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Infestation and damage status assessment of white mango scale *(Aulacaspis tubercularis)* insect at boloso sore and boloso bombe districts of Wolaita Zone South Ethiopia

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ABSTRACT

This fruit devastating pest of white mango scale (*Aulacaspis tubercularis* Newstead; Hempitera: Diaspididae) insect is an economically important pest and damages the mango fruit by sucking the sap through its piercing-sucking mouth part from mango leaves and fruits. Since the 2010 outbreak in Ethiopia due to a poor internal quarantine system this insect pest was distributed and invaded the whole mango-producing region in the country. Therefore, the aim of this study was to assess the infestation and severity status of WMS insects to get evidence for upcoming management investigations. The survey was carried out at Boloso Bombe and Boloso Sore districts in South Ethiopia Wolaita Zone in 2023. Among mango-producing farmers by using a semi-structural questionnaire 45 farmers were intervened through random selection. Geographic location and ten samples of mango leaf were collected from four cardinal directions per tree of each stop for examining the infestation and severity status of WMS. The occurrence of this pest at study locations was in 2016 as interviewed farmers respond. Since then, due to a lack of attention by farmers currently, it was distributed and covered the whole study area. As confirmed by this study the infestation ranged from 60 to 100% and damage or severity rated from moderate to very high. Among surveyed locations, 29% of mango farms were very highly, 52% highly and 20% moderately damaged. From the total study area, almost 31% of mango farms reduced 100% yield and the reduction of yield ranged from 50% to 100%. Before the outbreak of this invasive insect pest, the study area farmers were harvesting nearly 272 kg of mango fruit per tree and at normal times yield reduction was almost 43 kg per tree. After the prevalence of WMS insect per tree yield was almost 44 kg and the reduction of yield was alarmingly increased to 228 kg per tree as shown by this study data. Even though this insect pest is a devastating pest of mango fruit, however, it can be controlled through different management practices. Therefore, the management practice of this pest is categorized into three such as cultural, biological and biochemical. Culturally managed by Mango tree pruning, planting resistant materials, using proper spacing, cleaning or sanitation, burying infected residues and fruits, smoking different repellents of dry grass, animal dung, mango leaves and lemon bark or lemon mixed organic materials in one smoking can/pot and hanging inside mango tree. Foliar Spraying of various botanical extracts such as Neem seed extract (*Azadirachta indica*). Several concoctions made from ash, soap and goat urine were mixed and sprayed on infested mango fruit leaves and twigs. Various predators and parasitoids are used as Biological control. Soil drenching of systemic chemical insecticides also can control this insect pest. The way to control this serious damage and hinder the expansion of this invasive insect pest, integrated experimental investigation using the above-explained mechanisms will be advisable to enhance mango fruit yield.

Keywords: White Mango Scale, Occurrence, Infestation, Damage and Control

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Introduction

The white mango scale insect, *Aulacaspis tubercularis,* is an order of Hemiptera and the family Diaspididae which is characterized by having a piercing-sucking mouth parts and it can be reproduced from five to six generations per year (Megersa *et al.,* 2020). This insect originated in Asia, and then currently spread throughout the world mango-producing areas and has threatened mango production all over the globe (Dinka *et al*., 2019). It is an important pest in North and South America, Australia, the Caribbean Islands and East and West African countries (Nabil *et al*., 2012). As a mango pest, it was recorded earlier in a few mango-producing areas but now it is an important pest of mango globally. After occurrence in one mango farm, because of its small body size spread very quickly with planting materials of seedlings, fruits and as well as through wind in all producing areas (Otieno, 2021). As stated by Azrag *et al.* (2022), countries in East, South and West Africa are highly suitable for Aulacaspis tubercularis establishment. Currently, the White mango scale insect is distributed over 72 countries in Africa, Asia, Europe, Oceania and South and Central America. It attacks over 50 plant species belonging to 18 families including crops of economic importance such as Anacardiaceae *(Mangifera indica),* Arecaceae *(Cocos nucifera),* Rosaceae *(Prunus* spp.*),* Myrtaceae *(Psidium guajava),* Cucurbitaceae *(Cucurbita pepo),* Lauraceae *(Persea Americana),* Rutaceae *(Citrus* spp.*),* Sapindacea *(Litich chinensis),* Zingiberaceae *(Zingiber officinale)* are seriously damaged among others. Especially since it causes huge economic losses in many countries of tropical regions. In South Africa WMS insect for the first time outbreaks since 1947 however, this insect pest in Ethiopia occurred in 2010 in Western Ethiopia Oromia Region East Wolega Zone at Guto Gida District in Green Focus Ethiopia Private Farm (Wale and Melis, 2022). Ethiopia is currently producing various types of fruits in wide coverage linked with a legacy of green development to contribute her parts as a one of solution finder for global warming and to meet the goal of climate resilient or climate-smart agriculture. As reported by Anjulo (2019), followed by avocados and bananas in the production area Mango took third rank and its coverage was estimated at 15,373.04 ha. *Aulacaspis tuberculars* introduced in Ethiopia almost a decade ago and it is invading the whole country where mango is grown and causing to lose from 50% up to 100% of mango yield. Mango is widely grown in Ethiopia preceded only by banana in terms of economic importance. The annual production in Ethiopia is 133, 704.93 tones with land coverage of 19,497.92 ha and its production is 6.86 tones ha^{-1} which accounts for 0.18% of the world production (Fita *et al*., 2020). White mango scale insect pest is the most severe and the second important mango pest followed by fruit fly. Young mango trees are severely infested with white mango scales exposed to high leaf loss, twig death, fruit drop and finally the whole plant death. It is a serious agricultural pest which retarded the growth of young seedlings at the nursery and injures the shoots, twigs, leaves, branches and fruits by sucking the plant sap. It causes deformations, defoliation, drying up of young twigs, dieback, poor blossoming, and death of twigs by the action of toxic saliva. The commercial value of local as well as international market demand is lowered drastically for mango fruit because of low quality due to damage of this insect pest. The income of mango producers is decreased or lost due to WMS insects and currently, the profit from Mango fruit is almost nothing (Bakry and Baky, 2020; Babege *et al*., 2017; El-Metwally *et al*., 2011). Therefore, the main aim of this study is to provide a reference point for management intervention of this insect pest for future control.

Research Methodology

The WMS insect pest assessment has been carried out at Boloso Sore and Boloso Bombe districts of Wolaita Zone South Ethiopia. The survey has been conducted since the June 2023 cropping season. South region central zones receive a bi-modal pattern of rainfall. The first rainfall period covers from March to May and the second from July to October. During the investigation period average monthly precipitation was 8.6 mm in June. The monthly minimum and maximum temperatures were 15^{o}C and 25.8^{o}C. For the period of study, the monthly minimum and maximum temperature of June were 13^{o}C and 25^{o}C respectively. The assessment undertaking began at Boloso Bombe administrative district of geographic location 07^{o}81'40" N", 037^{o}34'28" E and Altitude 1520 meter above sea level. Similarly, Boloso Sore district administrative area Areka is located about 300 km southwest of Addis Ababa, in Ethiopia found at 7°04'N longitude and 37°41'E latitude and altitude of 1800 meters above sea level. The soil at Areka is deep, and highly weathered with a pH of 4.8. The climate is tropical, with mean annual rainfall of about 1500 mm. The daily mean maximum and minimum temperature of the area are 25^{o}C and 13^{o}C, respectively. The main soil type in the area is not soil or nitisol (deep, red, well-drained soil with some clay content). The Survey was conducted purposively at 5-kilometer intervals by randomly selecting the Mango plant per stop. At each stop individual farmer was interviewed by using a semi-structured questionnaire and a total of 45 mango producer farmers were interviewed regarding this insect pest across two districts. Ten sample leaves per tree have been taken from four cardinal directions of North, South, East and west to examine the infestation and severity status of WMS insects and to record the number of Egg, Crawlers, Males, Females and their colony abundance of scale insects for further mean-variance investigation. The infestation and damage status of WMS insects was scored by using a 0-5 scale and eggs, crawlers, and Females were scored in number. In the course of Leafe examining pin and Magnifying hand lens were used to remove the scale cover and differentiated egg, crawlers, and male and female scale insects for proper scoring. The geographic location of study areas was recorded by using GPS coordinates (Geographic Position System). The collected data were managed by using Microsoft Excel 2010 and ready for analysis. The analysis of variance was conducted by using the SAS statistical system of window 9.0 and mean separation was analyzed by Fisher's LSD test.

Results

The outbreak of white mango scale insects at study locations was explained by respondent farmers for the first time since 2016 G.C. The prevalence and distribution were below 4% of mango farms at the time and restricted for two consecutive years in this area without expansion to new farms (Fig 5). Currently, this was history, due to the lack of due attention of farmers to control this invasive insect it was distributed to the whole mango farms of study locations. The infestation per tree ranged from 60-100% and damage was rated from moderate to very high. Among surveyed locations, 29% of mango farms were very highly, 52% highly and 20% moderately damaged. Almost 31% of mango farms were reduced 100% yield from the total study areas and the range of yield reduction was 50-100%. A similar research finding was reported by Dinka *et al.* (2019) the severity status of the white mango scale on mango trees rated from high to very high in southwest Ethiopia.

Table 1. Damage status of white mango scale insect on mango fruit at study locations of Boloso Sore and Boloso Bombe districts of Wolaita Zone South Ethiopia.

Region	Zone	Districts	Sampled Mango Farm	North	East	Altitude Meter a.s.l.	Infestation %	Damage or Severity Index	Rate of Damage or Severity status	Yield Kg Per Tree Before Insect outbreak	Yield Kg Per Tree After Insect outbreak	% Yield Reduction
SEPR	Wolaita	B.Sore	Matala himbecho	07º92'90"	037º38'10"	1606	100	>5	Very High damage	100	0	100
«	«	«	Matala himbecho	07º93'00"	037º38'58"	1627	80	4	High damage	350	100	71.5
«	«	«	Chama himbecho	07º72'10"	037º42'26"	1685	90	4	High damage	50	0	100
«	«	«	Chama himbecho	07º74'00"	037º41'42"	1547	95	>5	Very High damage	100	0	100
«	«	«	Chama himbecho	07º81'50"	037º40'57"	1678	80	4	High damage	200	25	87.5
«	«	«	Himbecho matala niusi 01	07º84'40"	037º39'59"	1719	80	5	High damage	300	35	88.4
«	«	«	Himbecho municipal	07º82'90"	037º39'30"	1710	70	4	High damage	300	50	83.4
«	«	«	Shuye homba	07º73'20"	037º39'40"	1709	90	5	High damage	300	70	76.7
«	«	«	Wormuma	07º71'80"	037º42'39"	1702	70	3	Moderate damage	150	50	66.7
«	«	«	Achura	07º82'00"	037º42'15"	1687	100	>5	Very High damage	300	0	100
«	«	«	Achura	07º91'80"	037º42'49"	1703	60	4	High damage	1000	100	90
«	«	«	Xiyo himbecho	07º94'70"	037º41'10"	1685	60	3	Moderate damage	200	50	75
«	«	«	Wormuma	07º76'50"	037º42'51"	1616	60	4	High damage	100	50	50
«	«	«	Areka 01	07º67'00"	037º42'38"	1619	90	5	High damage	25	0	100
«	«	«	Areka 04	07º27'00"	037º43'10"	1619	85	5	High damage	100	0	100
«	«	«	Dolla	07º11'40"	037º43'00"	1820	60	3	Moderate damage	100	25	75
«	«	«	Dolla	06º59'20"	037º44'29"	1798	70	4	High damage	300	100	66.7
«	«	«	Areka 01	07º45'30"	037º41'34"	1768	100	>5	Very High damage	50	12	76
«	«	«	Dubo	07º42'20"	037º91'90"	1718	90	5	High damage	200	12	94
«	«	«	Sore homba	07º41'00"	037º40'26"	1758	90	>5	Very High damage	200	12	94
«	«	«	Sore homba	07º45'40"	037º40'18"	1752	90	5	High damage	300	50	83.4
«	«	«	Sore homba	07º54'70"	037º40'50"	1738	95	>5	Very High damage	200	25	87.5
«	«	«	Shuye homba	07º54'70"	037º40'50"	1738	90	5	High damage	100	0	100
«	«	«	Sore homba	07º57'30"	037º40'19"	1738	80	4	High damage	100	12	88
«	«	«	Sore homba	07º54'80"	037º40'40"	1743	90	>5	Very High damage	50	0	100

«	«	«	Shuye homba	07°55'00"	037°40'90"	1756	95	>5	Very High damage	50	0	100
«	«	B.Bomibe	Adila	07°75'50"	037 38 22	1642	100	>5	Very High damage	300	50	83.4
«	«	«	Adila	07°83°90"	037°37'40"	1616	100	5	High damage	300	50	83.4
«	«	«	Farwocha	07°83'90"	037°36'39"	1539	100	>5	Very High damage	700	300	57.15
«	«	«	Bombe farmer association	07°84'10"	037°35'37"	1564	80	>5	Very High damage	650	100	84.6
«	«	«	Mehal ambe	07°74'70"	037 34 24	1469	100	>5	Very High damage	450	50	88.9
«	«	«	Gido ambe	07°71'60"	037°34'46"	1469	95	3	Moderate damage	200	25	87.5
«	«	«	Gido ambe	07°63'80"	037° 33'54"	1469	100	5	High damage	100	0	100
«	«	«	Gido ambe	07°63'81"	037°32'59"	1445	100	5	High damage	100	0	100
«	«	«	Gebere mahiber	07°83'80"	037°34'56"	1494	35	3	Moderate damage	300	45	85
«	«	«	Ajora	07°95'70"	037°35'29'	1619	100	5	High damage	300	0	100
«	«	«	Ajora	07°10'20"	037°35'59"	1446	100	5	High damage	200	0	100
«	«	«	Ajora	07°95'40"	037°37'30"	1580	100	>5	Very High damage	900	150	83.4
«	«	«	02 kebele	07°81'40"	037°34'28"	1520	60	3	Moderate damage	300	50	83.4
«	«	«	Kuto ambe	07°89'00"	037°38'37"	1484	70	3	Moderate damage	400	75	81.25
«	«	«	Kuto ambe	07°81'41"	037°32'39"	1450	40	3	Moderate damage	200	25	87.5
«	«	«	Badaye	07°80'10"	037°31'34"	1399	30	3	Moderate damage	500	150	70
«	«	«	Badaye keriko	07°75'21"	037°30'39"	1394	95	5	High damage	300	0	100
«	«	«	Kiriko badaye	07° 74'01"	037°29'48"	1312	35	4	High damage	300	45	85
«	«	«	Matala himbecho	07°10'40"	037°40'60"	1619	70	5	High damage	500	50	90

The mean square analysis of variance result for the damage status of this insect pest at study locations revealed that highly significant difference (P<0.01). Across locations infestation of white scale on mango fruits exhibited significant (p<0.05) difference for all study areas. These variations may be due to, varietal, agroecological, prevalence time, the cultural practice of individual farmers, topography, wind effect etc.

Table 2. The mean square of ANOVA result for infestation and damage status of WMS insect of the study locations.

Source of Variation	df	Damage index		Damage/ Severity%		Yield Before WMS Outbreak		Yield After WMS Outbreak	
		Sum square	Mean square	Sum square	Mean square	Sum square	Mean square	Sum square	Mean square
Loc	1	0.057	0.057^{ns}	78.49	78.49^{ns}	226576	226576*	5276.56	5276.56^{ns}
I	9	18.84	2.094**	8060.12	895.56**	247516	27501.9*	23089.32	2568.48*
Loc*I	9	1.92	0.48*	1794.06	448.5*	91993.44	22998.36^{ns}	6231.5	1557.8*
Error	34	9.72	0.28	5213.99	153.35	1444137.54	42474.63	101698.63	2991.13
Total	53	30.5		15146.66		2010222.98		136296	
Cv%			12		17		75		126

*Key: Loc=Location, I=Incidence, CV=Coefficient of Variation, *=Significant, **=highly significant and ns=Non significant*

Table 3. Mean value of WMS insect incidence and damage of the surveyed locations.

S.n.	Incidence%	Damage Index	Damage/Severity%	Yield Before WMS Outbreak	Yield After WMS Outbreak
1	100[a]	5[a]	95[a]	500[a]	150[a]
2	100[a]	5[a]	84[a]	340[a]	65[ab]
3	100[a]	4.8[a]	82.42[a]	330[ab]	55[ab]
4	93.75[a]	4.6[a]	79.38[ab]	320[ab]	54[ab]
5	90[a]	4.4[ab]	71.40[abc]	316.7[ab]	51[ab]
6	85.56[ab]	3.8[abc]	57[bcd]	300[abc]	45[ab]
7	81.25[b]	3.5[cd]	53[cd]	200[b]	25[b]
8	80[b]	3.4[cd]	52.5[cd]	170[b]	18[b]
9	80[b]	3[d]	50[cd]	153[bc]	10[b]
10	78.85[bc]	3[d]	40[d]	100[c]	0[b]
Mean	81.5	4.4	72	271.6	43.1
$LSD_{0.05}$	12.16	2.04	10.69	120	32
P Value	0.04	<.0001	<.0001	0.03	0.04
CV%	24	2	17	35	42
P	*	**	**	*	*

*Key:LSD=Least Sginificance Difference, CV=Coefficient of Variation, *=significance, **=highly sgnificance*
Means with the same letters are not significantly different at P<0.05 probability levels in comparison to $LSD_{0.05}$

White Mango Scale Insect Heavily Infested Mango Tree (Photo: Andualem A.)

Explained as interviewed farmers during semi-structured questions regarding mango yield and its importance for their livelihood. The fruit of mango has been providing many benefits for study area farmers. The producers could cover the school cost of students from their income, money from its sales used to construct houses and to buy different domestic animals, used to fill nutritional and food gaps, used as raw material for factories and juice houses, serve as animal feed and shade, control soil erosion, used as fence and old tree for fuel purpose etc. However, when we saw the yield of mango before this invasive insect occurred average per tree was nearly 272 kg and at normal times yield reduction was almost 43 kg.

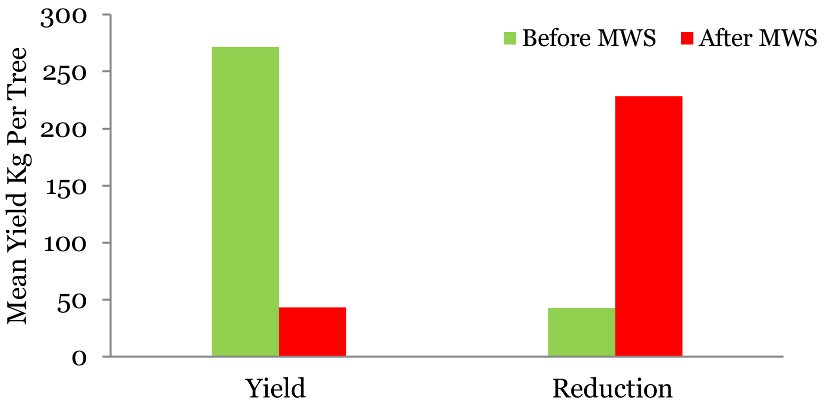

Fig 1. Average yield and yield reduction in kg per tree before and after WMS insect prevalence.

White mango scale insect prevalence has faced serious production constraints and resulted in significant yield reduction annually at study locations. Due to this case, the income and livelihood of farmers were reduced drastically. Yield reduction per tree was closely 228 kg and this exhibited how much this insect was an economically important pest of mango fruit. This implied that serious attention is needed to control unless production of mango fruit in Ethiopia remains in a dangerous situation.

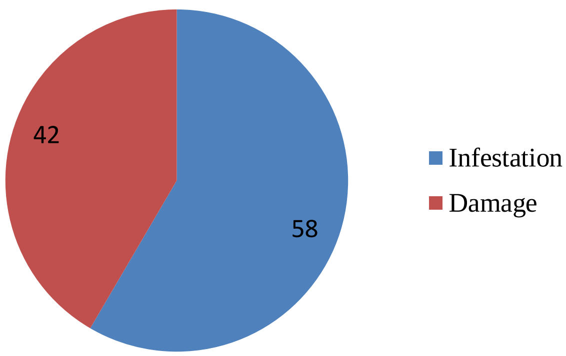

Fig 2. Mean percentage of infestation and damage of WMS insects on Mango fruit of the study area.

Mango Fruit Leaves Invaded and Damaged by WMS Insect (Photo: Andualem A.)

The expansion of white mango scale insects at study locations spread throughout the whole mango farm. This insect infested total mango trees of the study areas and as explained by the interviewed farmers progressively spreading seasonally. Currently, the damage status of this pest alarmingly increased up to 100% yield reduction on the majority of mango farms in study locations. The average percent of infestation and damage status showed the maximum peak of the white mango scale (Fig. 2) in the area.

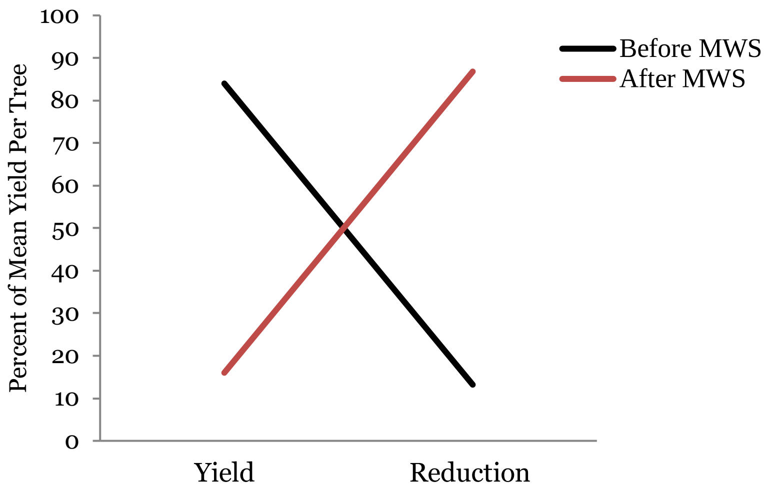

Fig. 3. Percentage of yield reduction at study locations before and after outbreak of WMS insect.

Immature Mango Fruit dropped on the ground because of WMS Insect Damage (Photo: Andualem A.)

The report of various scholars suggested that the white mango scale is a devastating insect of mango fruit. In a similar way through this study percentage of yield reduction has seen nearly up to 87% per tree of mango fruit. Thereby, the consequence of scale insects has a very serious negative effect on mango production and productivity. As the farmer's explained due to the case of the white mango scale insect they were replacing other plants instead of mango plants and used mango trees for fuel purposes in fires. The yield reduction percent of study areas results confirmed the negative impact of scale insects on mango fruit (Fig. 3).

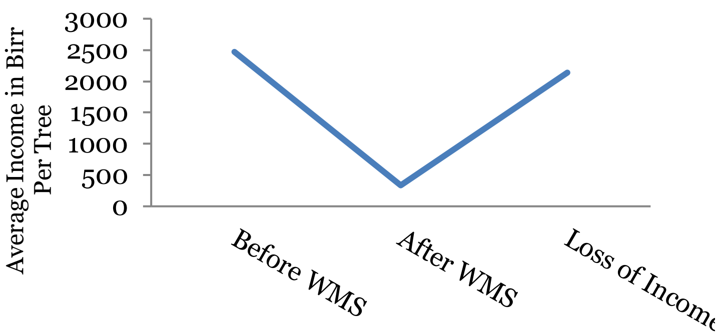

Fig. 4. The farmers' income variation from mango production before and after white scale insect prevalence at study locations.

Mango fruit provides much importance to the surveyed area's farmers as suggested by interviewed farmers. However, this invasive white mango scale insect aggressively reduced their mango yield by up to 100% as they told. Periodically the farmer earns an average income of up to 2470 ETB (Ethiopian birr) per mango tree before the outbreak of this dangerous enemy of mango fruit insect pest. After the prevalence of the white scale, the income reduced considerably to 335 ETB per tree. Per season the study areas farmers lose 2135 ETB per tree due to mango white scale insect damage (Fig 4).

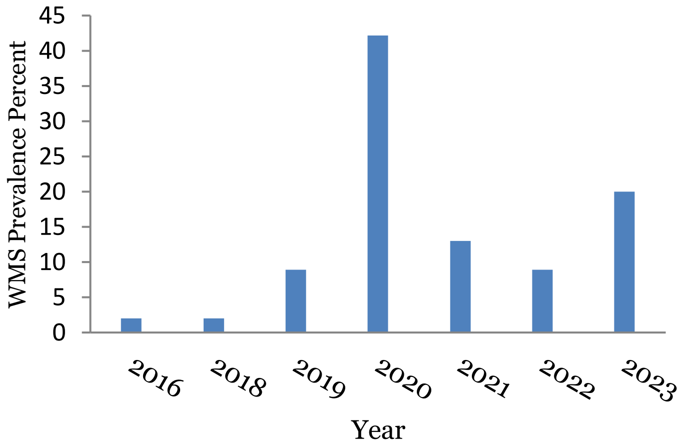

Fig. 5. The occurrence and expansion percent of wms insect on study areas mango farm.

Various Scale Insects on Mango Fruits (Photo: Andualem A.)

This invasive white mango scale insect spread throughout the country after first prevalence in western parts of Ethiopia at Wolega zone of Oromia region in green focus private mango farm since 2010. Then after, it took only six years to arrive at these study locations. White mango scale insects were transported with external forces like wind, birds, insect pests, infested planting materials and the bags that held the infested mango fruit. At these study locations of Boloso Sore and Boloso Bombe districts, it occurred since 2016 and at the time its infestation percent was only below four percent of mango farms Fig. 5. For two successive years it stayed in the first infested farm within similar infestation percent without expanding to other mango farms of the area. Then after two years, the infestation and distribution percentage increased at a very fast rate from 5%-45% from 2018-2023. Currently, the white mango scale insect was covering the whole mango farm of study locations with moderate to very high damage status (Fig. 5).

Discussion

The analysis of variance results for damage status of this insect pest at study locations revealed that highly significant difference ($p<0.01$). Across locations infestation of white scale on mango fruits exhibited significant ($p<0.05$) difference for all study areas. The invasive insect pest of white mango scale is a serious threat nowadays to Ethiopian mango fruit-producing farmers. This insect has piercing-sucking mouthparts and damages the fruits by sucking sap from leaves and fruit. The infestation of this insect pest at study locations covered a hundred percent mango fruit farm. The extent of this insect expansion is increasing highly from season to season as suggested by respondent farmers. The status of fruit damage caused by white mango scale insects rated from moderate to very high. Damaged mango trees were detected by premature fruit drop, dry leaves and small fruit size. Similar findings were reported by Babege *et al.* (2017) and Dinka *et al.* (2019), based on their reports the WMS was spreading from its original infestation area to other mango-growing neighbouring districts. The severity status of the white mango scale on the mango tree rated from high to very high in southwest Ethiopia. Due to the lack of a proper internal quarantine system at all study locations currently WMS insect distributions attain their maximum peak. Severely infested mango trees reduced yield from 50-100% and among surveyed locations, 31% of farms scored 100% yield reduction. The mango tree invaded with white scale exhibited green photosynthetic parts of leaf covered with white scale and dry, pink blemish colored fruit with full of black spot on the dermal tissue, the fruit quality deteriorated and reduced market value, shrivel and very small sized fruit and the whole premature fruit was a drop on the ground. This result aligned with the report of Megersa *et al.* (2020), who reported that the WMS insect is a devastating pest of mango fruit and attacked fruit color changed to a pinkish blemish on the skin of matured and ripe fruits. Abo-Shanab (2012) also reported that WMS insect causes fatal damage and fruit causing conspicuous pink blemishes around insect feeding sites resulting in external lesions rendering it unmarketable for export. This serious Mango fruit destructive pest expands its scope into the whole study area within in short period with high spreading through the help of external factors. The perception of study area farmers regarding this insect pest was almost nothing. As interviewed farmers responded they don't have any idea how to take an intervention measure to control this pest and among the interviewed nearly 9% of farmers said they are praying to God. During the interview, 73.3% of respondent farmers have not applied any management on their mango fruit farm to control this pest. Out of the interviewed 13.3% of farmers try to manage their fruit farm through weeding, pruning, burning dropped leaves and residues, applying Urea and compost fertilizer, hoeing and earth up around mango roots, fumigating with fire smoke applying ash etc. The rest 4.4% of farmers are waiting for government support to control this pest as they said. Even though this insect pest is a devastating pest of mango fruit, however, it can be controlled through different management practice applications as different scientists and scholars have done elsewhere. Therefore, the management practice of this pest is categorized into three such as cultural, biological and chemical. Via cultural management by applying Mango tree management pruning, using resistant planting materials, planting at proper spacing, cleaning or sanitation, burying infected residues and fruits, smoking by using different prepared repellents of dry grass, animal dung, mango leaves and lemon bark or lemon mixing all organic materials in one smoking can/pot which has whole at the bottom and hanging inside mango tree. Foliar Spraying of various botanical extracts such as Neem seed extract (*Azadirachta indica*). Several concoctions made from ash, soap and goat urine were mixed and sprayed on infested mango fruit leaves and twigs. Biological weapons of the natural enemy used to control WMS insects are different predators and parasitoids such as Aphenilind parasitoid (*Aphytis chionaspis*). Soil drenching of systemic chemical insecticides also can control this insect pest. Habtamu *et al.* (2020) reported that culturally controlling methods were practised by Ethiopian farmers like smoking plant debris under a mango tree by using fallen mango leaves, grasses, weeds, and animal dung within the mango orchard areas has chase the insect pests away from the fruit trees. As reported by Otieno (2021) cultural and agronomic practices of using resistance variety, proper planting space, tree management via pruning, scouting, smoking by using repellent organic materials, parasites and predators and using chemical insecticides are effective and recommended practices for preventing the prevalence and control of this insect pest. Similar findings by Fita *et al.* (2020) reported that *Azadirachta indica* seed powder water extracts have a better impact on knocking down the population of *Aulacaspis tubercularis* and it can potentially be used for the management of the newly emerging and inflicting mango pest *A. tubercularis*. The research result of Siam and Othman (2020) confirmed that the Botanical extracts of garlic and aloe combination were superior in its lethal effect in seasons 2017 and 2018 as it decreased the scale insects ratio to 37.98, 59.35 and 80.002% after 1, 3, and 7 days spraying interval respectively. The finding result reported by Habtegebriel *et al.* (2020) confirmed that the integrated use of a systemic soil-drenching insecticide (Thiamethoxam 25% WG) and tree management can significantly reduce the number of WMS life stages on infested mango trees indicating that it is a promising approach to the control of the WMS.

Conclusion

This invasive white mango scale insect spread throughout the country after first prevalence in western parts of Ethiopia at Wolega zone of Oromia region in green focus private mango farm since 2010. Then after, it took only six years to arrive at these study locations. White mango scale insects were transported with external forces like wind, birds, insect pests, infested planting materials and the bags that held the infested mango fruit. At these study locations of Boloso Sore and Boloso Bombe districts, it occurred since 2016 and at the time its infestation percent was only below four percent of mango farms.

Even though this insect pest is a devastating pest of mango fruit however, it can be controlled culturally by pruning, planting resistant plant materials, planting at proper spacing, cleaning or sanitation, burying infected residues and fruits, and smoking repellents. Different natural enemies of predators and parasitoids can control WMS insects biologically. Foliar spraying of botanical extracts also can prevent mango fruit damage from this insect est. Soil drenching of systemic chemical insecticides also can control this insect pest.

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Conflict of interest

The authors declared that have no conflict of interest.

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