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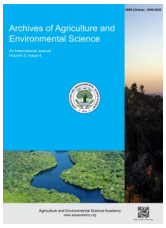

ORIGINAL RESEARCH ARTICLE

Assessments and identification of major insect pests on sweet orange (*Citrus sinensis*) in the field at Darasalaam district, Somaliland

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ABSTRACT

A field survey was carried out in 2024 to assess major insect pests of sweet orange in Darasalaam district. Among three extensive sweet orange-growing villages namely Maluugta, Horri-Haadlay, and Kal-Qoray were selected. A total of 214 sweet orange orchards were assessed and the study applied a purposive sampling technique for both qualitative and quantitative approaches. In order to quantify qualitative phenomena related to the ranking of the common insect pests on sweet orange orchards, indexing was carried out. The obtained data was coded and subjected to SPSS version 20. The result showed, that a leaf miner, mealy bugs, brown scale insects, citrus black flies, fruit-sucking moths, and pysllids were identified as major insect pests on all range farms. These major insect pests were ranked by individual respondents of farmers with 6 as the highest rank and 1 as the lowest rank. Weightage was given for the ranked position as 1.6, 1.1, 0.79, 0.42, 0.20, and 0.06 for first, second, third, fourth, fifth, and six positions respectively. Likewise, according to major reasons for incidence, climate change received an index of 1.40, placing it in the first rank, followed by poor management practices, lack of knowledge, weak planting material and poor soil fertility status were indexed 0.41, 0.19, 0.08 and 0.02, respectively. This study provides benchmark information about major insect pests of sweet oranges in the field in order to develop an effective and safe insect control strategy for the orange farms in Darasalaam district.

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INTRODUCTION

Sweet orange (*Citrus sinensis* L.) is the most widely grown fruit crop throughout the world (Ekpete *et al*., 2013). The woody, evergreen, perennial citrus shrub (Citrus spp.) is grown for its distinctive, non-climacteric fruit, which resembles berries (Kader, 1992). Sweet orange is a member of the Rutaceae and Aurantioideae sub-families, and it is one of the most economically important horticultural crops (Musasa, 2017). It is a compact perennial tree that usually grows to a height of 7.5 meters, though it occasionally exceeds 15 meters (Etebu & Nwauzoma, 2014). Sweet orange (*Citrus sinensis*) is the most popular citrus fruit cultivated for commercial purposes globally (Fu *et al*., 2011), which also contributes microelements to the human diet (Economos & Clay, 1999). It is locally termed as Liin macaan, and it is one of the highly demanded fruit crops in Somaliland (MoAD, 2007). It is believed that oranges originated in Southeast Asia and were first cultivated in China around 2500 BC, where it was referred to as a "Chinese" apple (Ehler, 2011). These fruits play a significant role in the human diet and rich in simple sugars, dietary fiber, amino acids, vitamins, and minerals (Rouseff & Nagy, 1994; Economos & Clay, 1999). Hesperidin, narirutin, naringin, and eriocitrin are the main flavonoids found in citrus species (Ghasemia *et al*., 2009).

Citrus sinensis represents the largest citrus cultivar groups grown around the world, accounting for 70% of the total annual production of Citrus species. Today it is grown commercially worldwide in tropical, semi-tropical, and some warm temperate

regions to become the most widely planted fruit tree in the world (Ehler, 2011). The FAO reports that 75.5 million tons of sweet oranges are produced each year on more than 3.8 million hectares of land globally (FAOSTAT, 2020). Top producing countries are Brazil, India, China and United State with 16.7, 9.8, 7.6 million tons respectively (FAOSTAT, 2020). According to Oke *et al.* (2020), South Africa and Nigeria are the largest producing countries, while in Africa Tanzania has become the largest citrus producer after Kenya. Despite there is no reliable available comprehensive data on orange production in Somaliland, but orange production is scattered throughout the country. Due to a number of biotic and abiotic factors, citrus production has been reduced globally (Farnsworth *et al*., 2014). Among biotic factors; insects are major constraints in citrus production (Tena Garcia, 2011). Insect pests are one of the most important constraints of citrus production in the world. Numerous insect pests and disease are attacked by citrus plants, which reduce quantity and quality of fruits (Mahmood *et al*., 2014). Major insect pests of citrus crop are citrus leaf miners (*Phyllocnistis citrella*), citrus psyllids (*Diaphorina citri*), citrus fruit flies (*Bactocera minax* and *B. dorsalis*), citrus whiteflies (*Dialeurodes citri*) and citrus mealy bugs (*Drosicha mangiferae* and *Planococcus citri*) (Tahir *et al*., 2015).

Citrus cinesis production, is a component of the horticulture industry, has a potential in the provision of employment, generation of income and improving the nutritional status for the Somaliland people. In Somaliland, Cit*rus cinesis* is one of the key fruit crops rank after Papaya, yet its present status is threatened by a number of problems, including low production caused by insect pests (Mohamed, 2023). Orange farming occurs as part of intercropped with other crops, vegetables and non-orange trees. Orange fruits are one of Somaliland's most important horticultural cash crops and fruits are sold fresh to the local markets. It is grown in most regions of the country with highest production mainly occurs in the western regions (Abdiraxmaan, 2019). Despite no detailed study has been reported yield losses of sweet orange due to insect pests' infestation in Somaliland. In Somaliland insect pests are the predominant problem on crops which leads significant nutritional and yield loss of 20%-80% due to the failure to implement timely pest management practices (Ahmed, 2020). As with other fruits, *citrus sinesis* is attacked by several pre-harvest insect pests causing severe direct and indirect losses throughout the country (MoAD, 2024). In any parts of Somaliland, citrus orchards have been experiencing serious decline, Low yields and stagnation of production due to insect pests and diseases (MoAD, 2023). Such problems are sometimes accentuated by nutritional deficiencies, age of the plants, shortages of land, pest and diseases, declining government support, increasing competition from imports and lack of credit/investment capital (Abdicasiis, 2022). However, the available information about occurrence, prevalence, incidence, severity, distribution and, the extent of damage of major insect pests of sweet orange in Somaliland is very limited. Thus, this study was initiated to assess and obtain basic knowledge on major insect pests of sweet orange in the field in order to develop an effective and safe insect control strategy that are sustainable and compatible with citrus farmers' conditions in Darasalaam District. Therefore, the outcomes of this study will provide a base line of information for researchers, scientists, farmers and Ministry of Agricultural Development in Somaliland and other stockholders.

MATERIALS AND METHODS

Description of the study area

In 2024, a field survey was conducted in the main *citrus sinesis* growing areas in Darasalaam District (Figure 1). It locates 30 km north of capital city of Somaliland Hargeisa city, and sits at an elevation of 1,276 m. Its location is 9°33'32"N, 44°3'35"E. The altitude of the district is situated in between 1400 and 2000m above sea level and characterized by having a bimodal rainfall autumn and spring. It receives the bulk of precipitation averaging 300- 600 millimeters annually, whereas average maximum temperatures were 30 °C (MOAD, 2022). In the district the highest temperatures were observed in March, and coldest moth was experienced in December. In the study areas, the dominant features of the soil's physical properties are a sandy, loamy texture. Mixed farming systems are well experienced in this district. Sweet Orange is the major fruit tree crop cultivated and it is leading citrus producing area across the country.

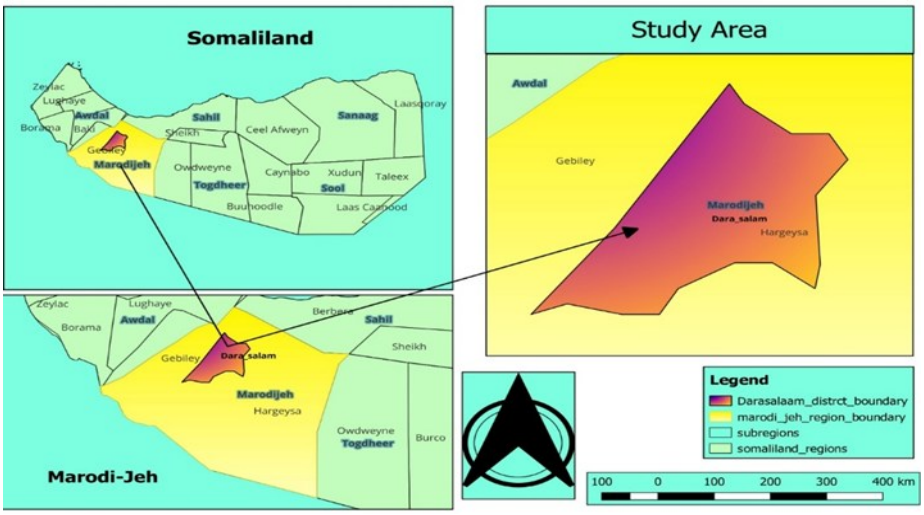

Figure 1. *Map showing the study area (Source: MoAD, 2024).*

Sampling methods and data sources

Among 19 agricultural villages under Darasalaam district, 3 main hubs sweet orange-growing villages, namely Maluugta, Horri-Haadlay, and Kal-Qoray, were selected based on production potential and the importance of insect pests. Regarding our sampling method, a purposive sampling technique was applied for the selection of farmers. During the surveys, primary data were collected by using structured and semi-structured questions to collect a range of information related to the farmers' demography, their socioeconomic, sweet orange varieties, farming experience, biotic constrains, seasonal incidence of insect pests, management practices of insects with consideration major insect's pests in the field. The total of 214 farmers were selected and sampled by using the formula given by Yamane (1967).

$$n = \frac{N}{1 + N(e)^2}$$

n = sample size N = population size e = sampling error ^ = raised to the power of.

Indexing and Scaling

In order to quantify qualitative phenomena related to the ranking of the main insect pests on sweet orange orchards, indexing was carried out. Scaling technique provides the intensity of respondents towards the propositions (Miah, 1993). The equation was used to index and rank the most prevailing insects in the study area.

$$Iimp = \sum (Si \times Fi / N)$$

Where, Iimp = Index of importance; Si = Scale value at i^{th} severity; Fi = Frequency of i^{th} severity; N = Total number of respondents; ∑ = Summation.

Data analysis

Based on the objectives of the study, descriptive statistics model was applied. Statistical Package for Social Sciences (SPSS) version 20 was used to analyze the collected data. Descriptive statistics such as frequency and percentage distribution, were employed to analyze the quantitative data.

RESULTS AND DISCUSSION

Sweet orange varieties and farming experience

According to the sweet orange varieties obtained from the interviewed farmers. The results showed that 44.4% of the farmers were cultivated Xayfa variety, followed by Xiindoob variety 9.8%, while 45.8% cultivated both varieties (Figure 2). This refers to the Darasalaam district Office of Agriculture report 2015, which reported that both Xayfa and Xiindoob varieties, are widely distributed in Darasalaam due to their high yield and presented a good potential to resist diseases and to adopt variability of rainfall patterns. According to years of sweet orange farming experience approximately 83.2% had more than 20 years of farming experience oranges, 6.5% were cultivating 5-10 years, and 8.9% for 10-15 years. The study site with the shortest duration of farming sweet oranges, less than 5 years, accounted 1.4%. The study gets support from Mukhtaar (2019), who reported cultivation of sweet oranges in the Darasalaam region is transferring from one generation to another.

Planting position and planting propagation material

Form the farmland, the study revealed that 91.1% of the farmers had planted their sweet orange in the mid-portion of the field while (8.9%) cultivated edge of the farms. FAO (2011) reported that trees planted on the edges of the terraced field encounter stones in their root zone suffer malnutrition, and are more prone to decline. On the other hand, it has been found that most of the farmers used grafted saplings (62.1%), followed by mixed planting materials of seedlings from seed and grafted (30.4%), and only 7.5% of the farmers used seed. This result indicated that majority of famers used grafted saplings. These findings are in conformity with. Mortton (1987) indicated that propagation of sweet orange through seed is associated with problems like poor pollen production, self-incompatibility, and muscular embryo. Likewise, Dagnew *et al*. (2014), indicated that most commonly-used rootstocks is sour orange.

Figure 2. *Abu-xundub and Xayfa sweet orange variety.*

Table 1. Sweet orange varieties produced in Darasalaam district.

Variety type	Study sites				
Variety	**Maluugta**	**Horro-Hadley**	**Kal-Qoray**	**Total**	**Percentage**
Xayfa variety	41	24	30	95	44.4
Xiindoob variety	5	9	7	21	9.8
Both varieties	19	69	10	100	45.8
Farming experience					
1-5 years	2	0	1	3	1.4
5-10 years	4	5	5	14	6.5
10-15 years	7	9	3	19	8.9
More than 20 years	52	88	38	178	83.2

Source: Field Survey, 2024

Table 2. Planting positions of sweet orange trees.

Planting position	Study sites				
Position	**Maluugta**	**Horro-Hadley**	**Kal-Qoray**	**Total**	**Percentage**
Middle of the field	59	92	44	188	91.1
Corner of the field	6	10	3	26	8.9
Plant material used					
Seed propagated	4	9	3	16	7.5
Grafting	48	56	29	133	62.1
Mixed	13	37	15	65	30.4

Source: Field Survey, 2024

Table 3. Ranking of the insect pest that occurred in the study area.

Ranking of the insect pest		
Insect pest	**Index**	**Rank**
Mealy bugs	1.28	I
Leaf miner	1.14	II
Fruit sucking moth	0.64	III
Citrus black fly	0.26	IV
Psyllid	0.19	V
Red scale insects	0.14	IIV
Ranking of major reasons for insect incidence		
Lack of effective insecticides	2.88	
Climate change	1.40	I
Poor management practices	0.41	II
Lack of knowledge to type of insects	0.19	IV
Weak planting material	0.08	V
Poor fertility status of soil	0.02	IIV

Source: Field Survey, 2024

Table 4. Disease control methods and training status.

Management	Study sites				
	Maluugta	**Horro-Hadley**	**Kal-Qoray**	**Frequency**	**Percentage**
Cultural control	7	11	2	20	9.3
Botanical control	0	0	0	0	0
Chemical control	58	91	45	194	90.7
Biological control	0	0	0	0	0
Training status of the farmers					
Yes	2	5	0	7	3.3
No	63	97	47	119	96.7

Source: Field Survey, 2024

Ranks and major insect pests

In the present study, it was observed ranks and major insects' pests' in Table 3. After a field visit of sweet orange orchards, a total of six economically important insect pests were reported as key insect pests. Infestation was dominated by mealy bugs followed by leaf miners, fruit-sucking moths, citrus black flies, psyllid, and red scale insects (Figure 3). In addition to that insect pests were ranked by individual respondents with 6 as the highest rank and 1 as the lowest rank. Weightage was given for the ranked position as 1.28, 1.14, 0.64, 0.26, 0.19, and 0.14 for first, second, third, fourth, fifth, and sixth positions respectively. This is study is consistent with Sundari & Santhi (2006) who reported Red scale, leaf miner, Mediterranean fruit fly, false codling moth, thrips, aphids and bud mites were identified as a major pest on all citrus farms of Ethiopia. Farmers in the study sites were asked to rank major reasons for insect pest incidence in the study area. According to the reasons of insect incidence climate change received an index of 1.40, placing it in the first rank, followed by poor management practices, lack of knowledge, weak planting material and poor soil fertility were indexed 0.4, 0.19, 0.08 and 0.02, respectively. Notably, the lack of effective insecticides, despite its high index of 2.88, was not ranked, indicating it may not be considered a primary reason in this context.

Seasonal incidence of insect pests

As depicted in Table 4, farmers reported a number of dominant insects' pests that affected their produce. Mealy bugs' leaf miners, fruit-sucking moths, citrus black flies, pysllids, and red scale insects were regarded as the major insect pests, these pests severely limit or totally decimate sweet orange production (Figure 4). High incidence and peak multiplication of pest population were observed. From March to October in mealy bugs, May to October for leaf miners, May to September for fruit-sucking moths, April to September for citrus black flies, April to October for pysllid, and March to November for red scale insect infestations. Our results are in agreement with Hared (2014) who documented that insect pests of economic importance are recorded at their peak population during the summer season (intermediate season), because, during this time of the year there are ample food resources and climatic factors are conducive.

Figure 3. *Leaf miner damage and red scale insect infestation on fruits.*

Figure 4. *Citrus black flies and mealy bug infestation over the leaves.*

Table 5. Seasonal incidence of insects' pests.

Insect pests	Emergence	Peak season	Disappear
Mealy bugs	March	March – October	December
Leaf miner	March- April	April – October	November-December
Fruit sucking moth	April	May - September	December
Citrus black fly	April	April- September	December
Psyllid	March –April	April – October	December-January
Red scale insects	March	March - October	November

Source: Field Survey, 2024

Insect pests' management practices and training status of the farmers

During the survey, farmers were widely relied on synthetic insecticides to manage insect pests in their orchards (90.7%). In contrast, cultural control was depicted by a much smaller proportion of farmers (9.3%) across the study areas, while none of the farmers did not practice any botanical control (0%). Cultural control is mainly done through orchard sanitation to reduce insect population and infestation levels by removing infested fruit both fruit on the ground and hanging from trees. In a similar study, Barre (2021) recorded that the insects are generally controlled by means of pesticide application in Somaliland farms. In this study farmers were asked to indicate whether they had received any training or extension field staff related to pests and their management. Overwhelming majority (96.7%) of the farmers across the study sites revealed that they haven't received any training, while few growers highlighted that they receive training and extension services (3.3%). This finding is line with Faa'is (2020) who indicated that providing training can introduce farmers to modern agricultural practices like improved pest management, soil conservation, organic farming, climate-resilient crops, and water-saving techniques that can increase crop yields and farm output.

Conclusion

On the basis of findings, it is concluded that there are six economically important insect pests in the study area. Infestation was dominated by mealy bugs followed by leaf miners, fruit-sucking moths, citrus black flies, Psyllid, red scale insects and these pests effect the yield of and also deteriorate fruit quality. In addition to that insect pests were ranked by individual respondents with 6 as the highest rank and 1 as the lowest rank. Weightage was given for the ranked position as 1.28, 1.14, 0.64, 0.26, 0.19, and 0.14 for first, second, third, fourth, fifth, and sixth positions respectively. According to insect pest incidence a peak emergence and multiplication were observed in the summer season.

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DECLARATIONS

Authors' contribution

Conceptualization, Methodology: J.B and M.M.; Software, validation: J.B; Investigation: J.J. and M.M.; Data curation: J.B.; Writing -original draft preparation: J.B, M.M and N.E.; Writing-review and editing: J.B.; Supervision: J.B., M.M. and N.E. All authors have read and agreed to the published version of the manuscript.

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Supplementary data: No supplementary data is available for the paper.

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