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Screening of Ginger Accession for Disease Resistance, Growth Performance, Yield Related At Wolaita Zone, Southern Ethiopia

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Abstract

Ginger (*Zingiber officinale* Rosc.) is an important member of the family Zingiberaceae due to its medicinal and seasoning properties. The study was conducted at Farawocha Research Center, during main cropping season three year 2009 to 2012 to find out the resistance accession of ginger bacterial wilt disease *Ralstonia solanacearum* biovar III race 4. The land was medium high and the soil was clay loam in texture. The experiment was laid out in Randomized Complete Block Design with three replications. A total of twenty four ginger accessions (24) different germplasm collected variety (Gm-41/08,Gi-190/73, Gi-52/68, GW-12/08, Gi-53/86, Gi-107/94, Gi-30/79, Gi-36/79, GN-305/73, Gi-75/20 and Gi-84/20) are more susceptible variety GN-181/08,G-102/78,G-57/86, and local Gi-(Basketo 01) as check were used in this experiment. Among these varieties, six verities including "Gi-180/73", "Gi-37/79", "Gi-30/73", "GW-28/08", "Gi-85/86" and "GH-06/95 (Basketo local)" was found to be moderately resistant against bacterial wilt having laid on percentage of disease incidence 28.87% to 37.5% in 2009 to 2010 E.C and four ginger cultivars "Gi-305/73" (48.6%),"Gi-38/79(Volvo)",(47.5%)"Gi-70/79"(42.2%), Gi-190/73(40.6%) was found to be very high promised resistant bacterial wilt, having less disease incidence consecutively for three years. No resistant varieties/accessions were found in this investigation in both the year. Accession was have the same result, the highest yield (7.15 t/ha) was obtained from Gi- 305/73, Gi- 38/79 (Volbo), and Gi- 180/79 in 2009 to 2012EC while it was highest from Gi-Basketo 01 (7.27 t/ha) which was identical to GW-190/73, (7.02 t/ha) and Gi-181/86), (6.94 t/ha).

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Keywords

Screening, Ginger, Accession, BW, and yield

Introduction

Ginger (*Zingiber officinale Rosc*.) is an important member of the family *Zingiberaceae* due to its medicinal and seasoning properties. Ginger (*Zingiber officinale Rosc*.) it is one of the major spice crops of our country. It is also used as condiment, flavoring agent, in the preparation of non-alcoholic beverage and is also known to have numerous medicinal properties.

In Ethiopia, ginger is grown in an area of 45,164 ha with production of 716,550 t ha^{-1}) (MoARD, 2007a)). Ginger yield on farmers field is very low i.e., 15.87 t ha^{-1} which is far less than the crops potential. This is attributed to several factors; of which shortage of improved varieties, poor agronomic practices and poor soil fertility are the most important ones (Haile Michael *et al*., 2008; MoARD, 2007).

The production of ginger greatly reduced by the bacterial wilt disease. Ginger disease is a complex problem caused by multiple factors. Bacteria, fungi, nematodes, soft rot and rhizome rot are responsible for this disease. Bacterial wilt, yellows, leaf spot and soft rot are four major diseases of ginger. Bacterial wilt (*Ralstonia*

solanacearum soft rot/rhizome rot, Leaf spot (*Phyllostica zingiberi* Nematodes were commonly known to cause disease on ginger crop. Ginger bacterial wilt disease caused by R. *solanacearum* is known as most limiting factor in Hawaii. Ethiopia, in the history of spice research achievements, no The study of bacterial wilt is of economic importance in the whole world. In the developed world it forms a serious threat to the limited fertile arable land that is available. In the developing countries, the danger lies in the general food shortage that will be aggravated by the decline in crop production due to the presence of bacterial wilt (Ibrahim*et al.*, 2017). Furthermore, it has the potential to lead to total crop loss when propagation material is contaminated thus posing a serious threat to the hungry. *Ralstonia solanacearum* has a wide host range, which makes it difficult to have a generalized estimate of the economic losses caused by the bacterial wilt disease. Direct yield losses vary widely according to host, cultivar, climate, soil type, cropping practices and pathogen strain. Therefore, the level of damage is commonly expressed on a crop-by-crop basis, and can range from minimal crop loss to very high economic damage (Elphinstone, 2005).

In SNNPR ginger is cultivated under sub-optimal conditions with rain fall often less than 1500 mm per year and at lower temperatures (Endrias and Asfaw 2011). However, reasonable yields have been recorded under sub-optimal conditions of the country. As indicated in statistical data in 2006/2007, about 2,896,372 quintals of fresh ginger was produced from an area of 18,240 ha indicating regional average rhizome yield of 160 qt/ha (BOARD, 2008). Same is true with Boloso Bombe woreda with only slight variation in the proportion of land used for ginger production. An estimated total yield of 123, 7760 quintals of fresh ginger rhizomes in the year 2008 was obtained from the total area of 8,986 ha of land from the two major ginger cultivating woreda (Endrias and Asfaw 2011).

The status of ginger bacterial wilt incidence in major growing areas of Ethiopia and identified the causal agent of ginger wilt. In Ethiopia, *Ralstonia solanacearum sp*. was found responsible for bacterial wilt complex of ginger Gowda and Melanta (2000). Besides the pathogens, acidic soil condition is an important factor for this disease. To some extent rhizome may be controlled by spraying chemicals. But in most cases efficient control is not achieved by chemicals. However there are many approaches to manage the disease without environmental pollution. Among them, search for resistant cultivars to the disease is the most effective method and economically feasible. In view of the above facts, the present investigation was undertaken.

Therefore, the objective of this study was;
To screen out promising ginger cultivars for disease resistance under field conditions.

Materials and Methods

This experiment was conduct in Boloso Bombe Woreda Farawoch kebele, farmer land which is nearest to Wolaita Sodo University research site (Fig. 1). The experiment was laid out in RCB design with three replications. Geographically, the experimental site is found $7^0$8'8.9'' North Latitude and $37^0$36'35.17'' East Longitude with altitude of 1592 meter above mean sea level. Boloso Bombe Woreda is one of the 12 Woredas in Wolaita Zone. The area is situated along Ajora falls in Wolaita Zone with a capital town of Bombe which is located 325 km and 55km away from Addis Ababa and Wolaita Sodo town through Hosanna exit, respectively. The relative location of the Woreda is Kembata Tembaro at North, Boloso Sore Woreda at East, Sodo Zuria and Kindo Koisha Woreda at South, and Damot Sore woreda at West. Geographically, the area locates 7.03 to 7.19 North (Latitude) and 37.44 to 37.66 East (Longitude). The altitude of the Woreda is 501- 2500 meter above sea level. The total area of the Woreda is 272.2 square km and contains 21 rural kebeles and 2 town kebeles in total of 20 kebele administrations (Woizer, BAoRD, 2014).

Planting and experimental design

Twenty-four accessions of ginger varieties from the ginger germplasm collection were used for the investigation. The accessions collections from different parts of the country were planted in bacterial wilt disease infected or hot spot to find out the resistant lines against disease and evaluated during 2009 to 2012.E.C at Farawocha, Wolaita Sodo University, and Agricultural Research Station. Accessions were arranged in a complete randomized block design with four replications. The plot size was 4 m long and 3 m wide and consisted four rows with 21 plants per row, which comprised a total of 84 plants per plot. The spacing between plots and blocks were 0.3 m and 1.5 m, respectively. Rhizomes/seed were planted at a spacing of 40cm and 20 cm between rows and plants, respectively. Planting was done on ridges of about 20 cm high. Undamaged and reasonably uniform rhizomes of each

accession were planted in two consecutive years 2018 and 2019 with a planting depth of 4 cm.

Fertilizer was applied at the rate of blended NPS fertilizer NPS0 (0 kg NPS ha^{-1}), NPS1 (50 kg NPS ha^{-1}), NPS2 (100 kg NPS ha^{-1}), and NPS3 (150 kg NPS ha^{-1}), one third was applied during planting and the rest two third was side dressed in two applications, three weeks and five weeks after plant emergence. Land preparation, planting and other management practices were applied as per the recommendations of (Tadesse and Asfaw, 2013). The accession numbers and source are shown in Table 1 below.

Disease incidence (%)

The incidences of bacterial wilt were recorded and starting from thirty four days after planting, the plants were regularly monitored and recorded. The number of infected plants was considered and percentage of infected plants with disease incidence was estimated as suggested by Agrios (2005),

% Wilt incidence =

$$\frac{\text{Number of wilted plants in each field X 100}}{\text{Total number of plants in each field}}$$

Finally average incidence was calculated for each accession.

Results and Discussions

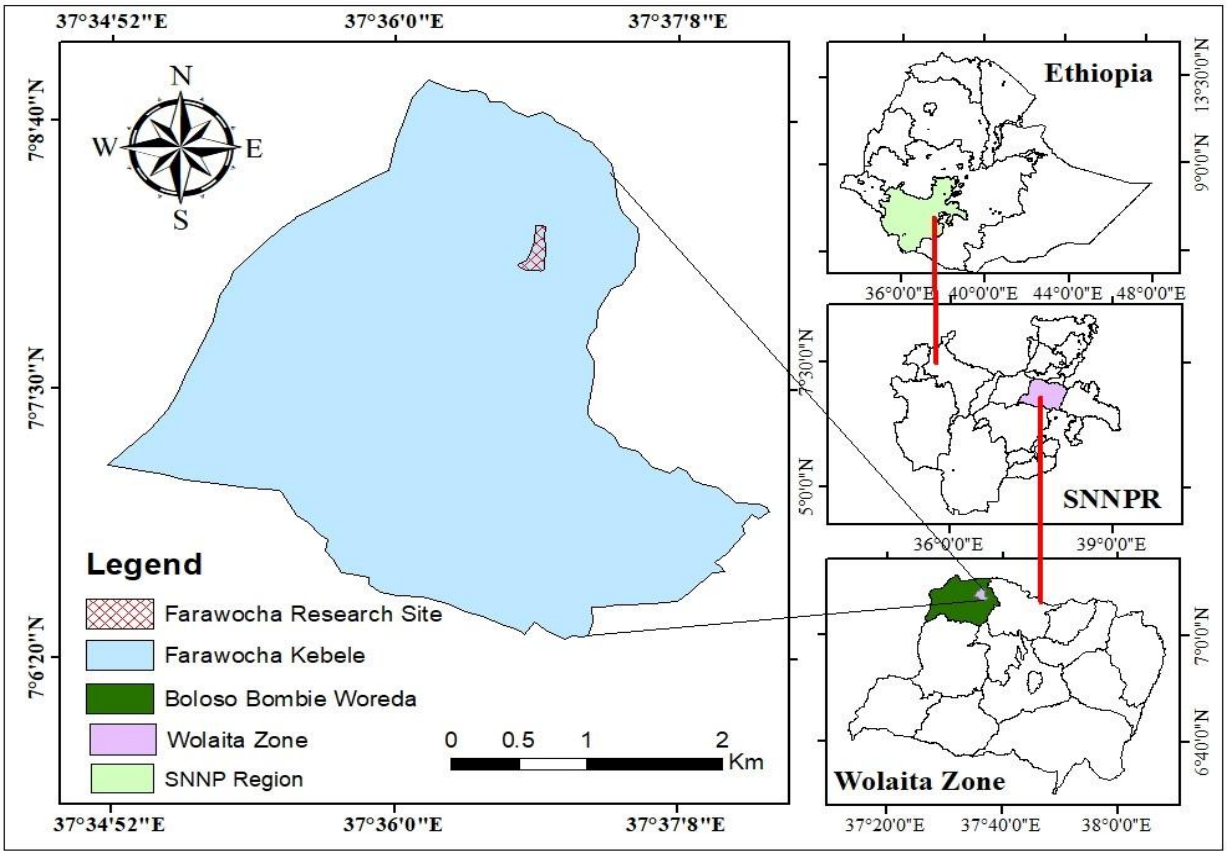
The results shows that, Out of the 24 ginger accessions screened three cultivars were found to be highly susceptible, Gi-53/86 having minimum percentage of disease incidence (18.15%) followed by Gi-39/79(17.22%) and Gi-181/73 (15.66%) in 2010 to 2012. Six ginger accession "Gi-180/73", "Gi-37/79", "Gi-30/73", "GW-28/08", "Gi-85/86", and "GH-06/95 (Basketo local)" was found to be moderately resistant against bacterial wilt having PDI 28.87% to 37.5% in 2009 to 2010 E.C and PDI 26.88%in 2010 to 2012. Four accessions viz, Gi-52/86, Gi-57/86, Gi-84/20, and GI-25/86 were found moderately susceptible having minimum percentage of disease incidence (PDI), 23.1%, 24.80% and 25.31%, 25.9% in 2009 to 2010, respectively. Four "Gi-305/73" (48.6%), "Gi-38/79(Volvo)", (47.5%) "Gi-70/79"(42.2%), Gi-190/73(40.6%)was found to be very high promised resistant bacterial wilt diseases complex, having less disease incidence consecutively for three years.

Table.1 Description of ginger accession numbers and sources that were used for the study

S.N.	Accessions code	Source*	S.N.	Accessions code	Source*
1	Gi-180/73	*Collected*	14	Gi-30/73	*Collected*
2	GH-06/95	*Collected*	15	GN-108/08	*Collected*
3	GM-41/08	*Collected*	16	Gi-180/78	*Collected*
4	Gi-37/79	*Collected*	17	Gi-57/86	*Collected*
5	Gi-38/79	*Collected*	18	Gi-37/69	*Collected*
6	Gi-52/68	*Collected*	19	Gi-141/79	*Collected*
7	Gn-12/09	*Collected*	20	GW-190/73	*Collected*
8	Gi 28/86	*Collected*	21	Gi-181/73	*Collected*
9	Gi-107-1/94	*Collected*	22	Gi-37/86	*Collected*
10	Gi-36/79	*Collected*	23	HG-70/79	*Collected*
11	Gi-305/73	*Collected*	24	Gi-74/86	*Collected*
12	Gi-75/20	*Collected*			
13	Gi-84/20	,,			

The source indicates Woreda (*district)* and administrative zones in Ethiopia where the accessions were collected.

Fig.1 Experimental site Map and Woreda (Farawoch kebele research site) and wolaita zones



There were seven(Gm-12/09, Gi-141/79, GH-70/79, Gn-108/08, Gi-102/79, Gm-41/08 and Gi-107/94)cultivars showed susceptible to disease complex, percentage of disease incidence value ranging from 13.33% to 11.85% in 2010 to 2012. No resistant varieties or accession were found in this investigation. In case of fresh rhizome weight yield, the highest fresh yield (145.7 t/ha in 2009-2010 and 149.3 t/ha in 2010 to 2012) was obtained from the cultivars Gi-57/86 and the lowest yield (132.8 t/ha in 2009 to 2012 E.C, as obtained from the line Gi-30/86.Table 1. Incidence of bacterial wilt on different ginger accession during 2009-2010 varieties

In conclusion, ginger is one of the most important spices, used as condiment, flavoring agent, in the preparation of non-alcoholic beverage, largely for small scale farmer in Ethiopia and is also known to have numerous medicinal properties. In Ethiopia, the bacterial disease has been reported on Potato, Tomato, Pepper, Enset, Banana and ornamentals but ginger bacterial wilt is not yet reported and new to Ethiopia.

From the three years result, it may be concluded that, four ginger cultivars “Gi-305/73” (48.6%), "Gi-38/79(Volvo)”, (47.5%) "Gi-70/79”(42.2%), Gi-190/73(40.6%) was found to be very high promised resistant bacterial wilt, having less disease incidence consecutively for three years as well as gave the highest yield among the 24 accession/variety. There was no resistant variety in this study. So this study should not be continued for the next year.

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