Assessment the Production Constraints of Phyllody and Fusarium Wilt Diseases in Sesame (Sesamum indicum L.) Genotypes in Western Zone of Tigray

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Abstract
The study was conducted during 2016 main season with the objectives of (i) to identify fusarium and phyllody resistant sesame genotypes in the area, (2) to study the prevalence, incidence and severity of phyllody and fusarium wilt among genotypes in the study area .From each variety 10 random sample plants were taken in each study areas and assessed for phyllody and fusarium wilt. Data showed that phyllody and fusarium appeared at different growth stages: seedling, flowering and capsule formation. Phyllody diseases Incidence and severity was higher at capsule formation this is due to many transmitting agents available during flower initiation and capsule formation. The study indicated that phyllody diseases were 100 percent prevalence, 5%-100%, severity and 0% - 30% incidences. HuRC-3 and HuRC-4 were resistant genotypes whereas Setit -1, Hirhir, Humera-1, Land race gumero were highly susceptible (HS). Three varities HuRC-1, Setit-2 and WARC-95 showed moderate susceptible (MS). Fusarium wilt was distributed the study areas 100% prevalence and mean % incidence ranged from 5% (Rawuyan) to 25% (Humera) and percent severity was ranged from 5% (Rawuyan) to 12.5% (Maykadra). Maykadra (12.5%) and Adebay (10%) phyllody severity recorded high severity percent followed by Rawuyan (5%) and Humera (5%). Fusarium wilt severity was recorded from 5%-100% among genotypes and 100% prevalence and mean % incidence ranged from 10% (Humera) to 25% (Maykadra). The percent disease severity was ranged from 20% (Humera) to 50% (Maykadra). Fusarium wilt was high incidence and severity in Maykadra followed by Rawuyan and Humera. HuRC-1, Setit -1, Hirhir, HuRC-3, and HuRC-4 were among the resistant (R) sesame whereas land race Gumero moderate susceptible. HuRC-4, WARC-95, Set-t-2, Hirhir, Humera-1, HuRC-4, HuRC-3 were resistant (R) and Setit-1, HuRC-1 moderate resistant (MR) whereas land race gumero identified as moderate susceptible (MS) to fusarium wilt.
Keywords: prevalence,, incidence, severity, resistance, susceptible

1.0 INTRODUCTION

Sesame is ancient crop known and used by man, its center of origin is not clearly known (Jaiwal and Rana, 2003). Since it was growing in India from ancient times and according to different archeological evidences many authors (Bedigian and Harlon, 1986; Brar and Ahuja, 1979; Nayar and Mehar, 1970 cited by Jaiwal and Rana, 2003) believed that sesame was originated in India. Some other scholars also believed that sesame was originated in Africa. On the other hand, Ethiopian sesame researchers, Gemechu and Bulcha (1993) also gave the originality of sesame to Ethiopia based on the assessment of the crop for its diversity and era of cultivation in the country.

The major constraints in sesame production worldwide are lack of widely adapting cultivars, shattering of capsules at maturity, non-synchronous maturity, poor stand establishment, lack of fertilizer responses and low management practices (Ashri, 1994).

Minot and Sawyer (2013) reported that about 28% productions decrement of sesame in Ethiopia is due to insect and diseases. Among the many insect pests affecting sesame production worldwide are sesame seed bug (Elasmolomus sordidus), sesame webworm (*Antigastra catalaunalis*), termites, gall midge (*Asphondilia sesami*), green vegetable bug (*Nezara viridula*), African bollworm (*Helicoverpa armiger*) and jassids (Orosius albicinctus) have been recorded in Ethiopia (Geremew *et al*., 2012) and the first four in their order of priority are common in the western and north western Tigray. In the sesame growing parts of Tigray sesame seed bug (*Elasmolomus sordidus*) caused a weight loss of 94.7% after stored in opened sacks (Muez *et al*., 2008). Weeds are also the major problems in sesame producing areas of western zone Tigray causing a yield reduction up to 86.3% when emerge simultaneously and remained unweeded throughout the entire growing cycle (Mizan, 2011).

Phyllody or “Gren Flowers” is one of the most important and destructive diseases of sesame in Turkey. The disease caused by a mycoplasma-like organism (phytoplasma) is present in the world where sesame is grown. The incidence of this disease varying year to year and its incidence is minor most of the growing area in the world. The incidence of this disease was reported as high as 100% in India and 90% in Burma (Beech, 1981). Sesame phyllody is not seed borne. In nature, disease is mainly spread by leafhopper *Orosius albicinctus* and survives in alternate hosts (Akhtar *et al.,* 2009).The major disease symptoms were floral virescence, phyllody, proliferation, and seed capsule cracking, seeds germinating in capsules, formation of dark exudates on foliage and floral parts, yellowing, shoot apex fasciations. Infected sesame plants exhibited symptoms that varied according to growth stage and time of infection. Infection at an early stage of growth resulted in cessation of internodes elongation, reduction in leaf size, and stunting (to about two thirds of normal plant height). The entire inflorescence was converted into twisted reduced leaves closely arranged on the top of the stem, with very short internodes. Infections that occurred later in the season caused characteristic symptoms, such as virescence, phyllody, and witches' broom (Khalid *et al*., 2009).In the present study phyllody disease was successfully transmitted from diseased to healthy sesame plants using grafting, dodder, and the leafhopper *O. albicinctus* (Kolte, 1985).

Phyllody is accompanied by abundant vegetative growth. The internodes are very much shortened and there is abundant abnormal branching due to the stimulation of axillary buds, and the plants bear small-sized leaves. The disease symptoms become evident in the flowering stage and floral organs are transformed into green leafy structures. Inside the ovary, petiole-like outgrowths are produced instead of ovules (Beech, 1981).

Sesame is vulnerable to infection by a number of pathogens that cause considerable yield losses. Among the major diseases, phyllody is a very serious disease, which can inflict up to 80% yield loss with a disease intensity of 61-80% (Kumar and Mishra, 1992). It has been reported from India, Iran, Iraq, Israel, Burma, Sudan, Nigeria, Tanzania, Pakistan, Ethiopia, Thailand, Turkey, Uganda, Upper Volta and Mexico. Data on the incidence of phyllody in each genotype was recorded by counting the number of infected plants and total population before harvest from the first flowering. Resistance or susceptibility of genotypes was based on the average percentage of plants infected by the disease, following a seven point (0-6) rating scale, where 0 = no infection (highly resistant); 1 = 0.1-10% plants infected (resistant); 2 = 10.1-20 % plants infected (moderately resistant); 3 = 20.1-30 % plants infected (tolerant); 4 = 30.1-40 %plants infected (moderately susceptible); 5 = 40.1-50 % plants infected (susceptible) and 6 = more than 50 % plants infected (highly susceptible) (Akhtar *et al.*, 2009).

Wilt caused by *Fusarium oxysporium* f.spp. Sesami (*Fos*) is a devastating disease infecting the crop right from seedling to maturity resulting in crop losses to varied degrees depending on the severity of infection. It has been reported as a most important soil born disease causing severe economic losses on sesame in different countries (Kang and Kim 1989; Chung and Hong 1991). As it is a soil borne disease and once noticed in the field cannot be easily controlled by any means, insulation of agronomically superior genotypes with genetic resistance to the disease is therefore, the best means to manage it and thereby minimize the yield losses. Unfortunately very little is known on the existence of reliable sources of resistance (Gaikwad and Pachpande, 1992).

Fusariym oxysporium sfp.sesami (Fos) is one of the most important soil borne fungal diseases infecting on root, stem and foliar components and causes economic yield loss in different countries. To evaluate the resistance level of collected white sesame genotypes 1-5 scale were used based in the infection percentage as follows:1-20%=1, 20.01-40=2,40.01-60=3,60.01-80=4,80.01-100=5. (El-Bramawy and Wahid, 2007) the comments of those scale values [1=Resistant(R), 2= Moderate Resistant (MR), 3=Moderate Susceptible (MS), 4=Susceptible (S) and 5=highly susceptible (HS)]. In sesame growing areas of northern Ethiopia there is no information for the production constraints of diseases bacterial blight, fusarium wilt and phyllody prevalence, incidence and severity of the tested varieties. Therefore; the study was designed with the following objectives (1) to evaluate level of resistance of different genotypes for fusarium wilt and phyllody diseases across different locations, (2) to study the incidence and severity of fusarium wilt and phyllody diseases across different locations.

2.0 Material and methods

The experiment was laid out in randomized complete block design (RCBD) with three replications in all testing sites. Each genotype was randomly assigned and sown in a plot area of 2m x 5m with 1m between plots and 1.5 m between blocks keeping inter and intra row spacing of 40 cm and 10 cm, respectively. Each plot had a total area of 10 m^2 and total of five rows and 6m^2 net plot areas with three harvestable rows. The experimental plots were ploughed two times (first time before sowing and secondly during sowing) to maintain fine seedbed suitable for crop establishment. Each experimental plot received the same rate of DAP (100 kg/ha) and Urea (50 kg/ha) fertilizer and all field management practices were done equally and properly as per the recommendations to the study areas.

Nine (1 local mostly used by farmers, Hirhir and 8 collections) sesame genotypes were under pipe line testing their resistance for many year and selected by their yield and level of resistance under natural infected field condition. After national trails in different agro ecology those we tested them at high fusarium and phyllody natural sick plot areas during 2016. All disease related and agronomic data were collected and in all genotypes across locations; prevalence, incidence and severity during 2016 cropping season in northern Ethiopia at six locations namely: Humera, Maykadra, Adebay and Rawuyan. 10 randomly sample plants were taken to check the healthy and diseased plants from each the variety Phyllody and fusarium wilt disease prevalence, severity, incidence were recorded and calculated according to the formula http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%209.%20Pl%20Path%20111-%20MEASUREMENT%20OF%20DISEASE pdf. After data collected and organized very well analysis was made using GenStat 16th edition (2009) statistical software was used for most of the statistical analyses.

2.1. Description of the Study Areas

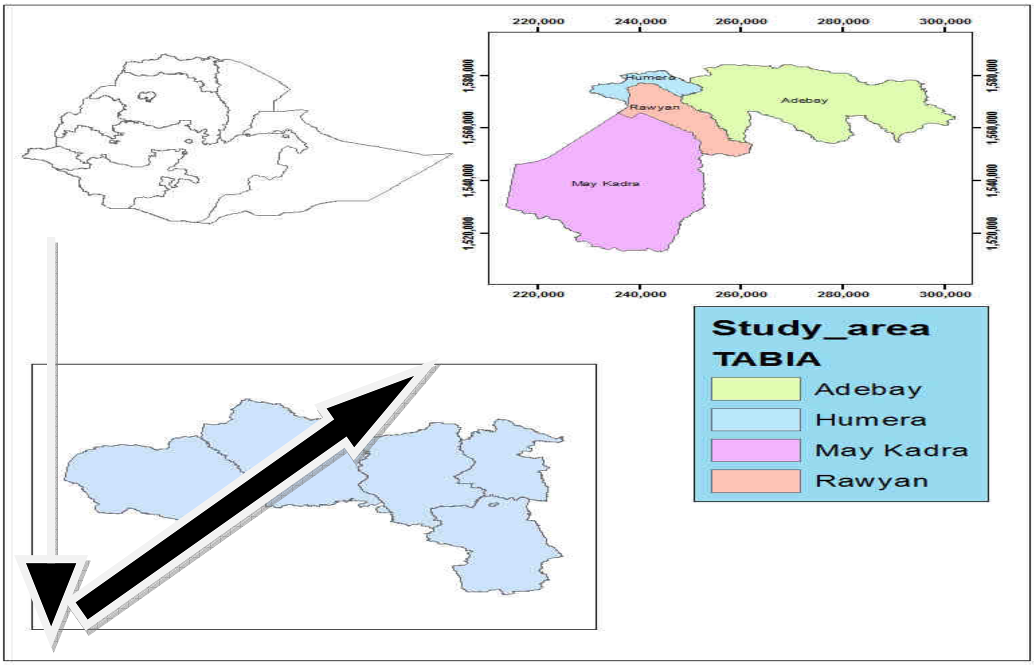

Figure 1. Map of study areas

Table 1: Agro-climatic and soil types of six tested locations in Northern Ethiopia

Description	Rawyan	Maykadra	Humera	Adebay
Altitude(m.a.s.l)	570	646	560	609
Latitude (°N)	14°05'	14°02'	14°15'	14°15
Longitude (°E)	36°34'	36°35'	36°37'	36°38'
R.F. (mm)	550	NA	576.4	560
Temp. (°C)	18.8-37.6	NA	18.8-37.6	18.8-37.6
Soil type	Vertisol	Chromic vertisol	Chromic Vertisol	Chromic Vertisol

Source: Bereket and Yirgalem (2012) Meteorology data (Dansha, Humera, and Maykadra): IPMS Ethiopia, (2005) (for Gendawuha). NA=Not Available

Table:2 description of study materials in 2016 main season

Varieties	Status	Sources	Color
Hirhir	local	HuRC	White
HuzzRC-1	Advanced line	HuRC	White
HuRC-3	Candidate	HuRC	White
HuRC-4	Candidate	HuRC	White
humera-1	Released	HuRC	White
Land race gumero	Candidate	HuRC	White
setit -1	Released	HuRC	White
setit-2	Released	HuRC	White
WARC-95	Candidate	HuRC	White

Sources: Humera agricultural research center, 2015

2.2 Diseases prevalence: proportion or percentage infected areas/ fields from the total assessed areas. Diseases prevalence tells us the geographic distribution of the diseases. The percent diseases prevalence is calculated as follows: http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%209.%20Pl%20Path%20111-%20MEASUREMENT%20OF%20DISEASE pdf

$$\textbf{Disease prevalence (DP \%)} = \frac{\text{Total infected areas} \times 100}{\text{Total assessed areas (field)}}$$

2.3 Diseases incidence: is the proportion or percentage of diseased leaves in a plant, diseased stalks or tillers or diseased seedlings in afield. It is the diseased percentage of parts or pants in the sample or population. Disease incidence generally tells about the prevalence of the disease in a given areas or host population. The percent of diseases incidence is calculated as follows http://www.hillagric.ac.in/edu/coa/ppath/lect/plpath111/Lect.%209.%20Pl%20Path%20111-%20MEASUREMENT%20OF%20DISEASE pdf.

$$\textbf{Diseases incidence (DI \%)} = \frac{\text{number of infected plants}}{\text{Total number of assessed plants}} \times 100$$

.isease severity (DS) is the percentage of relevant host tissues or organ covered by symptom or lesion or damaged by the disease. Severity results from the number and size of the lesions. Disease severity tells about the extent of damage caused by diseases. Diseases severity calculated using the following formula (Wheeler, 1969).

$$\textbf{Disease severity or Infection index} = \frac{\text{Sum of all disease rating}}{\text{Total no. of rating x maximum disease grade}} \times 100$$

3. RESULT AND DISCUSION

3.1 Incidence and severity of sesame phyllody

From each variety 10 random sample plants were taken in each tested environment and sesame phyllody was assessed from the sampled plants during 2016 main season. Diseases infection revealed significance difference among genotypes in all studied areas. From the assessment result phyllody was appeared at different growth stages seedling, flowering and capsule formation. Incidence and severity of phyllody Diseases were higher at capsule formation this was due to many transmitting agents available during flower initiation and capsule formation. The diseases incidence was sever in 2016 cropping season due to continuous high rain fall, high humidity and low temperature conditions may provided favorable conditions for severe incidence.

From the study indicated that phyllody diseases was 100 percent prevalence, severity recorded from 5%-100%, incidence from 0% -30% in the tested areas. HuRC-3 and HuRC-4 were identified as resistant genotypes whereas Setit -1, Hirhir, Humera-1, Land race gumero, were highly susceptible (HS). Three varities HuRC-1, Setit-2 and WARC-95 showed moderate susceptible responses (MS) indicated in table 3.

According to the study result fusarium wilt were distributed in all the studied areas (100% fusarium prevalence) and mean % incidence ranged from 5% (Rawuyan) to 25% (Humera). The percent disease severity was ranged from 5% (Rawuyan) to 12.5% (Maykadra). Phyllody was high incidence and severity in Maykadra and Adebay illustrate in table 5.

Table3: Phyllody prevalence, incidence and severity on sesame genotypes in 2016 main season

genotypes	**Total plants/quad**	**%prevalence**	**%Incidence**		**%severity**	
			Range	**mean**	**Range**	**mean**
Hirhir	30	100	5-30	14	40-80	66.67-HS
HuRC-1	37	100	5-20	10.25	10-50	36.28-MS
HuRC-3	32	100	0-10	4.75	10-25	15.32-R
HuRC-4	37	100	0-15	7.25	5-25	19.33-R
humera-1	29	100	5-25	20.25	10-100	78.64-HS
Land race gumero	32	100	5-25	17	10-60	54.33-HS
Setit -1	26	100	5-30	15.25	5-75	52.59-HS
setit-2	29	100	5-15	13.25	5-50	46.49-MS
WARC-95	34	100	10-25	14.25	10-50	43.51-MS

(0-6) rating scale, where 0 = no infection (highly resistant); 1 = 0.1-10% plants infected (resistant); 2 = 10.1-20 % plants infected (moderately resistant); 3 = 20.1-30 % plants infected (tolerant); 4 = 30.1-40 %plants infected (moderately susceptible); 5 = 40.1-50 % plants infected (susceptible) and 6 = more than 50 % plants infected (highly susceptible) (Akhtar *et al.*, 2009).

Table4: Phyllody prevalence, incidence and severity on sesame genotypes in 2016 main season

Districts/ locations	**Prevalence**	**%Incidence in 2016**		**% severity in 2016**	
		Range	**Mean**	**Range**	**Mean**
Humera	100	0-50	25	0-10	5
Adebay	100	5-30	15	5-20	10
Maykadra	100	0-15	15	5-25	12.5
Rawuyan	100	0-5	5	0-10	5

3.2. Prevalence, Incidence and severity of fusarium wilt

Fusarium wilt diseases severity was recorded from 5%-100% among genotypes and 100 percent prevalence in the tested and assessed locations. HuRC-1, Setit -1, Hirhir, HuRC-3, and HuRC-4 were among the resistant (R) sesame varieties. Whereas land race Gumero moderate susceptible to fusarium wilt disease in the tested environments indicated in Table 5.

Research efforts should be further concentrated towards identification of more resistant genotypes by including vast and diverse germplasm from different parts of the northern Ethiopia. HuRC-4, WARC-95, Set-t-2, Hirhir, Humera-1, HuRC-4, HuRC-3 were identified as resistant (R) and Setit-1, HuRC-1 were identified as moderate resistant (MR) whereas land race gumero identified as moderate susceptible (MS)indicated in table 5. Parental material in the development of mapping population for tagging of wilt resistance gene(s) in sesame similar work was reported from (Jyothi, 2009).

According to the study result fusarium wilt were distributed in all studied areas (100% fusarium prevalence) and mean % incidence ranged from 10% (Humera) to 25% (Maykadra). The percent disease severity was ranged from 20% (Humera) to 50% (Maykadra). Fusarium wilt was high incidence and severity in Maykadra followed by Rawuyan and Humera illustrate in table 5.

Table5: Fusarium wilts prevalence, incidence and severity of nine genotypes

Districts/ locations	**Total plants/quad**	**%prevalence**	**%Incidence in 2016**		**% severity in 2016**	
			Range	**Mean**	**Range**	**Mean**
Hirhir	30	100	5-100	50	0-30	15- R
HuRC-1	37	100	10-60	30	5-100	40- MR
HuRC-3	32	100	0-20	20	0-10	10- R
humera-1	37	100	5-50	25	0-10	10- R
HuRC-4	29	100	0-25	25	0-10	5- R
Land race gumero	32	100	0-100	100	0-60	50- MS
setit -1	26	100	0-50	25	0-50	25- MR
setit-2	29	100	0-15	10	0-10	5- R
WARC-95	31	100	0-10	10	0-5	5- R

Six points rating scale (1-5) 1-20%=1, 20.01-40=2, 40.01-60=3, 60.01-80=4, 80.01-100=5. (El-Bramawy and Wahid, 2007) the comments of those scale values [1=Resistant(R), 2= Moderate Resistant (MR), 3=Moderate Susceptible (MS), 4=Susceptible (S) and 5=highly susceptible (HS)].

Table4: Fusarium wilts prevalence, incidence and severity across locations in 2016 main season

Location	**Field inspected**	**%prevalence**	**%Incidence**		**%severity**	
			Range	**mean**	**Range**	**mean**
Humera	5	100	0-10	10	20-40	20
Adebay	5	100	0-15	15	10-60	30
Maykadra	5	100	10-50	25	30-100	50
Rawyan	5	100	10-25	12.5	5-50	25

4.0 CONCLUSIONS

From each variety 10 random sample plants were taken in each tested environment and sesame phyllody was assessed from the sampled plants during 2016 cropping seasons. Diseases infection revealed significance difference among genotypes in all studied areas during the main season. From the assessment result phyllody was appeared at different growth stages seedling, flowering and capsule formation. Incidence and severity of phyllody Diseases were higher at capsule formation time this was due to many transmitting agents available during flower initiation and capsule formation. The diseases incidence was sever due to continuous high rain fall, high humidity and low temperature conditions may provided favorable conditions for severe incidence.

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