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Occurrence and Evaluation of Insecticides for Control of Coffee Thrips (*Diarthrothrips Coffeae*) at Cheleleki, Southwest Ethiopia

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Abstract: *Ethiopia is the source of several economically important cultivated crops around the world and among these crops, Coffea arabica L. is the most important gift to Ethiopia. The average national production is very low. Biotic and a complex set of abiotic stresses are among the factors reducing coffee yield and quality. Diarthrothrips coffeae is one of the drought dependent insect and which defoliated the coffee leaves heavily during prolonged drought. This pest distributed and damaged coffee gravely in different coffee growing areas of the country. Due to the climate change, there is an increase in number of population, distribution and damage level of coffee thrips in Ethiopia. For occurrence of these insect assessment 20 -25 coffee trees per selected coffee farms were selected, and the percent incidence of Diarthrothrips coffeae ranged from 0.04% to 100%. To reduce the damage caused by this insect some organic insecticides evaluated as one component of integrated pest management. Five treatments including unsprayed plots were evaluated by using completely randomized block design with three replications at Cheleleki estate farm on naturally infested coffee field. The mortality percent of mixed treatment i.e. nimbecidine with detergent five days up to twenty one days after application resulted 100%. This treatment is more effective as compared to others in terms of thrips management and cost of control.*

Keywords: *Thrips, Damage, Incidence, Nimbecidine, Detergent and Mortality*

1. INTRODUCTION

Ethiopia is the source of several economically important cultivated crops around the world. Among those C. arabica is one of the gifts for Ethiopia and Ethiopia is the 3rd largest C. arabica producer after Brazil and Colombia (ICO, 2015). Coffee is one of the world's most valuable agricultural commodities which accounts for two-thirds of the global coffee market (Labouisse et al., 2008). Coffee is crucial to the economies accounting for more than 50% of the exports of the world's least developed countries (ICO, 2015). More than 125 million people worldwide are deriving their income directly or indirectly from its products (Mishra and Slater, 2012).

Globally, C. arabica production is about 153.87 million 60 kg bags in 2016 (ICO, 2017), and that of African countries is around 16.43 million of 60 kg bags (ICO, 2017), whereas the estimated annual national production of coffee in Ethiopia is about 7.83 million of 60 kg bags (CSA, 2017). The average national production was about 670 kg ha^{-1} (CSA, 2017) which is very low. Biotic stress (insects, disease and weeds) and a complex set of abiotic stresses are among the factors reducing coffee yield and quality. Insect pests are among the number of factors considered to reducing coffee production both in quality and in quantity (Million and Bayissa, 1986; Million, 2000). Coffee thrips (Diarthrothrips coffeae), is potentially important coffee insect pests, which defoliated the coffee leaves heavily during prolonged drought.

Due to the climate change, there is an increase in number of insect pest population and out breaks of insects (Kambrekar et al., 2015), some coffee insect pests benefited from the rise in temperature (Jaramillo et al., 2009; 2011) and increased in their generation per life cycle. Drought dependent coffee insect like coffee thrips increased in damage level and spread in different coffee growing areas of Ethiopia. To reduce the damage caused by D. coffeae; assessing the occurrence, and evaluation of some organic insecticides as one component of integrated pest management are highly important. But, recommended insecticides (organic) for coffee thrips control in Ethiopia is lacking. Therefore, this

activity was initiated with objective of assessing the occurrence and evaluation of some organic insecticides as management option for coffee thrips control in Ethiopia.

2. METHODOLOGY

2.1. Description of Study Area

The assessment of coffee thrips occurrence carried out in plantation and research centers on naturally infested coffee fields, as described in Table 1. At Cheleleki estate farm some organic insecticides were evaluated as management option for thrips control.

Table1. *Description of the three study areas*

Geographical information	Estate farm		Research center	
	Cheleleki	Gomma	Melko (JARC)	Agaro sub-center
Altitude (masl)	1350	1485	1753	1697
Latitude	$7^0$59'N	$7^0$35'N	7 º 40'37''N	7 º 50'35"N
Longitude	$36^0$45'E	$36^0$37'E	36º 49' 47''E	36º 35'E
Mean annual rainfall (mm)	-	1525	1531	1616
Mean annual max. temp (^{0}C)	-	29.9	26.2	28.4
Mean annual min. temp (^{0}C)	-	13.4	11.5	12.4
Located from Addis Ababa	461km	406km	368km	468km
Located from Jimma town	105km	50km	12km	57km
Source	Horizon Plantation P.L.C		JARC, Center profile	

2.2. Experimental Procedures

2.2.1. Assessment of the Coffee Thrips Occurrence

For occurrence of coffee thrips 20 -25 coffee trees per selected coffee farms were assessed and the underside of coffee leaves were examined by using hand lenses. Then the number of damaged and undamaged coffee trees by thrips were counted and recorded. Also shade level (heavy, intermediate and open coffee field based up on the canopy of the shade trees), shade types (either permanent or temporal shades), and planted year (crop age) was recorded during data collection to determine the infestation of this coffee pest at Gomma II, Cheleleki, Agaro and Melko. In addition to those areas the information on occurrence of this pest was gathered from other areas. The damage percent (incidence) was calculated using the below formulae;

$$\text{Incidence} = \frac{Number\ of\ affected\ plant\ units}{Total\ number\ of\ plant\ units\ (health + affected\ units\ counted} x100$$

2.3. Evaluation of Some Insecticides for Coffee Thrips Control

For evaluation of some organic insecticides as management options five treatments including check (unsprayed plots) were evaluated by using completely randomized block design with three replications at Cheleleki estate farm. Nimbecidine, detergent and the mixture of nimbecidine with detergent and one inorganic insecticide (Lamdex 5%EC) was used as treatment and evaluated at Cheleleki estate farm on naturally infested coffee field , as described in Figure 1.

The plots consist of three groups of 13 coffee trees and five coffee trees per plot were selected and marked for treatment evaluation. Five leaves were randomly selected per coffee tree and the numbers of coffee thrips per each leaf were counted before and after spray by using hand lenses that could magnify the pest ten times. Thrips density were counted one day before spray and closely monitored up to 21 days after application in five days interval.

Figure1. *Products used. A, show the three insecticides. Figure B, show when nimbecidine added to detergent.*

Calibration was made before spray, and during treatment application four knapsacks were used separately. Application rate of the treated treatments were based on the recommended rate per hectare on tagged product, as described in Table 2.

Table 2. *Application rate of insecticides per recommended rate*

Treatments	Chemicals L/ha	H_2O L/ha	Per knapsack (15L of water)
Nimbecidine	3L	600L	0.075L ~ 0.08L(80ml)
Lamdex 5%EC	0.4L	200-250L	0.03-0.024L(30ml)
Detergent (gm)	-	-	100gm
Nimbecidine + Detergent (gm)	-	-	0.04L+50gm
Control (unsprayed)	-	-	-

L= liter, ml = milliliter and gm= gram.

2.3.1. Statistical Analysis

For occurrence of coffee thrips the mean percent incidence was determined. Whereas, for insecticide evaluation the thrips density before and after sprayed was subjected to the analysis of variance (ANOVA) as per Gomez and Gomez (1984), using SAS version 9.0 computer software. Mean separation was performed by using Least Significant Difference (LSD) at 5 % level of probability.

3. Results And Discussion

In all assessed coffee farm fields, the percent incidence of coffee thrips increase in spread and damage level. The percent incidence of Diarthrothrips coffeae ranged from 0.04% to 100% at Melko research center and Gamma II estate farm, respectively. The assessment result indicated that D. coffeae highly damaged coffee in intensive coffee production system (Gomma II) as compared to other assessed fields. The mean percent infestation of D. coffeae in assessed fields ranged from 60% - 100%, 2.5% - 100%, 37.5% - 75% and 0.04% - 95% at Gomma II, Cheleleki, Agaro and Melko, respectively.

Table3. *Percent infestation of coffee thrips in different coffee farm fields*

Location	Planted year	Incidence	Location	Planted year	Incidence
Goma II	2012	100.0%	Agaro	2014	75.0%
	2012	60.0%		2016	45.0%
	2013	85.0%		2016	37.5%
	2013	95.8%		2016	50.0%
	2014	100.0%		2016	50.0%
Cheleleki	-	100.0%	Melko	-	0.04%
	-	2.5%		-	95.0%
	-	60.1%		-	25.0%

The damage level varies in different shade types and shade levels, but high percent incidence recorded in open field and temporal shade types. This variation in different shade levels and types indicated that recommended shade trees can contributed to coffee thrips management. In open field coffee farms the percent incidence of coffee thrips heavily defoliated the leaves and recorded greater than 50%. At Agaro, Bisana (Croton macrostached) shaded coffee farms injured and this may due to Bisana does not persist its leaves during dry period. Coffee under Bisana shaded easily exposed to sun light during dry season and this could fasten the coffee thrips infestation and spread.

Damage percent was observed in all assessed and other coffee farm fields, this indicated that this insect widely distributed in other coffee growing agro ecologies of the country such as; south (Wonago and Dale), south west (Bebeka, Gomma, Mana and Saka Chokorsa) and in west direction (Anfilo) reported as 50% crop damaged by this particular coffee insect. This coffee insect pest damaged coffee gravely during prolonged drought and increased in intensity and distribution in different parts of coffee growing areas of Ethiopia, as described in Figure 2.

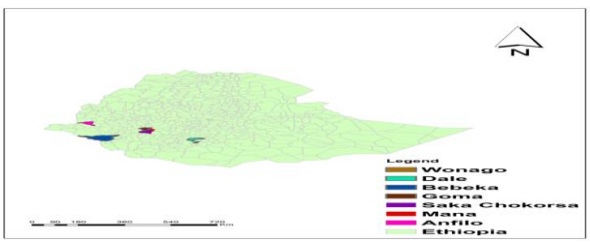

Figure2. *Occurrence of coffee thrips in different coffee growing areas of Ethiopia*

To reduce the damage and yield loss caused by this drought dependent coffee insect pest in Ethiopia, some organic insecticides evaluated as one component of integrated pest management.

The analysis of result showed that all tested chemicals showed significant difference on coffee thrips population as compared to check (untreated plots), as described in Table 2. Based on the result on 5th day after application nimbecidine, lamdex 5% EC and the mixture of nembecidine and detergent were control coffee thrips. The nimbecidine, detergent and the mixture of those two products showed significant differences in thrips density reduction.

The mortality percent of nimbecidine and detergent mixture, and lamdex 5% EC five days after application up to twenty one days were 100%. Similarly, for detergent treatment mortality percent was 52.2%, one day and five days after spray and 97.9% and 99.7% mortality after ten days and fifteen days after application respectively. Starting from the day of application up to 21days the mixture of nimbecidine and detergent totally (100% mortality) control this pest population. There are no statistically significant differences among the evaluated insecticides (nembecidine, lamdex 5% EC and the mixture of the two organic insecticides) to control coffee thrips density. But, in terms of cost the mixed treatment highly effective in terms of cost of control and bio agent compatibility than inorganic pesticide (Lamdex 5%EC).

Table 2. *Mean comparison of thrips before and after treatment.*

Treatments	Days after application					
	1BSp	**1DASp**	**5DASp**	**10DASp**	**15DASp**	**21DASp**
Nimbecidine(l)+Detergent(gm)	34.83	0.0^{c}	0.0^{b}	0.0^{b}	0.00	0.0^{b}
Lamdex 5%EC	33.2	0.0^{c}	0.5^{b}	0.0^{b}	0.00	0.0^{b}
Detergent (gm)	50.0	17.7^{b}	2.2^{b}	0.33^{b}	0.33	0.0^{b}
Nimbecidine	41.8	0.0^{c}	1.5^{b}	0.0^{b}	0.0	0.0^{b}
Untreated	59.5	39.5^{a}	6.83^{a}	4.7^{a}	0.33	24.8^{a}
Cv(%)	26.8	27.2	31.8	23.7	30.2	30.25
p<	0.149	0.0001	0.0008	0.0018	0.46	0.0042

BSp= before spray, DASp day after spray, Means followed by the same letters are not significantly different ($p<0.05$). CV= coefficient of variance.

4. Conclusion

Diarthrothrips coffeae is one of the drought dependent insect and which defoliated the coffee leaves heavily during prolonged drought. Due to change in climate (prolonged drought this pest distributed and damaged coffee gravely in different coffee growing areas of Ethiopia. The plant products and other organic pesticide (detergent) could reduce the coffee thrips below unacceptable level. Other management options should also be needed to reduce the damage and yield loss caused by coffee thrips in Ethiopia.

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