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Research Article

Host Plant Response of Sesame (*Sesamumindicum L.*) Varieties to Sesame Bacterial Blight Diseases in South Omo Zone

Misgana Mitiku[1*], Yosef Berihun[2], Kedir Bamud[2], Tekle Yosef[2], Yesuf Eshete[2], Wondimu Adila[2]

[1]Department of Agriculture, Southern Agricultural Research Institute, Areka Agricultural Research Center, Areka, Ethiopia; [2]Department of Agriculture, Southern Agricultural Research Institute, Jinka Agricultural Research Center, Jinka, Ethiopia

ABSTRACT

Sesame (*Sesamumindicum L.*) is one of economically important oil crops in Ethiopia. The production and yield of sesame affected by both biotic and abiotic factors. Among the biotic factors, sesame bacterial blight is a major constraint across the major sesame growing areas. A field experiment was conducted on the Bena-Tsemay Woreda farmer's field at Enchete and Chali kebeles under irrigated and rain-fed conditions, respectively in 2019 main cropping season. This study aimed to evaluate sesame varieties for their resistance reaction to sesame bacterial blight under natural infection in the target areas. A total of seven varieties were used in the experiment by using a Randomized Complete Block Design (RCBD) with three replications. In both locations, the lowest disease severity was recorded in Humera-1 variety (15.93% and 39.26%) in Enchete and Chali respectively. Humera-1 variety was significantly different ($p<0.05$) from Adi and Abasena varieties for both kebeles in disease severity. The highest disease severity was recorded on Adi variety (68.15% and 42.60%) both in Chali and Enchete kebeles respectively. Humera-1, Dicho, and Walin were grouped as moderately resistant in Enchete but moderately susceptible in Chali. The analysis of variance showed that significant differences ($p<0.05$ in seed yield). The mean maximum yield (1071.7 kg/ha and 752.63 kg/ha) was also obtained from the variety Humera-1 in Chali and Enchete respectively. The minimum yield (553.61 kg/ha and 100.28 kg/ha) was recorded in Adi variety in Chali and Enchete respectively. Humera-1 had the lowest disease development and had the highest seed yield than the rest of the varieties tested in both locations. Thus, variety Humera-1 is identified as the most promising variety to be produced in both locations of Bena-Tsemay woreda and other similar agro-ecologies. Next to Humera-1, Dicho in Chali and Obsain Enchete locations perform better in lowering of bacterial blight disease and gave higher yield.

Keywords: *Xanthomonas campestris*; Sesame varieties; Yield; PSI

INTRODUCTION

Sesame (*Sesamumindicum L.*) is one of the major economically important oil crops and the second major source of foreign currency, next to coffee in Ethiopia. Sesame production in Ethiopia covers 370,141.06 ha area of land with a total production of 255,903.430 tones and its productivity was 0.69 t/ha. Sesame is used as a cash crop, export commodity, raw material for industries, and as source of employment opportunity in Ethiopia. A considerable proportion of the population generates income from oilseed farming, trade, and processing. The meal or oilcake remaining after oil extraction can be used as an animal feed [1].

Nevertheless, the productivity of sesame has remained very low mainly due to both biotic and abiotic factors including diseases. Among sesame diseases, sesame bacterial blight is caused by *Xanthomonas campestris pv. sesami*, (Xcs) is most important one. The disease affects the plant at any age and under severe conditions, producing extensive blight of the foliage, invading petioles, flowers and stems, and causing defoliation and sterility. Bacteria infect plants through stomata and wounds, spreads in intercellular space outside plant cell walls. The severity of bacterial blight is related to soil moisture and relative humidity [2].

X. campestris persists 16 months on seed that affects seedlings while 4-6 months in the soil. Since the pathogen is soil-born, when favorable conditions are available, it can appear as an epidemic because the pathogen can survive for 6 months in soil and 16 months in the seed. The disease is known to cause losses of about 60% capsule and 25%-40% seed yield in Egypt, 21%-27% seed yield in India, and complete crop failure in Sudan and Ethiopia.

Correspondence to: Misgana Mitiku, Department of Agriculture, Southern Agricultural Research Institute, Areka Agricultural Research Center, Areka, Ethiopia, E-mail: misganamitiku441@yahoo.com

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To reduce the risk of this pathogen, it needs effective management options to stop it from being epidemic.

Bacterial blight-resistant sesame varieties are rarely available though some level of variations among breeding lines in tolerance/resistance to sesame BB disease exists. This is due to the low degree of genetic variability among sesame genotypes under production in Ethiopia. Determining the degree of tolerance/resistance in existing sesame varieties would contribute to identify materials that can serve as good parental sources for future resistance breeding programs against the disease. *X. campestris* persists 16 months on seed that affects seedlings while 4-6 months in the soil [3].

In South Omo Zone, there are plenty of land resources for large-scale farming with favorable agro-climatic conditions for sesame production. To use this resource properly and to benefit our country as well as the pastoral and agro-pastoral community, there should use improved technologies. Using high yielding and disease resistant varieties are the most important ones, where a disease is one of the important limiting factors for crop cultivation, the evaluation of the reaction of sesame varieties to bacterial blight is an important goal for disease management. It is the ideal and most economical means of controlling the sesame bacterial blight. Therefore, the use of resistant varieties becomes part of integrated disease management and is the ideal way for preventing damage to crops by diseases. Thus, the study was initiated to evaluate sesame varieties for their resistance/tolerance to sesame bacterial blight disease under natural infection in Bena-Tsemay Woreda South Omo Zone, Southern Ethiopia [4,5].

MATERIALS AND METHODS

Description of experimental site

The experiment for screening BB disease resistance varieties was conducted in South Omo Zone, Benna-Tsemay Woreda (Chali and Enchete kebeles) under rain fed and irrigated conditions, respectively using the natural disease source in 2019 cropping season. The experiment site on Enchete kebele is located at 36°59'58''E longitude and 05°21'47''N latitude and an altitude of 566 meters above mean sea level. Geographically, Enchete is situated in South Ethiopia at about 649 km from Addis Ababa. The long-term weather data of the area revealed that the mean annual rainfall of the area is 51.74 mm with a range of 32.52 mm to 74.33 mm, whereas Chali kebele is located at 036°44'07''E longitude and 05°38'18''N latitude and an altitude of 1334 meters above mean sea level. The experiment was conducted during the main cropping season [6-8].

Experimental materials and design

A total of 7 varieties Dicho, Abasena, Chalsa, Obsa, Walin, Adi, and Humera-1/standard check/were evaluated in the experiment. The experiment was laid out in RCBD with three replications. Each treatment was randomly assigned into a plot area of 12 m^2 (3 m × 4 m) and Spacing of 40 cm and 10 cm between rows and plants, respectively. The spacing between blocks and plots was 1 m.

First land preparation was carried by tractor and second and third was by oxen. Totally land was ploughed 3 times. The row sowing method was used with a seed rate of 4 kg/ha. After emergence, the seedling was thinned and weeded 3 times by hand. No soil fertilizer was applied. The experiment at Enchete kebele was irrigated through furrow irrigation at 2-4 days and 5-10 days intervals at seedling and vegetative stages respectively [9].

Disease assessment

Bacterial blight disease severity data were recorded on eight randomly selected and marked plants from the middle rows of each plot and the reaction of the sesame varieties to bacterial blight were categorized according to the scale outlined by Sarwar and Haq where 0=0%, 1=0.1%-5%, 2=5.1-10%, 3=10.1-20%, 4=20.1%-50%, 5=50.1%-70%, 6=>70% with a response of immune, highly resistant, resistant, moderately resistant, moderately susceptible, susceptible and highly susceptible, respectively. The severity grades were converted to Percentage Severity Index (PSI) according to the formula by for analysis.

PSI(%)=(Sum of individual numerical ratings/Total number of plants assessed) × 100

Yield and yield components

Data on plant height, number of branches per plant, number of pods per plant, number of seeds per pod, thousand seed weights, and yield parameters were recorded in both locations [10].

Data analysis

Data on bacterial blight disease severity, incidence, plant height, number of branches, and number of capsules per plant, number of seeds per capsule, yield, and thousand seed weight were subjected to Analysis of Variance (ANOVA) using the statistical package SAS 9.0. The Least Significant Difference (LSD) was used for the mean comparison at 5% probability level [11].

RESULTS AND DISCUSSION

Reactions of sesame varieties against bacterial blight disease

The experiment was conducted at two locations under irrigated (Enchete) and rain-fed (Chali) conditions in the 2019 cropping season. Due to agro-climatic differences and cropping system, no combined analysis was done; instead, data were analyzed separately for each location. Generally, the higher bacterial blight severity was recorded in Chali kebele than Enchete kebele; that is why a variety is MR (Moderately Resistant) in Enchete becomes MS (Moderately Susceptible) in Chali. This difference might be due to the high moisture and humidity in the Chali location. This is because the disease mainly develops in the rainy season or with high relative humidity at night, as indicated (Table 1) [12].

The analysis of variance showed significant differences in PSI value between varieties. The lowest disease severity (15.93% and 39.26%) was recorded in the Humera-1 variety in Enchete and Chali kebeles, respectively. Next to Humera-1, a lower PSI value was recorded from Walin (45.18%) and Dicho (47.04%) in Chali, as well as in Enchete kebele from Dicho (17.41%) and Walin (20%). The highest bacterial blight (BB) severity (68.15% and 42.60%) was recorded on Adi variety followed by Abasena (65.92% and 30.74%) in Chali and Enchete kebeles, respectively. The variety Humera-1 was significantly different ($p<0.01$) from Adi and Abasena varieties while no statistical difference with the remaining varieties in Chali kebeles. In Enchete kebele it showed a significant difference with Adi, Abasena, and Obsa, while no significant difference with other varieties. Humera-1, Dicho, and Walin varieties were found to be Moderately Resistant (MR) in Enchete, whereasthese varieties were categorized as Moderately Susceptible (MS) in Chali kebele. Varieties Obsa and Chalsa were found MS to sesame BB disease in both locations [13]. The varieties Adi and Abasena were identified

as MS in Enchete while susceptible (S) in Chali kebele. Humera-1 variety reacted to SBB as MS in the optimum moisture area of Humera. This result agreed with this study at the Chali location but disagree with Enchete kebele which is MR. Variety Dicho were moderately resistant to bacterial blight over locations and years. This result hasthe same finding as Enchete location and contradicts Chali's result (Table 2).

All varieties showed sesame bacterial blight disease symptoms in both locations. In this study, none of the varieties ranked as immune, highly resistant, or resistant.

However, Humera-1, Dicho, and Walin varieties were found to be moderately resistant in Enchete kebele whereas these varieties were categorized as moderately susceptible in Chali kebele. The research showed that the variety Humera-1 was moderately susceptible. The varieties Adi and Abasena were identified as susceptible in Chali kebele but moderately susceptible in Enchete kebele. Bacterial blight Disease Incidence (DI) was 100% and ranged from 83.67% to 100% for Chali and Encehete kebeles, respectively [14].

The severity of the disease increases starting from the first occurrence, even if the level of disease development varied among varieties. From these varieties, none of them were found disease-free. This is agreed with Gollaet who tested 17 sesame genotypes. Naqviet similarly reported that sesame germplasms showed different levels of resistance to the disease with no complete resistance level tested at Faisalabad, Pakistan under natural conditions. Seventy tested genotypes did not show total resistance; however, a clear difference in the degree of resistance was noted.

Yield and yield components

There were significant differences ($p< 0.05$) among the varieties in yield and yield-related components. The average yield of the sesame varieties ranges from 1071.7 kg/ha (Humera-1) to 553.61 kg/ha (Adi) and 752.63 kg/ha (Humera-1) to 100.28 kg/ha (Adi) in Chali and Enchete kebeles, respectively (Tables 3 and 4). Significant differences were observed between varieties in Plant height, Capsules per plant, seeds per Capsules, Yield, and Thousand seed weight except for Branch number which is non-significant in Chali kebele. These all parameters were also significantly different ($p<0.05$) between varieties except plant height and branch number for Enchete kebele. Differences in yield and yield components among tested varieties were attributed to their genetic potential for yield and disease resistance. In both location Humera-1 was relatively high yielder and according to MoARD, productivity of Humera-1 variety was 5.9 kg/ha-900 kg/ha.

Table 1: Incidence and severity of bacterial blight on 7 sesame varieties across locations during 2019.

Locations	Enchete Kebele		Chali Kebele	
Varieties	**DI (%)**	**PSI (%)**	**DI (%)**	**DSI (%)**
Dicho	86.67	17.41^{CD}	100	47.04^{B}
Abasena	93.33	30.74^{B}	100	65.92^{A}
St.check/Humera-1	73.33	15.93^{D}	100	39.26^{B}
Chalasa	93.33	22.00^{CD}	100	44.07^{B}
Adi	100	42.60^{A}	100	68.15^{A}
Obsa	100	23.08^{C}	100	48.52^{B}
Walin	93.33	20.00^{CD}	100	45.18^{B}
CV (%)	14.19	16.18		12.54
LSD (%)	Ns	7.01	Ns	11.41

Note: DI: Disease Incidence; PSI: Percent Severity Index; CV: Coefficient of Variation; LSD: Least Significant Difference; Ns: Non-significant.

Table 2: The reaction of sesame varieties to bacterial blight disease for Enchete and Chali kebeles in 2019 in the main cropping season.

Variety	Enchete Kebele		Chali Kebele	
	PSI (%)	**Disease Reaction**	**PSI (%)**	**Disease Reaction**
Dicho	17.41	Moderately Resistant	47.04	Moderately susceptible
Abasena	30.74	Moderately Susceptible	65.92	Susceptible
Humera-1	15.93	Moderately Resistant	39.26	Moderately susceptible
Chalsa	22.00	Moderately Susceptible	44.07	Moderately susceptible
Adi	42.60	Moderately Susceptible	68.15	Susceptible
Obsa	23.08	Moderately Susceptible	48.52	Moderately susceptible
Walin	20.00	Moderately Resistant	45.18	Moderately susceptible

Note: PSI: Percent Severity Index.

Table 3: Mean values of yield and yield components on sesame varieties at Chali kebele during 2019.

Varieties	PH	BN	CPP	SPC	Yield/kg/ha	TSW/g
Dicho	168.80^{B}	6.20	123.43^{BC}	70.00^{B}	899.20^{C}	2.17^{CD}
Abasena	209.93^{A}	4.43	79.07^{E}	60.27^{C}	575.83^{E}	3.00^{A}
Humera-1	177.67^{B}	4.97	152.40^{A}	80.20^{A}	1071. 7^{A}	2.50^{BC}
Chalasa	175.40^{B}	5.00	133.50^{B}	71.17^{B}	734.72^{D}	1.83^{D}
Adi	198.10^{A}	4.10	58.10^{F}	60.10^{C}	553.61^{E}	2.83^{AB}
Obsa	169.60^{B}	4.87	108.80^{CD}	74.27^{AB}	971.80^{AB}	2.33^{C}
Walin	174.37^{B}	4.67	103.57^{D}	70.60^{B}	845.00^{C}	2.33^{C}
CV (%)	4.88	14.08	8.22	6.55	6.67	8.80
LSD (≤5%)	15.80	Ns	15.85	8.10	90.67	8.10

Note: PH: Plant Height; BN: Branch Number; PPP: Pods Per Plant; SPC: Seeds Per Capsule; TSW: Thousand Seed Weight; CV: Coefficient of Variation; LSD: Least Significant Difference; Ns: Non-significant.

Table 4: Mean values of yield and yield components on sesame varieties at Enchete kebele during 2019.

Varieties	PH	BN	PPP	SPC	GY/kg/ha	TSW/g
Dicho	204.07	4.07	91.27^{C}	69.4^{A}	692.78^{A}	2.5^{B}
Abasena	216.33	4.47	141.33^{A}	62.00^{BC}	387.08^{B}	3.6^{A}
Humera-1	197.73	4.60	116.60^{B}	67.93^{AB}	752.63^{A}	2.5^{B}
Chalasa	189.53	3.93	104.27^{BC}	70.93^{A}	659.03^{A}	2.17^{B}
Adi	179.07	1.13	63.97^{D}	56.87^{C}	100.28^{C}	3.33^{A}
Obsa	197.00	4.07	95.27^{BC}	69.93^{A}	581.25^{AB}	2.33^{B}
Walin	196.53	3.00	89.80^{C}	67.47^{AB}	674.03^{A}	2.17^{B}
CV (%)	9.77	18.86	12.75	5.45	20.20	10.88
LSD (≤5%)	Ns	Ns	22.77	6.44	197.53	0.51

Note: PH: Plant Height; BN: Branch Number; PPP: Pods Per Plant; SPC: Seeds Per Capsule; GY: Grain Yield; TSW: Thousand Seed Weight; CV: Coefficient of Variation; LSD: Least Significant Difference; Ns: Non-significant.

In Chali kebele, the highest average yield was obtained from Humera-1 (1071.7 kg/ha) followed by Obsa (971.80 kg/ha) variety. The lowest significant yield was recorded in Adi (553.61%) followed by Abasena (575.83%). Variety Humera-1 was significantly different ($p<0.05$) from the rest of the evaluated varieties except Obsa. Humera-1 gave a yield of 1071.7 kg/ha followed by Obsa (971.80 kg/ha) in Chali kebele. Comparatively, Humera-1 variety showed better performance in bacterial blight disease tolerance and seed production in both locations.

In Enchete kebele, analysis of variance result showed that all other parameters had shown significant difference, except plant height and branch numbers. The varieties Humera-1 (752.63 kg/ha), Dicho (692.78 kg/ha), Walin (674.03%) and Chalsa (659.03%) showed similar statistical values between them. Relatively Humera-1 and Dicho varieties are high yielders in the area. The lowest significant yield was recorded in varieties Adi (100.28 kg/ha) followed by Abasena (387.08 kg/ha), respectively.

In exceptional case variety, Adi and Abasena were found vulnerable to termite attack. These varieties' yield reduction is due to termites in addition to sesame BB disease. The infestation was observed in both locations of the study areas; however, this soil-dwelling insect pest was more challenging in Enchete than Chali location.

CONCLUSION

In Enchete, the lowest bacterial blight disease was found in Humera-1/standard check (15.93%) followed by Dicho (17.41%). These varieties were found moderately resistant to bacterial blight disease. A higher yield was also found from Humera-1 (752.63 kg/ha) followed by Dicho (692.78 kg/ha). Even if these varieties have no statistical difference with some of the sesame varieties, the best performing varieties numerically were Humera-1 and Dicho. These varieties would be recommended for the specific community and its vicinity practicing irrigation agriculture.

In Chali, even though no significant difference with some varieties, the lowest bacterial blight disease was found in Humera-1 (39.26%) followed by Dicho (44.07%), and highly significant yield was found from Humera-1 (1071.7 kg/ha) followed by Obsa (971.8 kg/ha). Even though Obsa and Dicho varieties are found under the same disease category which is moderately susceptible, so relatively high yielder variety Obsa was recommended for Chali location next to Humera-1.

RECOMMENDATION

In both locations, the variety Humera-1 showed relatively high yield and lower disease recording though it is not immune/resistant to bacterial blight disease. It was categorized as Moderately Resistant in Enchete kebele and Moderately Susceptible in Chali kebele.

Thus, variety Humera-1 would be the best promising variety from evaluated varieties in low rainfall and irrigated areas followed by the respective varieties in each location.

Further study should be carried out including many recently released sesame varieties for improved sesame production and their tolerance/resistance to bacterial blight disease. In addition, sesame varieties should be tested for their vulnerability or resistance/tolerance to manage the risk of termite's attacks.

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