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Original Research Article

Aqueous Plant Extracts for Organic Management of Early and Late Leaf Spots in Groundnut (*Arachis hypogaea* L.)

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A B S T R A C T

Early and late leaf spot diseases in groundnut are causing major crop loss as high as 70%. An approach of integrated disease management is advocated for its management. Many researchers have discussed application of biocontrol agents which are highly efficient to give sustainable control to the disease. Less discussed measures are the use of plant extracts for the leaf spots management. The plant extracts of garlic clove (*Allium sativum*), lantana leaves (*Lantana camara*), Bougainvillea leaves (*Bougainvillea spectabilis*), onion bulbs (*Allium cepa*), calotropis leaves (*Calotropis procera*) were tested along with groundnut and neem cake and *Trichoderma harzianum* as different treatments in the field experiment. The aqueous extracts of these plant products were tested by seed treatment and two sprays at the appearance of disease. It was observed that seed treatment and two sprays with 10% aqueous extract of *A. sativum* recorded the lowest early leaf spot and late leaf spot disease severity (23.5% and 5.3%) and reduced early leaf spot disease by 52.2% and late leaf spot by 68.6% as compared with control. The treatment with aqueous extract of *A. sativum* was found to improve yield and was also remunerative.

Keywords

Extracts, groundnut, Leaf spots, Cercospora arachidicola, Phaeoisariopsis personata

Introduction

Groundnut (*Arachis hypogaea* L.) belongs to the family Fabaceae, is an important annual legume crop in many tropical and sub-tropical countries of the world. The two fungi commonly responsible for leaf spot diseases are *Cercospora arachidicola* Hori, causing Early leaf spot and *Phaeoisariopsis personata* (Berk. & Curt.) v. Arx causing late leaf spot. The leaf spots damage the plant by reducing available photosynthetic area, by lesion formation, and by stimulating leaflet abscission (McDonald *et al.*, 1985). The early and late leaf spots occur either alone or together in the same field.

Leaf spots symptoms occur at 30-36 days after sowing and increase in intensity up to harvest time. The losses due to leaf spots are threefold: reduced pod yield, lowered quality of groundnut and fallen leaves though provide organic matter but inoculum of the other fungus develops on it (Hasan *et al.*, 2014) and thereby increase cost of production (Brennemen and Culbreath 2000). The loss in pod yield due to the disease was recorded as 70% in groundnut (Subramanyam 1980). Antagonistic fungi (Mane *et al.*, 2012, Jambhulkar *et al.*, 2016), bacteria and botanicals (Adiver 2004,

Kishore and Pande 2005) have broad spectrum antifungal activity against leaf spots and stem and root rot diseases of groundnut. It was previously reported that different plant extract found to inhibit the conidial germination of *C. arachidicola* and *P. personata* (Alam *et al.,* 2002, Hossain and Hossain 2013).

With the increase in awareness among consumers about toxic hazards of chemicals to the crop the importance of non-chemical methods of disease control has been emphasised. The use of plant extracts with antifungal activity offers an economical, safe and easily available alternative method for management of leaf spot diseases in groundnut (Adiver 2004, Hasan *et al.*, 2014). At the same time Trichoderma formulations are reported to be effective in controlling seed, soil and air-borne diseases of the crops (Jambhulkar *et al.,* 2016). In the present study we are evaluating comparative efficacy of plant extracts and *Trichoderma harzianum* Th3 against leaf spot diseases of groundnut.

Materials and Methods

The experiment was carried out at Borwat Research farm, Agricultural Research Station, Banswara, Maharana Pratap University of Agriculture and Technology, Udaipur, during Kharif seasons of 2012, 2013 and 2014. The cultivar selected for this study was GG-2 because it is more susceptible to leaf spot diseases. The experimental field containing a clay loam soil (N 80 Kg $ha^{-1,}$ P 15 Kg ha^{-1}, K 290 Kg ha^{-1}, organic carbon 0.75%,EC 0.25dSm^{-1}, pH 7.6). The experimental field was prepared by adding farm yard manure (FYM) 5t/ha and gypsum @ 175 Kg ha^{-1}. The design of the experiment was randomised block design with three replications of each treatment. The experimental treatments include seed treatment and two sprays of aqueous extract of T1- garlic clove (*Allium sativum*)@ 10% (w/v), T2- lantana leaves (*Lantana camara*) @ 10% (w/v), T3- *T. harzianum* @ 6g/kg seeds, T4- Bougainvillea leaves (*Bougainvillea spectabilis*) @ 10 % (w/v), T5- onion bulbs (*Allium cepa*) @ 10% (w/v), T6- Neem cake (5q/ha) + two sprays with NSKE at 4ml/lit water, T7- calotropis leaves (*Calotropis procera*) @ 10% (w/v), T8- Groundnut cake (5 q/ha) + NSKE and T9- Untreated control.

Aqueous plant extracts were prepared by grinding fresh plant parts in a mortar pestle and requisite quantity of water was added and the content was filtered through double layered muslin cloth to prepare the concentrated extract. Other treatments include *Trichoderma harzianum* Th3 @ 10g/kg seeds and two sprays @10g/lit water, soil application of neem and groundnut cake 500kg $ha^{-1}$and untreated control.

The each plot size was of 3x3 m^2. Seed to seed and row to row distance was 15cm and 30 cm respectively. Half of the total urea and the entire amount of phosphorus and potash were applied at the time of final land preparation. The other half of the urea was applied to the field as top dressing 60 days after sowing. Data recording of number of pods/plant, pod yield per plant, shelling %, pod yield per hectare were done at harvest of crop. The economics of different application against leaf spot diseases was also worked out. The data obtained for different characters were analysed to find out the significant difference among treatments. Disease severity was recorded starting from 30 DAS and it was rated as per disease rating scale (1-9) given by Subrahmanyam *et al.,* 1995 and determined as PDI (Percent Disease Index) by using formula given below.

$$\% \text{ Percent Disease index (PDI)} = \frac{\text{Sum of total rating}}{\text{Total number of observations x Highest grade in the scale}} \times 100$$

Results and Discussion

All the treatments significantly ($P<0.05$) reduced the severity of *Cercospora arachidicola* and *Phaeoisariopsis personata* on groundnut crop. The untreated control of *C. arachidicola* showed % disease severity score of 6-8 on a 9 point scale given by Subrahmanyam *et al.,* 1995. While untreated control of *P. personata* recorded % disease severity score of 4 on a 9 point scale. The aqueous extract of *A. sativum* recorded the lowest disease severity of 23.5% and reduced early leaf spot disease by 52.2% as compared with control. The lowest late leaf spot disease severity of 5.3% was recorded for treatment with aqueous extract of *A. sativum* which reduced disease severity by 68.6% as compared with control. The next best treatment for management of Cercospora leaf spots was aqueous extract of lantana which recorded % disease severity of 27.9% and it was at par with treatment of *Trichoderma harzianum* (28.5%). These treatment reduced Cercospora leaf spot disease by 43.3% and 42.1% respectively. Interestingly the second most effective treatment for management of late leaf spots *P. personata* was application of *T. harzianum* which recorded disease severity of 5.9% and reduced disease by 65.1% as compared with control.

The leaf extract (10%) of L. camara was also found effective to reduce early leaf spot disease severity which reduced disease severity by 43.3% as compared with control. While the bioagents *T. harzianum* Th3 was found significantly effective to reduce late leaf spot disease by 65.1% as compared with control (Table 1).

It was observed that there was increase in disease severity in the experimental year 2014 then the year 2013 and it became stable during 2015. It may be due to increase in inoculum load from first year to second year of experiment and the control measures did not allow to multiply the inoculum to make it stable in the subsequent year. The treatment with aqueous extract of *A. sativum* reported to produce maximum pod yield (25.9q/ha) (fig 2). The maximum yield from this treatment was due to maximum number of pods per plant (32.7) and maximum pod yield per plant (68.75g) (fig. 1). The economics of the cultivation of groundnut with the application of various plant products and T. harzianum was evaluated to find out the most remunerative and most effective treatment for management of leaf spot diseases. It was reported that the treatment with *A. sativum* 10% was found to be most remunerative and it gave Benefit: Cost ratio of 3.2. It was the only treatment which was found economic with the highest return of Rs. 101100.00. The other treatments were not economic and fetch less returns than untreated control. Thus it can be concluded from the present findings that the leaf spot diseases of groundnut can economically be controlled by seed treatment and spraying with 10% aqueous extract of *A. sativum* at 10 and 20 days after first emergence of disease.

The aqueous plant extract from different plant material having proven medicinal properties are being used among the traditional and tribal peoples since time immemorial. The logic behind this practice is to utilise proven efficacy of bioactive compounds possessing antimicrobial properties present in plant parts. Many researchers reported about use of plant extract prepared from fresh plant materials but as many are used to dry the plant parts before using for extraction.

Description of leaf spot rating scale (1-9) Subrahmanyam *et al.*, 1995

Leaf spot score	Description	Disease severity (%)
1	No disease	0
2	Lesion largely on lower leaves; no defoliation	1-5
3	Lesion largely on lower leaves; no defoliation; very few lesion of middle leaves; defoliation of some leaflets evident on lower leaves	6-10
4	Lesion on lower and middle leaves, but severe on lower leaves; defoliation of some leaflets evident on lower leaves	11-20
5	Lesions on all lower and middle leaves; over 50% defoliation of lower leaves	21-30
6	Lesions severe on lower and middle leaves; lesion on top of leaves but less severe; extensive defoliation of lower leaves; defoliation of some leaflets evident on middle leaves	31-40
7	Lesions on all leaves but less severe on top leaves; defoliation of all lower and some middle leaves	41-60
8	Defoliation of al lower and middle leaves; lesion severe on top leaves and some defoliation of top leaves evident	61-80
9	Defoliation of almost all leaves leaving bare stems; some leaflets may be present, but with severe leaf spots	80-100

Table.1 Effect of various different plant extracts and bioagents against early leaf spot and late leaf spot of groundnut

Treatments	PDI Early leaf spot					PDI Late leaf spot				
	2012	2013	2014	Pooled PDI	% ROC	2012	2013	2014	Pooled PDI	% ROC
Allium sativum	11.7 (19.95)	30.4 (33.1)	28.7 (32.4)	23.5 (29.0)	52.2	0	4.9 (12.8)	5.7 (12.6)	5.3 (13.3)	68.6
Lantana camara	20.0 (26.52)	33.5 (35.3)	30.2 (33.3)	27.9 (31.9)	43.3	0	9.6 (18.05)	10.4 (21.5)	10.0 (18.4)	40.8
T. harzianum	16.7 (24.12)	35.4 (36.5)	33.5 (35.4)	28.5 (32.3)	42.1	0	6.2 (14.4)	5.5 (14.2)	5.9 (14.0)	65.1
B. spectabilis	16.7 (24.03)	51.4 (45.8)	48.5 (44.1)	38.9 (38.6)	20.9	0	13.6 (21.6)	11.7 (21.3)	12.7 (20.8)	24.8
Allium cepa	13.3 (21.40)	52.1 (46.2)	48.7 (44.3)	38.0 (38.1)	22.8	0	9.9 (18.3)	8.6 (17.7)	9.3 (17.7)	45.0
Neem cake + NSKE	17.7 (24.9)	40.5 (39.4)	39.4 (38.9)	32.5 (34.8)	33.9	0	12.3 (20.5)	10.5 (20.5)	11.4 (19.7)	32.5
C. procera	25.0 (29.92)	43.9 (41.4)	43.5 (41.3)	37.5 (37.7)	23.8	0	14.0 (23.6)	11.7 (20.0)	12.9 (21.0)	23.7
Gr.nut cake+ NSKE	26.7 (31.00)	48.1 (43.9)	46.1 (42.8)	40.3 (39.4)	18.1	0	11.1 (19.4)^{abc}	10.8 (19.3)	11.0 (19.3)	34.9
Control	31.7 (34.22)	61.4 (51.6)	54.6 (47.6)	49.2 (44.6)	-	0	16.3 (23.8)	17.5 (25.4)	16.9 (24.3)	-
CV CD (0.05)	15.41 2.52	9.87 3.64	12.31 2.64	12.4 2.58		0	18.1 2.13	13.1 3.13	15.8 2.66	

Table.2 Economics of different organic farming treatments against leaf spot diseases Groundnut

Treatment	Treatment cost/ ha	Total cost of cultivation /ha	Gross return (Rs./ha)	Net Return / ha (Rs./ha)	B:C Ratio
Allium sativum	6200	31200	132300	101100	3.2
Lantana camara	4300	29300	106050	76750	2.6
T. harzianum	6300	31300	124250	92950	3.0
B. spectabilis	4300	29300	94500	65200	2.2
Allium cepa	6200	31200	89250	58050	1.9
Neem cake + NSKE	7250	32250	105000	72750	2.3
C. procera	4300	29300	86800	57500	2.0
Gr.nut cake+ NSKE	7200	32200	85400	53200	1.7
Control	0	25000	73850	73850	3.0

Fig.1 Effect of treatment with different organic plant extract and bioagents on pod yield/plant and no. of pods per plant

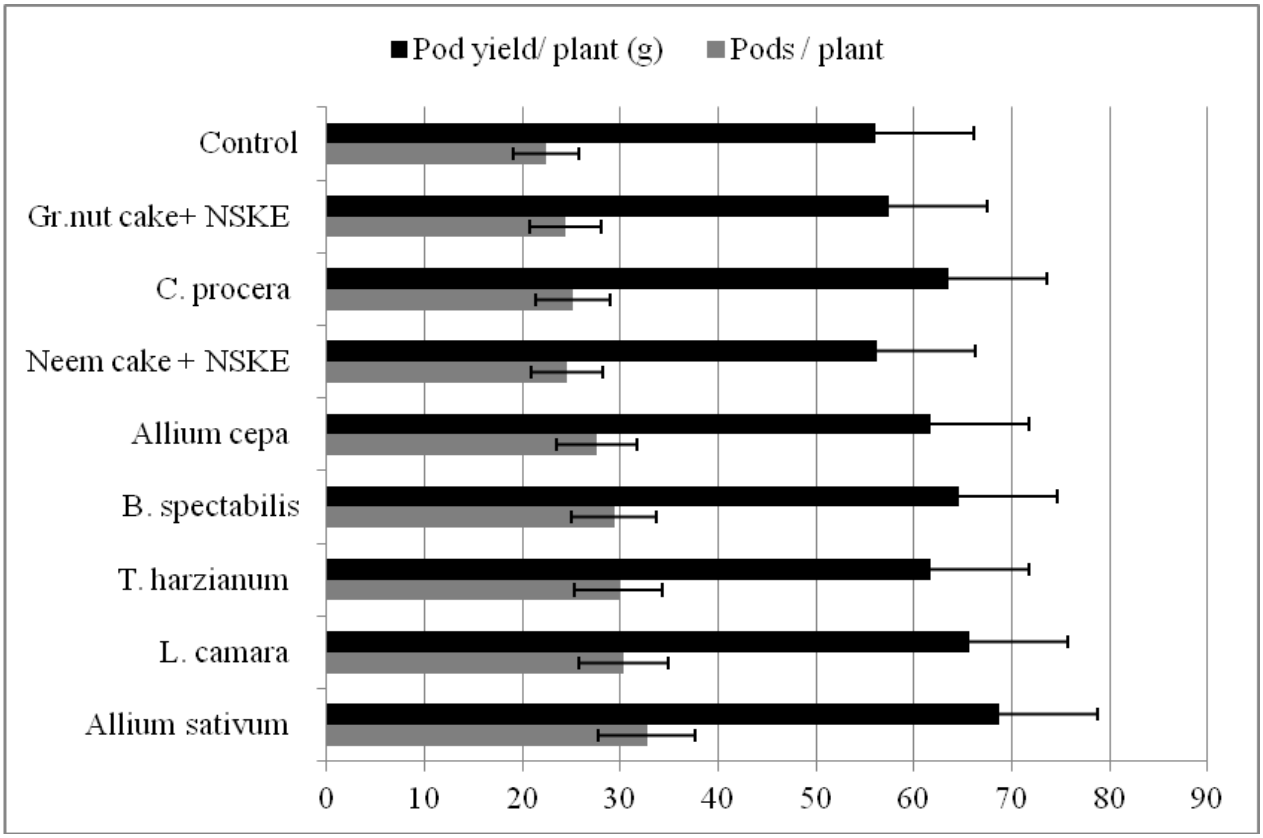
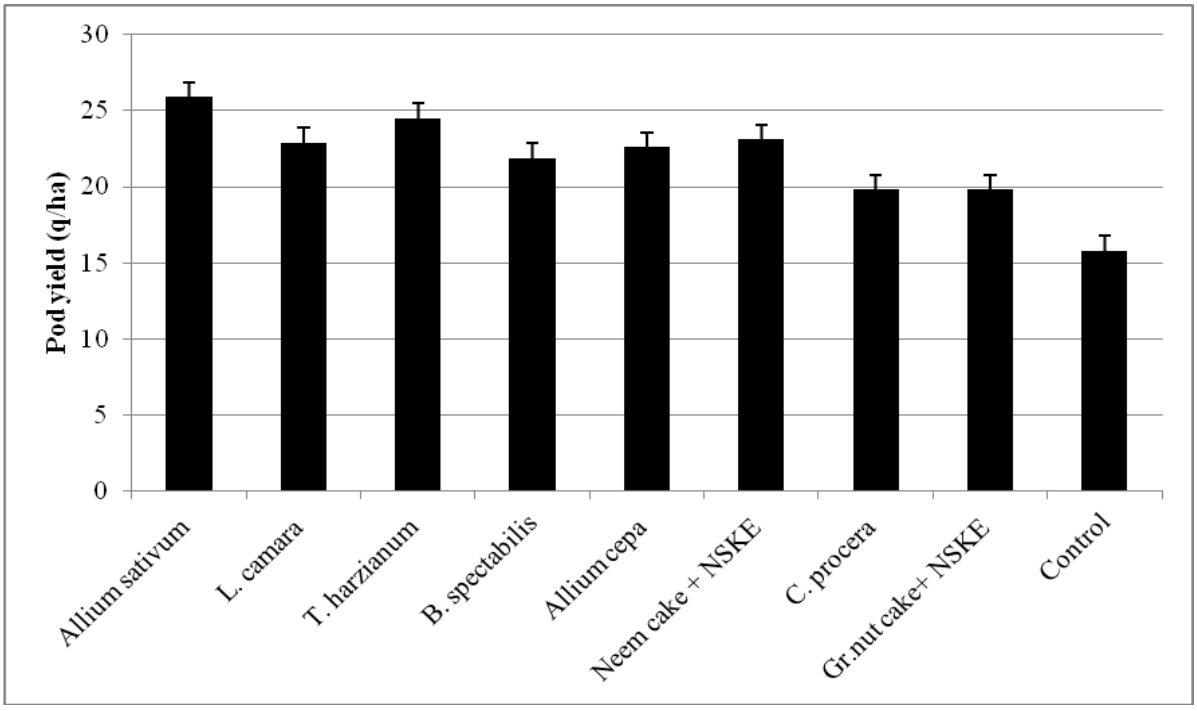
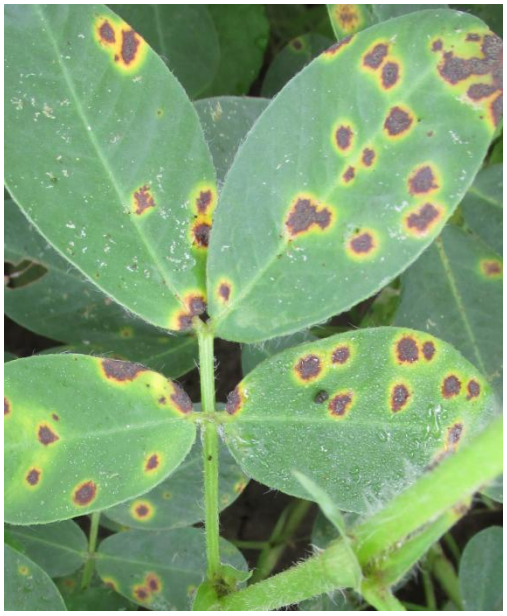
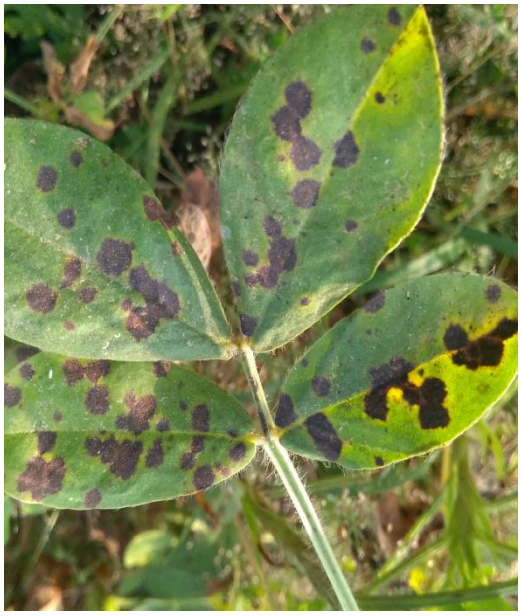


Fig.2 Effect of treatment with different organic plant extract and bioagents on pod yield





A. Early leaf spot



B. Late leaf spot

This may be due to differences in water content within different plant tissue, plants are usually dried and to a constant weight before extraction. Some even dry plant parts at 40°C for 72h. In the present study the plant materials used include garlic clove (*A. sativum*), *L. camara* leaves, bougainvillea (*B. spectabilis*) leaves, onion bulb (*A. cepa*), Calotropis (*C. procera*) leaves. Experiment also includes neem and groundnut cake and *T. harzianum* as treatments. The results of the experiment showed that there was

reduction in disease severity of *C. arachidicola* and *P. personata* as compared with untreated control. This confirms the antifungal efficacy of these plant parts. In Burkina Faso, an in vitro study proved that the plant extracts are effective against *C. arachidicola* and *P. personata* (Koita *et al.*, 2010; Koita *et al.*, 2012). In the present the aqueous extract of *A. sativum* (10%) reduced % disease severity of early leaf spot by 52.2% and late leaf spots by 68.6% as compared with control. It was noted that the leaf extract of *L. camara* was found effective to reduce disease severity of early leaf spot disease but was found in effective to reduce late leaf spot disease so effectively. Study showed that treatment with T. harzianum Th3 significantly manages late leaf spot disease. It may be due to capacity of *T.harzianum* Th3 to induce Induced Systemic Resistance (ISR) which develops resistance against the pathogen. It was found at par with the treatment with Propiconazole (0.1%) and Difenconazole (0.1%) which was reported to reduce leaf spots diseases by 65.21% and 66.93% respectively (Sunkad *et al.*, 2005). Treatment with aqueous extract of native plants species at Burkina Faso, *Lippia multiflora*, and *Ziziphus mucronata* were found very effective to increase pod yield, and reduced disease severity (Koita *et al.*, 2017). Therefore, it shows that use of fungicides is not the only alternative for effective management of leaf spots diseases in groundnut. The natural products as plant extracts have potential as environmentally safe alternative and valuable component of integrated pest management (Goussous *et al.*, 2010). Our results are in accordance with the findings that have demonstrated the antifungal efficacy of A. sativum extracts in vitro and in vivo (Islam *et al.*, 2001; Masum *et al.*, 2009; Okigbo *et al.*, 2009; Ruhul *et al.*, 2009; Rukhsana *et al.*, 2010; Perello *et al.*, 2013)

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