cleared that all the treatment significantly increased the germination percentage of seed. Maraiki (2013) also recorded enhanced (67% and 40%) tomato seed germination when treated with *Artemisia absinthium* and *Ocimum basilicum* leaf extracts, respectively.

Growth parameters

Shoot length

The data presented in the Table 1 showed that all the treatments were able to significantly increased shoot length over control at 30, 45, 60 and 75 days age of plant. Among the treatments, the maximum shoot length was recorded in *Datura* treated plant representing 28.11, 40.18, 55.19, and 66.13 cm against in case of control at 30, 45, 60 and 75 days age of plant, respectively. Among the treatments, minimum shoot length was recorded in case of seedling dip in plant extract of *Melilotus alba* representing the value of 20.00, 28.97, 41.50 and 52.56 cm. From the table, it was also cleared that the all the treatments were able to increase shoot length over control. Marraiki (2013) also recorded positive effect on shoot length of tomato when treated the seeds with *Ocimum basilicum.* He was recorded maximum shoot length of 6.5 cm.

Root length

Ninety days after transplanting, the tomato plant was uprooted and the root length was measured separately by using scale. The data presented in the Table 3 revealed that the maximum root length (19.30 cm) was recorded in the *Datura* treated plants. Other treatments such as *Salix* sp. (18.40 cm), *Convolvulus* (17.10 cm) and *Physallis* (16.70 cm) also showed significant increase in root length over control (10.30 cm). Marraiki (2013), also re-

Table 1: Effect of plant extract on germination of seed and shoot length of tomato seedling at different days of interval (Blotter paper method)

Treatment	Shoot length of tomato seedling (in cm) Days							Germination (%)
	1	2	3	4	5	6	7	
Melilotus alba	0.4	1.3	4.2	4.7	5.4	6.00	6.4	75.00
Solanum nigram	0.2	0.4	0.8	1.2	2.00	3.2	6.00	70.00
Physalis minima	1.00	2.1	5.0	6.1	7.00	7.8	8.7	87.5
Salix sp.	1.5	3.2	6.00	6.4	7.3	7.5	8.00	80.00
Datura fastusa	1.5	3.1	6.0	6.5	7.1	7.6	8.5	90.00
Convolvulus arvensis	0.2	0.5	0.6	0.6	0.7	1.00	2.00	55.00
Achyranthus aspera	0.5	1.7	4.5	5.7	6.8	7.5	8.6	80.00
Parthenium hysterophorus	1.3	2.3	5.5	6.4	7.00	7.6	8.00	90.00
Control	1.3	2.00	4.00	5.7	6.4	7.2	7.9	86.5
S.E(d)	0.106	0.136	0.217	0.272	0.340	0.421	0.476	1.360
C.D. (0.05)	0.223	0.286	0.457	0.571	0.714	0.886	1.00	2.859

Table 2 : Effect of plant extracts on shoot length of tomato plant at different days of intervals (Glass house condition)

Treatments		Shoot length (cm)			
		30 DAT	45 DAT	60 DAT	75 DAT
T_1	*Melilotus alba*	20.00	28.97	41.50	52.56
T_2	*Solanum nigram*	23.00	37.15	50.98	60.07
T_3	*Physalis minima*	21.55	35.80	47.63	57.89
T_4	*Salix* sp.	20.50	30.20	43.80	54.60
T_5	*Datura fastusa*	28.11	40.18	55.19	66.13
T_6	*Convolvulus arvensis*	21.30	30.98	43.53	54.51
T7	*Achyranthus aspera*	22.45	31.00	45.50	58.10
T8	*Parthenium hysterophorus*	25.23	40.17	53.00	63.35
T9	Control	18.60	25.70	34.63	44.29
	SE(d)	0.544	0.680	0.816	0.952
	CD (0.05)	1.144	1.429	1.716	2.001

Table 3 : Effect of plant extracts on root length, fresh and dry shoot and root weight tomato plant at 90 days age of plant

Treatment		Root length(cm)	Fresh Root weight (g)	Dry Root weight (g)	Fresh Shoot weight (g)	Dry Shoot weight (g)	Yield/ plant (g)
T_1	*Melilotus alba*	11.10	7.01	2.50	32.56	5.00	390
T_2	*Solanum nigram*	14.50	6.50	3.00	34.50	6.60	410
T_3	*Physallis minima*	15.11	9.50	3.59	38.50	7.10	440
T_4	*Salix* sp.	16.70	8.20	2.40	37.80	5.90	420
T_5	*Datura fastusa*	17.10	980	3.70	40.60	8.70	480
T_6	*Convolvulus abensis*	13.90	7.50	2.60	35.90	6.50	430
T7	*Achyranthus aspera*	19.30	7.50	3.62	32.80	6.20	400
T8	*Parthenium hystarophorus*	18.40	8.80	3.50	39.70	8.60	460
T9	Control	10.30	3.50	0.48	29.50	3.40	325
	SE(d)	0.330	0.451	0.175	0.696	0.405	11.547
	CD (0.05)	0.653	0.948	0.366	1.464	0.850	24.26

ported increased root length with the use of *Ocimum basilicum* extract. It is also supported by Kumar and Khanna (2006). They observed increased root length with the use of neem seed kernel extract.

Fresh and dry shoot weight

Fresh shoots of tomato plant were weighted on an electronic balance and the data presented in the Table 3 showed that all the treatments were able

Table 4 : Effect of plant extract on disease severity of *Alternaria solani* of tomato

Treatment	Disease severity (%)		
	5 days	10 days	15 days
Melilotus alba	12.65	18.20	21.23
Solanum nigram	15.21	20.05	23.41
Physallis minima	12.48	19.02	22.43
Salix sp.	14.16	17.75	21.51
Datura fastusa	5.18	9.14	11.94
Convolvulus arvensis	19.65	23.45	27.37
Achyranthus aspera	10.56	14.98	17.65
Parthenium hysterophorus	9.25	12.65	16.83
control	61.10	80.92	95.12
S.E (d)	0.544	0.680	0.879
C.D. (0.05)	1.143	1.429	1.847

to increase the fresh shoot weight of tomato plants over control. The maximum fresh shoot weight was recorded in seed treatment with *Datura* plant extracts, representing 40.60 g followed by *Parthenium* treated plant, showing 39.70 g fresh weight at 90 days age of plants.

Similarly, plant shoot were dried in an oven at 70^0C until constant weight. Then, it was weighted on an electronic balance and the data was presented in the Table 3. It has found that the maximum dry shoot weight (8.70 g) was recorded in the *Datura* treated plant followed by *Parthenium* treated plant the rest of the treatments were also sowing superior over control. Above mentioned result also supported by Ahmed *et al.,* (2004). They found that leaf extract of *Datura* not only controlled citrus nematodes *Tylenchulus semipenetrans* but also stimulated plant growth. Similarly Zarina *et al.* (2003) found that soil amendment with leaf extract of *Datura* as well as *Datura* extract treated increased the growth of brinjal plants while controlling root knot nematode, *Meloidogyne javanica.*

Table 5 : Effect of foliar spray with plant extract on total soluble protein content of tomato leaves after 5days, 10days and 15 days of final spray

Treatment	Total soluble protein content (mg/g of fresh leaves)			% Incidence	
	5 days	10 days	15 days	Over control -1	Over control -2
Melilotis alba	25.45	27.56	26.54	22.42	24.45
Solanum nigram	24.43	26.34	25.47	34.74	38.32
Physalis minima	29.10	30.65	28.30	18.64	20.72
Salix sp.	20.67	22.76	22.45	35.18	39.87
Datura fastusa	29.49	29.56	29.13	49.27	54.17
Convolvulus arvensis	23.27	25.21	23.85	9.23	10.21
Achyranthus aspera	25.86	27.15	26.32	21.65	23.76
Parthenium hysterophorus	28.16	29.45	28.75	43.13	47.45
Control-1	20.67	22.76	21.45		7.70
Control-2	19.85	20.69	19.88	-8.33	
S.E.(d)	0.374	0.402	0.397		
C.D. (0.05)	0.781	0.840	0.829		

Table 6 : Effect of foliar spray with plant extract on total soluble phenol content of tomato leaves after 5 days, 10 days and 15 days of final spray

Treatment	Total soluble Phenol content (mg/g of fresh leaves)			% incidence	
	5 days	10 days	15 days	Over control -1	Over control-2
Melilotis alba	1.54	1.69	1.63	15.45	16.36
Solanum nigram	1.33	1.65	1.59	7.34	7.85
Physallis minima	1.81	2.02	1.98	30.82	33.06
Salix sp.	1.68	1.82	1.77	1.65	1.80
Datura fastusa	2.50	2.80	2.76	44.05	47.11
Convolvulus arvensis	1.57	1.69	1.63	21.57	22.68
Achyranthus aspera	1.98	2.60	2.55	17.95	19.63
Parthenium hysterophorus	2.25	2.23	2.17	25.46	27.62
Control-1	1.48	1.59	1.51		
Control-2	1.36	1.46	1.41		
S.E(d)	0.139	0.178	0.163		
C.D. (0.05)	0.290	0.371	0.339		

Table 7 : Correlation coefficient of disease incidence with soluble protein and total phenol

Biochemical parameters	Days after pathogen inoculation	Correlation coefficient(r) with disease severity	Regression equation
Total soluble protein	5 days	-0.6470	Y=81.418 -3.5123X
	10 days	-0.6020	Y=77.8956 -37.8176X
	15 days	-0.6765	Y=109.0805 -4.0626X
Total phenol	5 days	-0.4922	Y=85.87 -34.6551X
	10 days	-0.5047	Y=107.9005 -3.1958X
	15 days	-0.5059	Y=94.56587 -38.7318X

Fresh and dry root weight

Similarly, fresh roots of tomato plant were also weighed on an electronic balance and the data represented in the Table 3 showed that all the treatments were able to increase the fresh root weight of tomato plant over control. The maximum fresh root weight was recorded by *Datura* extract treated plants, representing 9.80 g followed by *Parthenium* treated plants. The root of tomato plant were dried in an oven at 70^0C and then it was weighted on an electronic balance and the data in the Table 3 showed that the maximum dry root weight (3.70 g) was recorded in *Datura* treated plants.

Yield

The efficacy of plant extracts has been tested on

tomato yield. The tomato products were harvested and the yield was separately weighted for each treatment. It has found that the maximum yield was recorded per plant in *Datura* treated plant where treatment was given as seedling dip in *Parthenium* extract, followed by foliar spray with the *Parthenium* extracts showing 460 g per plant. From the table it is cleared that all treatments significantly increased tomato yield.

Effect of plant extracts on bio-molecules

To evaluate the biomolecular changes associated with the effect of plant extract during pathogenesis, and development of disease tomato leaves were harvested at 5, 10 and 15 days of final spray of plant extract to estimate the soluble protein and total phenol content.

Total soluble protein

The data presented in Table 5 showed that the soluble protein contents in *Datura* extract treated leaves were 29.49 mg/g, 30.65 mg/g, and 29.13 mg/g of fresh have at 5, 10 and 15 days after final spray which is the highest among all the treatments. The soluble protein content of control-1 were 20.67 mg/g, 22.76 mg/g and 21.54 mg/g at 5, 10 and 15 days after final spray whereas in case of control-2 the values are 19.85 mg/g, 20.69 mg/g and 19.88 mg/gm respectively. After 15 days, *Datura* treated leaves showing (29.13 mg/g) and 49.27 mg/g higher protein content over control-1 and 45.17 % higher than control-2. All other treatment also had significantly higher protein content than control-1 and control-2. From the table it is also clear that all treatment increased protein content to a maximum at 10^{th} day of pathogen inoculation, there after it decreased gradually from 10 to 15 days. The decreased protein in diseased plant than healthy may be due to utilization of some protein by the pathogen. Similar results also reported by Biswas *et al.* (2003). They estimated elevated level of total soluble protein in wheat when treated with crude extracts of *Chaetomium globosum.* Arzoo *et al.* (2013) also reported increased levels of total soluble protein in plant extract treated tomato seedlings. Chandrasekaran and Rajappan (2001) found the alteration in protein and sugar content of soybean plants as induced by plant extract, antagonists and chemicals.

Total phenol

The result presented in Table 6 shows that all the treatment significantly increased the total phenol content as compared to control-1 and control-2 at 5, 10, and 15 days after final spray. The maximum amount of phenol content was found in *Datura* extract treatment with a value of 2.50 mg/g, 2.80 mg/g and 2.76 mg/g of leaves against 1.48 mg/g,1.59 mg/g and 1.51 mg/g respectively in control-1 and 1.36 mg/g, 1.46 mg/g and 1.41 mg/g, respectively control-2 at 5^{th}, 10^{th} and 15^{th} days. The percent increase in phenol contents in *Datura* treated leaves were 44.05% and 47.11% higher than control-1 and control-2 respectively at 15^{th} days of final spray which was followed *by Parthenium, Physallis* and *Achyranthus.* The data in Table 6 also shows that the phenol content for all treatment increase from 5 to 10 days period but again decrease from 10 to 15 days. The result showed that the phenol content of all treated plant increased up to a certain period and then it decreases. The increased phenol content in treated plant might be responsible for defense response in plant. Daayf and Fernando *et al.* (2003) reported induction of phenolic compounds in two cultivars of cucumber by treatment with extract of *Renoutria sachalinensis.* Arzoo *et al.* (2013) also reported higher level of total phenols in plant extract treated tomato seedlings.

Effect of plant extracts on severity of disease

The effect of seedling treatment and foliar spray of plant extract on tomato plant revealed that there is decline in Early Blight severity due to various treatments under glass house condition (Table 4). The susceptible variety RT-6 of tomato showed a 100% Early Blight severity in case of *Alternaria solani* treated plant. The minimum severity of Early blight incidence was recorded in *Datura* extract treated plant which was 5.18% followed by *Physallis, Parthenium, Salix* and *Convolvulus* extract treated plants, showing 9.25%, 10.56%, and 12.48% disease severity, respectively. The decrease in disease severity might be the activity of plant extract against development of disease. Matern and Kneusal (1988) suggested that the first stage of defense mechanism involve a rapid accumulation of phenol at the infection site which restricts or slows the growth of the pathogen.

Correlation coefficient of disease incidence with soluble protein and total phenol

The leaves treated with plant extract increased level

of soluble protein. A negative correlation (r) -0.6470, -0.6020 and -0.6765 was found between disease severity and soluble protein content. Similarly, disease severity decreased with increased level of total phenol content and there was a negative correlation (r)-0.4922, -O.5047 and -0.5059 between total phenol content and disease severity (Table 7). The corresponding simple regression equation also shows the negative relation between total soluble protein and disease severity as well as total phenol and disease severity. (Nicholson and Hamnerschidt, 1992; Adesh, *et al.,* 2008; Girdhari, *et al.,* 2008).

REFERENCES

Adesh. 2008. *Induce resistance in tomato against Fusarium wilt through inorganic chemicals*. M.Sc. Thesis. C.S.A University of Agriculture and Technology, Kanpur.

Ahmad M.S., Mukhtar, T. and Ahmad, R. 2004.Some study on the control of citrus nematode (*Tylenchus semipenetrans*) by leaf extract of three plant and there effect on plant growth variables. J. *Plant Sci.* **3** : 544-548.

Andreu, A. B. and Caldiz, D. O. 2006. Early management of late blight (*Phytophthora infestans*) by using systemic fungicides applied to seed-potato tubers. *Crop Protection.*, **25**:281-286.

Arzoo Kahkashan and Biswas S.K., 2013. Effect of Plant Extracts as Seed Treatments on Growth Parameters, Seedlings Mortality and Biochemical Changes in Tomato. *International Journal of Bio-resource and Stress Management* **4**:047-053.

Balanchard, D. 1992. *A colour atlas of tomato diseases*.Wolfe Pub. Ltd., Brook House, London, p. 298.

Basu, P.K. 1971. Existence of chlamydospores of *Alternaria porrii* f.sp. *solani* as over wintering propagules in soil. *Phytopathology*, **61** : 1347-1350.

Biswas, S.K ., Srivastava, K.D., Aggarwal, R. Shelly Praveen and Singh, D.V. 2003. Biochemical changes in wheat induced by chaetomium globosum against spot blotch. pathogen. *Indian Phytopath.* **54:** 374-379.

Chandrasekaran, A., and Rajappan, K. 2001. Alteration in protein and sugar content of soyabean plants as induced by plant extracts, antagonists and chemicals. *Indian J. of Myc. and Pl. Path.* **31**, 350-352.

Chaudhari, S. M. Patel, R. N. Patel, R. L. and Patel, N. H. 2002 Management of Early Blight of potato through chemicals *Indian Journal of Plant Protection.*, **30**:184-186.

Dyaaf F Adam and Fernando, W.G.D. 2003. Comparative screening of bacteria for biological control of potato late blight (strain US-8) , using in-vitro deteched leaves and whole plant testing systems . *Canadian Journal Of Plant Pathology* . **25,** 276-284.

Ganeshan, G. and Chethana, B. S. 2009. Bioefficacy of pyraclostrobin 25%EC against Early Blight of tomato. *World Applied Sciences J.* **7**: 227-229.

Girdhari L.K., Biswas S.K. and Srivastava S.S.L. 2008. Biochemical evidence of defense response in paddy induced by bioagents against brown leaf spot pathogen. *Indian Phytopath.* **61**:197-203.

Kumar, S. and Khanna, A.S. 2006. Effect of Neem Based Products On The Root-Knot Nematode, *Meloidogyne incognita,* and Growth of Tomato. *Nematol. medit.* **34:** 141-146.

Marraiki, Najat. 2013. Investigating the Effect of Aqueous Medicinal Leaf Extracts on Tomato Seed Quality. *Biosci. Biotech. Res. Asia.* Vol. **10:** 843-847.

Matern, U. and Kneusel, R.E. 1988. Phenolic compounds in plant disease resistance. *Phytoparasitica.* **16**: 153-170.

Mathur, K. and Shekhawat, K.S. 1986. Chemical control of Early Blight in Kharif sown tomato *Indian Journal of Mycology Plant Pathology*, **16**: 235-238.

Moore, W.D. And Thomas, H.R. 1942. Some cultural practices that influence the development of *Alternaria solani* on tomato seedlings, *Phytopathology*, **32** : 1176-1184.

Nicholson, R.L., Hammerschmidt, R., 1992. Phenolic compounds and their role in disease resistance. *Annu. Rev. Phytopathol.* **30,** 369-389.

Ramakrishnan, B., Kamalanathan And Krishnamurthy, C.S. 1971. Studies on Alternaria leaf spot of tomato. *Madras Agricultural Journal*, **58** : 275-280.

Rands, R.D.1917. The production of spores of *Alternaria solani* pure culture. *Phytopathology*, **7:** 316-317.

Sahu D. K., Khare C.P., Singh, H.K., and Thakur M.P. 2013. Evaluation of Newer Fungicide for management of Early Blight of Tomato in Chhattisgarh. *The Bio-scan* **8**: 1255-1259.

Stevenson, W.R. 1977. Use of Captafol and Chlorothalonil on reduced application method schedules for tomato disease control in India. *Plant Disease Reporter*, **61**: 803-805.

Zarina, B., Ghaffar, A. and Maqbool, A. 2003. Effect of plant extracts in the control of *Meloidogyne javanica* root knot nematode on brinjal. *Pakistan J. Nematology* **21**: 31-35.