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Distribution and damage status of moringa moth (*Noorda blitealis* Walker) on *Moringa stenopetala* Baker (Cufod.) in Southern Rift Valley of Ethiopia

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Moringa stenopetala Baker (Cufod.) commonly called as African Moringa, is a native or endemic multi-purpose tree species in East Africa. An insect pest, moringa moth (*Noorda blitealis* Walker) has become an important pest on moringa trees in Southern Rift Valley of Ethiopia. The present study was carried out to determine the distribution and damage status of moringa moth (*N. bliteails*) on *M. stenopetala* in the study areas of Konso, Derashe and Arbaminch Zuria districts of Southern Rift valley of Ethiopia. Qualitative and quantitative data of defoliation severity were collected during the periods of heavy defoliation in major and minor rainy seasons of the year 2011. The damage rating values were taken by using the Arc GIS 9.3 and Arc GIS 10.0 softwares and the SNNPR data map of Ethiopia was used to make the distribution map. The visual damage rating mean values of the trees and the defoliation percentage were determined with respect to seasonal variations, cropping systems, altitudinal differences, and host plant age differences. The extent of defoliation by moringa moth was recorded maximum during the major rainy season than minor rainy season and the reduced leaf biomass production of moringa trees (31-70%) were recorded during the month of July at the mixed- cropping system condition and more than75% recorded during the months of July and December for mono-cropping system condition. Moderate to severe defoliation was recorded within the altitude range of 1200- 1600 m. a. s. l. The leaves of old trees having large trunk and canopy size were more resistant to moringa moth attack than the leaves of younger trees that have relatively small trunk and canopy size during both the major and the minor rainy seasons. Succulent and younger leaves were grown after continuous and periodic leaf harvest, which were more susceptible for attack by moringa moth larvae than tender and older leaves which stayed for longer periods on the tree without continuous harvest. This study was helpful in identifying the gaps concerning the basic information on spacial and seasonal distribution of moringa moth in these areas of Ethiopia. Further study could be conducted on various methods of managing this pest on moringa trees and growers may have enough quantity and better quality of moringa vegetables that could be produced.

Key words: *Moringa stenopetala*, *Moringa moth*, *Noorda blitealis*, distribution, damage status, larval density.

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Introduction

Moringa stenopetala Baker (Cufod.) belongs to the family Moringaceae and commonly called African moringa or cabbage tree. It is a native or endemic multi-purpose tree species in East Africa which is grown in Southern Ethiopia, Northern Kenya and Eastern Somalia (Grubben and Denton, 2004). This tree is one of the most frequently cultivated indigenous species for its palatable leaves in the semi arid areas of Konso, Derashe and Arbaminch Zuria districts of the Southern Rift Valley of Ethiopia and locally called as "*haleko*" or "*shiferaw*". It is also cultivated from the lower Omo Valley to the north and in the neighboring regions of South Omo, Gamo Gofa and Borena (Grubben and Denton, 2004).

It is a multi-purpose miracle tree with tremendous potential uses such as food for human beings, feed for livestock, medicine, dye, perfume, skin lotion, lubricant and water purification (Agena, 2009). The moringa leaves are nutritionally rich and an excellent source of concentrated proteins, vitamins and minerals (Armelle de and Melanie, 2010). In Konso, Derashe and other growing districts of Southern Rift Valley of Ethiopia, the leaflets of moringa trees are used in the daily meal of the people. The leaflets are separated from the rachis then stripped and plunged into boiling water with salt or sodium carbonate and cooked to be consumed as vegetable combined with maize and sorghum flour to prepare the widely known local meal "*kurkufa*" and "*cheka*" (Agena, 2009). It has also potential medicinal uses such as: the root bark is being used to kill different kinds of intestinal worms, increases food appetite, to protect abdominal constipation, cure for different kinds of respiratory diseases such as bronchitis and influenza and the stem bark is being used to treat eye diseases, intestinal worms, and to decrease or neutralize the venom power of snake, bee, scorpion and wasp (Grubben and Denton, 2004). The leaves are also being used to cure wounds, to protect vomiting, and facilitate digestion process, reduce hypertension and solve diabetes problems. The seed oil is being used to treat rheumatism, cold problems, goiter, liver and pancreatic diseases. In the Konso area of Ethiopia, the smoke from burning roots are being used as a treatment for leprosy and the leaves are renowned for their effectiveness against diarrhoea (Makonnen *et al*., 1997).

However, in the Southern Rift Valley of Ethiopia, where moringa cultivation has been widely practiced on farmlands and inside compounds, the insect-pest problem has been observed as major production constraint. An insect pest known to be moringa moth, *Noorda blitealis* Walker (Lepidoptera: Crambidae: Noordinae) is causing extensive damage to the leaves of moringa trees mostly during the rainy seasons (April –August) (Agena, 2009). The pest outbreak is known to appear twice in a year, even though the extent of

incidence varied. During the severe damage periods of moringa moth, the whole branches of moringa trees appear to be defoliated and leave the local urban and rural people with no choice for vegetables (Agena, 2009). Even though this tree is resistant to most insect-pests and diseases, the green leaf caterpillar of moringa moth, defoliates the foliage of the tree causing extensive damage. Infestation in mature plants results in partial or complete defoliation which in turn cause reduced growth. This will aggravate the loss in potential of the plant to withstand the rigors from other biotic and abiotic stresses.

So far, limited work on the distribution and damage status of this pest has been reported in moringa growing areas within the Southern Rift Valley areas of SNNPR, Ethiopia. Estimation of the damage status and insect pest population is needed in decision making for pest management programs for better cultivation of the crop. Hence, this study was conducted to study the distribution and damage status of moringa moth (*Noorda blitealis* Walker) on *M. stenopetala* in different localities of major moringa growing districts of the Southern Rift Valley of Ethiopia and also to prepare the distribution maps of moringa moth in the major moringa growing districts of the study areas.

Materials and methods

Description of the study areas

The study was conducted in three major moringa growing districts in the Southern Rift Valley of SNNPR, namely: Arbaminch Zuria, Derashe and Konso. Arbaminch Zuria district is in Gamo Gofa zone and Derashe and Konso districts are in Segen zone of SNNPR, Ethiopia (Figures 1 and 2). The study area is located at the southern part of the country within GPS coordinate location of 5^{o}-6^{o} N and 37^{o}- 37^{0}30'E. It is a vast area covering around 22,500 km^2 and endowed with mountainous rugged highland topography with vast plain lowlands. The mean annual rainfall and temperature of these areas are 750mm and 27^{0}C respectively. The area has bimodal climate, the major rainy season is the 'belg' season from March to May, and the minor 'meher' season is from September to November both in the lowland and highland areas. '*Hagaya'* is called minor rainy season from August to October in Derashe and Konso areas. Soil in the study areas are majorly characterized by black color with high clay content and water holding capacity, it cracks during dry season of the year and hence it is vertisol in its origin. In the rugged mid-highland areas of Derashe and Konso remnants of volcanic ashes predominantly exist indicating the surrounding soil to be cambisol in its origin (KWOA, 2010).

Distribution of moringa moth and preparation of distribution map

The survey work on moringa moth distribution was conducted in the three major moringa growing districts namely: Konso, Derashe and Arbaminch Zuria. These areas are hot spots for this insect during rainy seasons. Besides these areas, other neighboring districts were also included for observations. Global Positioning Systems (GPSs) and sketch mapping techniques, supplemented with ground surveys provided the major sources of information on the extent and severity of insect-induced tree defoliation (Simson and Coy, 2009). Using GIS techniques and the survey work the map of the areas where the green leaf caterpillar of moringa moth was found during both seasons of the year 2011 in and outside the study areas was made. For mapping, the necessary area coordinate points were taken inside and outside the study areas where moringa trees are being cultivated. Garmin 60 GPS, Arc view 3.3, Arc GIS 9.3 and Arc GIS 10.0 softwares were used for the analysis and mapping the distribution and prevalence of the pest. Data map for the study areas were obtained from SNNPR Finance and Economy Development Bureau and GIS experts of Arbaminch Municipality and Gamo Gofa zone. Finance and Economy Department participated in formulating and manipulating the Arc view to get maps in JPEG. Larval density and defoliation severity rating values were also used to show the infestation severity status of moringa moth in the distribution map.

Methods of surveying, data Collection and analysis

The structured and semi- structured interviewing methods were used for survey. During this work, everyone who participated in the discussion answered a set of specific questions about moringa, moringa moth, their interaction and other relevant questions. Both qualitative and quantitative data collection methods were used. Qualitative data were obtained through methods such as interviews, on-site observations and focus group discussions (Fig. 3). Quantitative data included both primary and secondary data were taken from field conditions and from documents of relevant offices. The collected data gave the necessary information about the actual situation of the research work. Participatory data collection strategies were used by interacting and discussing with farmers within the study areas about the moringa, moringa moth and their interactions. There were ten respondents per PA, a total of 120 respondents were interviewed with the checklists was prepared. The respondents represented diversified groups of the society considering age, sex, educational status, occupation and other aspects of sampling. Issue of gender was properly addressed. Women were included so as to make the study more responsive

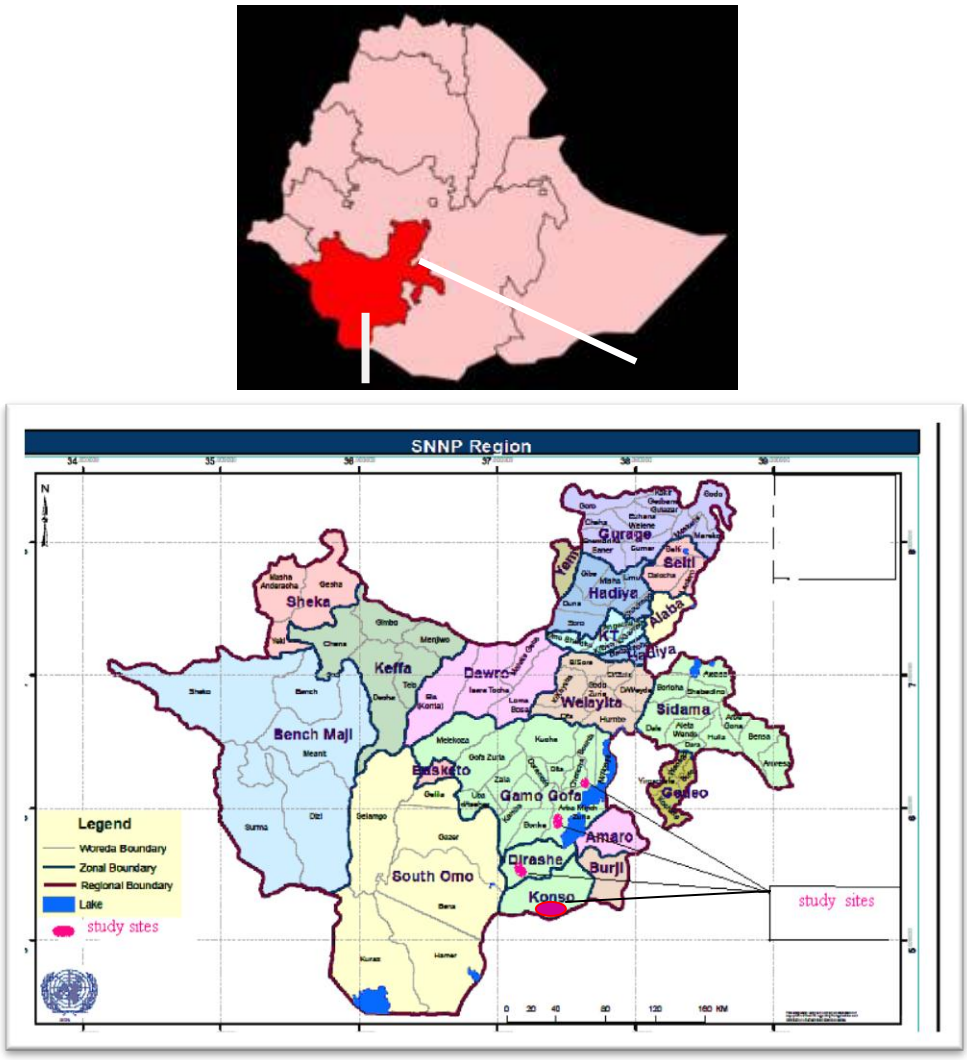


Fig. 1. Geographical location of the study areas, Ethiopia

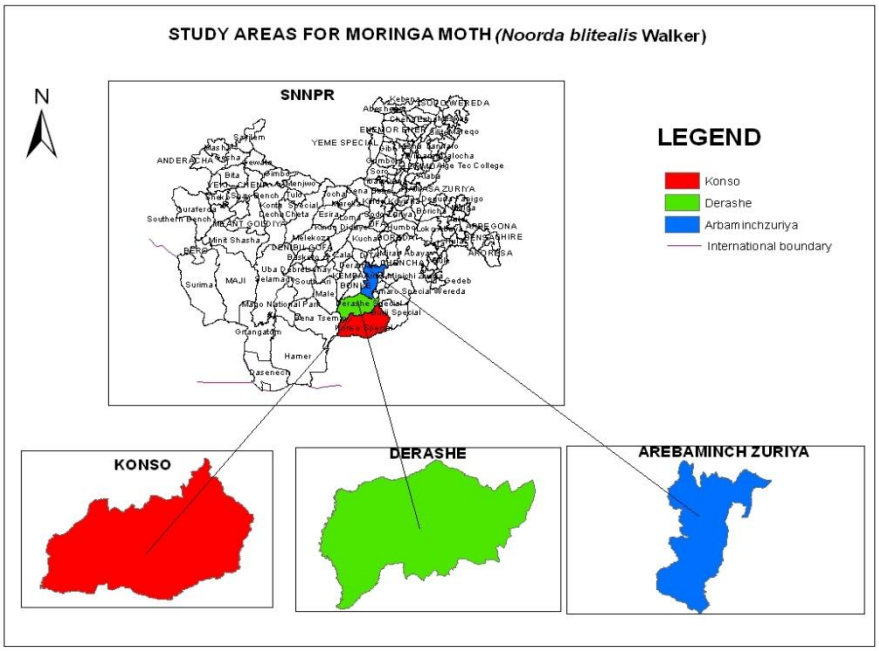


Fig. 2. Map of the study area

From all the respondents requested, 26% of them were females and 74% were males. All of them were farmers and dwellers of the respective kebele. The issue of gender was properly addressed eventhough the proportion of males to females differs due to sampling limitations. All respondents of various age groups were selected based on the predetermined age classes. From all the respondents involved in the questionnaire, the majority of them were 31 and 45 years of age having total percentage value of 58%. This was followed by those whose age was 45 to 60 having a percentage value of 24%, and those whose age is 18 to 30 years old were 18% from the total respondents. For describing sampling sites, information such as GPS readings, distances from visual cues (e.g. 100 meters from road side), or any distinguishing topographic features were recorded. The data obtained from the field and questionnaires were analyzed using Ms- Excel and Statistical Package for Social Sciences (SPSS-17). Statistical mean values were computed for quantitative data by looking at average scores (mean values) of field observation results of sample trees. Average scores of field survey results for the parameters were compared with leaf damage (defoliation extent).

Fig. 3. Discussion with local farmers in the study areas at different sites.

Estimation of defoliation extent

Four representative kebeles from each district were chosen making a total of 12 kebeles for the whole study. All the 12 kebeles are major moringa tree producing kebeles within the Southern Rift Valley areas of SNNPR from Konso district, Gaho, Mechelo, Doketu and Sorobo kebeles; from Derashe district, Onota, Holte, Hybena and Walayte kebeles; and from Arbaminch Zuria district, Wozeqa, Shele mela, Chano mille and Lante kebeles. These rural kebeles are highly populated and the people in these areas practice mixed farming to be their major way of life. Stratified random sampling was used and 12 moringa trees from each kebele having age differences (young and old) were randomly selected. Trees were considered to be young if 5-15 years of age and old if above 15 years. Observations on defoliation started after commence of moringa moth. The defoliation status was evaluated using the visual damage rating scales of 0-4. The 12 trees (6 young and 6 matured/aged) were marked per kebele basis. Every week, medium sized branches were visually observed from all the directions of the tree crowns for rating purposes. The extent of damage on sample trees were rated from 0 to 4 (Belloti and Kawano, 1980). This was supported with illustrations for the purposes of rating sample trees as shown in Figure 4.

Fig. 4. 0-4 Score defoliation rating index of moringa moth on moringa trees.

Percent defoliations were compared among cropping systems (mono cropping and intercropping conditions), seasonal variations (major and minor rainy seasons), altitudinal differences (lowland and high land) and host plant age differences (young and matured/old). Observations were taken during major rainy season in the month of July and minor rainy season in the month of December. The Mechelo and Gaho kebeles were seleced for the mixed-cropping case and Doketu and Sorobo kebeles for the mono-cropping case. Observations on the presence of the larvae of moringa moth and ultimately mean percent defoliation were recorded. The effect of cropping system in selected sample areas within the study area was conducted. The major cropping systems considered were mixed-cropping and mono-cropping. Under these two circumstances, the study was basically conducted in Konso district where both farming systems is being practiced. The descriptions on the distribution map of the defoliation levels were obtained through visual damage rating. The defoliation percentages were considered as severe, moderate and light/low levels (Dellinger *et al.*, 2010).

Estimation of larval densities

Sampling on feeding of moringa moth larvae provides a reasonable estimate of defoliation and special distribution of the caterpillars over the tree canopies. Larval population was recorded during heavy infestation only from one kebele to show the relationship of larval density with defoliation extent. A sequential sampling system for estimating larval densities was used on 12 sample moringa trees sequentially at three crown levels on the month of December 2011 when the pest problem occurred at Kararo area of Doketu kebele of Konso district. Larvae of *N. blitealis* were counted randomly from 1square meter foliage of moringa tree from lower, middle and upper part of the crown to estimate per tree basis. Three branches from each part of the crown were selected. Counting the larvae by beating method was not applicable becausethe larvae are living in silken web. Thus, it was counted very carefully from the tree after marking the $1m^2$ area. Larval densities in relation to defoliation extent were described by phases for defoliating moths was done by using the rating procedure (Dellinger *et al*., 2010). Average larval density values were described as no/ low (<3 larvae/m^2 foliage), medium (3-30 larvae/m^2 foliage) and high (>30 larvae/m^2 foliage) which is positively correlated with low, moderate and severe defoliation extent values.

Basic information on moringa moth through questionnaires

The presence or absence of the moringa moth at its damaging stage, the major biotic and abiotic factors that contribute for its occurrence, distribution and damage status, the local names of the pest at different areas, the season at which it causes defoliation, the time at which defoliation stops, impacts of defoliation, which part and stage of the crop is susceptible for defoliation, other hosts of the pest, natural enemies observed, any traditional (cultural) method of combating the pest, other pests and diseases observed and other relevant information's were obtained through questionnaires and interviews, which served as input for developing management strategies for future work.

Results and discussions

Distribution of moringa moth in maps

The distribution maps made for moringa moth within the study areas for both the major and minor rainy seasons for the year 2011 provided an overview of the presence of moth, defoliation extent and severity of the pest (Figs. 5 and 6). It also provided information to conduct other ground and aerial sketch map surveys and other sophisticated remote sensing land satellite imaging to have high standard distribution map for this particular pest. The map was prepared for kebeles inside and outside (neighboring) the study areas which were affected by this particular pest. Areas with severe defoliation were marked with red, areas with moderate defoliation were marked with light red and areas with no defoliation due to the non-occurrence of moringa moth were marked with green on the distribution maps.

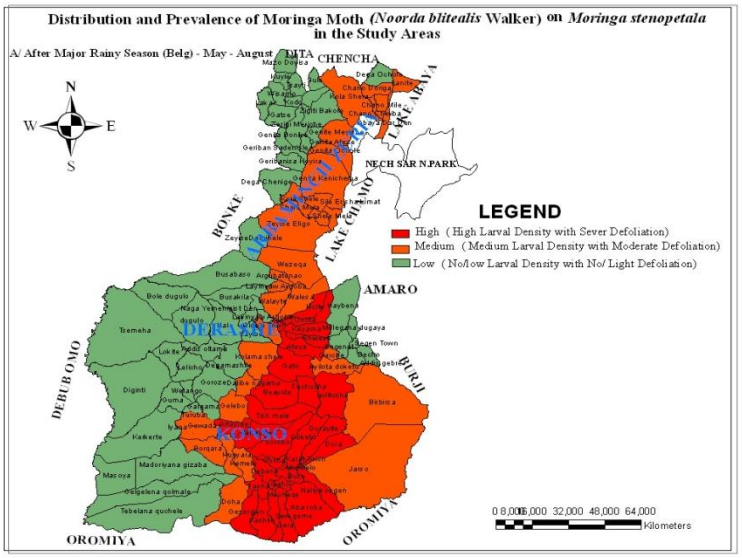


Fig. 5. Distribution and prevalence map of moringa moth on moringa trees in the study areas just after periods of major rainy season (May-August) in the year 2011.

Figure 5 shows the extent of defoliation caused by the moringa moth during the major rainy season of 2011 at some kebeles in Konso and Derashe districts. The kebeles in Konso district were recorded to have severe levels of defoliation at Fuchucha, Be-ayde, Lultu, Tishmale, Arfayde, Lehyte, Sorobo, Doketu, Dera, Durayite, Karat town, Gocha, Mechelo, Buso, Gamole, Debena, Fasha, Gaho, Naleya segen, Mecheqe, Abaroba, Sewgeme, Gera and Kashele. The kebeles in Derashe district were recorded to have severe levels of defoliation at Holte, Onota, Keyama, Shelelo, Ateya and Gato. Moringa moth caused severe defoliation during minor rainy season on 2011 only in some kebeles such as Sorobo, Doketu Durayite and Dera in Konso district. The distribution map also shows that moderate defoliation occured in Wozeqa, Zeyise Eligo, Shele Mela, Kola Shele, Ganta Kanchama, Kola Shara, Chano Mile, Chano Chalba, Chano Dorga and Lante kebeles in Arbaminch Zuria district for the major rainy season in the year 2011. But, there was no occurrence of the pest in its larval stage on moringa trees in Wozeqa, Shele Mella, Chano Mille and Lante kebeles of Arbaminch Zuria district during and just after the minor rainy season in the year 2011(Fig. 6).

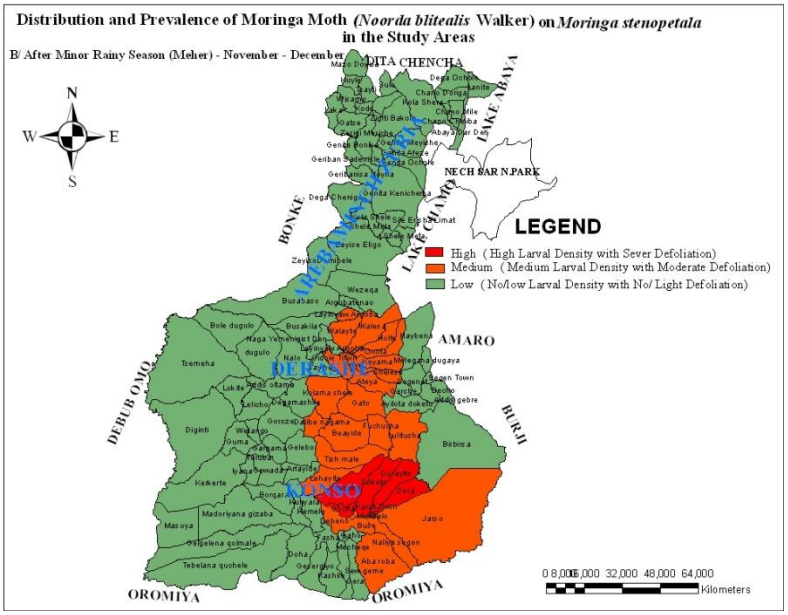


Fig. 6. Distribution and prevalence map of moringa moth on moringa trees in the study areas just after periods of minor rainy season (November- December) in the year 2011.

Estimation of larval density of moringa moth

The mean value of larval population was recorded maximum (21.4 larvae/m2) at lower crown and minimum (11.6 larvae/m2) at upper crown (Table 1). The variation in larval numbers at crown levels depends on the larval stage and might be due to larval movement towards lower side for pupation. High defoliation was observed on crown levels where high number of larvae was observed and also high numbers of larvae were present and feeding on twigs having greater foliage biomass. Such type of phenomenon was also observed on other moringa trees beside trees under the study. Similar findings were also previously reported by Alfaro (1991); Dechasa (1995) and Agena (2005).

Defoliation percentage of moringa moth on moringa trees

The distribution and prevalence of moringa moth have direct effect on the defoliation status on moringa trees. The defoliation severity mean values of the sample trees in major and minor rainy seasons were shown in Table 2 and Fig. 7.

Table 1. Larval density of *N. blitealis* on *M. stenopetala* during infestation period in December, 2011 at Doketu kebele of Konso wereda

Sample Tree	No. of larvae observed per m^2 of foliage			Total	Mean
	At lower crown	At middle crown	At upper crown		
1	12	18	10	40	13.3
2	35	31	25	91	30.3
3	16	10	8	34	11.3
4	6	17	7	30	10.0
5	24	20	12	56	18.6
6	36	28	12	76	25.3
7	14	9	5	28	9.3
8	22	26	19	67	22.3
9	5	7	4	16	5.3
10	28	11	10	49	16.3
11	24	14	12	50	16.6
12	35	15	16	66	22.0
Total	257	206	140	603	200.6
Mean	21.4	17.2	11.6	50.2	16.7
SEm	1.96	0.095	2.41	4.46	1.48

Table 2. The defoliation severity values of moringa trees by moringa moth during the major and minor rainy seasons in the Year 2011

No.	District	Kebele	Sample trees (average)	Major rainy season-Defoliation severity mean value(0-4 Scale)	Minor rainy season-Defoliation severity mean value(0-4 Scale)
1	Konso	Gaho	GY	2.2	0.0
			GM	1.5	0.0
		Mechelo	MY	2.8	0.5
			MM	1.3	0.3
		Doketu	DY	3.5	3.6
			DM	3.2	2.2
		Sorobo	SY	3.5	3.3
			SM	2.9	2.9
2	Derashe	Onota	OY	3.2	1.3
			OM	2.4	0.8
		Holte	HoY	3.4	2.1
			HoM	2.2	0.9
		Hybena	HY	2.2	0.0
			HM	1.6	0.0
		Walaite	WY	2.3	1.0
			WM	1.3	0.3
3	Arbaminch Zuria	Wozeqa	WoY	3.1	0.0
			WoM	2.2	0.0
		Shele Mella	SmY	3.1	0.0

	SmM	2.1	0.0
Chano Mille	CmY	3.0	0.0
	CmM	2.3	0.0
Lante	LY	2.8	0.0
	LM	2.2	0.0

*Y= Young moringa trees:M= Matured/Old moringa trees; other capital letters represent the first letter of Kebele names.

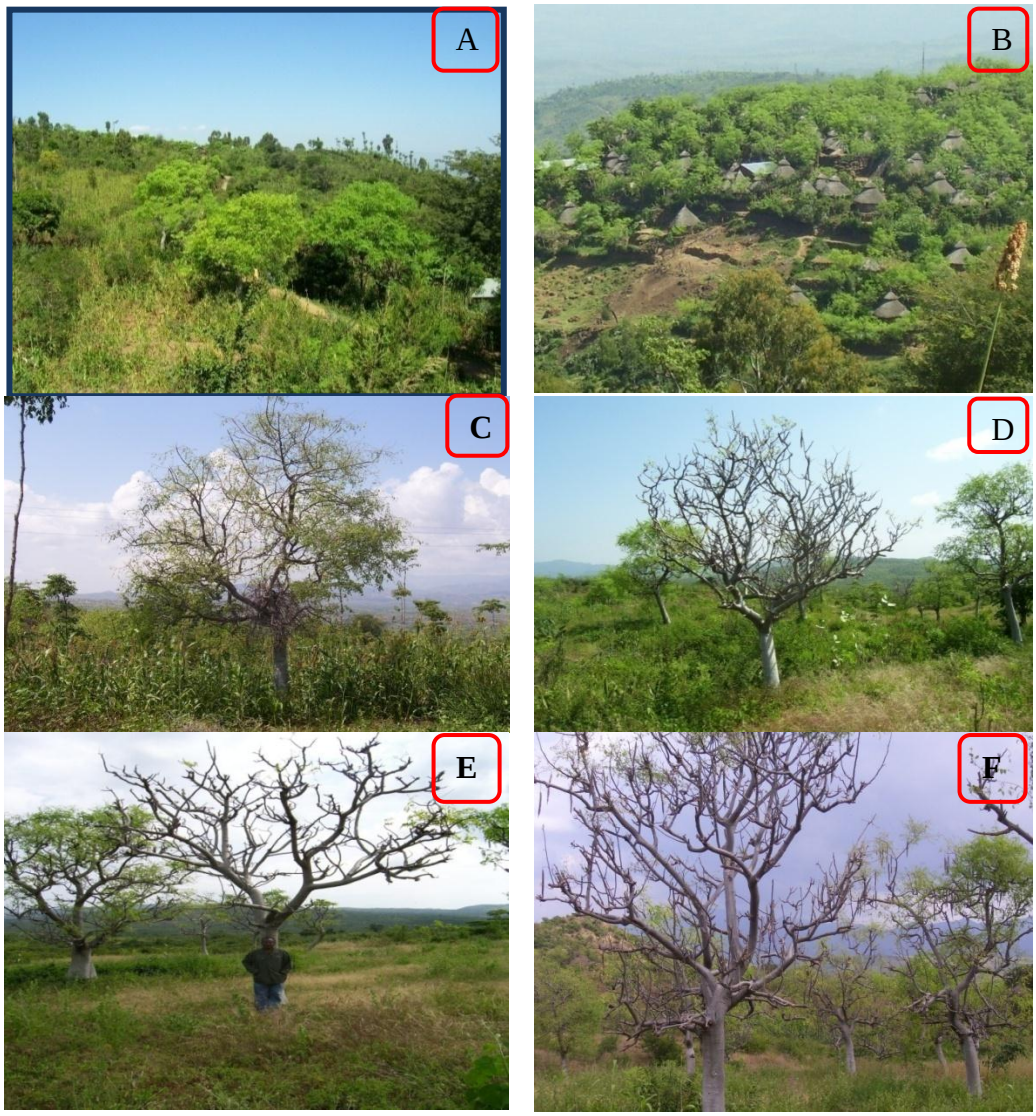


Fig. 7. (A) Moringa trees as one component of agro forestry in Southern Rift Valley of Ethiopia (B) inside cultural villages of Konso, (C), (D), (E), & (F) Defoliated moringa trees by moringa moth at Konso and Derashe areas.

Defoliation percentage vs. seasonal variations

Percent defoliation varied from season to season and it was recorded more during major rainy season than minor rainy season. Maximum percentage defoilaion was recorded in Doketu (84%) and Sorobo (80%) kebeles during the major rainy season. About 65% defoliation was recorded in both Onota and Holte kebeles and 62%, 61%, 62% and 58% defoliations were recorded in Wozeqa, S. Mella, C. Mille and Lante kebeles respectively during the major rainy season. Less than 30% defoliation was observed in Gaho, Hybena and Walyte kebeles during both seasons. During the minor rain season, defoliation was severe in Sorobo (77%) and moderate in Doketu (67%) kebeles of Konso district and moderate in kebeles in Onota and Holte in Derashe district and no defoliation occurred in all sample trees in Gaho kebele in Konso; Hybena and Walyte kebeles of Derashe district and in all the study kebeles in Arbaminch Zuria district due to the non- occurrence of moringa moth. Hence, the extent of defoliation by moringa moth was greater during major rainy season than minor rainy season in the year 2011(Figure 8). The variation in defoliation percentage between the two seasons was mainly due to the variation in amount and distribution of weather conditions such as rainfall and temperature, which have direct influence on the pest population. Similar findings were also previously reported by Dechasa (1995) and Agena (2009).

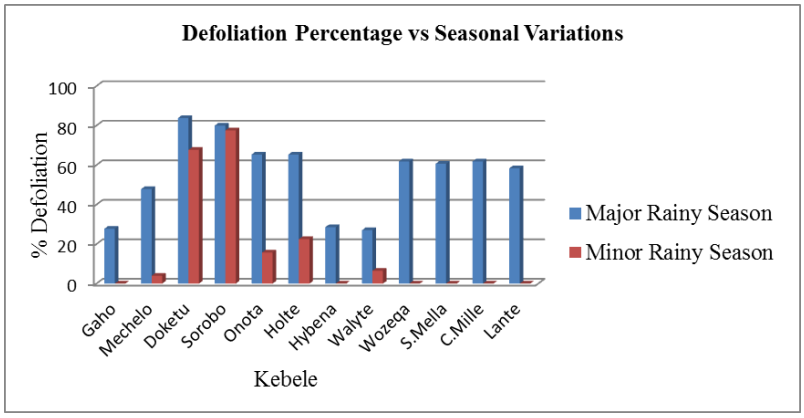


Fig. 8. Defoliation percentage of moringa moth on moringa trees with respect to seasonal variations during the year 2011.

Defoliation percentage vs cropping systems

During major rainy season, defoliation percentage in mixed cropping system was 20 and 32 in Gaho and Mechelo Kebeles, respectively, and it was 65 and 75% in Sorobo and Doketu kebeles, respectively. However, it was

recorded more on mono -cropped fields at Gaho and Mechelo with 28 and 48 % defoliation, respectively, and at Sorobo and Doketu Kebeles it was 80 and 84%, respectively, during major rainy season (Figure 8).During the minor rainy season (December) of the same year, the level of defoliation was 0 and 4% in Gaho and Mechelo kebeles, respectively, for both the inter-cropped and mono-cropped field conditions. At Doketu and Sorobo kebeles, the percentage defoliation was 67% and 77%, respectively, for mono-cropped fields and 60% and 69% in mixed cropped fields. The reason for the low defoliation status in the mixed crop fields was probably due to the abundance of natural enemies and crop diversity influences (Figure 9).

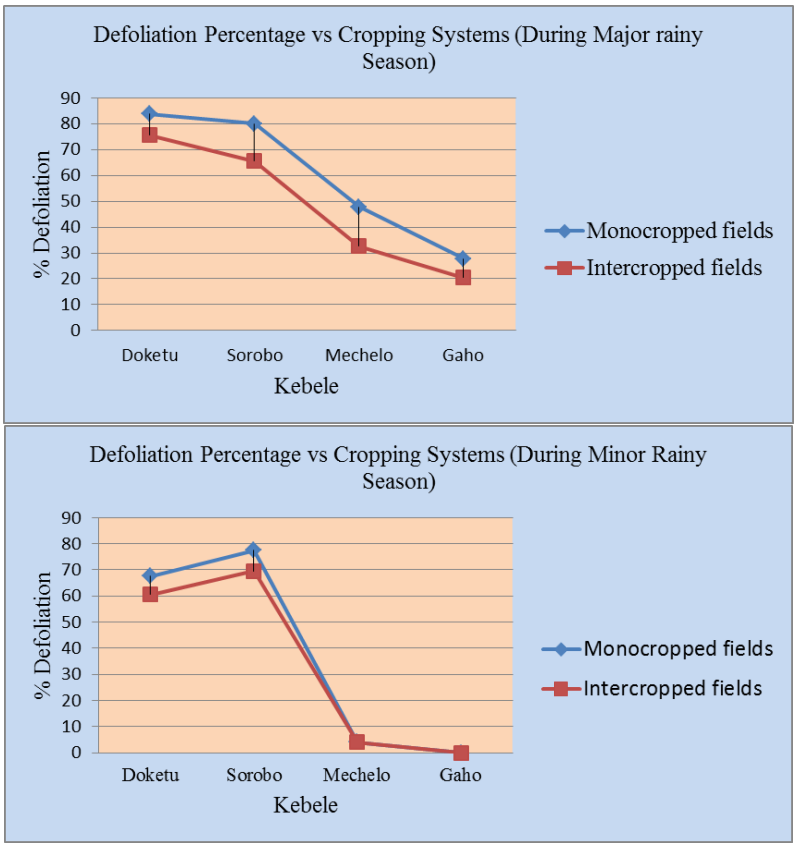


Fig. 9. Defoliation percentage of moringa moth on moringa trees (with respect to cropping systems) during major and minor seasons.

The percentage defoliation was low during both the major and the minor rainy seasons on moringa trees planted in inter-cropped fields than in mono-cropped fields where moringa trees grow in both fields. Pest occur and cause defoliation in moringa trees during the major rainy seasons in the months of

April to August (Agena, 2009). In this study, it was confirmed that there were moringa moth prevalence on moringa trees during minor rainy season in the months of November and December in few kebeles of Konso and Derashe districts (Figs.7 and 8). The survey results showed that defoliation by moringa moth larvae reduce leaf biomass production of moringa trees by 31-70% during the month of July at the mixed crop condition and more than 75% during the months of July and December in the year 2011 for mono-cropping system condition.

Defoliation percentage vs altitudinal differences

Defoliation caused by moringa moth was recorded within altitude range of 1200- 1600 m. a. s. l. however; moringa plants grew well within the range of 900-1600 m.a.s.l. (Fig. 10). In mid-highland areas like Gaho kebele (with altitude of 1820 m. a. s. l.), the pest is known to cause moderate defoliation during the months of May to August. This also happens in mid-highland areas of Hybena kebele (with altitude of1700 m.a.s.l.) in Derashe district during major rainy season. The defoliation was very low in areas having altitudes below such as in Massoya kebele (600 m.a.s.l.) in Konso district. The moringa moth was not known to exist and cause damage on moringa trees in areas having elevation above 2000 m.a.s.l. within the study areas. In fact, the moringa trees fail to grow and perform well in areas above 2000 m.a.s.l.

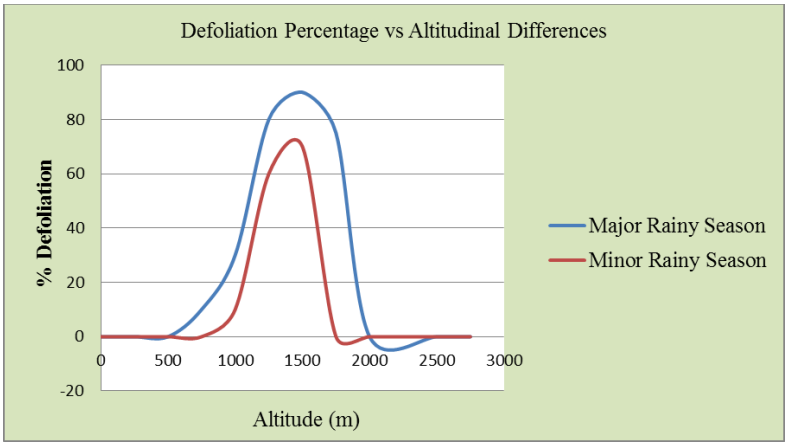
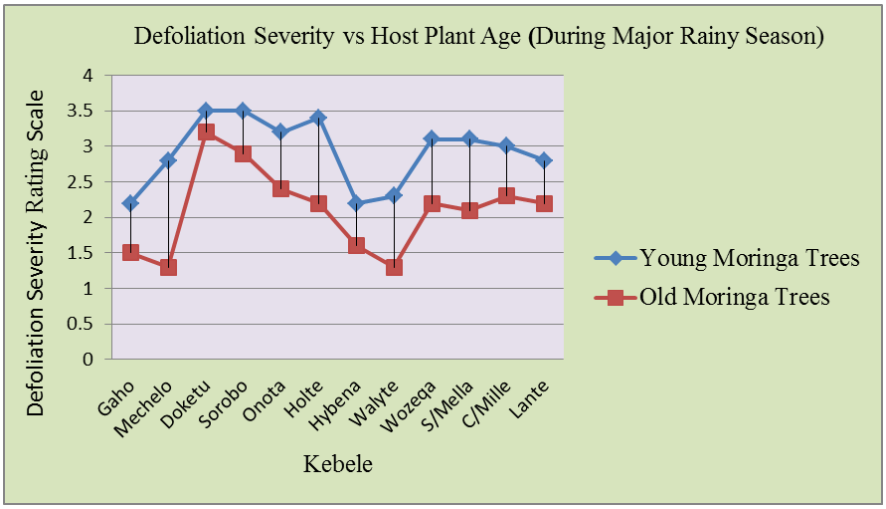


Fig. 10. Defoliation percentage of moringa moth on moringa trees (with respect to altitudinal differences) during major and minor rainy seasons of the year 2011 in the study areas.

Defoliation severity vs host plant age differences

Defoliation severity rating values showed that younger moringa trees were severely defoliated with average severity rating values of 3-4 in kebeles in

Sorobo, Doketu, Mechelo, Onota, Holte, Walyte and with severity rating values 2-3 in all kebeles in Arbaminch Zuria district , Gaho of Konso district and Hybena of Derashe district during the major rainy season (Fig. 11). Even though there is variation in defoliation severity rating values between the two seasons, due to the non occurrence of moringa moth during the minor rainy season in all kebeles in Arbaminch Zuria district, in Gaho kebele of Konso district and in Hybena kebele of Derashe district, no defoliation was observed on moringa trees. The soft, succulent and younger leaves which were grown after continuous and periodic leaf harvest were more susceptible to attack by moringa moth larvae than tender and older or aged leaves, which stayed for longer periods on the trees without continuous harvest. These leaves were bitter and harder than the younger leaves, hence, the green leaf caterpillar of moringa moth do not preferred. The old trees having large trunks and the canopy size were more resistant to moringa moth attack than younger trees that have relatively smaller trunk and canopy size during both the major and the minor rainy seasons. This might be due to bitter taste brought about by the increment in alkaloids and other chemical contents of the leaves. Due to this reason, even the local people do not consume the old moringa leaves. They consume the leaves from trees which are repeatedly or continually harvested and have coppicing ability for the next nearby harvest time (Alfaro, 1991).



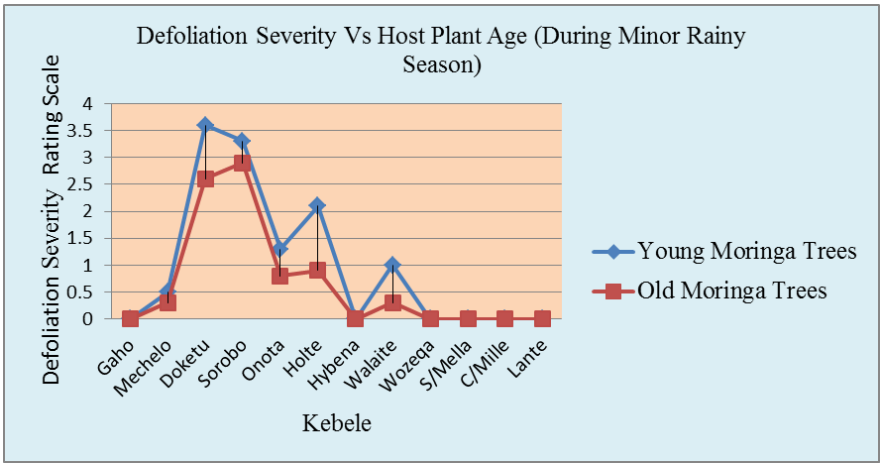


Fig. 11. Defoliation severity of moringa moth on moringa trees (with respect to host plant age)

Perceptions of respondents on moringa moth

Prevalence of moringa moth: The responses of interviewees indicated that there was moringa moth prevalence in all the study kebeles in the three districts during the major rainy season in 2011 at various infestation levels. During this season, its presence had already been described by all of the respondents in the study areas. Even though the occurrence of this pest was 100% in all the 12 kebeles during the major rainy season, there was no moringa moth prevalence at all the study kebeles of Arbaminch Zuria district during the minor rainy season in 2011. According to the respondents' feedback from the respective kebeles, there were moringa moth occurrence in the kebeles of Konso and Derashe districts during the minor rainy season but the extent varied between kebeles. All the respondents (100%) from all kebeles said that there was no moringa moth prevalence during the dry summer seasons before the periods of rainy seasons. All of the respondents from all kebeles said that the major factors for the occurrence of this pest were the prevailing weather condition of the area (majorly rainfall and temperature) and the presence of moringa trees in the areas.

Times of introduction of moringa moth to the areas: All the respondents (100%) from all kebeles said that the pest is known to exist and cause damage on moringa trees long years ago beginning from early times of moringa cultivation.

Local names of moringa moth: All of the respondents from all the study kebeles in Konso district said that the local name of moringa moth is "*Setyta*"; all the respondents from all the study areas in Derashe district said that the local name of moringa moth is "*Shetyta"* and all of the respondents from all the

study kebeles in Arbaminch Zuria district said that the local name of moringa moth is "*Gutsune*".

Nature and impacts of damage: all of the respondents from all the study kebeles said that the larvae of moringa moth caused damage to moringa trees by defoliation at times of occurrence and caused shortage of vegetable for both rural and urban people of the areas. They also said that the larva produces silky web and with the help of the web it folds the leaves together and feeds by biting and chewing the leaves.

Other hosts of moringa moth: allof the respondents from all kebeles in the study areas said that larvae of moringa moth were not observed and caused damage in any other crops other than moringa. During this study, no other crops or plants were seen to be attacked by moringa moth other than moringa trees and also moringa trees are not preferred by other insect pests except flea beetle attack on moringa leaves observed in Chano Mille kebele.

Natural enemies observed: None of the respondents from Derashe and Arbaminch Zuria districts did not respond to what the natural enemies of the moringa moth to be, probably due to lack of careful observations; but 50% of the respondents from Konso district said that, a black bird locally known as "*awaleta*", a lizard called "*telqyta*" and a spider locally known as "*kelengelata*" were observed to be major predators of the moringa moth.

Pest management practices: all of the respondents from all kebeles in the study areas mentioned that there were no cultural or other management practices done so far by the farmers as well as any other government agency as well as non-government organization to manage this important pest of moringa. The farmers said that, since the defoliation caused due to the pest is severe and temporal, they did not give attention in managing the pest.

Results of supplemental works to the study: From this survey work results, it was confirmed that, moringa moth caterpillar completes all its instar stages by feeding on the leaves of moringa. Hence, the larval stage is the most damaging and conspicuous stage. The larvae is light green in color, thin and slender in shape and produce silky web. During periods of high infestations all moringa trees appear defoliated. Even though according to David and Anthakrishnan (2004), larvae pupate in the soil, in this survey, it was found that the insect pupate inside the cracked and matured pods of moringa collected from Arbaminch area. As a supplemental work to this survey study, larvae of *N. blitealis* were collected in the month of December 2011 from Doketu kebele of Konso district, where moringa tree plantations were seriously affected by the pest, to study the lifecycle and morphology of the insect pest. Larvae were feed daily with fresh moringa leaves inside a well ventilated and sawdust filled rearing cage at Arbaminch plant health clinic. The larvae started to pupate by

producing silky web and with the help of the web, the individual larva bring and hold together the sawdust threshes to make shelter and hide inside it. Within two weeks time, all larvae changed to pupae. Again after two weeks time, the small moths of *N. blitealis* emerged from each cocoon. The larva is thin and slender in shape with light green in color and increases in size while growing. The pupa is red brown in color. The actual pictures of the larva, pupa and adults are shown in Fig. 12.

Conclusion

Moringa moth was recorded as a major insect-pest of moringa trees during the rainy seasons and was known to appear twice in a year, even though the extent of loss vary from season to season and from place to place . Larvae feed on leaflets in a thin silken web on the lower surface. Caterpillar of this pest is a periodic defoliator of *M. stenopetala trees* in the Southern Rift Valley of Ethiopia causing shortage of edible leaves. Outbreak occurrence is quite expectedly every year during and just after months of rain. This pest of moringa trees emerges mainly as periodic defoliator covering relatively large area during and just after the month of heavy rain (i.e. April) up to the month of August during the major rainy season in the semi arid areas of Southern Rift Valley of Ethiopia. There was no traditional (cultural) or any other method and activity done by farmers in the area or any other development organization so far to manage this important pest of moringa. Moreover, less attention was given so far in the research and development of this important crop as compared to other crops such as cereals, legumes, fruits and other vegetables. This was probably due to lack of awareness by concerned stalk holders about the incredible uses of this multi-purpose miracle tree. This work may be helpful in identifying the gaps concerning the basic information on spacial and seasonal distribution and damage status of moringa moth in these areas of Ethiopia. Therefore, using the information obtained as input, further research should be conducted on various methods of managing this important pest of moringa trees so that the growers (farmers) may have enough amount and better quality moringa vegetable.

Fig. 12. Moringa moth, larvae (A); pupae (B); Adults, ventral side (C) and dorsal side (D).

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