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Evaluation of Different Phytochemical Extracts for the Management of Early Blight of Tomato

Muhammad Yasin[1], Fazli Raziq[1], Saeed Ullah[1], Dost Mohammad[2], Abdul Aziz[3], Bilal Ahmad[4], Habib Ullah Khan[3], Zahid Hussain[2], Suleman Khan[5], Faizan[1], Muhammad Uzair Khan[6]

[1]Department of Plant Pathology, Faculty of Crop Protection Sciences, University of Agriculture, Peshawar, KP, Pakistan.
[2]Department of Plant Protection, Faculty of Crop Protection Sciences, University of Agriculture, Peshawar, KP, Pakistan.
[3]Deprtment of Agricultural Chemistry and Biochemistry, Faculty of Nutrition Sciences, University of Agriculture, Peshawar, KP, Pakistan.
[4]Cereal Crops Research Institute Pirsabak-Nowshera, KP, Pakistan.
[5]Deprtment of Plant Pathology, University of Agriculture, Faisalabad, Punjab, Pakistan.
[6]Department of Agronomy, Faculty of Crop Production Sciences, University of Agriculture, Peshawar, KP, Pakistan.

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Correspondence to: Muhammad Yasin, Department of Plant Pathology, Faculty of Crop Protection Sciences, University of Agriculture, Peshawar, KP, Pakistan.
Email: yasin.pathology@gmail.com

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ABSTRACT

Background: Early blight is a serious disease of tomato that reduces both yield and quality. Farmers often use chemical sprays to control it, but these can harm the environment and lose effectiveness over time. Using plant-based extracts is a natural and safer option to manage this problem. **Objective:** To evaluate the various phytochemical extracts for the management of early blight of tomato. **Methdology:** The antifungal efficacy of ten medicinal plants, namely; prickly acacia (Acacia nilotica L.), datura (Datura alba L.), black pepper (Piper nigrum L.), turmeric (Curcuma longa L.), garlic (Allium sativum L.), ginger (Zingiber officinale L.), oleander (Nerium oleander L.), eucalyptus (Eucalyptus globulus L.), ashwagandha (Withania somnifera L.), chinese date (Ziziphus mauritiana L.) along with the fungicide Mancozeb, were evaluated against Alternaria solani, the causal agent of tomato early blight, under in vitro and screen house conditions, and data was analyzed using the CRD model (ANOVA). **Results:** The In-vitro experiment with Potato Dextrose Agar (PDA) medium amended with 500 mg/L dose of the plant powder preparations, Mancozeb to be the most effective in reducing colony diameter of A. solani after 7-14 days of incubation. All the ten tested plants also reduced the colony diameter of A. solani significantly ($p<0.05$) as compared with unamended control. However, garlic, oleander and turmeric were found to be superior to the other plants. Similarly, these three plants, along with Mancozeb, also markedly reduced fungal biomass and spore concentration. In the screen house study (3000 mg/L), disease severity after the second application was lowest in Mancozeb-treated plants (16.7%), followed by garlic (26.6%), oleander (26.7%), and turmeric (30.0%), while the untreated control showed the highest severity (96.7%). Yield assessment revealed that during the first picking, maximum fruits per plant were obtained with Mancozeb (6.3), followed by garlic (5.3), oleander (4.7), and turmeric (4.7), whereas untreated, eucalyptus, and datura-treated plants produced the lowest (3.0 fruits each); a similar trend was recorded during the second picking. Furthermore, Mancozeb, garlic, oleander, and turmeric significantly improved plant growth attributes, including plant height, fresh weight, and dry weight, compared to untreated plants. **Conclusions:** It is concluded that garlic, oleander, and turmeric can be used as effective alternatives for managing early blight in tomato, with oleander being particularly promising due to its low cost and abundant availability.

INTRODUCTION

In the globe, the tomato (Lycopersicon esculentum L.), a member of the Solanaceae family, is the second most significant vegetable crop after potatoes. Basically, they came from South America and have grown widely in 173 nations worldwide, yielding over 195 million tons of tomatoes annually. The United States and Spain are the next two nations that produce the most tomatoes, after China and India (FAO, 2012). In Pakistan, it was cultivated on 17336 hectares during the kharif season at a total output of 145872 tons in 2013–2014, and on 45594 hectares during the rabi season at a total production of 453716 tons. In Khyber Pakhtunkhwa (KP), tomatoes were therefore grown on 10327 hectares during 2013 and 2014, with an overall production of 91318 tons. Similarly, 40352 tons of tomatoes were produced overall on 3623

hectares during the Rabi season (Annonymous, 2015). Commercially produced cultivars in the nation include Money Maker, Roma, and Rio Grande, most of which were imported from other nations, namely the United States and Europe.

Abiotic and biotic stressors reduce tomato output. Drought, water logging, temperature, nutrient deficiencies, soil toxicity, acidity, pH, and so forth are examples of abiotic factors. Additionally, tomatoes are vulnerable to biotic agents, including bacteria, nematodes, viruses, fungus, and protozoa (Balanchard, 1992; Agrios, 2005). Environmental factors are the main determinant of early blight disease. When the disease-friendly environmental factors, such as temperature and relative humidity, are present, *Alternaria solani* produces greater damage.

According to Mathur and Shekhawat (1986), if the natural conditions are favorable for the disease's progression, the early blight disasters range from 50 to 86 percent. Areas with high rainfall, frequent and prolonged nocturnal dews, and mild temperatures (24–29°C) are susceptible to epidemics (Peralta et al. 2005). Fruit rot, collar rot, and foliage infection are all brought on by it. Along with other Solanaceous crops including eggplant (S. melongena L.), hot peppers (Capsicum spp.), and potatoes, it infects tomatoes. Fruit, twigs, stems, and leaves are among the aboveground plant elements that *Alternaria solani* can infect (Sherf and MacNab, 1986).

The older leaves first have tiny, black, necrotic lesions; subsequently, the spots grow and form a distinct concentric ring encircled by a yellow, hollow, chlorotic leaf region. The disease causes collar rot, a huge, black, depressed partial girdle on the stem region close to seedling level. Collar rot is sometimes referred to as stem canker since it is similar to the latter. On the mature plant's twigs and major branches, little black sunken lesions form. These lesions get larger and form a concentric ring that resembles the symptoms of diseased leaves (Walker 1952; Sherf and MacNab 1986; Gardner 1990).

Fruit can also exhibit the symptom at any stage, whether it is green or ripe, albeit semi-ripe fruit is more vulnerable than full fruit. Dark, squishy, sunken spots occur at the stem end of heavily diseased fruits, which then fall to the ground too soon. Mycelial expansion on the stem end is essentially what creates the spot. The spot gets bigger and takes on the shape of a concentric ring, just like other plant components (Sherf and MacNab 1986; Pandey et al. 2003).

Conidia, which are easily transmitted by infected seeds and seedlings, spraying water, field workers, and air movement and flow from one area to the next, are how the disease spreads. Despite being the most significant illness, there are no precise data on losses in Pakistan. There have been reports of 79% yield losses elsewhere, though (Basu, 1974; Dater and Mayee, 1981; Sherf and MacNab, 1986; Gwary and Nahunnaro, 1998), with 20–24% of those losses occurring in the field at the seedling stage (Sherf and MacNab, 1986).

For elimination of the pathogen inoculum various management practices are available such as, cultural control, resistant varieties and application of different types of fungicide (Wharton and Kirk, 2012). Farmers often think for a disease control strategy that is quick in response. The application of fungicide is one such option (Gondal *et al.,* 2012). Nowadays, mostly used fungicides inhibit either germination, growth or multiplication of pathogens (Agrios, 2005). There are different types of fungicides available in the market which is effective against early blight of tomato such as Mancozeb (Singh *et al*, 2001). Nowadays, the population is expanding daily and the amount of land used for agriculture is decreasing; feeding such a fast-growing population is extremely challenging. Production and quantity are being improved in an effort to meet the increasing demand. Furthermore, a variety of synthetic pesticides are employed for this purpose in order to stop crop losses brought on by infections and pests. On the other hand, synthetic pesticides seriously harm aquatic life, humans, and animals as well as the environment. The best way to manage illness is to utilize resistant kinds, but sadly, there aren't any standard resistant types available. Because the virus has a wide host range, cultural methods like crop rotation are not more effective. Biological control agents are effective for disease management up to limited area such as screen houses, but not for large area such as field condition. Moreover, it is more effective against soil borne pathogens as compared to air borne pathogens.

In order to protect the ecosystem from the harmful effects of synthetic pesticides, eco-friendly pest control techniques must be sought. Applying plant extracts is therefore one way to manage illnesses that don't cause issues or make things more difficult than other techniques of controlling weeds, insects, and other diseases. According to Onaran and Yanar (2016), researchers have investigated plant compounds and essential oils that are beneficial against bacteria, nematodes, fungus, insects, and weeds. Plant pathogenic fungi have been shown to be inhibited or killed by natural compounds obtained by many plant species. Similarly, secondary metabolites with antimicrobial qualities, such tannins, terpenoids, and alkaloids, are also found in several plant species (Patel et al., 2015). To achieve this, plant pathologists are looking for methods to control plant diseases that are quicker, safer, more efficient, and more financially viable.

MATERIALS AND METHODS

This study was conducted in 2016 at the University of Agriculture Peshawar's Department of Plant Pathology. Dr. Zahid Hussain, Assistant Professor, Department of Weed Science, University of Agriculture, Peshawar, identified the plants gathered from the Peshawar district. Selected plants were examined in vitro and under screen house conditions for antifungal efficacy against *Alternaria solani*, the causative agent of tomato early blight (Table 1).

Source of Pathogen Culture

Alternaria solani culture was obtained from the Department of Plant Pathology's culture bank at the University of Agriculture, Peshawar. To multiply, the pathogen culture was injected into Potato Dextrose Agar (PDA) media. To prepare the medium, conventional procedures were followed. Sterilized media was then placed into sterilized Petri dishes. The pathogen was then injected at the middle of the plates, wrapped in parafilm, and incubated at 25°C for one week. Pure cultures were

stored in a refrigerator at 4˚C for future use after one week in figure 1.

Collection of Plant Samples

Table 1 lists the fresh plant samples that were obtained. Leaves were removed from the remainder of the plant, cleaned with tap water, and air dried in a shaded area. After ten days, the dried leaves were ground into fine powder with an electric grinder and stored separately in airtight bottles for further study.

In Vitro Study

The antifungal activity of plant powders against *Alternaria solani* was evaluated using the poison-food technique (Flack, 1907; Seema et al., 2011). Potato dextrose agar (PDA) medium was sterilized and amended with 500 mg/L of each plant powder or Mancozeb before being poured into sterile Petri plates, while unamended PDA served as the control. A 5 mm mycelial plug of *A. solani* was aseptically placed in the center of each plate, and treatments were arranged in a completely randomized design (CRD) with three replications. Plates were incubated at 25 °C for two weeks, and colony diameter was measured along two perpendicular lines to calculate mean growth. For biomass estimation, the plates were weighed before inoculation and again after one and two weeks of incubation, with the difference representing fungal biomass. Spore concentration was determined by washing plates with 10 ml sterile distilled water, detaching conidia with a glass rod, diluting the suspension (10, 100, 1000 times), and counting spores under a haemocytometer using the standard formula.

No of spores/ml=No of spore per mm square × dilution ×5000

Screen House Study

Nursery Preparation and Transplantation

The study was done to see how different plant extracts affect tomato yield and early blight disease. Rio Grande tomato seedlings were first grown in big clay pots for about a month with normal watering and fertilizing. Later, they were moved into 16 cm pots filled with a mix of clay, sand, and farmyard manure (1:1:1). The experiment had 12 treatments, including plant extracts, a fungicide as positive control, and distilled water as negative control, each repeated three times in a random design (Table 2). Plants were looked after using normal gardening practices.

Inoculum Preparation and Inoculation

The inoculum of *A. solani* was prepared by adding sterile water to 10-day-old cultures and gently scraping the colonies with a glass rod to release spores. The mixture was then filtered through cheesecloth to remove fungal threads, and the spore concentration was adjusted to 104 spores/mL using a hemocytometer. Sixteen days after transplantation, tomato plants were sprayed with the spore suspension using a hand sprayer during the evening to reduce drying and increase chances of infection.

Preparation of Plant Extract

Ten grams of plant powder prepared from the plants listed in table 1 were immersed in 100ml of sterilized distilled water, mixed and allowed to soak for 24hrs. After 24hrs the mixture was filtered through Whatman No.4 filter paper to get pure extract (Preethi *et al.,* 2010). The aqueous extracts were stored at 4°C for further use.

Plant-extract Application

Plant extracts were administered at 3000mg/L one week after pathogen inoculation using a hand sprayer. Control pots were treated with sterile distilled water or fungicide (Mancozeb). Each treatment was reproduced three times in a fully randomized (CR) design. The sprays were performed twice at 14-day intervals.

Data Collection

Data were recorded on the following parameter.

Disease Severity

Disease severity was recorded for each treatment using 0-5rating scale (Table 3) Vakalounakis, (1983). Disease severity scale was converted into percentage of early blight index (PEBI) for each plant using the following formula (Pandey *et al.,* 2003).

$$\text{PEBI} = \frac{(\text{Sum of all ratings} \times 100)}{(\text{Number of leaves sampled} \times \text{maximum disease scale})}$$

Number of Fruits

Fruits per plant were counted in each replication, packed twice, and averaged after each harvesting.

Plant Height

After the plants were uprooted, the average of each replication was calculated using a measuring tape to measure each plant from root to apical buds.

Plant Fresh and Dry Weight

All tomato plants were brought to the Plant Pathology Laboratory after being carefully uprooted. An electronic balance was used to weigh each plant, and data was collected. After being meticulously tagged, each plant was allowed to dry for 15 days. Data was recorded on the plants that had dried.

Statistical Analysis

The recorded data was statistically analysed using Statistix software package 8.1. The CRD model was analysed using the ANOVA approach. Means that differed substantially from one another were separated using the LSD test (Steel et al. 1997).

Table 1

list of plants used against Alternaria solani

S/No	Common name	Vernacular/ Local Name	Botanical Name	Plant parts used
1	Prickly acacia	Kekar	*Acacia nilotica* L.	Leaves
2	Datura	Zahar butay	*Datura stramoniu m* L.	Leaves
3	Black Pepper	Tur mirch	*Piper nigrum* L.	Seeds
4	Turmeric	Korkaman	*Curcuma longa* L.	Commerci al Powder
5	Garlic	Uga	*Allium sativum* L.	*C*loves
6	Ginger	Adrak	*Zingi*ber *officinale* L.	Rhizomes

7	Oleander	Ghuraskay	*Nerium Oleander* L.	Leaves
8	Eucalyptus	Lachi wana	*Eucalyptus globulus* L.	Leaves
9	Ashwagandha	Koti lal	*Withania somnifera* L.	Leaves
10	Chinese date	Baira	*Ziziphus mauritiana* L.	Leaves

Table 2

Randomization plan of screen house study conducted to evaluate the effect of different Phytochemical for the management of early blight of tomato.

Prickly acacia	Mancozeb	Turmeric
Datura	Ginger	Sterilized Distill water
Black Pepper	Eucalyptus	Garlic
Turmeric	Sterilized Distill water	Chinese date
Mancozeb	Ashwagandha	Oleander
Ginger	Prickly acacia	Black Pepper
Oleander	Garlic	Ashwagandha
Eucalyptus	Chinese date	Datura
Ashwagandha	Datura	Prickly acacia
Chinese date	Black Pepper	Ginger
Garlic	Turmeric	Eucalyptus
Sterilized Distill water	Oleander	Mancozeb

Table 3

Assessment Key for early blight of tomato

Scale	Disease severity
0	No visible lesions on leaves
01	Up to 10% leaf area affected
02	11-25% leaf area affected
03	26-50% leaf area affected
04	51-75% leaf area affected
05	More than 75% leaf area affected, or leaf abscised

Figure 1

Pure Culture of Alternaria solani on PDA Medium

RESULTS

In-vitro study

Effect of plant powder preparations on colony diameter of *Alternaria solani.*

There were extremely significant differences (P=0.00) between the treatments. The fungicide (Mancozeb) adjusted plates showed the lowest colony diameter (8.3mm) after a week of incubation, followed by garlic extract (13.0mm), oleander (13.7mm), turmeric (16.7mm), and ginger (21.0mm). The unamended control plates showed the largest colony diameter (45.0mm). Keker (37.8mm), datura (40.3mm), and eucalyptus (41.2mm) all considerably decreased the colony diameter of *A. solani*, although they were less successful than the other plants in doing so. (Table 4).

Following a two-week incubation period, the Mancozeb amended plates (Figure 2) had the smallest colony diameter (11.3 mm), followed by the garlic (17.7 mm) (Fig. 3), oleander (18.3 mm) (Fig. 4), turmeric (19.3 mm) (Fig. 5), and ginger extracts (22.3 mm) (Fig. 6). The unamended control plates (Fig. 7) had the largest colony diameter (74.7 mm) (Table 4).

Effect of plant powder preparations on biomass of *Alternaria solani.*

Significant variations between the treatments were noted during a week of incubation (Table 4). In Mancozeb-amended plates, the lowest biomass (231.0 mg) was found, followed by ginger (285.0 mg), oleander (261.3 mg), turmeric (269.3 mg), and garlic (261.7 mg). The unmodified control plates had the highest biomass (1763.7 mg). Even eucalyptus was able to drastically reduce the biomass of *A. solani* when compared to the unmodified control, despite being the least effective plant in this regard. After two weeks of incubation, the biomass of *A. solani* showed a similar trend.

Effect of plant powder preparations on the spore concentration of *Alternaria solani.*

After two weeks of incubation significant differences (P=0.00) were observed among the different treatments (Table 4). The minimum spore concentration (4.3×10^4spore/ml) was observed in Mancozeb amended plates followed by garlic (5.3×10^4spore/ml) and oleander (5.7×10^4spore/ml). The maximum spore concentration (11.3×10^4spore/ml) was recorded in the unamended control plates. Only eucalyptus failed to reduce the spore concentration of *A. solani* significantly.

Table 4

Colony diameter, biomass and spore concentration of Alternaria solani as recorded on PDA medium amended with various plant powder preparations @500 mg/L.

Treatment	Colony diameter (mm)		Fungal Biomass (mg)		Fungal spore concentration
	After 7-days	After 14-days	After 7-days	After 14-days	(10^4/ml) After 14-days
Mancozeb	8.3 f	11.3 f	231.0 i	269.3 j	4.3 g
Garlic	13.0 e	17.7 e	261,0 hi	279.3 ij	5.3 fg
Oleander	13.7 e	18.3 e	261.7 h	307.0 ij	5.7 efg
Turmeric	16.7 e	19.3 e	269.3 gh	323.0 hi	6.3 def
Ginger	21.0 d	22.3 e	285.0 gh	365.0 gh	6.7 def
Ber	27.7 c	29.7 d	297.0 g	410.0 g	7.3 def
Pepper	29.2 c	30.0 d	343.7 f	468.0 f	8.0 bcd

Ashwagandha	30.0 c	32.2 d	421.7 e	607.7 e	8.7 bc
Keker	37.8 b	44.3 d	964.0 d	1089.0 d	9.0 bc
Datura	40.3 b	57.3 c	1212.7 c	1682.0 c	9.3 b
Eucalyptus	41.2 b	62.7 b	1501.0 b	1839.0 b	9.7 ab
Control (unamended PDA)	45.5 a	74.7 a	1763.7 a	3377.7 a	11.3 a
C.V	8.11	7.95	2.88	3.03	15.27
$LSD_{0.05}$	0.3694	0.4725	31.648	46.927	1.9660

Figure 2
Growth of Alternaria solani on PDA amended with 500 mg/l dose of Mancozeb after 14-days of incubation at 25 oC

Figure 3
Growth of Alternaria solanion PDA amended with 500mg/l dose of garlic extracts after 14-days of incubation at 25 oC

Figure 4
Growth of Alternaria solani on PDA amended with 500 mg/l dose of oleander powder after 14-days of incubation at 25 oC

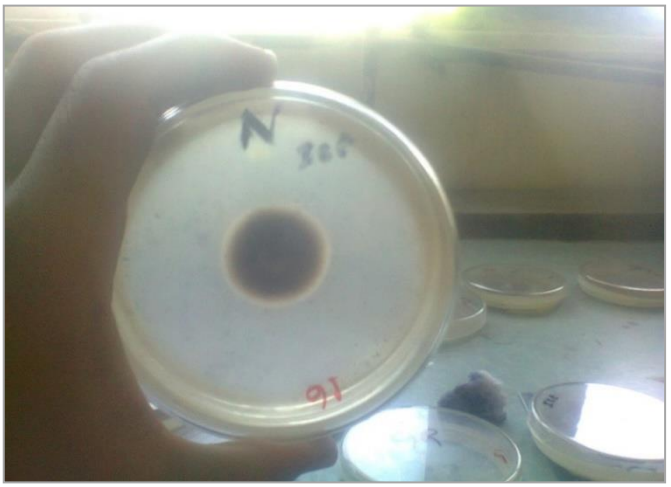


Figure 5
Growth of Alternaria solanion PDA amended with 500mg/l dose of turmeric powder after 14-days of incubation at 25 oC

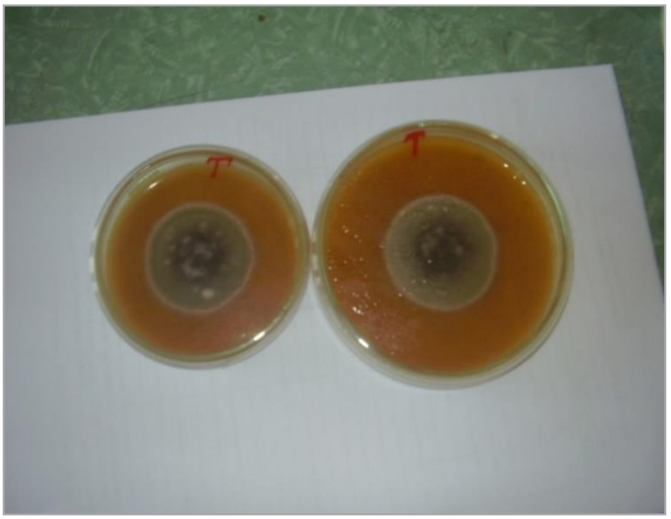
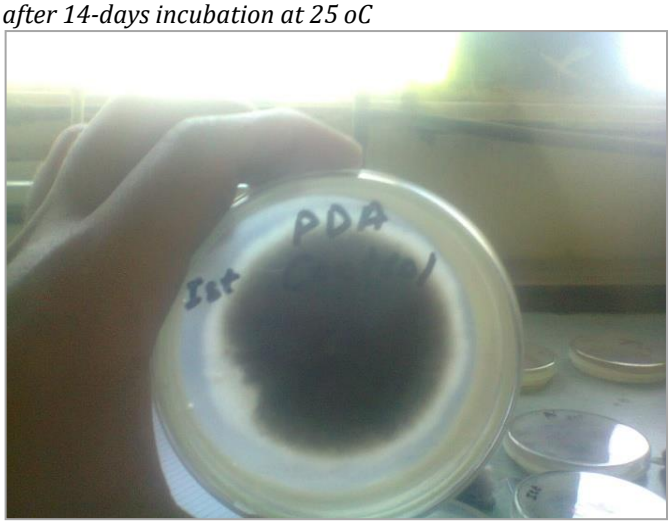


Figure 6
Growth of Alternaria solani on PDA amended with 500 mg/l dose of ginger extracts after 14-days of incubation at 25 oC

Figure 7

Growth of Alternaria solani on unamended PDA medium after 14-days incubation at 25 oC



Screen house study

Effect of application of plant powder extracts on disease severity

According to the illness severity data, the therapies differed significantly (P=0.001) (Table 5). When Mancozeb or plant extracts were applied first, tomato plants treated with Mancozeb showed the lowest disease severity (15.0%), followed by garlic (20.0%), oleander (21.7%), and turmeric (25.0%). Datura and eucalyptus were the least effective plants among those evaluated, with illness severity averages of 46.7% and 55.0%, respectively. However, untreated control plants showed the highest disease severity, at 68.3%.

Significant variations (P=0.00) were noted between the treatments following a second administration of Mancozeb and plant extracts (Table 5). The tomato plants treated with Mancozeb showed the lowest disease severity of 16.7%, followed by garlic (26.6%), oleander (26.7%), turmeric (30.0%), and ginger (33.3%). The untreated control plants showed the highest disease severity of 96.7%, followed by datura (73.3%) and eucalyptus (83.3%).

Effect of plant extracts on number of fruits/plants

During the first fruit picking there were significant differences (P=0.01) among the treatments (Table 5). The maximum numbers of fruits (6.3) were obtained from the plants treated with Mancozeb followed by garlic (5.3), oleander (4.7) and turmeric (4.7). The minimum number of fruits (1.7) was obtained from untreated control plants of tomato.

Differences among treatments were highly significant (P=0.00) with regard to second picking of fruits/plant of tomato. The minimum fruits (0.7) were obtained from untreated control plants while maximum fruits were obtained from Mancozeb or garlic (6.0 each) followed by oleander (5.7) and turmeric (5.0) (Table 5).

Effect of plant extracts on plant height

Highly Significance differences (P=0.00) were observed among the treatments with respect to plant height (Table 5). The highest plant height of (87.0cm) was recorded in plants treated with Mancozeb followed by garlic (85.7cm), oleander (84.1cm) and turmeric (82.2cm). The lowest plant height (54.7cm) was recorded in the untreated control plants of tomato.

Effect of plant extracts on fresh weight of tomato plants.

Differences in fresh weight of tomato plants were highly significant (p=0.000) (Table 5). The maximum fresh plants weight (103.6g) was recorded for Mancozeb followed by garlic (102.5g), oleander (101.4g) and turmeric (91.2g). The minimum, fresh plant weight (40.2g) was recorded for the untreated control plants. Eucalyptus treated tomato plants did not differ significantly from the untreated control plants.

Effect of plant extracts on dry weight of tomato plants.

The dry weight of tomato plants showed significant variations (P=0.00) across treatments (Table 5). The highest weight (67.8g) was observed for Mancozeb, which was followed by turmeric (58.2g), oleander (58.5g), and garlic (65.1g). The untreated tomato control plants had the lowest dry weight (14.7g).

Table 5

Effect of different plant extracts/fungicide on disease severity (%) of early blight, fruit numbers, plant height, fresh and dry weight of tomato plants

Treatment	Disease severity (%) recorded after plant extracts application		Number of fruits		Plant height (cm)	Plant weight	
	12-days	30-days	First picking	Second picking		Fresh (g)	Dry (g)
Mancozeb (check)	**15 i**	**16.7 i**	**6.3 a**	**6 a**	**87 a**	**103.6 a**	**67.8 a**
Garlic	20 hi	26.6 g	5.3 am	6.0 a	85.7 ab	102.5 a	65.1 ab
Oleander	21.7 hi	26.7 g	4.7 bc	5.7 a	84.1 ab	101.4 a	58.5 bc
Turmeric	25 gh	30.0	4.7 bc	5.0 ab	82.2 abc	91.2 ab	58.2 bc
Ginger	28.3 fgh	33.3 f	4.3 bcd	4.7 abc	80.7 bcd	86.8 abc	56.9 bc
Ber	31.7 efg	35.0 f	4.0 bcd	4.0 bc	80.6 bcd	78.3 bcd	50.5 de
Pepper	35.0 def	41.7 e	4.0 bcd	3.3 cd	77.6 cd	75.6 bcd	44.9 ef
Ashwagandha	40.0 cde	58.3 d	3.3 cd	3.3 cd	75 de	71.4 cd	38.2 fg
Keker	43.3 cd	68.3 c	3.3 cd	2.3 df	70.9 ef	63.6 d	34.3 gh
Datura	46.7 bc	73.3 c	3.0 de	2.3 df	70.7 ef	63.5 d	27.8 hi
Eucalyptus	55.0 b	83.3 b	3.0 de	1.6 ef	68.8 f	60.1 de	24.0 i
Control (untreated plants)	68.3 a	96.7 a	1.7 e	0.7 f	54.7 g	40.2 e	14.7 j
C.V.	13.95	7.95	24.82	23.93	4.71	14.52	23.79
$LSD_{0.05}$	8.4258	6.5868	1.6616	1.5125	6.0713	19.126	5.1332

Figure 8

Typical concentring ring of early blight produces on tomato foliage under screen house

DISCUSSION

In this study, several plants were employed to reduce *Alternaria solani*-caused tomato early blight. Traditionally, chemical fungicides have been used to manage this illness, but they are toxic to aquatic life, people, and animals. For plant disease control, using alternative sources is necessary to reduce the negative impacts of chemical fungicides. Using plant extracts might be one of these choices. In addition to being environmentally benign and readily biodegradable, they also prevent diseases from becoming resistant to plant-based toxins. Many secondary metabolites, including alkaloids, tannins, saponins, glycosides, steroids, and flavonoids, have been identified in plants with antibacterial qualities (Cowan, 1999). They have been reported to have shown good results both under *in-vitro* and *in-vivo* conditions (Bergaoui *et al.,* 2007, Zaker and Mosallanejad, 2010).

Ten plants were utilized in this investigation. Garlic, oleander, turmeric, and ginger powders among these plants effectively inhibited the growth of pathogens in comparison to the other plants that were evaluated. According to reports, these plants possess antimicrobial chemicals that help prevent illness by either inhibiting pathogen development directly or causing systemic resistance (Kagale et al, 2004). Other researchers (Curtis et al., 2004; Kreb et al., 2006; Latha et al., 2009) have also documented the efficacy of plant powders of ginger, garlic, oleander, and turmeric.

Flavonoids and other bioactive substances found in plants have been shown to attach to water-soluble proteins and reduce their functionality (Marjorie, 1999). According to Hannah et al. (2004), garlic produces volatile bioactive chemicals called allicin and ajeon that prevent fungal spores from germinating. Various kinds of antibacterial chemicals have been found in Nerium oleander (Bhuvaneshwari et al., 2007). Myricetin and rutin, two antifungal chemicals, were investigated in dried N. oleander leaves (Elsadig et al., 2007). According to Shimada (2006) and Thiago et al. (2008), secondary metabolites of plants have varying mechanisms of action against infections. For example, tannin disrupts protein synthesis and damages the cell wall of the pathogen. According to (Sasidharan and Menon, 2010) ginger's primary antifungal ingredient is gingiberene, which fights Aspergillus niger and Candida albicans. Phenolic compound such as flavonoids which are synthesized by plants play vital role against pathogen attack. They could bind with soluble proteins, cell wall and act as bacterio static (Yadav *et al.,* 2011). Alkaloids, flavanoids, carbohydrates, glycosides, tannins, isoflavonoids, terpenoids, amyrin and oleanolic were reported in different parts of *N. oleander* (Elsadig *et al*. 2007; Rajendran, 2011 p). All parts i.e. leave, shoots and roots of *N. oleander* possess antimicrobial properties and has significantly reduced colony growth of several fungi such as *Macrophominaphaseolina*, *Sclerotiumrolfsii,* and *Fusarium oxisporum.* (Ullah *et al*. 2014). Alkoloid hermine has been reported to have antifungal and antimicrobial activity (Amel *et al.,* 2012). Many bioactive substances were reported to have antimicrobial as well as physiological properties (Iraqui *et al.,* 2013).

Fungicides often work well to manage plant diseases, increasing output and lessening the severity of the illness. For instance, the fungicide Mancozeb is frequently used to control *Alternari solani*, but plant extracts like garlic, oleander, turmeric, and ginger are nearly as effective as Mancozeb. They also significantly decreased the severity of the disease and increased yield because of certain antimicrobial compounds. For instance, garlic contains allicin and ajoene, oleander contains cardiac glycoside, turmeric contains curcuma and other antimicrobial compounds, and ginger contains gingerols and zingiberene. Among the botanicals examined, keker, datura, and eucalyptus extracts were less effective. Less antibacterial chemicals might be the cause.

The application of plant extracts should be made at the right time like the application of fungicide such as after the initial appearance of disease symptoms. Similarly, the right concentration and frequency of application should be worked out for each plant extract preparation. The application should be done when the weather is clear since rainwater might wash them off the plant. Along with using plant extracts, appropriate culture techniques such avoiding insect and pest attacks should be used to reduce plant damage. Despite using Mancozeb, garlic, and oleander extracts at the same concentration, there was no discernible difference in their efficacy. Therefore, it is hypothesized that using the same or higher concentration of extracts in future studies will boost yield and lessen the severity of sickness.

CONCLUSIONS

Garlic (*Allium sativum*), oleander (*Nerium oleander*), and turmeric (*Curcuma longa*) demonstrated strong antifungal potential next to Mancozeb, effectively reducing early blight severity and improving tomato growth and yield. Due to its low cost and availability, oleander deserves further attention for wider use against plant diseases.

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