

Exploring biopesticidal potentials of family Capparaceae to manage early blight of Tomato (*Solanum lycopersicum* L.)

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Abstract

Early blight of Tomato caused by *Alternaria solani*, is get managed with the help of biopesticides, eight leaf extracts (*Capparis brevispina* D.C., *Capparis tomentosa* Lam., *Capparis zeylanica*, *Capparis rigida*, *Capparis grandis*, *Capparis decidua*, *Capparis divaricate*, and *Capparis sepiaria*). *Capparis zeylanica* and *Capparis grandis* was found very efficient at 10% concentration of leaf extracts (15.33 and 16.66) respectively. In 10 % concentration of *Capparis zeylanica*, 2.33 conidia per microscopic field was found and 7456.00, conidia of *Alternaria solani* was found at per ml suspension, this is the lowest count, Highest number of PCE was also observed in the same concentration and leaf extract. The fungal pathogen *Alternaria solani* completely inhibited by leaf extracts and managed the disease. Rather than toxic chemical fungicides leaf extracts were used for controlling fungal disease. This is an Eco-friendly management of fungal disease.

Key words: Early blight, *Capparis*, *Alternaria*, Eco-friendly

Introduction:

Fungal diseases have always been a major problem for tomato crops. Growers generally use chemical fungicides to treat this type of diseases. However, these products are toxic to the environment and the consumer, especially if the pre-harvest interval is not respected. Plants are constantly threatened by a variety of pathogenic microorganisms present in their environments, such as bacteria, fungi, and viruses which cause diseases that significantly contribute to the overall loss in crop yield worldwide, (Peng Y. and *et.al*, 2021). Fungi are ubiquitous in the environment, and infection due to fungal pathogens has become more common. The genus *Alternaria* Nees is widely distributed in nature and its species are among the most common fungi on the phyllosphere (Lopes and Martins, 2008). Phytopathogenic fungi are controlled by synthetic fungicides; however, the use of these is increasingly restricted due to the harmful effects of pesticides on human health and the environment (Harris *et al.*, 2001). Substances from plant extracts and essential oils are control options that aim to reduce and/or

mitigate the use of pesticides, since the intensive use of these chemicals may generate environmental problems. The adversities of these products include contamination of food, soil, and water; intoxication of farmers; selection of resistant phytopathogens; and eradication of beneficial soil microorganisms (Maia *et. al.*, 2015).

Tomato is the utmost important and popular vegetable crop grown round the world (Ahmad F and *et. al.*, 2017, Chanthini, K, and *et.al.*, 2018). Tomato belongs to the genus *Lycopersicon* and Family Solanaceae. The main diseases are fusarium wilt, early blight, damping off, late blight, tomato mosaic virus, verticillium wilt, and bacterial wilt. (Varma and *et.al.*, 2018, Rex and *et. al.*, 2019, Roy, C.K. and *at. al.*, 2019). Out of all, the most damaging disease caused by pathogenic fungus *A. solani* is early blight, which results in major loss both in quantity and quality of fruit yield. (Tomazoni E.Z. *et.al.*, 2016, S, Perveen *et.al.*, 2019). The early blight of tomato is considered as the most devastating disease resulting in pre and postharvest stages resulting in a drop in yields of 35 to 78% (Awan Z.A, Shoaib A., (2019). Several researchers have recently exploited higher plant products as novel chemotherapists in plant defence, which are important sources of new agrochemicals for plant disease control (Devi N.O. *et.al.*, 2017). The natural products are considered to be the best as alternative to synthetic chemicals due to less negative environmental impact. (Raza, W. *et.al.* 2016).

Plants have been a rich source of medicines because they produce a bioactive molecule, most of which probably evolved as chemical defences against predation or infection (Anitha *et. al.*, 2016). Excessive and irrational use of synthetic pesticides pose dangerous to biodiversity and overall ecosystem, these chemicals combat various phytopathogens which are inhibited various crop diseases, but on the other hand they have their adverse effect on human health and environment. Pesticides of chemical origin pollute water, air soil (Manuel *et al.*, 2008). The worldwide trend towards safe environment methods for controlling plant diseases in sustainable agriculture practice needs reduced usage of synthetic chemicals.

As plants contain various chemicals which showed antifungal, antibacterial activities, therefore the present study was undertaken to manage fungal pathogen *Alternaria solani*, causing disease to Tomato (*Lycopersicon esculentum*), through the leaf extracts of eight plants of family Capparaceae (*Capparis brevispina* D.C., *Capparis tomentosa* Lam., *Capparis zeylanica*, *Capparis rigida*, *Capparis grandis*, *Capparis decidua*, *Capparis divaricate*, and *Capparis sepiaria*). The testing of the efficacy of such potential plant-based sources for antifungal activity could be an important step towards the assessment of the degree of variability among the diverse natural flora (Manoorkar and Gachande, 2014).

Materials and Methods:

Pathogenic fungi, *Alternaria solani*, identified on diseased plant parts of host (*Lycopersicon esculentum*) was collected from different districts of Maharashtra and fungal pathogen was isolated. The pathogen was maintained on Czapek Dox agar medium.

Fresh plant materials viz. leaves were collected from different parts of Maharashtra, India. These all eight plants of family Capparaceae (*Capparis brevispina* D.C., *Capparis tomentosa* Lam., *Capparis zeylanica*, *Capparis rigida*, *Capparis grandis*, *Capparis decidua*, *Capparis divaricate*, and *Capparis sepiaria*) leaves were thoroughly washed with tap water and then followed by distilled water and kept in dark in filter papers at room temperature till completely dry. Then plant material was individually pulverized to obtain dry powder. For each plant 25 gm powder was taken. Extract of each plant material of every plant was prepared in ethanol and distilled water and serve as stock extract, the toxicity of extract was determined against pathogenic fungi, *Alternaria solani* following food poisoned technique (Mishra and Tiwari, 1992).

Different concentrations of extracts were prepared (10%, 25%, 50% and 100%) supplemented with Czapek Dox agar medium, four concentrations of each plant material of every plant were made each concentration with three replications and control were kept. These petri plates then inoculated with six mm disc of fungal mycelium, which is obtained from seven-day old culture of fungal pathogen. These inoculated plates kept upside down and inoculated in BOD incubator at $28^{\circ}\text{C} \pm 2^{\circ}\text{C}$. Radial growths of fungal colonies were measured at different intervals. Antifungal activities of extracts of different plant parts of all eight plants was studied, sporulation of test fungi on different extracts was calculated by following equation.

$$\text{Spores per ml} = \frac{\text{No. of spores observed per microscopic field}}{12.5} \times \frac{40,000}{1}$$

The percentage control efficacy is also studied, which was calculated by following formula.

$$\text{P. C. E.} = 100 \left(1 - \frac{X}{Y} \right)$$

Where,

X = The diameter of the mycelia growth on extract treated host.

Y = The diameter of the mycelia growth on untreated host (Control)

Table 1: *In vitro* study of antifungal activities of leaf extracts (biopesticides) of Capparaceae on growth of test fungi *Alternaria solani*.

Sr. No.	Leaf extract (biopesticides)	Concentration in %	*Diameter of fungal Colony (in mm)
			<i>Alternaria solani</i>
1	<i>Capparis tomentosa</i> Lam.	10	21.33
		25	0.00
2	<i>Capparis grandis</i>	10	16.33
		25	0.00
3	<i>Capparis zeylanica</i>	10	15.66
		25	0.00
4	<i>Capparis rigida</i>	10	37.33
		25	18.33
		50	0.00
5	<i>Capparis brevispina</i> D C	10	28.33
		25	0.00
6	<i>Capparis decidua</i>	10	39.66
		25	22.66
		50	0.00
7	<i>Capparis divaricate</i>	10	22.33
		25	0.00
8	<i>Capparis sepiaria</i>	10	42.33
		25	17.33
		50	0.00
		Control	90.00
		SE	3.32
		CD	7.08

*Radial growth in mm is the average of three replicates.

Fig. No. 1: Effect of biopesticides on growth of *Alternaria solani*

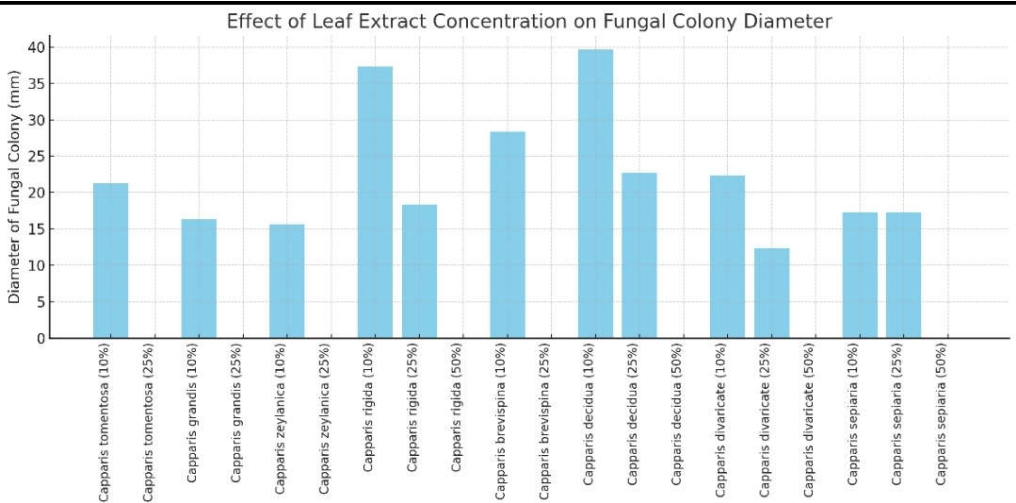


Table 2: Antifungal activities of leaf extracts (biopesticides) of Capparaceae on sporulation of *Alternaria solani*.

Sr. No.	Leaf extract (biopesticides)	Concentration In %	Sporulation of <i>Alternaria solani</i>	
			*No. of conidia per microscopic field	No. of conidia per ml suspension
1	<i>Capparis tomentosa</i> Lam.	10 %	7.33	23556.00
		25 %	0.00	0.00
2	<i>Capparis grandis</i> L. f.	10 %	3.00	9600.00
		25 %	0.00	0.00
3	<i>Capparis zeylanica</i> L.	10 %	2.33	7456.00
		25%	0.00	0.00
4	<i>Capparis rigida</i>	10 %	14.33	45856.00
		25 %	8.00	25,600.00
		50%	0.00	0.00
5	<i>Capparis brevispina</i> D C	10 %	6.33	20.256
		25 %	0.00	0.00
6	<i>Capparis decidua</i>	10 %	23.33	74,656.00
		25 %	10.66	34112.00
		50 %	0.00	0.00
7	<i>Capparis divaricate</i>	10%	11.33	36256.00
		25%	0.00	0.00
8	<i>Capparis sepiaria</i>	10%	24.33	77856.00
		25%	14.33	45,856.00
		50%	0.00	0.00
		Control	29.00	92800.00
		S.E.	1.82	5829.27
		C.D.	3.83	12247.30

*No. of conidia per microscopic field in 10X

Fig. No. 2: Effect of biopesticides on conidial production of *Alternaria solani* per ml suspension

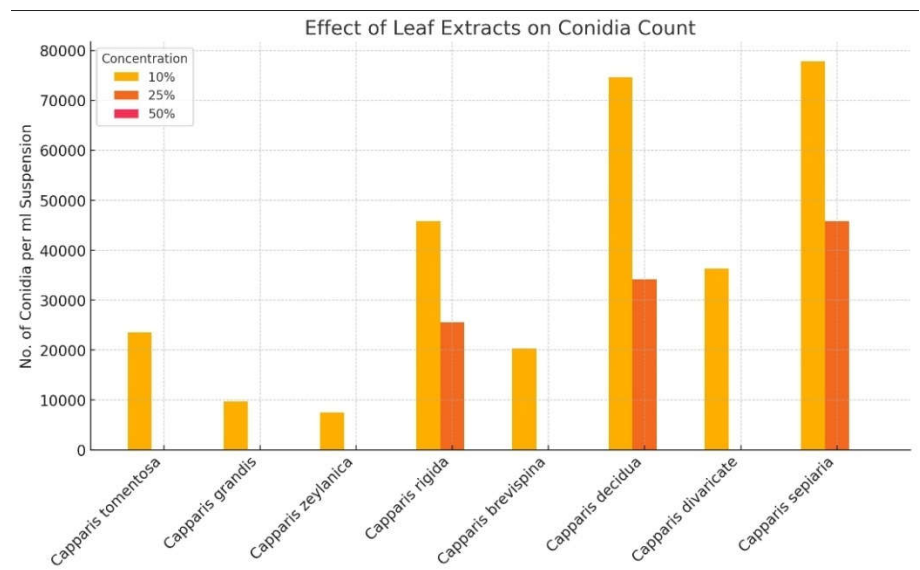


Fig. No. 3: Effect of biopesticides on conidial production of *Alternaria solani* per microscopic field

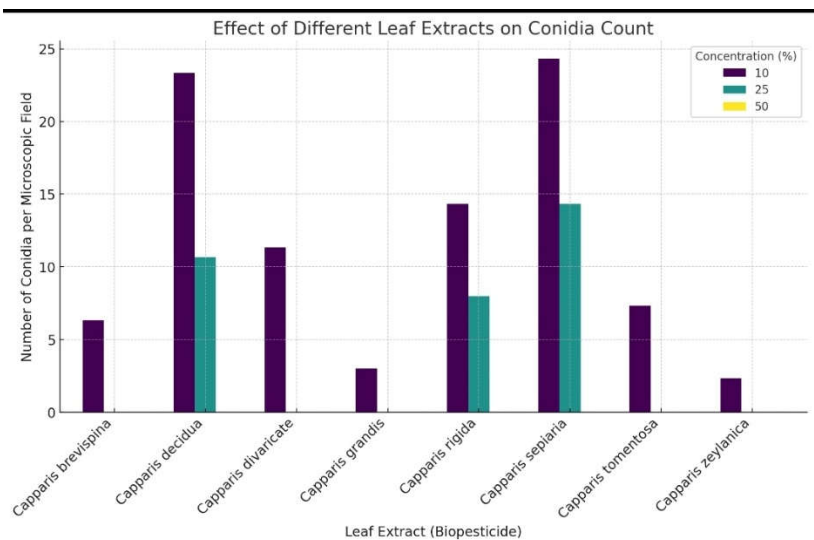


Table 3: *In vivo* study of antifungal activities of leaf extracts (biopesticides) on growth of *Alternaria solani*.

Sr. No.	Leaf extract (biopesticides)	Concentration In %	Sporulation (conidial production) of <i>Alternaria solani</i>	
			Growth in mm	% of control efficacy (PCE)
1	<i>Capparis tomentosa</i> Lam.	10 %	20.00	57.44
		25 %	0.00	100.00
2	<i>Capparis grandis</i> L. f.	10 %	8.00	82.97
		25 %	0.00	100.00
3	<i>Capparis zeylanica</i> L.	10 %	7.00	85.10
		25%	0.00	100.00
4	<i>Capparis rigida</i>	10 %	22.00	53.19
		25 %	9.00	80.85
		50%	0.00	100.00
5	<i>Capparis brevispina</i> D C	10 %	18.00	61.70
		25 %	0.00	100.00
6	<i>Capparis decidua</i>	10 %	23.00	51.06
		25 %	11.00	76.59
		50%	0.00	100.00
7	<i>Capparis divaricate</i>	10%	10.00	78.72
		25%	0.00	100.00
8	<i>Capparis sepiaria</i>	10 %	24.00	48.93
		25 %	12.00	74.46
		50%	0.00	100.00
		Control	47.00	0.00
		S.E.	2.54	6.13
		C.D.	5.41	13.06

Fig No. 4: *In vivo* study of antifungal activities of leaf extracts (biopesticides) on growth of *Alternaria solani*.

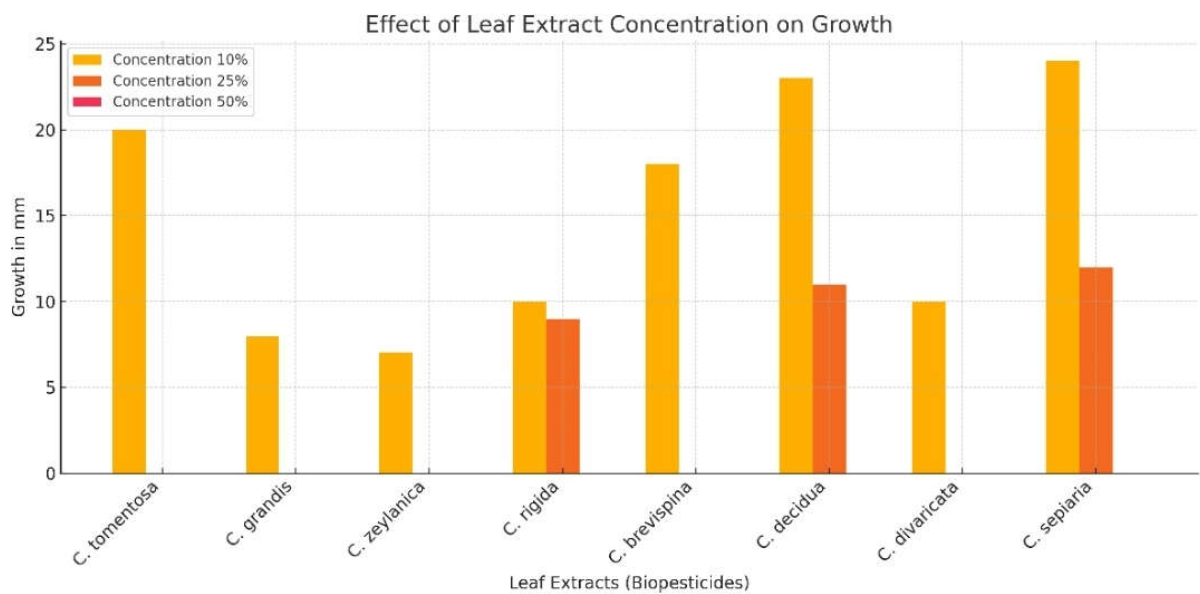
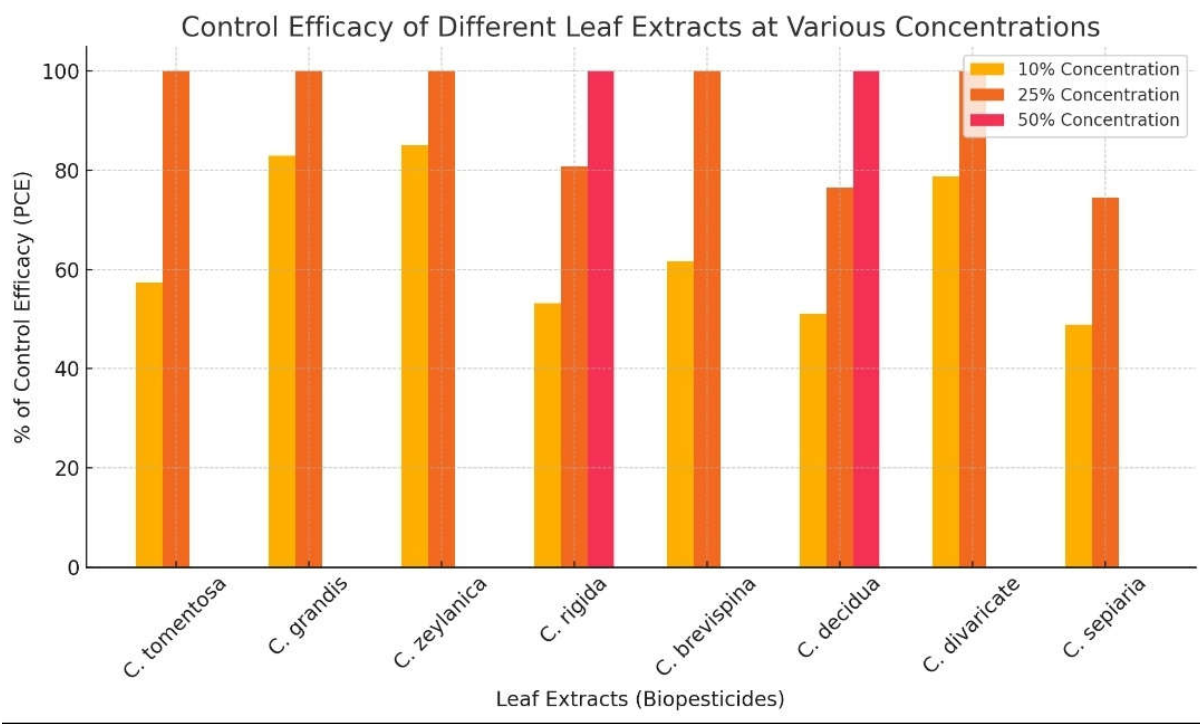


Fig. No. 5: Percentage Control Efficacy (PCE) of different plant extracts against *Alternaria solani*.



Results and Discussion:

To manage early late blight of Tomato caused by *Alternaria solani*, eight leaf extracts of plants from family Capparaceae was checked in 10 %, 25%, 50% and 100% concentration. The leaf extracts of *Capparis zeylanica* and *Capparis grandis* was found more effective, which inhibited pathogen *Alternaria solani* completely at 25% concentration, and at 10 % concentration it showed 15 and 16 cm growth respectively. (Table No.1) Following to this leaf extracts of *Capparis tomentosa* Lam. and *Capparis divaricate* showed their antifungal effects against pathogenic fungi, which exhibit (21.33 and 22.33 in 10% concentration) and at 25 % concentration it totally inhibited the test fungi. (Table No.1).

Leaf extracts (biopesticides) of all eight plant extracts were also studies against the test fungi *Fusarium solani* to know how much number of conidia was found in microscopic field with tested leaf extracts concentration wise and on the basis of that with the help of above formula number of conidia per ml suspension was get calculated. (Table No. 2). The leaf extract of *Capparis zeylanica* L. showed lowest conidia per microscopic field (2.33) at 10% concentration only, the number of conidia get calculated in the same concentration i.e. 7456.00 (Table No.2). followed to this, the leaf extract of *Capparis grandis* L. f., at 10% concentration number of conidia found, 3.00 and number of conidia per ml of suspension was calculated was 9600.00, (Table No. 2). Remaining leaf extracts of four plants showed greater number of conidia both in microscopic field and per ml suspension.

In vivo percentage control efficacy (PCE) of every biopesticide against test fungi was also studied, leaf extract of five plants i.e. (*Capparis brevispina* D.C., *Capparis tomentosa* Lam., *Capparis zeylanica*, *Capparis grandis*, and *Capparis divaricate*), showed 100% percentage control efficacy at 25% concentration, and remaining three plant extracts i.e. (*Capparis rigida*, *Capparis decidua* and *Capparis sepiaria*), showed 80.85%, 76.59% and 74.45 %, percentage control efficacy respectively at the 25% concentration. At 10% concentration, leaf extract of *Capparis zeylanica* L., showed highest number of PCE (85.10%) and leaf extract of *Capparis sepiaria*, showed lowest number of PCE (48.93%) at 10 % concentration.(Table 3).

Five plant extracts (*Peganum harmala*, *Ocimum basilicum*, *Caralluma europaea*, *Nerium oleander* and *Eucalyptus globulus*) are tested for their in vitro efficiency against four pathogenic fungi: *Alternaria solani*, *Botrytis cinerea*, *Botrytis cinerea* taken from fruit, *Phytophthora infestans* and *Oidium oxysporum*, the study of the fungal/fungistatic effect

revealed that all the studied extracts have a fungal effect against the treated fungi. (Zineb Abbad *et.al.*, 2023)

According to, Farzana A.N. (2014), the antifungal activity of ethanol and acetone extract of leaves of nine medicinal plants: *Piper betel*, *Lowsonia inermis*, *Psidium guajava*, *Carica papaya*, *Moringa oleifera*, *Mimosa pudica*, *Catharanthus roseus*, *Adhatoda vasica* and *Andrographis paniculata* against *Fusarium oxysporum* the causal agent of Fusarium wilt in tomato was assessed. All the extracts inhibited mycellial growth at various levels. Among them the superior inhibition (100%) was found in 15% concentration of ethanol extract of *Lowsonia inermis* and *Psidium guajava* against *Fusarium*. According to, Zaker and Mosallanejad, (2010), Pure methanol (m) and methanol water (mw) extracts of 5 plants namely: peppermint, eucalyptus, lavandula, Russian knapweed and datura were screened for their antifungal ability against *Alternaria alternata*, the causal agent of *Alternaria* leaf spot of potato at 5, 10 and 15% concentrations in vitro. methanol extracts of eucalyptus, peppermint and lavandula had impressive antifungal effects in inhibiting the mycelial growth as well as spore germination of the pathogen. The development of *A. solani* was also inhibited by approximately 30% when subjected to a concentration of 1000 μ L L⁻¹ citronella essential oil (Lucas, 2012). Citronella essential oil showed antifungal activity against *A. solani* and early blight control in tomato, which may due either to direct fungitoxic effect on the pathogen, inhibiting mycelial growth and sporulation. (2023). Antifungal activity of different concentrations (2, 4, 6, and 8% w/v) of leaf extracts of wheat (*Triticum aestivum* L) Maize (*Zea mays* L) Sunflower (*Helianthus annus* L) Chilies (*Capsicum annum*), Onion (*Allium cepa*), and Marogold (*Tagatus erectus* L) successfully inhibit corn rot disease of *Gladiolus* caused by *Fusarium oxysporum* (Tariq, 2008).

Conclusion:

Early late blight of Tomato caused by *Alternaria solani*, is get managed with the help of eight leaf extracts (*Capparis brevispina* D.C., *Capparis tomentosa* Lam., *Capparis zeylanica*, *Capparis rigida*, *Capparis grandis*, *Capparis decidua*, *Capparis divaricate*, and *Capparis sepiaria*). *Capparis zeylanica* and *Capparis grandis* was found very efficient at 10% concentration of leaf extracts (15.33 and 16.66) respectively. In 10 % concentration of *Capparis zeylenica*, 2.33 conidia per microscopic field was found and 7456.00, conidia of *Fusarium solani* was found at per ml suspension, this is the lowest count, Highest number of PCE was also observed in the same concentration and leaf extract. Rather than toxic chemical

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