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Management of powdery mildew (*Erisiphe polygoni*) disease in green gram by botanicals

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Abstract

Green gram is one of the important pulse crop cultivated in India an area of 2.5 million hectare in India, with a production of about 0.8 million tonnes. It is commonly known as Grain legumes is rich in protein content (18-31%) and play an important role in human and animal nutrition. In green gram, considerable losses in the production occur as a result of powdery mildew disease. Green gram powdery mildew caused by *Erisiphe polygoni* is the most serious foliar disease causing considerable economic losses. In the present study different plant extracts including weeds were evaluated under in vitro study their efficacy in inhibiting the conidial growth of *Erisiphe polygoni* by spore germination assay. The result showed that among the 31 plant extracts *Allium sativum*(10%) significantly inhibited the conidial germination of *Erisiphe polygoni* followed by *Prosopis juliflora*(10%) and *Trianthimum portulacastrum* (10%) which accounted of 93.90, 92.39 and 91.23 per cent respectively. The treatments proved effective under *in vitro* studies were tested under pot culture condition for managing the disease. The experiment revealed that, among the botanicals *A. sativum* (10%) significantly reduced the disease incidence of powdery mildew with recorded (60.90 %) followed by *P.juliflora* and *T. portulacastrum* (10%) which recorded 58.95 and 54.93 per cent reduction over control.

Key words: green gram, powdery mildew, *Erisiphe polygoni*, plant extracts, *A. sativum*

Introduction

India is the major pulses growing country of the world accounting roughly one third of the total area and one fourth of the total production (Pandy and Singh, 2001). Among the pulses, green gram (*Vigna radiata* L.) is an important crop in *Vigna* group with advantage of its cultivation in all three seasons. *i.e*., kharif, Rabi and spring seasons. Green gram is cultivated in an area of 2.5 million hectare in India, with a production of about 0.8 million tonnes.

The major states producing this pulse are Madhya Pradesh, Maharastra, Uttar Pradesh, Punjab, Andhra Pradesh, Karnataka and Tamilnadu. In Tamil Nadu, green gram is cultivated in a area of 1.27 million hectare with a production of about 6.15 million tonnes (SCRT, 2001-2002). Plant pathogens play an important role and pose challenges on the increased production of pulses, among which the fungi form the most important group of pathogens affecting pulse crops (Pal, 1998).

In green gram, considerable losses in the production occur as a result of powdery mildew (*Eryisphe polygoni)*, anthracnose (*Colletotrichum lindemuthianum)*, rust (*Uromyces appendiculatus)*, bacterial blight (*Xanthomonas phaseoli)*, leaf crinckle and yellow mosaic virus. Among these, powdery mildew is a serious problem in all the areas having rice based cropping systems of the country (Abbaiah, 1993). It occurs almost every year causing considerable yield loss due to reduction in photosynthetic activity and physiological changes (Legapsi *et al.*, 1978).

Increased use of potentially hazardous agro chemicals in the agro ecosystem has drawn the attention of the international community. Indiscriminate use of fungicides is not only harmful to human beings but adversely affect the microbial population present in the ecosystem. Hence use of botanicals is recommended. Plants possess some substances in their parts like leaves and bulb which are toxic to many fungi causing plant diseases. It is an effective, economical and ecofriendly method of disease management.

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Materials and Methods

Efficacy of plant extracts against powdery mildew *in vitro*. Preparation of plant extracts were according to method of Shekhawat, (1971).

The efficiency of extracts of 31 plant species listed in table below were tested against the conidial germination of *E. polygoni*.

Sl.No.	Part	Plant species used
1.	Leaf	*Ludwigia perennis, Tridax procumbens, Convolvulus arvensis, Rhynchosia minima, Phyllanthus niruri, Trianthema portulacastrum, Amaranthus spinosus, Elepohantopus scaber, Calotropis gigantea, Corchorus capsularis, Acalipha indica, Alternanthera sessilis, Tephrosia spinosa, Privalepto stachya, Sida spinosa, Echinocoloa crusgalli, Boerhaavia erecta, Logasca mollis, Clitoria terrnata, Parthenium hysterophorus, Pongamia glabra, Azadirachta indica, Lantana camera, Cynodon dactylon, Cenchrus sp, Datura stramonium, Prosopis juliflora*
2.	Flower	*Catharanthus roseus, Nerium oleander, Bougainvillea glabra*
3.	Bulb	Allium sativum

Cold water extract

Fresh plant materials were used for extraction. The materials were first washed with distilled water and finally with sterile water, ground in a pestle and mortar by adding sterile water at the rate of 1:1 (w/v). The macerate was squeezed using cotton wool to get the extract. The extract was strained through two layers of muslin cloth and finally through what man No. 1 filters paper. This formed the standard plant extract solution (100 %). This was further diluted either with the medium (or) sterile distilled water (v/v) to have the required concentration.

***Spore germination test* (Montgomery and Moore, 1938)**

The spore suspension (10^6 conidia / ml) was prepared using sterile distilled water. One drop of cold water extract of the botanicals at concentrations of 2, 5, 7, 10 per cent was placed on the cavity slides separately and allowed to evaporate. A drop of spore suspension was placed over the dried extract and incubated in a moist chamber in the laboratory. Spore germination test in distilled water served as control. Two replications were maintained for each treatment. The per cent spore germination was recorded and expressed as per cent inhibition over control (Vincent, 1927).

$$I = \frac{C - T}{C} \times 100$$

I = Per cent inhibition of spore germination
C = Spore germination in control
T = Spore germination in treatment

Evaluation of plant extracts at different concentration for the management of green gram powdery mildew – pot culture

The plant extracts which proved effective under laboratory condition in inhibiting the conidial germination were selected. Extracts were prepared from bulb of *Allium sativum*, fresh leaves of *Trianthema portulacastrum, Prosopis juliflora*, flower of *Bougainvillea glabra* and *Catharanthus roseus* by washing with tap water followed by sterile water and crushed in sterile distilled water at the rate of one gram tissue in one ml water (1:1 w/v) and filtered with double layer of cheese cloth. This formed the standard plant extract solution (100 %).

Seeds of green gram variety CO5 were sown in pots containing garden soil and sand in a 3:1 ratio. The plants were inoculated with spore suspension (10^6 conidia /ml) on healthy leaves after 30 days of sowing. The plant extracts were diluted with sterile distilled water in the required concentrations ie., 2, 5, 7 and 10 per cent and sprayed on plants separately when symptoms appeared. The experiment was in completely randomized design with three replications. The second spray was given after 10 days of the first spray. Carbendazim 0.1 per cent was also sprayed in one of the treatments. The pot containing inoculated plants without the treatmental spray were kept as control. Observations on disease intensity were recorded after the treatmental spray

at 10 days interval by examining 100 leaves from each treatment at random in 0-9 scale. The per cent disease index was calculated by using modified Mckinney's (1923) formula.

Statistical analysis

The data was statistically analysed (Gomez and Gomez, 1984). Pot culture and laboratory studies were laid in completely randomized design (CRD). The field trials were laid on a randomized block design (RBD). The percentage values were transformed into "Arcsine". The package used for analysis was IRRISTAT version 92-9 developed by International Rice Research Institute Biometrics unit.

Results and Discussion

Effect of plant extracts on the conidial germination of E. polygoni - in vitro

Preliminary screening of 31 plant extracts (prepared in cold water) against *E. polygoni* was conducted. Among the 31 plant extracts, the bulb extract of *Allium sativum*, leaf extracts of *Prosopis juliflora*, *Trianthema portulacastrum* and flower extracts of *Bougainvillea glabra* (1g/ml) showed maximum inhibition of spore germination of *E. polygoni* to an extent of more than 90 per cent. The bulb extract of *A. sativum* and leaf extracts of *P. juliflora* and *T. portulacastrum* significantly inhibited the spore germination of *E. polygoni* respectively recording 93.90, 92.39 and 91.23 per cent.

The flower extracts of *B. glabra*. (90.16%) *Nerium oleander* (89.86%) and *Catharanthus roseus* (88.11%) were the next effective treatments. The leaf extracts from *Cenchrus* sp exhibited the least inhibition of conidial germination of 4.30 per cent. The effect of the carbendazim (94.87%) was on par with the garlic clove extract in inhibiting the conidial germination (Table-1).

In general all the plant extracts tested had some antifungal principle which inhibited the conidial germination of *E. polygoni* when compared with the control (98.71%).

Table- 1: Effect of plant extracts on the conidial germination of *E. polygoni*

Sl.No.	Plant species (w/v)*	*Per cent spore germination	*Per cent reduction over control
1.	Ludwigia perennis	35.14 (36.35)^{o}	64.40^{h} (53.36)
2.	*Tridax procumbens*	48.10 (43.91)^{ijk}	51.26^{lm} (45.72)
3.	*Convolvulus arvensis*	77.70 (61.82)^{d}	21.27^{s} (27.45)
4.	*Rhynchosia minima*	52.80 (46.60)^{h}	46.57^{n} (43.03)
5.	*Phyllanthus niruri*	72.55 (58.40)^{e}	26.50^{q} (30.98)
6.	*Trianthema portulacastrum*	8.26 (16.70)^{vw}	91.23^{bc} (72.78)
7.	*Amaranthus spinosus*	15.77 (23.37)^{r}	84.03^{e} (66.47)
8.	*Elepohantopus scaber*	34.80 (36.15)^{o}	64.73^{h} (53.57)
9.	*Calotropis gigantea*	49.10 (44.48)^{ij}	49.52^{m} (44.72)
10.	*Corchorus capsularis*	35.13 (36.34)^{o}	64.40^{h} (53.37)
11.	*Acalipha indica*	29.30 (32.76)^{p}	70.31^{g} (56.98)
12.	*Alternanthera sessilis*	47.57 (43.57)^{il}	51.86^{klm} (46.06)

13.	*Tephrosia spinosa*	18.50 (25.46)^{q}	81.24^{f} (64.34)
14.	*Privalepto stachya*	13.32 (21.40)^{s}	86.49d (68.44)
15.	*Sida spinosa*	67.30 (55.12)^{f}	31.82^{p} (34.33)
16.	*Echinocoloa crusgalli*	91.11 (72.31)^{c}	7.68^{t} (16.00)
17.	*Boerhaavia erecta*	75.43 (60.31)^{d}	23.59^{r} (29.04)
18.	*Logasca mollis*	56.65 (48.79)^{g}	42.66^{o} (40.77)
19.	*Clitoria terrnata*	46.65 (43.07)^{jkl}	52.72^{kl} (46.56)
20.	*Parthenium hysterophorus*	44.70 (41.95)^{lm}	54.73^{gk} (47.72)
21.	*Pongamia glabra*	45.10 (42.18)^{dlm}	54.31^{jk} (47.47)
22.	Azadirachta indica	41.50 (40.10)^{n}	57.94^{i} (49.50)
23.	Lantana camera	50.36 (45.20)^{hi}	48.98^{mn} (44.41)
24.	Cynodon dactylon	42.61 (40.74)^{mn}	56.81^{ij} (48.91)
25.	Cenchrus sp	94.46 (76.41)^{b}	4.30^{u} (11.96)
26.	Datura stramonium L.	12.75 (20.92)^{s}	87.08^{d} (68.93)
27.	Prosopis juliflora	7.51 (15.88)w	92.39^{b} (74.00)
28.	Catharanthus roseus	9.71 (18.15)^{uv}	88.11^{d} (69.84)
29.	Nerium oleander L.	10.00 (18.42)t^{u}	89.86^{c} (71.44)
30.	Bougainvillea glabra	11.72 (20.00)^{s}t	90.169^{c} (71.71)
31.	Allium sativum	6.01 (14.15)^{x}	93.90^{a} (75.73)
32.	Carbendazim (0.1%)	5.06 (12.96)^{x}	94.87^{a} (76.94)
33.	Distilled water (control)	98.71 (83.87)^{a}	-

* Mean of three replications: Data in parentheses indicate arcsine transformed values
In a column, means followed by a common letter (s) are not significantly different at 5% level by DMRT
* 1 g of leaf / flower / bulb in 1 ml of distilled water

Effect of plant extracts at different concentrations on conidial germination of *Erysiphe polygoni - in vitro.*

The efficacy of plants extracts inhibiting the conidial germination of *E. polygoni* at different concentration were tested. The data in Table 2 showed that the bulb extract of *A. sativum* significantly reduced the conidial germination (4.17%) of the *E.polygoni* at 10 per cent concentration. As the concentration of the bulb extract of *A. sativum* increased, the conidial germination was reduced. The next best plant extract was *P. juliflora* followed by *T.*

portulacastrum, which recorded 92.59 and 79.58 per cent reduction respectively at the same concentration.

Evaluation of selected plant extracts against powdery mildew of greengram under pot culture condition.

A pot culture experiment was conducted with the effective plant extracts (10%) viz., *P. juliflora*, *A. sativum*, *T. portulacastrum*, *B. glabra* and *C. roseus* and a test fungicide carbendazim 0.1% to find out its efficacy against powdery mildew pathogen (*E. polygoni*). Incidence of powdery mildew was recorded at 45 DAS and 55 DAS and the results are presented in Table 3.

Among the six treatments, two foliar applications of *A. sativum* clove extract (10%) on 35th and 45th days after sowing significantly reduced the disease incidence from 68.28 per cent (control) to 26.30 per cent and it was on par with *P. juliflora* which recorded 28.01 per cent on 55 DAS. *A. sativum* and *P. juliflora* respectively recorded 60.90 and 58.95 per cent disease reduction over control. This was followed by *T. ortulacastrum* which recorded 54.93 per cent reduction over control. Among all the treatments, the fungicide carbendazim (0.1%) was significantly superior in reducing the disease incidence from 68.28 (control) to 13.52 per cent

Table- 2: Effect of plant extracts at different concentrations on conidial germination of *E. polygoni*

Treatments	*Per cent conidial germination				*Per cent reduction over control			
	Concentration (%)				Concentration (%)			
	2	5	7	10	2	5	7	10
T_1 – *C. roseus*	73.67 (59.13)^{b}	61.79 (51.82)^{b}	58.36 (49.81)^{b}	52.36 (46.35)^{b}	25.34 (30.22)^{e}	37.37 (37.68)^{e}	40.86 (39.73)^{e}	46.96 (43.25)^{e}
T_2 – *A.. sativum*	47.15 (43.36)^{f}	30.45 (33.49)^{f}	13.74 (21.76)^{f}	4.17 (11.79)^{f}	52.21 (46.26)^{a}	69.55 (56.51)^{a}	86.76 (68.66)^{a}	95.17 (78.13)^{a}
T_3 – *T. portulacastrum*	65.16 (53.82)^{d}	44.13 (41.63)^{d}	28.36 (32.18)^{d}	20.57 (26.97)^{d}	33.98 (36.65)^{c}	55.27 (48.02)^{c}	71.26 (57.58)^{c}	79.58 (63.13)^{c}
T_4 – *P. juliflora*	54.74 (47.72)^{e}	38.58 (38.40)^{e}	17.40 (24.65)^{e}	7.33 (15.71)^{e}	44.98 (41.86)^{b}	60.67 (50.81)^{b}	82.58 (65.33)^{b}	92.59 (74.20)^{b}
T_5 – *B. glabra*	70.59 (57.16)^{b}	59.30 (50.36)^{b}	52.83 (46.62)^{c}	46.29 (42.87)^{c}	29.80 (33.08)^{d}	40.00 (39.23)^{d}	46.45 (42.96)^{d}	53.08 (46.76)^{d}
T_6 – Distilled water (Control)	98.68 (83.41)^{a}	98.69 (83.41)^{a}	98.68 (83.41)^{a}	98.69 (83.41)^{a}	-	-	-	-

* Mean of three replications
Data in parentheses indicate arcsine transformed values
In a column, means followed by a common letter (s) are not significantly different at 5% level by DMRT

Effect of plant extracts on disease management

The *in-vitro* studies with 31 plant extracts revealed that the bulb extract of *A. sativum* (10%), leaf extracts of *P. juliflora* (10%) and *T. portulacastrum* (10%) and flower extracts of *B. glabra* (10%) *N. olender* and *C. roseus* (10%) proved effective in inhibiting the conidial germination of *E. polygoni*. The effective plant extracts were tested against powdery mildew disease under pot culture and field conditions.

Table -3: Evaluation of selected plant extracts against powdery mildew of green gram under pot culture conditions

Treatments (two sprays)	*45 DAS		*55 DAS	
	PDI	Per cent reduction over control	PDI	Per cent reduction over control
T_1 - *P. juliflora* (10%)	22.07 (28.02)^{d}	62.15 (52.03)^{b}	28.01 (31.95)^{e}	58.95 (50.15)^{b}
T_2 - *A. sativum* (10%)	20.50 (26.91)^{d}	64.83 (53.63)^{b}	26.30 (30.85)^{e}	60.90 (51.29)^{b}
T_3 - *T. portulacastrum* (10%)	24.49 (29.66)^{c}	58.00 (49.63)^{c}	30.10 (33.21)^{d}	54.93 (47.83)^{c}
T_4 - *B. glabra* (10%)	26.81 (31.18)^{b}	54.01 (47.30)^{d}	32.71 (34.88)^{c}	52.37 (43.36)^{c}
T_5 - *C. roseus* (10%)	27.14 (31.38)^{d}	53.41 (49.95)^{d}	35.00 (36.26)^{b}	48.70 (44.25)^{d}
T_6 - Carbendazim (0.1%)	11.17 (19.52)^{e}	80.03 (64.03)^{a}	13.52 (21.56)^{f}	80.17 (63.57)^{a}
T_7 - Unsprayed (Control)	58.32 (49.78)^{a}	-	68.28 (55.72)^{a}	-

* Mean of three replications
Data in parentheses indicate arcsine transformed values
In a column, means followed by a common letter (s) are not significantly different at 5% level by DMRT;
PDI = Per cent disease index

It was found that *A. sativum* (10%), *P. juliflora* (10%) and *T. portulacastrum* (10%) were most effective against powdery mildew of green gram and also increased the yield. Singh and Singh (1983) tested the efficacy of various plant extracts and oils against *E. polygoni* and reported that the conidial germination was considerably reduced in all the extracts and oils at 100 ppm. Neem and garlic oils proved highly effective against the conidial germination.

Foliar spray thrice at 15 days after sowing at 50 per cent flowering and 15 days later with the neem oil at 3 per cent or neem seed kernel extract at 5 per cent significantly reduced the powdery mildew of black gram (*V. mungo* L.) caused by *E. polygoni* (Mariappan *et al*., 1988).

Singh and Singh (1983) observed reduction in powdery mildew of pea when sprayed with neem and garlic oil at 2 per cent concentration. Raguchander (1997) reported that neem oil (3 per cent) effectively reduced the disease incidence in blackgram. The extracts of *Azadirachta indica*, *A. cepa*, *A. sativum* and *Z. officinale* were found highly effective against powdery mildew of pea (Sindhan *et al.*, 1998). Rettinassababady *et al.*, (2000) reported that three neem products (neem seed kernel, neem oil and neem cake), leaf extracts of prosopis (*P. juliflora*) and *Ipornea cornea* were effective against *E. polygoni* of blackgram. Singh *et al.* (1990) observed the 'ajoene' a compound derived from garlic (*A. sativum*) inhibited the spore germination of several fungi viz., *Alternaria solani*, *A. tenuissima*, *A. triticina*, *Aspergillus sp.*, *Colletotrichum sp.*, *Fusarium lini*, *F. oxysporum f. sp. semitectum* and *F. udum* which causes various diseases on crop plants.

The root extracts of *P. juliflora* completely inhibited the spore germination of *Drechslera*

rostrata and *Curvularia lunata*. (Charya *et al.* 1979). Sumathi (1996) stated that the antifungal protein from leaf extracts of *T. portulacastrum* inhibited the toxin production of *A. alternata*. Bhowmick and Vardham (1981) reported that extracts of *C. roseus* was successful in inhibiting the spore germination of *C. lunata. Pythium monospermum* was inhibited by the leaf extract of *Bougain villea glabra* (Alice, 1984).Bhore *et al.* (1995) stated that extracts from *A. sativum*, *Callestermon lanceolatus*, *Emblica officinalis* and *Punica granatum* were effective against *Aspergillus flavus* and *C. lunata* causing collar rot of peanut and leaf spot of sunflower respectively.

The sulphur containing compounds like allicin, allyl propyl disulphide, diallyl disulphide etc in *A. sativum* may be responsible for the antifungal activity. (Alice, 1984). The difference in inhibitory activity of extracts may be due to variation in composition of antifungal compounds in different plants (Shetty *et al.*, 1989). The plants having the antifungal principles can be isolated and they may be produced commercially for the management of powdery mildew disease which will be less hazardous and ecofriendly.

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