Int.J.Curr.Microbiol.App.Sci (2019) *8*(8): 2906-2921

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 08 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.808.335

Efficacy of Selected Aqueous Plant Extracts, Fungicides and their Combinations against Disease and Pest Control on Tomato in Hamelmalo

Niat Yemane, Russom Kiflu, G. Yonatan Teklemariam, G. Sethumadhava Rao* and Y. Syed Danish

Department of Plant Protection, Hamelmalo Agricultural College, Keren, Eritrea

**Corresponding author*

Keywords

Balanites seed kernel extract, Disease incidence, *Lantana* flower extract, Pest infestation, Severity

Article Info

Accepted:
22 July 2019
Available Online:
10 August 2019

A B S T R A C T

The tomato (var. *sumberson)* is highly susceptible to diseases caused by microorganisms as well as pest infestations; as a result serious loss is caused thereof in the production of those crops. On the background of these facts, the research was focused on controlling the diseases through the selected treatments with the objectives of evaluating the efficacy of *Lantana camara* extract, *Balanites* extract and their combinations to assess on controlling the pest/disease incidence and severity in tomato field conducted in Hamelmalo Agricultural College. The experiment was conducted in RCBD with the treatments: *Lantana* flowerextract, foliar fungicide (Mancozeb), soil fungicide (Sulphur dust), *and Balanites* seed kernel extract, combinations of fungicides with *Lantana* extract and *Balanites* extract and Control. The insect pests i.e. Leafminer, Whitefly and African boll worms; two bacterial diseases: Bacterial rot and Bacterial speck; one fungus: Early blight and a viral disease were recorded in the field during the study period. Aqueous extract of *Balanites* seed kernel and Mancozeb, after treatment, also showed good control on both early blight and soft rots. There was a significant difference among all the treatments in every disease recorded in comparison to control. In the case of disease severity, the treatments of T1, T2 and T4 showed drastic decrease in the early blight whereas T6, T5 and T1 showed drastic reduction in soft rots on tomato. A drastic control of Leafminer was noticed by T2 and T6 from 18.4% to 7.5% and from 19.3% to 11.3% before and after treatments, respectively.

Introduction

Tomato (*Lycopersicon esculentum* Mill) belongs to Solanaceae and is the second most important vegetable crop next to potato. The estimated world production of tomato is about 89.8 million mt from an area of about 3,170,000 ha; the leading producers are China (with 25.3% of the total production), USA, Mexico and Egypt (Basheer, 2006). This nightshade family member is an important component in the diets of majority of Eritreans and alsoit serves as a cash crop for many farmers (Figure 1). High yields of tomato result in high incomes to farmers especially in areas such as Anseba, Gashbarka, and Asmara when it is cultivated on large scale particularly in the dry season. In Eritrea, the areas of high tomato production concentrations are in Hamelmalo, Keren, Elabred, Hagaz and ZobaMaekel. The tomato fruit has been found to have considerable health benefits (Asgedom *et al.,* 2011). In Eritrea, tomato is grown mostly under irrigation, and sometimes under rain fed conditions. Due its phenology, less investment and high demand in the market, farmers encouraged to grow tomato. Yet, the average yield of tomato in Eritrea has remained low, 15 Mt ha^{-1}, compared with 19Mt ha^{-1} on average in Africa, 23 Mt ha^{-1} on average in Asia and 27 Mt ha^{-1} on average worldwide (MoA, 2000). In most parts of Eritrea production of tomato is possible only twice a year like *Mai-ayni* (June - September in the highland) and *Forto-Sawa* (April - July in the lowland). Local farmers differentiated the tomato based on varietal characteristics as *San marzano* (angular) and as *Mar globe* (round). For a number of scientific reasons *San marzano* varieties are more preferable to *Mar globe* varieties (Asgedom *et al.,* 2011). Besides some institutional constraints, the farmers have also been facing, incidence and severity of diseases, pest infestations, and physiological disorders.

Diseases and Pests on Tomato in Eritrea and Other East African Nations

These diseases could cause yield losses of up to 10 to 15% (Agrios, 2005). Eritrean farmers indicated that insects like whiteflies and African boll worm (ABW) account for only 5% of the total yield loss. American ball worm was perceived to be the most serious insect pest among many tomato producers. Insects like leaf miner, leaf hopper and aphids also cause some damages but are considered to be less problematic (Asgedom *et al.,* 2011).

In East Africa the major insect pests of tomato include: leaf miners, white flies (those transmitting the tomato yellow leaf curl virus), tomato bugs, thrips (Tomato Spotted Wilt Virus), fruit worms, and spider mites. The major diseases of tomato prevalent in East African countries include: bacterial canker, speck, and spot, bacterial wilt, fusarium wilt, early blight, late blight, powdery mildew, root-knot-nematodes, viral diseases (tomato spotted wilt virus, tomato mosaic virus, tomato yellow leaf curl virus), blossom-end rot (Sithanantham, 2004). One of the investigations of Sethumadhava *et al.,* 2016 reveals that the most common diseases are infected by fungal, bacterial and viral that are transmitted by pests are found in all surveyed villages i.e. *Waznte*t, *Awrari*, *Genfelom*, *Basheri*and *Hamelmalo* in subzoba Hamelmalo. Early blight and late blight were the most common in all villages while the diseases caused by pests such as tomato borer and *Septoria* leaf spot rarely found. Powdery mildews were observed in both *Waznte*t and *Genfelom* villages.

Farmers use chemicals such as Afghan, Bylaton, Euparen and Daconil with the advice of the extension agents of the Ministry of Agriculture. However, the most farmers do not have a thorough understanding of disease types and their control measures. Though the synthetic, broad-spectrum fungicides and insecticides are a satisfactory solution for fungal and pest control; but the indiscriminate use of chemical applications is a threat to natural ecosystem, environment and human health. Plant extracts such as species of the neem tree, sweet flag, onion, garlic, custard apple, pyretrum, derris, common *Lantana*, holy basil, black pepper, and common ginger have been used for several centuries and were known in tribal or traditional cultures around the world (Weinzierl, 1998). These botanicals keep attracting and more attention given worldwide as they are considered as a suitable alternative to synthetic insecticides. Besides designation of currently inadequate botanical treatments which are efficient and somehow more effective as well as less expensive is bringing the Eritrean local farmers the challenges of facing low management practices in their tomato fields. Hence this research is being proposed to meet the objectives to calculate the disease incidence, severity and yield loss due to diseases; the percentage of pest infestation; evaluate the efficacy of extracts of *Lantana camera* and *Balanites aegyptica* as botanicals, pesticides and their combinations on control of diseases of tomato.

Major Insect Pests Recorded in Tomato Crop

The specific miner of tomato crop is called as *Loriomyza trifoli* which attacks usually on tomato leaf tissues and often on fruits and can cause tremendous economic losses in suitable conditions for immediate attack and multiplication (Byers, 2015). They are leaf-miners, whitefly [*Trialeurodes vaporariorum*–(Hemiptera)] (Flint, 2006), African boll worms (*Helicoverpa armigera*) are major pests of 25 wild host plants plus some major crops including tomato (Cherry *et al.,* 2003). All these pests can cause 14-16 percentage economic losses that may, however, vary in different seasonal periods and in particular geographical locations of Eritrea. These pests are playing interesting roles in disease development on a particular environmental condition by serving up a variety of disease causal agents the essential epidemiological needs and factorize their quantity of inoculum per an infection locus. Such insect pests are called vectors of diseases.

Materials and Methods

Experiment Site

The experiment was conducted in the fields of Hamelmalo Agricultural College (HAC) from the late winter season until early summer. Hamelmalo is located 13 km North of Kerenand the altitude of the area is about 1330 m above mean sea level (Fig. 2). The average rainfall and annual temperature of the area are 436 mm and 24°C respectively.

Experimental Design

The experiment was conducted in a randomized complete block design with two controls in the treatments (the untreated control and the standard control) in which the treatments are *Lantana camara* flower extract, fungicides (Mancozeb and sulphur Dust), combinations (‘*Lantana* flower extract 5% and Sulphur dust’, ‘Sulphur dust and Mancozeb’, ‘*Balanites* seed kernel extract 5% and Mancozeb’) and control. Response of the tomato variety to *Lantana* flower extract, *Balanites* seed kernel extract, fungicides, and their combinations of these treatment levels was studied. Each treatment was replicated three times in a total of 24 experimental plots. Each experimental plot consists of 4 rows of 5 tomato planted with a spacing of 30cm between each tomato plant in a row and with spacing of 75cm between the rows. The data was collected from the 3 randomly selected and tagged plants from each of the 24 plots. The tomato seedlings were watered at regular intervals of 5-7days until the emergence of flowers thereafter were watered at 3-4 regular intervals and will be stopped until few green fruits are remained on the field (Fig. 3).

Preparation of aqueous extract of *Lantana camara* flowers

The fresh plant material of *Lantana camara* Linn. (Family: Verbenaceae) was collected from the farm areas of HAC and carried in reusable plastic bag and was placed in a freezer to maintain its turgidity. The fresh flowers were detached from the tested plant materials and are subjected to fine powdered form. Hundred grams from the powdered flower samples was weighed and mixed in 1000ml distilled water. The solution was boiled, cooled until room temperature and filtered through the cheese cloth followed by filtration by Whatman No.1 filter paper. Then the filtrate was kept under normal room temperature and was sprayed on tomato plants on15-day interval for two months (Eweis and Amber, 2011).

Preparation of aqueous extract of *Balanites aegyptiaca* seed kernels

Five kilogram of dried seeds of *Balanites aegyptiaca* (Family: Zygophyllaceae) were collected from the surrounding of HAC. The seeds were smashed down and all the pulp ground by using pistil and grinder to a fine powder from which 500 grams were weighed, taken in different containers and mixed in 100ml distilled water to collect 5% extraction percentage of concentration. For about 24 hours the filtrate in the flask was allowed to remain in the laboratory at room temperature. At last stage of extraction the liquid filtrate in the two flasks was brought in one and kept under normal temperature and was sprayed on the tomato crop on 15-day interval for two months (Bishnu and Zeev, 2005) (Fig. 4).

Formulation and Application of Chemicals

Available fungicides (Mancozeb, Pungix, and sulphur dust) were formulated and applied at recommended dosage on the tomato crop.

Application of the plant extracts was in foliage area and was carried out until the end of this study with 7-days intervals. Foliar sprays were, generally, applied twice (7-day interval) using knap sack sprayer (Table 1).

Data Collection

Detailed assessment on incidence and severity of important diseases and pests infestations percentage on tomato in accordance to the primary objectives of the research was carried out on 72 randomly selected plants out of 24 plots in the HAC field. The observations were recorded on 7 days post-spray and 1 day pre-spray basis with regard to the most prevalent (fungal, bacterial, and viral) diseases and pests (insects) of tomato.

Observation for pest infestations

The pre-treatment observation were recorded at 1-day before spraying while the post treatment observations were recorded on the 1st day after each three spray at 7 days interval.

Leaf miner

Three plants per plot were selected at random and six leaves (two at upper, two at middle and two at lower) in every plant were observed for the phyto-extract and to calculate the percentage infestation by leaf miner, 18 leaves of three selected plants, were observed.

$$\left[\%Leaf\ infestation\ by\ leaf\ miner = \frac{No.\ of\ damage\ leaf\ observed}{Total\ No.\ of\ leaf\ observed} \times 100\right]$$

White fly

Three plants per plot were selected at random and the numbers of nymph and adult flies were counted in each plant.

Fruit borer

According to Rishikesh, 2013, the following data were assessed.

Larval population: The trial was observed on three randomly selected plants per plot. The number of larva as per fruit was physically recorded at pre-treatment and 7 days after treatment.

Percentage of damaged fruits: After each picking, the numbers of damaged and healthy fruits were recorded to calculate the damage percentage.

Percentage losses of fruit yield: Fruits of all the pickings were separated in to healthy and infested fruits to calculate the percentage weight losses.

$$\left[\% \; losses \; of \; fruit \; yield = \frac{Damaged \; fruits \; (wt.)}{Total \; fruits \; (wt.)} \times 100\right]$$

Observation for Diseases Incidence and Severity

Disease Incidence (DI) was assessed by the following formula:

$$\text{Percentage of disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \text{ X } 100$$

Disease Severity (DS) with the preformed disease index were recorded and calculated as following formula:

$$\text{Percent disease severity} = \frac{\text{Sum of all infected ratings}}{\text{Number of rating X Maximum rating scale}} \text{ X } 100$$

The disease severity was calculated by using 0-9 scale of Reifshneider *et al.*, (1984). Where Grade-0 means no conspicuous symptoms are observed and Grade-9 indicates all leaves and stems drying and dead due to disease (Table 2).

Data Analysis

All the data collected were subjected for statistical analysis of variance by using GENSTAT software package at 5% level of significance.

Results and Discussion

Among the observed diseases and infestations by pests, three were insect pests i.e. Leaf miner, White fly and Fruit borer; two were bacterial diseases i.e. Bacterial rot and Bacterial speck; one fungus i.e. Early blight and a viral disease caused by Tomato Leaf Curl Virus were recorded (Table 3).

The major insect pest, Leaf miner (*Loriomyza trifoli*) was noticed during the third week after plantation. The damage is caused by the apodous maggot which makes whitish zigzag infestation between epidermal layers of leaf which could be seen by holding the leaf against bright-light. White flies (*Bemisia tabaci*) were appeared on the fourth to fifth week after plantation and were observed sucking the cell sap from the lower surface of the leaves and transmit the leaf curl viruses which later become prevalent on the plant. Larvae of Fruit borer *(Helicoverpa armigera)* pest were observed feeding on tomato fruits by making holes. The pest infestation appeared after two months of plantation when the fruits were first seen. Bacterial speck disease caused by *Pseudomonas syringae* was recorded after first and during second month after plantation. The specks are very small and do not penetrate the fruits deeply and is first seen in the green fruits. Bacterial rot caused by *Ralstonia solanacearum* was observed wherever the insect pest infestations are recorded. Symptoms of Tomato Leaf Curl Virus which are transmitted by a whitefly appeared during the second month after plantation, the symptoms were upward curl of the leaves, dropping of flowers and stunting the plant. Early blight symptoms due to *Alternaria solani* were observed at the end of the first month; they were developed as dark concentric rings and encircled by yellow colour margins on the leaf surface (Fig. 5).

The results of efficacy of various treatments (T1= aqueous extract of *Lantana* flowers (LE); T2= aqueous extract of *Balanites* seed kernel (BSKE); T3= Fungicide for Soil borne fungus (SBF) T4= Fungicide Foliar Spray (FSF); T5= T1+T3; T6= T3+T4; T7 =T2+T4; T8= Control) on 'percentage of disease incidence' is given in table 4. The overall maximum disease incidence was observed in early blight at T8 (Control) 85.58% and the lowest disease incidence is observed in bacterial rot, caused by *Ralstonia solanacearum*, of T6 ('Sulphur dust and Mancozeb') which is 5.56%. In overall, after treatment, the increasing trend in disease incidence of early blight (*Alternaria solani*) was noticed in T8.The highest decreasing phenomenon of *Tomato Leaf Curl Virus* (TLCV) is observed in T2 (Aqueous extract of *Balanites* seed kernel 5%) from 72.22% to 68.67% which is so accounted for 3.55% decrease. The maximum disease incidence of bacterial speck is observed in T4 and very low is recorded in T6 as well as T3.

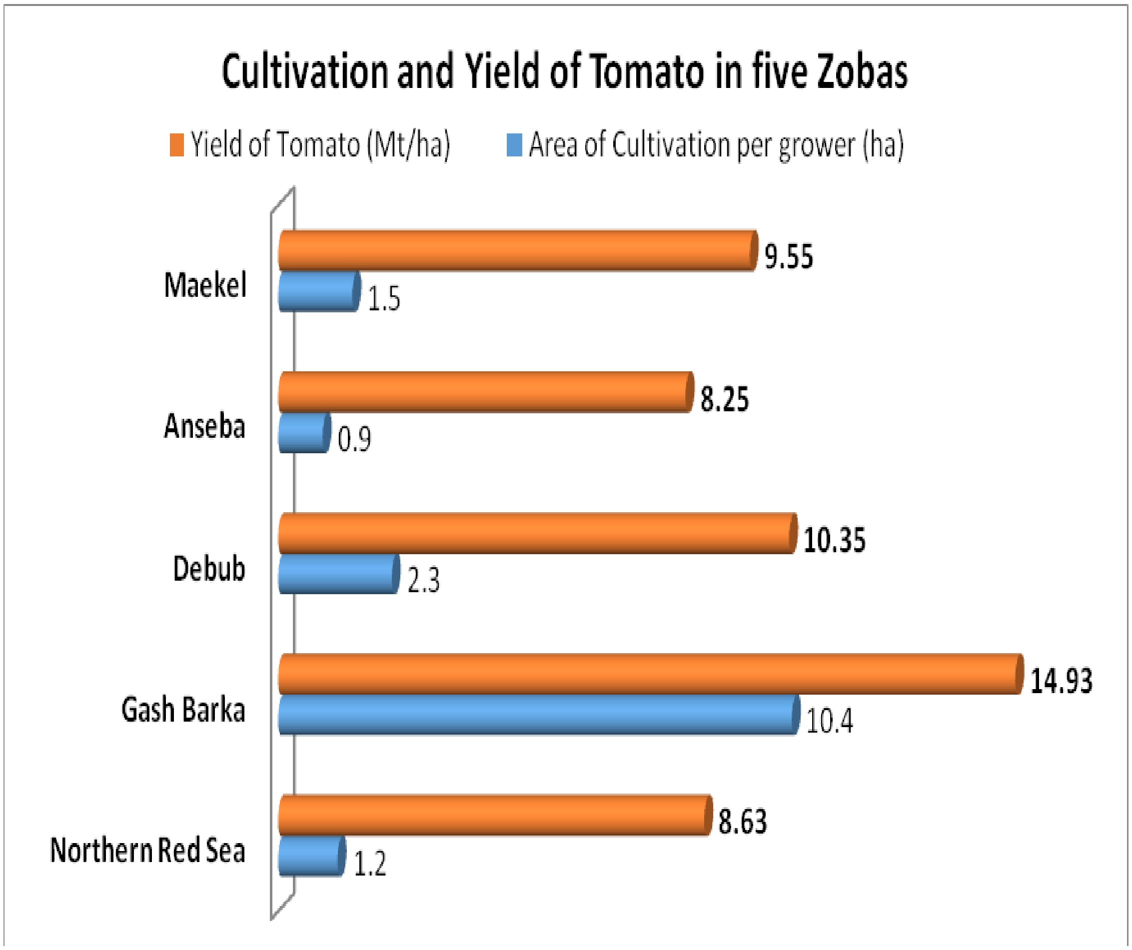
Maximum increase in bacterial rot incidence is seen in T8 and maximum decrease is recorded in T5. The T7, T5 and T3 showed relatively effective control over all diseases. T6 and T1 showed high effect on almost all diseases after treatment. It is supporting to the research done by Eweis *et al.,* 2011 that the antimycotic behavior of essential oil of flower of *Lantana camara* was effective on mycelial growth, conidia and/or sclerotia germination and had a significant inhibitory effect on the sclerotia/conidia in development and germination.

Effect of various treatments on 'percentage of disease severity' is presented in table 5. Early blight severity showed a maximum increase from 14.55% to 23.75% in T5 and from 7.78% to 11.3% in T8 and the highest reduction from 16.33% to 11.3% was observed in T2 (Aqueous extract of *Balanites* seed kernel 5%) among all other treatments. Hence it is conforming to the research done by Chapagain *et al.*, (2007) who reported that saponin rich extracts (4%) from *Balanites aegyptiaca* fruit mesocarp, showed 34.7% growth inhibition against *A. solani***.** The current results obtained were in supporting that, *Balanites* seed kernel extract also had antimicrobial activity against selected strains of Gram-positive bacteria, Gram-negative bacteria, and *Candida* (Ashaal *et al.,* 2010). The increased disease severity of bacterial rot from 3.55% to 5% was noted in T8 and maximum decrease was observed in T6 from 4.27% to 1.78%. The highest progress of disease severity was observed in early blight by T5 (before treatment 14.55% to after treatment 23.75%). T6 showed a significant difference when applied against bacterial speck and maximum decrease of bacterial speck severity was shown by T1 from 14.27% to 12.2% which is so accounted for 2.07% decrease. The highest disease severity among all other diseases was recorded in leaf curl viral disease of T8 (26.61%) and maximum decrease of leaf curl severity was noticed by T2 before treatment 14.83% and after treatment 12.22%.

In general, the maximum severity was observed in TLCV of T8 (26.61%) after treatment, and the lowest severity was seen in bacterial speck of T8 (1.11%) before treatment. There was a significant difference among all the treatments in every disease recorded in comparison to control. The C.V. that occurred in bacterial rot was recorded to be 25.6 and the reason for this could be due to the highest variant pest infestation of *Helicoverpa armigera* associated particularly with the bacterium causing the rot infection.

Table 6 shows the effect of various treatments on 'percentage of pest incidence'. The population per plant of African Boll Worm (ABW) showed a maximum (25%) in T7 after treatment and it was controlled both in T2 and T6 from 21.15% to 13.34%and from 11.53% to 8.33% respectively. However a drastic control of ABW was noticed by T1 and T2 from 7.69% to 1.67% and from 21.15% to 13.34% before and after treatments respectively.

Fig.1 Average Area of Cultivation and Average Yield in Five Regions of Eritrea



(*Source:* Asgedom *et al.*, 2011)

Fig.2 The Experiment Site in the Campus of HAC in ZobaAnseba (4), Eritrea

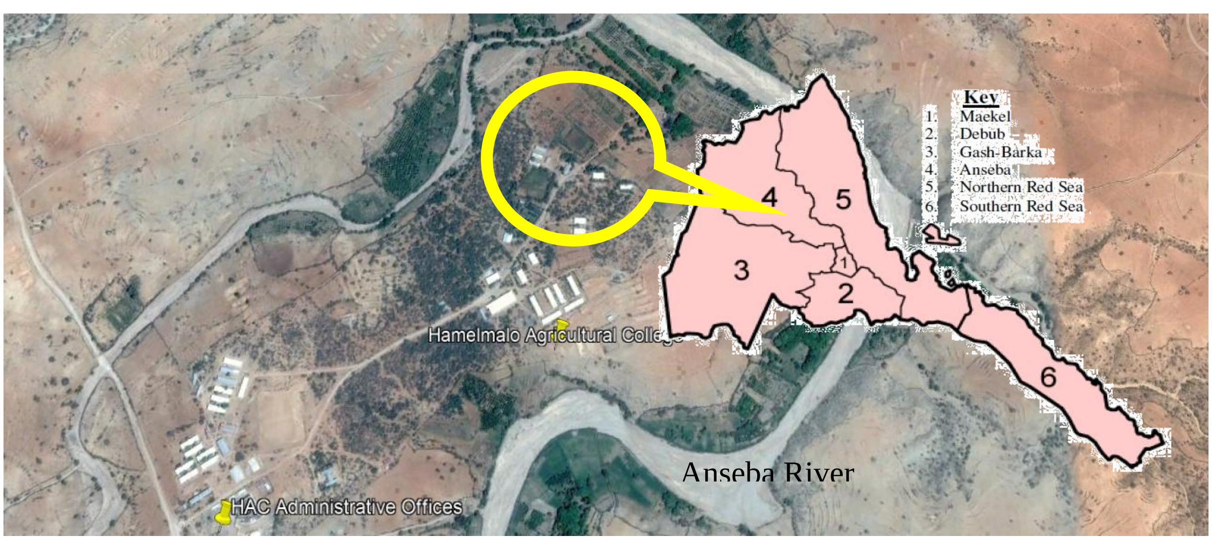


Fig.3 Seedlings (A) are ready to Transplant; Field Preparation (B) for the Cultivation of Tomato; Weeding (C) and Data Collection (D)

Fig.4 Flowers of *Lantana camara* (A) and seed kernels powder of *Balanites aegyptiaca* (B); Preparation of aqueous extract of flowers of *Lantana camara* and seed kernel aqueous extract of *Balanites aegyptiaca* (C) in Plant Protection Laboratory

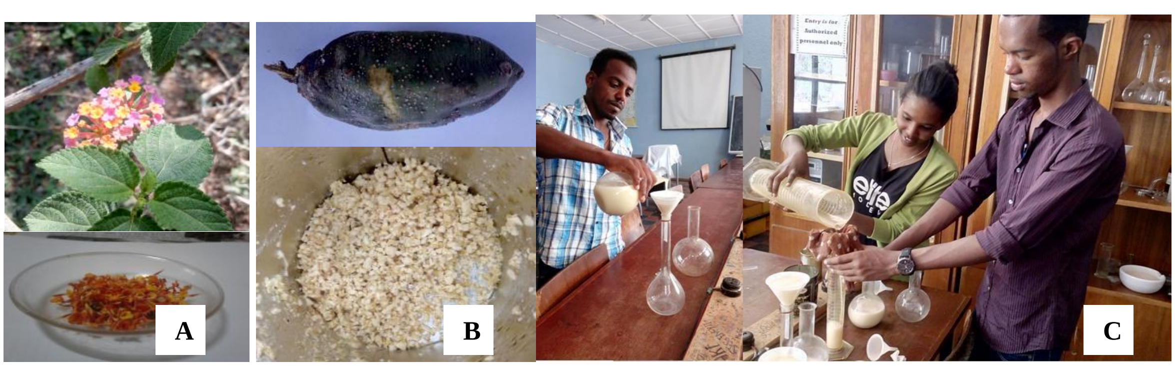
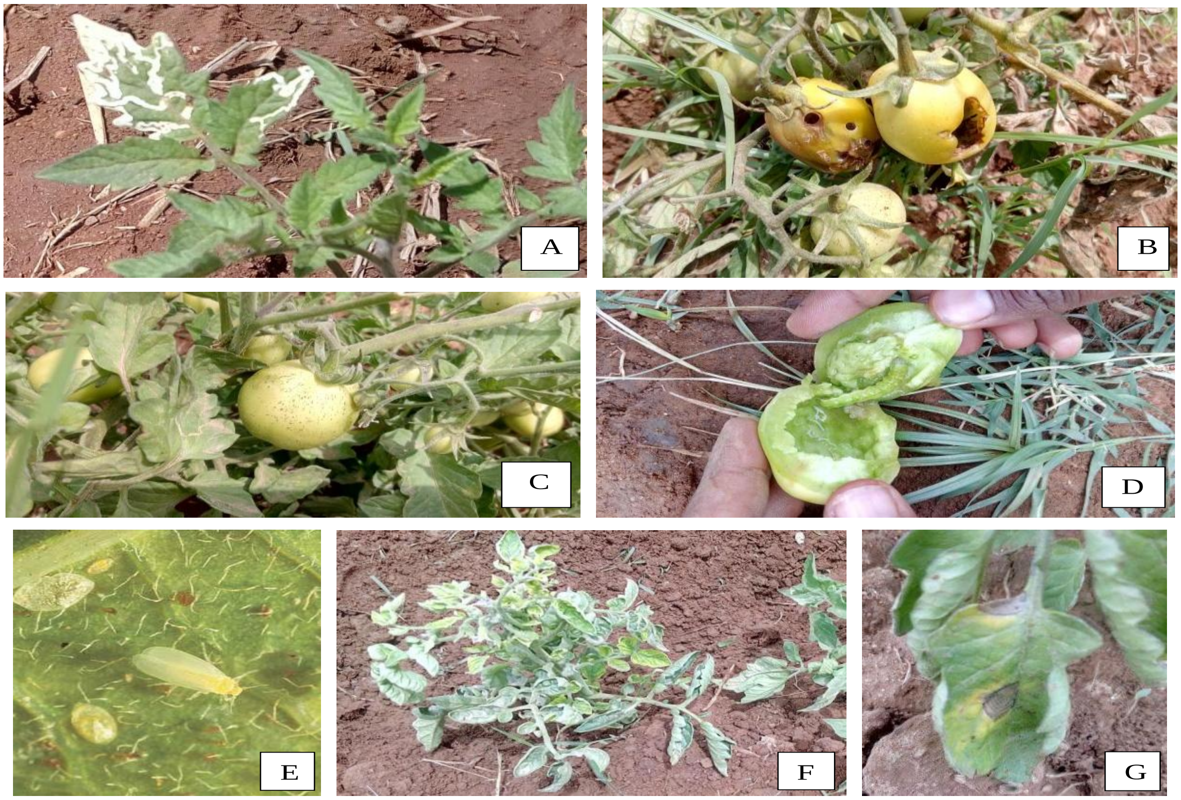
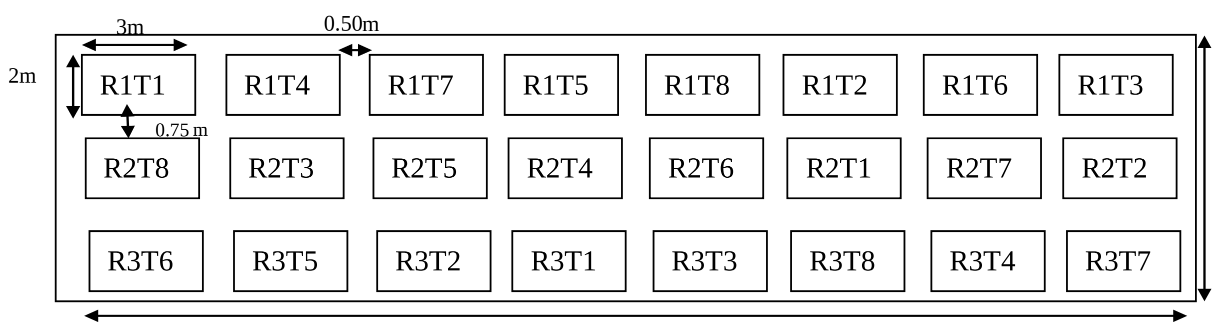


Fig.5 (A) Leafminer (*Liromyza trifoli*); (B) Fruit borer (*Helicoverpa armigera*) intermingled with Bacterial rot infections; (C) Bacterial Speck Disease; (D) Larva of fruit borer; (E) Whitefly (*Bemisia tabaci*); (F) Tomato Leaf Curl Virus and (G) Early blight disease



Design and Layout of the Experiment



Where:
T1= Aqueous extract of *Lantana* flower 5% (LFE)
T2= Aqueous extract of *Balanites* seed kernel 5% (BSKE)
T3= Fungicide for Soil borne fungus (SBF)
T4= Fungicide Foliar Spray (FSF)
T5= T1+T3; (50%+50%)
T6= T3+T4; (50%+50%)
T7 = T2+T4; (50%+50%)
T8= Control
R1= Row one; R2=Row two and R3= Row three.

Table.1 Type of Chemicals used during the Research Work

Mancozeb (Dithiocarbamate)		Punzix	Sulphur dust
Trade name	Anadoul	Punzix	HELB-sulphur
Dose per hectare	250g/100 lt of H_2O.	50 -100ml/200 lt H_2O	25 – 35kg/ha
Active ingredient	800 W.P.	Cypermethrine 10%WV	sulphur
Site of Application	Foliar application	Foliar application	Soil application
Type of pesticide	Fungicide	Insecticide	Fungicide
Target pests/diseases	Early and Late Blight, and Septoria Leaf Spot	Leaf miner	Scab, powdery mildew, rust, leaf worm

Source: (EDMS, 2004; Act 36/1947).

Table.2 Grade 'Rating Scale' of diseases on tomato

Grade	% of disease	Nature of infection
0	0	No conspicuous symptoms observed
1	0.1-0.9	A few scattered plant diseased but 1-2 signs &/or symptoms/plant (Very Highly Resistant)
2	1.0-4.9	A few scattered plant diseased but 5-10 signs &/or symptoms/plant (Highly Resistant)
3	5.0-9.9	A few plant diseased but 11-25 signs &/or symptoms /plant (Resistant)
4	10.0-24.9	A few plant diseased but 26-50 signs and/or symptoms /plant (Moderately Resistant)
5	25.0-49.9	Disease more common nearly every leaf let infected but plant remains normal in form, field looks normal green. (Moderately Susceptible)
6	50.0-74.9	Every plant diseased and about 5% leaf area is destroyed, field appears green dead. (Susceptible)
7	75.0-94.9	About 75% leaf area destroyed, field appears predominantly dried or green. (Highly Susceptible)
8	95.0-99.9	Only few leaves on plants but stem green. (Very Highly Susceptible)
9	>99.9	All leaves dead, stem drying. (Very Highly Susceptible)

Table.3 Common Insect Pests and Diseases Identified on Tomato Crop

Common name	Scientific name	Order	Family
Leafminer (i)	*Liromyzatrifoli*	Diptera	Agromyzidae
Whitefly (i)	*Bemisiatabaci*	Hemiptera	Aleurodidae
Fruit borer(i)	*Helicoverpaarmigera*	Lepidoptera	Noctuidae
Bacterial rot(b)	*Ralstonia solanacearum*	Eubacteriales	Eubacteriacea
Bacterial speck(b)	*Pseudomonassyringae*	-	Pseudomonadaceae
Tomato Leaf Curl Virus(v)	TLCV	-	Geminiviridae
Early blight(f)	*Alternaria solani*	Moniales	Dematiaceae

(b): bacterial disease (f): fungal disease (i): insect pest (v): viral disease

Table.4 Effect of Various Treatments on Percentage of Disease Incidence on Tomato in HAC

		% of Disease Incidence							
	Pathogens identified	*Alternaria solani*		*Ralstonia solanacearum*		*Pseudomonas syringae*		*Tomato Leaf Curl Virus*	
	Treatments	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
T1	Aqueous extract of *Lantana* flower 5%	71.52	68.27	15.12	13.9	56.7	55.6	71.11	67.84
T2	Aqueous extract of *Balanites* seed kernel 5%	81.29	80.71	10.53	9.73	43.9	44.5	72.22	68.67
T3	Sulphur dust	79.41	78.9	17.72	16.67	35.6	33.3	55.56	53.46
T4	Mancozeb	80.04	79.85	22.75	22.23	68.75	66.7	51.11	51
T5	Aqueous extract of *Lantana* flower and sulphur dust	72.51	72.51	12.27	10	44.87	44.5	54.45	52.22
T6	Sulphur dust and Mancozeb	68.52	66.52	7.61	5.56	33.5	33.3	66.67	65.55
T7	Aqueous extract of *Balanites* seed kernel and Mancozeb	70.5	70.17	8.93	8.3	56.38	55.6	66.67	65.25
T8	Control	85.51	85.58	29.37	30.83	43.31	44.5	68	71.33
	L.S.D	6.96		15.33		6.45		5.58	
	C.V	16.2		30.6		11.4		7.5	

Table.5 Effect of Various Treatments on Percentage of Disease Severity on Tomato in HAC

		% of Disease Severity							
	Pathogens identified	*Alternaria solani*		*Ralstonia solanacearum*		*Pseudomonas syringae*		*Tomato Leaf Curl Virus*	
	Treatments	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
T1	Aqueous extract of *Lantana* flower 5%	24.67	21.5	8.38	6.56	14.27	12.2	12.94	12.44
T2	Aqueous extract of*Balanites*seed kernel 5%	16.33	11.3	7.56	6.78	21.55	22.3	14.83	12.22
T3	Sulphur dust	13	10	5.5	4.55	15.22	14.11	13.52	12.94
T4	Mancozeb	23.75	20.7	3.33	2.78	3	1.89	18.77	17.95
T5	Aqueous extract of *Lantana* flower and sulphur dust	14.55	23.75	6.76	4.33	13.77	13.55	16.44	15.5
T6	Sulphur dust and Mancozeb	17.33	15.5	4.27	1.78	1.39	1.44	19.22	18.11
T7	Aqueous extract of *Balanites* seed kernel and Mancozeb	24.44	23.45	4.33	3.88	12	11.12	14.16	13.55
T8	Control	7.78	11.3	3.55	5	1.11	2	23.12	26.61
	L.S.D	3.99		1.49		1.59		3.13	
	C.V	19.4		25.6		13.6		16.6	

Table.6 Effect of Various Treatments on Percentage of Pest Incidence on Tomato in HAC

		% Incidence of Pest infestation					
	Insect pests observed	African Boll Worm larval population/plant		White Fly population/plant		Leaf Miner % infestation	
	Treatments	Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
T1	Aqueous extract of *Lantana* flower 5%	7.69	1.67	10.64	6.52	18.4	11.2
T2	Aqueous extract of*Balanites*seed kernel 5%	21.15	13.34	14.89	4.34	18.4	7.5
T3	Sulphur dust	11.54	13.34	6.38	10.86	17.4	18.1
T4	Mancozeb	7.69	15	17.02	21.73	21.6	23.4
T5	Aqueous extract of *Lantana* flower and sulphur dust	25	11.67	21.27	15.21	17.2	14.7
T6	Sulphur dust and Mancozeb	11.53	8.33	19.14	13.04	19.3	11.3
T7	Aqueous extract of *Balanites* seed kernel and Mancozeb	9.61	25	6.38	10.86	20.1	22.3
T8	Control	5.76	11.67	4.25	17.39	26.1	28.4
	L.S.D	4.143		3.403		3.81	
	C.V	29		22.5		17.7	

Table.7 Fruit Yield and Percentage Loss in Different Treatments

	Treatments	**kg/ plot**	**Average percentage loss**	**Net product**
T1	Aqueous extract of *Lantana* flower 5%	3.27	11.795	2.884
T2	Aqueous extract of *Balanites* seed kernel 5%	3.74	10.575	3.345
T3	Sulphur dust	2.114	6.51	1.97
T4	Mancozeb	1.86	20.725	1.475
T5	Aqueous extract of *Lantana* flower and sulphur dust	3.92	1.525	3.86
T6	Sulphur dust and Mancozeb	2.23	12.61	1.949
T7	Aqueous extract of *Balanites* seed kernel and Mancozeb	2.47	12.88	2.152
T8	Control	1.2	4.92	1.14
	Total yield	20.804	10.1025	18.71

White fly population was found in T8 4.25% before treatment and 17.39% after treatment for which the treatment is actually control but herein should be noticed to avoid confusion for percentages of before and after treatment are separately noted just for the purpose of record, whereas, by T2 the population of whiteflies were drastically controlled from 14.89% to 4.34%. According to present obtained data, the extracts of *Lantana* and *Balanites* showed significant difference in comparison to all the treatments.

The percentage of incidence of Leaf miner population was observed with a maximum in both before treatment (26.1%) and after treatment (28.4%) in T8 and T4 with before and after treatments was 21.6% and 23.4% respectively. A drastic control of Leafminer was noticed by T2 and T6 from 18.4% to 7.5% and from 19.3% to 11.3% before and after treatments respectively. T2 showed highest significant difference in the control of whitefly. Generally, the highest incidence was observed in leaf miner by T8 (28.4%), and the lowest is seen in whitefly byT8 (4.25%). The treatments above against the mentioned pests showed a significant difference among when compared to control and the C.V calculated in ABW and whitefly is 29 and 22.5 respectively. T5 (‘aqueous extract of *Lantana* flower 5% plus sulphur dust’) showed the highest significance approximated to 13.33% decrease in population of ABW compared to all the other treatments and to all other pests. The present investigation supporting the result of Miller *et al.*, 2005 and Gullino *et al.*, 2010, that the Mancozeb is often used in combination with other active ingredients as it has many sites of action, therefore delaying the occurrence of pathogen resistant strains. The present investigation reveals insecticidal potentialities of *Balanites aegyptiaca* due to the presence of highly active chemical constituents like alkaloid, saponin flavonoid and other organic acids, mainly embedded on the fruit mesocarp (Chavan *et al.*, 2014).

Table 7 reflects the yield loss due to the infections and infestation by both pathogens and insect pests. It is estimated that the total yield was acquired 20.804 kg/plot whereas, the percentage yield loss was evaluated 10.1025%. In the treatments of T5, T2 and T1, a more net product yield was obtained 3.86, 3.35 and 2.89 respectively. Application of ‘Aqueous extract of ‘*Lantana* flower and sulphur dust’ on the tomato crop showed the least percentage yield loss (1.525%), on the other hand, 20.73% which is the highest yield loss was recorded in the application of treatment of 'Mancozeb'. The T4 (Mancozeb) showed no control over the insect pests, after treatment and hence it could not improve the yield, due to the yield which was also recorded less (1.86 kg/plot) in the treated crop, following the least yield loss observed in control. Then, the similar trend follows in treatment of 'sulphur dust' (T3) which showed a decrease in yield when compared to the other treatments although the highest yield loss was recorded in T4. The result exhibited that mancozeb showed negligible significance in managing the diseases and did no significant control on the insect pests compared to the other treatments. Therefore thehighest yield loss was recorded in it.

Recommendation

Though it is difficult to recommend on the base of a few months study, but the present investigation reveals to the farmers that treatments of the aqueous extract of Lantana flower 5%, 'Aqueous extract of Balanites kernel 5%', 'Sulphur dust plus Mancozeb' and Aqueous extract of 'Lantana flower 5% plus sulphur dust' were the best applications for the controlling the diseases as well as insect pest.

Future Line of Work

Further research study on the application of botanicals and their combinations and at the different climatic conditions is needed for the managing the various diseases on tomato and other crops. The application of chemicals is not a solution for eradication of the diseases, on top of it, they may cause some another side effects on the human kind. To maintain the ecological balance and to avoid the magnification of chemicals it is encouraged to make use of plant extracts.

Acknowledgments

The authors are grateful to the Department of Plant Protection staff, Hamelmalo Agricultural College (HAC) for their technical support. The authors also extend great thanks to the farm manager, HAC. In addition to this, our gratitude goes to Mr. Danial Brhaneand Mr. Royrick for their comments on this manuscript.

References

Agrios, G.N. 2005. Plant pathology, 5th Ed, Department of plant pathology university of Florida, Elsevier Academic press 30 corporate Drive, suite 400, Burlington, MA 01803, USA.

Andy Cherry, Matthew Cock, Henk van den Berg and Rami Kfir. 2003. Biological Control of *HelicoverpaArmigera* in Africa. CAB International-2003. *Biological control in IPM systems in Africa*. The ACP-EU Technical Centre for Agricultural and rural Co-operation (CTA). Postbus 380.The Netherlands. ISBN: 0-85199-639-6. www.cabi-publishing.org

Asgedom, S., D. Esselink, P.C. Struik and B. Vosman.2011. Diversity among and heterogeneity within tomato cultivars from Eritrea. Afr. J. Biotechnol., p. 10 (in press).

Basheer, A.H.2006. Tomatoes Perspective in Syria, NAPC, Syria. Bose TK, Kabis J, Maity TK (2002). Vegetable Crops 1, Bhukeni, Calcutta.

Bishnu Chapagain and Zeev Wiesman. 2005.Larvicidal effects of aqueous extracts of *Balanites aegyptiaca* (desert date) against the larvae of *Culexpipiens* mosquitoes. African Journal of Biotechnology Vol. 4 (11), pp. 1351-1354, ISSN 1684-5315. http://www.academicjournals.org/AJB.

Byers, J.A. 2015.General Biology and Ecology of Leaf miners. Entomology Research Programs. California, USA.

Chapagain, B.P., Z. Wiesmanand L. Tsror.2007. In vitro study of the antifungal activity of saponin-rich extracts against prevalent phytopathogenic fungi.Ind. Crops Prod. 26: 109-115.

Chavan, R.W., S.S. Khadabadi, S.S. Saboo and G.G. Tapadiya. 2014. An important Enthomedicinal Plant *Balanites aegyptiaca* Del. American Journal of Enthomedicine, Vol. 1, No. 3, 122-128.

EDMS. 1948. South Africa Act. 36 of 1947.*Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36* of 1947.

Eweis M., S. Amber, S. 2011. International journal of botany. 7(4). Control of *Beta vulgaris* using *Lantana camera*.Linn.Essential oil in vitro. Egypt.

Flint, M.L. 2006. Pests in Gardens and Landscapes.University of California.Statewide IPM programs.

Hanan A Al Ashaal, Ayman A Farghaly, M MAbd El Aziz and Mohamed A A Ali. 2009. Phytochemical investigation and medicinal evaluation of fixed oil of *Balanites aegyptiaca* fruits (Balantiaceae). Journal of Ethnopharmacology, 127(2):495-501. DOI: 10.1016/j.jep. 2009.10.007. Source: PubMed.

International Centre of Insect Physiology and Ecology (ICIPE), 2016.Annual Report 2016. Nairobi, Kenya. icipe@icipe.org. www.icipe.org.

Maria LodovicaGullino, Federico Tinivella, Angelo Garibaldi and Gregory M Kemmitt. 2010. *Mancozeb: Past, Present, and Future*. Plant Disease 94(9): 1076-1087. DOI: 10.1094/PDIS-94-9-1076.

Miller, S. A. and Lewis Ivey, M. L. 2005.Hot water and chlorine treatment of vegetable seeds to eradicate bacterial pathogens. Ohio State University Extension Fact Sheet HYG-3085-05. http://www.oardc.ohio-state.edu/millerlab

Ministry of Agriculture. 2000. Horticulture Division Report, Asmara, Eritrea.

Reifschneider, F.J.B., P. Furumoto and F.A.R. Rilgueira. 1984. *Illustrated key for the evaluation of early blight of potato.* FAO.PI. Prot. Bull. 32(3): 91-94.

Rishikesh, M. 2013. Study on seasonal incidence of insect pest copmlex of tomato and their management with phyto extracts. A Thesis for Degree of Master Science.College of agriculture, India.

SethumadhavaRao, Syed Danish, Sham Keflemariam, HabenTesfagergish, RahwaTesfamariam, Tomas Habtemariam. 2016. Pathological Survey on Disease Incidence and Severity of Major Diseases on Tomato and Chilli Crops Grown in Sub Zoba Hamelmalo, Eritrea *International Journal of Research Studies in Agricultural Sciences 2-1, 13-24.*

Sithanantham, S. 2004. Development and Dissemination of IPM for Vegetables in Eastern Africa. *International Centre of Insect Physiology and Ecology (ICIPE).*ICIPE Science Press. Nairobi, Kenya. ISBN: 9290641665. http://www.icipe.org

Weinzierl, R. A. 1998. Botanical insecticides, soaps, and oils.In J. E. Rechcigl and N. A. Rechcigl (eds.), Biological and biotechnological control of insectpests. Agriculture and Environment Series. CRC Press LLC. 101-122.

How to cite this article:

Niat Yemane, Russom Kiflu, G. Yonatan Teklemariam, G. Sethumadhava Rao and Syed Danish Y. 2019. Efficacy of Selected Aqueous Plant Extracts, Fungicides and Their Combinations against Disease and Pest Control on Tomato in Hamelmalo. *Int.J.Curr.Microbiol.App.Sci.* 8(08): 2906-2921. doi: https://doi.org/10.20546/ijcmas.2019.808.335