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Evaluation of Botanicals to Manage Leaf Spots (*Passalora arachidicola* and *Passalora personatum*) of Groundnut (*Arachis hypogaea L.*) in Zoba Hamelmalo Region of Eritrea

Syed Danish Yaseen Naqvi, Adiam Fitsum, Yohannes Habte, Nardos Ghirmatsion, Luna Rezene, G. Sethumadhava Rao

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ABSTRACT

Groundnut (*Arachis hypogaea* L.) is grown globally and it is affected by many widespread diseases and infestations in all the groundnut growing areas. In Eritrea, leaf spot diseases are prevalent that is caused by fungi (*Passalora arachidicola* and *P. personata*) and results great losses. Botanical pesticides play an important role to control fungal infections due to their non-phytotoxic and eco-friendly nature. This study intended to evaluate the efficacy of selected botanicals *viz*., Neem (*Azadirachta indica)*, Melia (*Melia azadirach)*, Lantana (*Lantana camara)*, Datura (*Datura metel)* and Marigold (*Tagetes patula)* on plant height, intensity of leaf spots disease and yield of groundnut in Hamelmalo zoba, Eritrea, during 2017-2018. Extract of neem leaves (5.66, 14.10 and 25.38%) showed high significance in plant height after 20, 40 and 60 days, respectively, as compared to untreated control (21.07%) and mancozeb (treated control). The lowest disease intensity was recorded in the application of neem extract (15%w/v) at different days after sowing. However, mancozeb (2 g/liter) was the most effective and followed by Neem > *Melia* > *Lantana* showed improvement in plant growth and maximum reduction in disease intensity. The highest reduction rate in 'disease incidence' and 'disease severity' was found in Neem extract application (63.11 and 40.29) after mancozeb (56.52 and 36.18) at 95 DAS at 5% significant level. Among the botanicals, plants treated with Neem extract was observed with highest number of pods (89.45) and yield (98.10 q/ha) followed by *Melia* (5% w/v) *i.e*. 87.59 and 95.02 respectively.

Key words: Botanicals, Disease incidence and severity, Groundnut, Leaf spots, Yield.

INTRODUCTION

One of the important oil crops, groundnut (*Arachis hypogaea* L.) is grown in many tropical and sub-tropical regions of the world (Wudiri and Fatoba, 1992) and it is popular and universal crop cultivated in over 100 countries in six continents but mainly Asia, Africa and America. It has become a common edible diet due to its seed contains high quality edible oil (48%), easily digestible protein (26-28%) and carbohydrate (20%) including cystine and unsaturated fats such as oleic and linolic acids. It is locally called *phool,* a soil restorative crop and though it can grow better on sandy loam, it is raised on all types of soils, such as sandy, sandy loam and black soils. According to Alam *et al*., 1988, this crop contain *Rhizobium* bacteria laden root nodules and they fix about 80-160 kg N/ha per season. In Eritrea, groundnut is widely grown in Zoba Anseba and some parts of Debub and Gash-barka regions under rain fed conditions. The average productivity is about 900kg per hectare which is poor when compared with other groundnut producing countries in the world close to 3500 kg per hectare (Sibhatu *et al.*, 2008). This could be due to so many reasons such as erratic and uneven distribution of rainfall, low soil fertility, lack of improved cultivars and good quality of seeds, poor agronomic practice, insect pest and diseases.

Diseases are one of the important factors contributing to low yield. More than 70 diseases have been reported from this crop due to fungi (*Passalora* leaf spot, rust, blight, scab and powdery mildew), bacteria (bacterial wilt, bacterial leaf spot), virus (peanut mottle, peanut yellow spot, witches broom and groundnut streak necrosis) and nematode (root-knot, root-lesion, peanut chlorosis *etc*.) (Lukose *et al*., 2008). The damages caused by the diseases are defoliation, reduction in pod and haulm yield and quality of seeds and increasing cost of production (Brennemen and Culbreath, 2000). One of the prevalent diseases on Groundnut is Leaf spot (Tikka disease) in groundnut growing areas of Eritrea. Early leafspot is caused by *Passalora arachidicola* which develops small necrotic flecks that usually have light to dark-brown centers and a yellow halo. Late leafspot is caused by *Passalora personata* (Berk and Curt) which rise as small

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necrotic flecks that enlarge and become light to dark brown. Various control strategies such as botanical pesticides have been proposed as a replacement of chemical control against these diseases (Harman, 2000). Constituents of botanical extracts from higher plants have been noticed to be non-phytotoxic, easily biodegradable, more systemic and stimulating to host metabolism, in contrast to many synthetic pesticides (Dixit *et al*. 2000; Rasooli and Razzaghi 2004 and Bakkali *et al*. 2005). Hence, this study aimed to evaluate the efficacy of plant extract against *Passalora* leaf spot of groundnut; its comparative effect with mancozeb fungicide upon on plant height and yield under natural field conditions.

MATERIALS AND METHODS

Study area

The experiment was conducted in the fields of Hamelmalo Agricultural College (HAC), Eritrea which swathe an average temperature of 36°C, annual rainfall of 400mmand its altitude is 1328 meter above sea level (Sibhatu *et al.*, 2008). HAC located in Hamelmalo sub-zoba with latitude of 15°52′18″N and longitude of 38°27′ 55″ E.

Experimental layout

The experiment was laid out following randomized complete block design with three replication maintaining 3.0m × 4.0m plot with 1m irrigation channel and 0.5m between plots. The total gross and cultivated areas were 341m^2 and 252m^2, respectively. The Sowing seed (local variety *Valentia*) was done with seed rate of 16 kg/ha; by adopting seed to seed and line to line 30 and 40 cm and 2-3 cm deep (Fig 1). Irrigation was given to the crop as required and manual weeding was done according to its need.

Collection of plant materials and plant extracts preparation

Plant leaves of neem (*Azadirachta indica)*, melia (*Melia azadirach)*, lantana (*Lantana camara)*, Datura (*Datura metel)* and marigold (*Tagetes patula)* collected from premises of Hamelmalo Agricultural College and extracts were prepared from their fresh leaves. These plants were selected because they are associated with pest management and disease control practices in several parts of Africa (Choi *et al*., 2004). Extracts from different parts of neem tree contain terpenoids, desactylimbin, quercetin and sitosterol (Schaff *et al*., 2000 and Siddiqui *et al*., 2000). The leaves of *Lantana* yields 0.069% of citral essential oil, 0.053% of aterpinene, 6% of pymene and 43% of sesquiterpenes (Lachoria *et al.*, 2004 and Kausik *et al*., 2002). According to Ugwu *et al.,* (2017), the collected leaf samples of 50 grams of *Azadirachta indica* were washed and weighed into conical flask. The small cut pieces were ground in a mortar and pestle then the prepared mixtures 200 ml of extractant (water, ethanol and methanol) were added and left to extract at room temperature (Fig 2). The extracts were kept in sterilized brown bottles before use (Table 1).

Data collection and analysis

Data were recorded on appeared diseases, insect pests, grown weeds, plant height (cm) against treatments, incidence and severity of leaf spot, number of pods per plant and yield quintal per hectare.

Data collection for plant height

Plant height of five randomly selected plants per plot were recorded at 20, 40, 60 days after sowing. The plant height was measured from ground level up to the tip of the leaves using measuring scale.

Data collection for disease incidence

Incidence was estimated by taking seven plants per plot and ten leaf samples per plant then determined the overall score according to the number of plants. The following formula was used in determining the incidence of infections:

$$\text{Disease incidence} = \frac{\text{Diseased leaves}}{\text{Total leaf samples}} \times 100$$

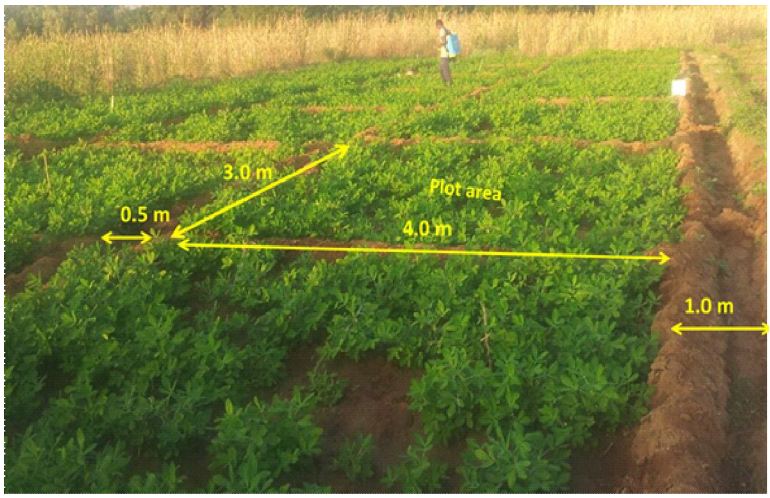

Fig 1: Layout of plots in HAC field.

Data collection for disease severity

Disease severity was recorded according to Davis *et al*. (1993). Mean percent severity was calculated by the following formula:

$$\text{Disease severity (\%)} = \{[B/ (A \times 9)] \times 100\}$$

Where,
B= Total disease rating.
A= Total number of samples.
9= Maximum grade.

According to Mayee and Datar (1986), the *Passalora* Leaf Spot (PLS) disease rating was given as per 0-9 scale in which the point scale is (1, 3, 5, 7 and 9) and the corresponding infected per cent area is (0.5 to <1); (1 to 5); (6 to 20); (21 to 50) and (>50) against the point scale (Fig 3).

Table 1: Plant extracts as treatments and their concentration.

Treatments	Plant extract	Concentration
T1	*Melia azadirach*	5% w/v
T2	*Azadirachta indica*	15% w/v
T3	*Lantana camara*	20% w/v
T4	*Datura metel*	20% w/v
T5	*Tagetes patula*	10% w/v
T6	Fungicide (Mancozeb)	80% wp
T7	Plain water	-

Data collection for number of pods and yield

At the time of harvesting the plants from each plot were carefully uprooted after 120 days and allowing no loss of pods. The plants from each treatment were collected and dried separately in sun for two to three days.

Number of pods per plant and yield (kg/ha) was assessed on the plants selected from $1m^2$ by $1m^2$ section of each plot. Number of pods was counted for each plant selected from the plot in the 1 by $1m^2$ sector and number of pods per plant was recorded. The total yield in each plot selected and weighed from the respective section in kg/m^2 was converted to q/ha and recorded.

RESULTS AND DISCUSSION

Seed germination

Eighty five percent seeds were germinated and gap-fillings were done immediately.

Diseases observed in the field

Phyllosticta leaf spot caused by *Phyllosticta arachidis hypogaea;* Alternaria leaf blight (*Alternaria alternate*), Early leaf spot (*Passalora arachidicola* Hori) and Late leaf spot (*Passalora personatum* (Berk. and Curt.) v. Arx,) [until recently *Phaeoisariopsis personata* was known as *Cercosporidium personatum*] diseases (Fig 4 and 5) were found during the study period and were identified as per the manual of 'Field Diagnosis of Groundnut Diseases'.

Fig 2: Preparation of plant extracts.

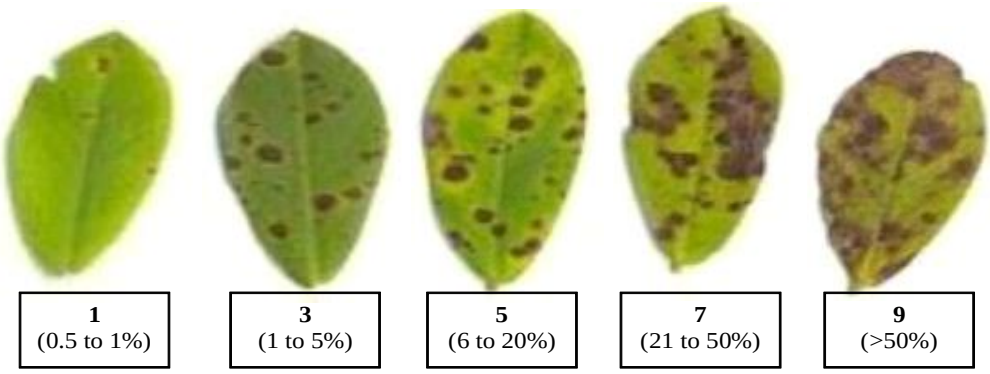

Fig 3: Infected per cent areas of leaves of groundnut as per the rating scale (1 to 9).

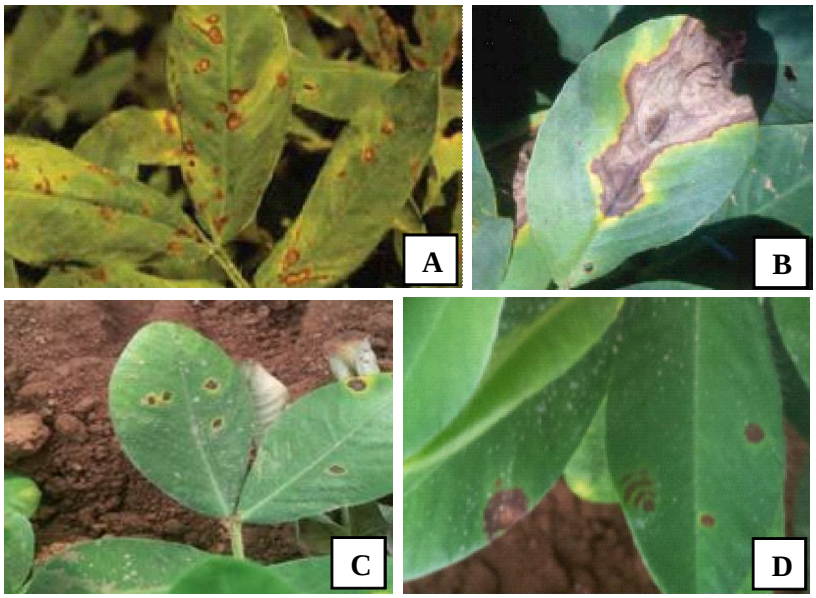

Fig 4: *Phyllosticta* leaf spot (A); *Alternaria* leaf blight (B); Early leaf spot (C) and Late leaf spot (D) diseases caused by fungi.

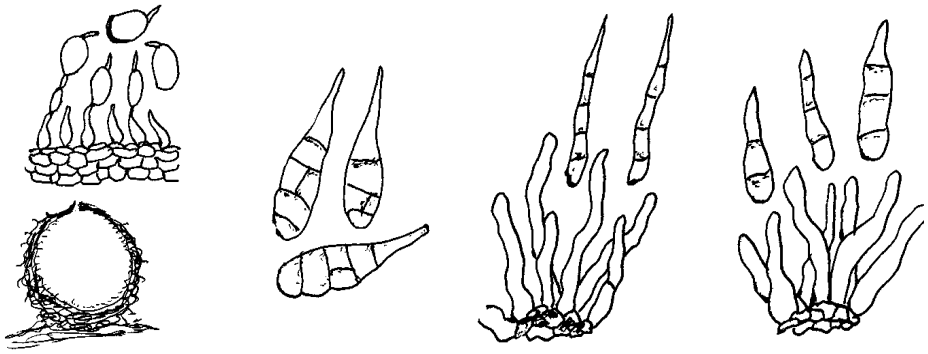

Fig 5: Conidia of *Phyllosticta arachidis; Alternaria alternate*, *Passalora arachidicola* and *Passalora personatum* (drawn as observe under the microscope).

Table 2: Insect pest and weeds recorded during filed trial.

Type of insects	Type of weeds	Type of other pest
Aphid: *Aphis cracivora* (Aphididae: Hemiptera)	*Cyanodon dactylon*	Squirrel
White fly: *Bemisia tabaci (*Aleyrodidae: Hemiptera)	*Hellitropium indicum*	Digging animal
Jassids: *Empoasca binotata* (Cicadellidae: Hemiptera)	*Cyperus rotundus*	
Leaf miner: (*Chromatomyia horticola:* Agromyzidae: Diptera)	*Cyanodon dactylon*	
Grasshopper: *Oxya velox (*Acrididae: Orthoptera)		

Insect pests, weeds and other pests

Different types of insect pests, weeds and animals were noticed throughout the crop growth (Table 2). Uniform application of carbaryl (insecticide) was applied to the field.

Plant height at 20, 40 and 60 days after sowing

Plant height in centimeters was recorded at 20, 40 and 60 days after sowing (DAS). The plant height at 20 and 40 days after sowing showed no significant among them. Application of treatments was not yet begun at 20 days after sowing and had no effect at 40 days after sowing (Table 3).

Plant height affected by different treatments at 60 DAS

Extract of *Azadirachta indica* (25.38) after mancozeb, showed high significance in plant height as compared to untreated control (21.07); followed by *Melia azadirach* (24.82) and *Lantana camara* (23.48). They showed no significance when compared with mancozeb (27.18). *Datura metel* (22.74) and *Tagetes patula* (21.94) showed no significance as compared to untreated control (Table 3). It is clearly stated that the height of plants and yield weight decreased due to the infection by *Passalora* leaf spot. According to McDonald *et al*., 1985, defoliation, reduction in number of pods and haulm yield and deterioration of

Table 3: Effect of treatments on groundnut plant height at 20, 40, 60 days after sowing.

Treatments	Height (in cm) of plant days after sowing (DAS)		
	20 DAS	40 DAS	60 DAS
T1 *Melia azadirach*	5.53	15.38	24.82
T2 *Lantana camara*	5.33	15.12	23.48
T3 *Tagetes patula*	6.03	15.33	21.94
T4 *Datura metel*	5.43	14.90	22.74
T5 *Azadirachta indica*	5.66	14.10	25.38
T6 Mancozeb (Fungicide)	5.30	14.80	27.18
T7 Plain water	5.20	14.90	21.07
L.S.D at 5%	NS	NS	2.46

quality of seeds are most common symptom of *Passalora* leaf spot.

Effect of plant extracts on disease incidence and disease severity

Efficacy of botanical extracts on disease intensity of leaf spot of groundnut at 35 DAS

The observation of leaf spot disease incidence percentage ranged from 2.21 to 5.25% under different treatments including control. The lowest incidence was recorded by *Azadirachta indica* (2.52) whereas highest incidence was recorded by *Tagetes patula* (4.31) and *Datura metel* (4.25) compared to treated and untreated control. The percentage of disease severity ranged from 2.22 to 5.24 under different treatments including control. The lowest severity was recorded by *Azadirachta indica* (3.18) and the highest severity was noticed by *Tagetes patula* (4.56) and *Datura metel* (4.32) (Table 4).

Efficacy of botanical extracts on disease intensity of leaf spot of groundnut at 50 DAS

The highest reduction in parentage of disease incidence was achieved with mancozeb (24.18) followed by *Azadirachta indica* (27.05), *Melia azadirach* (27.86) and *Lantana camara* (28.52). Their efficacy to reduce the parameter was significant compared to untreated control (48.06). The lowest reduction in this parameter was recorded when groundnut plant was sprayed with extracts of *Tagetes patula* (45.31) and *Datura metel* (44.56). The highest reduction in disease severity (%) was achieved with *Azadirachta indica* (9.93) after mancozeb (6.50). Their efficacy to reduce the parameter was significant compared to treated and untreated control (6.50 and 21.17, respectively). On the other side, the lowest reduction in this parameter was recorded with extracts of *Tagetes patula* (17.05) and *Datura metel* (16.03).

Efficacy of botanical extracts on disease intensity of leaf spot of groundnut at 65 DAS

Following mancozeb, *Azadirachta indica* performed 35.85% of disease incidence followed by *Melia azadirach* whereas, *Lantana camara* showed (37.94%) as compared to control. *Datura metel* and *Tagetes patula* showed high disease development (57.43% and 59.38% respectively) as compared to treated and untreated control. The percentage of disease severity reduction with *Azadirachta indica* performed best against rest of the botanicals that showed (19.97%) disease development followed by *Melia azadirach* 20.05% as compared to treated and untreated control 15.59 and 36.77, respectively. The efficacy of plant extracts of *Datura metel* and *Tagetes metel* showed high disease development (32.29 and 32.96) respectively.

Efficacy of botanical extracts on disease intensity of leaf spot of groundnut at 80 DAS

The plant extract of *Azadirachta indica* (47.85) was the most effective related to untreated control in disease incidence. *Melia azadirach* (49.21) performed the second best botanical in the experiment as compared to treated and untreated control (42.27 and 81.31, respectively). *Lantana camara* (77.27) was the least effective as compared to *Azadirachta indica* and *Melia azadirach*. However, *Datura metel* (77.05) and *Tagetes patula* (78.32) showed high disease incidence compared to treated and untreated control. Reduction in the percentage of disease severity with mancozeb (25.02) was the most effective one followed by *Azadirachta indica* (28.97). However, *Tagetes patula* (46.32) followed by *Datura metel* (45.59) and *Lantana camara* (43.32) showed high disease severity compared to treated and untreated control.

Table 4: Effect of selected treatments on percentages of disease incidence and severity at different days after sowing.

Treatments	Disease incidence (%)					Disease severity (%)				
	35 DAS*	50 DAS	65 DAS	80 DAS	95 DAS	35 DAS	50 DAS	65 DAS	80 DAS	95 DAS
T1 *Melia azadirach*	3.12	27.86	37.21	49.21	64.47	3.37	11.41	20.05	29.85	41.91
T2 *Azadirachta indica*	2.52	27.05	35.85	47.85	63.11	3.18	9.93	19.97	28.97	40.29
T3 *Lantana camara*	3.36	28.52	37.94	72.27	87.02	4.09	14.66	21.95	43.32	66.63
T4 *Datura metel*	4.25	44.56	57.43	77.05	87.88	4.32	16.03	32.29	45.59	65.15
T5 *Tagetes patula*	4.31	45.31	59.38	78.32	89.47	4.56	17.05	32.96	46.32	67.89
T6 Mancozeb	2.21	24.18	32.47	42.27	56.52	2.22	6.5	15.59	25.02	36.18
T7 Plain water	5.25	48.06	62.8	81.31	94.28	5.24	21.17	36.77	46.78	72.59
LSD at 5%	1.199	5.164	6.101	6.54	8.581	1.77	5.661	6.104	5.799	6.85

*Days after sowing.

Efficacy of botanical extracts on disease intensity of leaf spot of groundnut at 95 DAS

Maximum disease incidence (%) was obtained by *Tagetes patula* (89.47), followed by *Datura metel* (87.88) and *Lantana camara* (87.02) as compared to treated (56.52) and untreated (94.28) control. At the same time as, minimum disease incidence (63.11 and 64.47) was obtained when groundnut was sprayed with *Azadirachta indica* and *Melia azadirach* respectively. Maximum disease severity (%) was obtained by *Tagetes patula* (67.89), followed by *Datura metel* (65.15) and *Lantana camara* (66.63) as compared to treated (36.18) and untreated (72.59) control. While minimum disease severity (40.29 and 41.91) was obtained with *Azadirachta indica* and *Melia azadirach* respectively (Table 4).

The increased percentage of disease incidence and severity could be a reason for the reduction of height and yield weight of the crop. These results in conformity with Mirza (1998), that the increases in infestation play an important role for limiting the production and quality of groundnut. Despite the fact that, the present results showed, all the treatments were effective against *Passalora* leaf spot by enhancing the plant growth. However, as a matter of fact, mancozeb was most effective and followed by *Azadirachta indica*>*Melia azadirach*>*Lantana camara* showed improvement in plant growth and maximum reduction in disease intensity. The highest disease reduction was found in *Azadirachta indica* after mancozeb. The findings for disease intensity are in agreement with the findings of Mane (2012), Mushrif *et al*. (2017), Hossain and Hossain (2013b) and Muhammad and Bdliya (2011). In spite of this, our results do not correlate with the findings of Mapari and Sunil (2016) and Hasan *et al*. (2016) that *D. metel* showed better performance in their experiment.

Influence of plant extracts on number of pods and yield of groundnut (kg/ha)

Among the treatments, after mancozeb (98.6), *Azadirachta indica* (89.45) showed high significance as compared to untreated control (42.12), however, *Lantana camara* (72.55) showed slight significance compared to *Azadirachta indica* (89.45). *Azadirachta indica, Melia azadirach* showed no significance compared to mancozeb (98.6). *Datura metel* (64.17) and *Tagetes patula* (57.64) showed no significance compared to untreated control (42.12). The yield (q/ha) of *Azadirachta indica* (98.10) showed high significance as compared to untreated control (46.17) followed by *Melia azadirach* (95.02). *Lantana camara* (74.13) showed slight significance compared to *Azadirachta indica* and *Melia azadirach* and they showed no significance when compared with mancozeb (110.51). At the same time as *Datura metel* (64.97) and *Tagetes patula* (59.25) showed no significance compared to untreated control (46.17). These results were in compare with Hasan *et al*. (2016) (Fig 6).

The study findings indicated that among the leaf extracts, *Azadirachta indica* achieved maximum in disease reduction and yield production as compared to control. The results of this present study showed that maximum disease development in control (T7) plants where no treatment was provided. Among the botanicals *Azadirachta indica* was observed to have highest number of pods and yield followed by *Melia azadirach*. Similar results were obtained by Mane (2012) and Hossain and Hossain (2013a). The use of botanicals with antifungal activity offers an economic, safe and easily available alternative method for the management of leaf spot of groundnut. It is worth mentioning that the use of plant material for diseases control is one among the possible strategies for inclusion in an integrated pest management program. The botanicals comprise potential for control of plant fungal diseases with non-phytotoxic compounds which are environment friendly. It is therefore, the plant extracts can be applied in many ways such as sprays, powders, drenches or diluents in irrigation waters. Based on the findings of the present study, it may be concluded that these botanicals or leaf extracts can successfully to be used for eco-friendly management of leaf spot disease of groundnut and to obtain higher yield by avoiding fungicidal chemical.

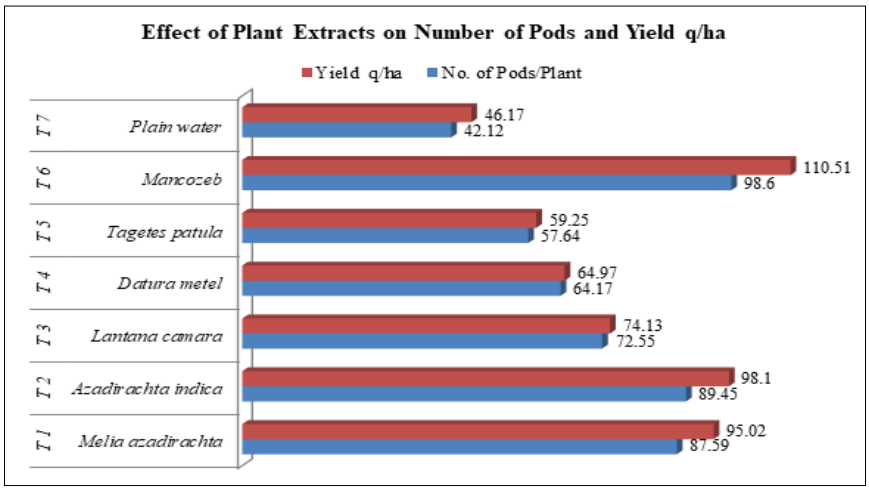

Fig 6: Effect of plant extracts on number of pods and yield (q/ha).

CONCLUSION

In Eritrea groundnut is common edible diet due to its high quality edible oil and is widely grown in Zoba Anseba, Debub and Gash-barka regions under rain fed conditions. About 70 diseases have been reported from this crop due to fungal, bacterial, viral and nematode infections. Experiments were conducted in the campus of Hamelmalo Agricultural College to identify the effect of botanicals in controlling these diseases. Plant leaves of neem (*Azadirachta indica)*, melia (*Melia azadirach)*, lantana (*Lantana camara)*, datura (*Datura metel)* and marigold (*Tagetes patula)* were used along with fungicides as treatments. Data were recorded on diseases, pests, weeds, plant height (cm) against treatments, incidence and severity, number of pods per plant and yield quintal per hectare. Phyllosticta leaf spot, Alternaria leaf blight, Early leaf spot and Late leaf spot diseases were found. Some aphids, whiteflies jassids and leaf miners and few weeds and other pests were also noticed. The height of plants and yield weight were decreased due to the infection by *Passalora* leaf spot. Among the botanicals, plants treated with Neem extract was observed with highest number of pods (89.45) and yield (98.10 q/ha) followed by *Melia azadirach.*

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Competing interests

Authors have declared that no competing interests exist.

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