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PERFORMANCE EVALUATION OF SOME CHILI PEPPER (*CAPSICUM* SPP) GENOTYPES FOR ANTHRACNOSE (*COLLETOTRICHUM CAPSICI* (SYD)) RESISTANCE IN SNNP REGION OF ETHIOPIA

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ABSTRACT: Ten chili (*Capsicum* spp) varieties were screened for resistance to anthracnose (*Colletotrichum capsici*) in field experiments at two locations, Alaba and Maraqo. Starting seven days after transplanting, plants in each plot were monitored for diseases symptoms and infections. Data on incidence and severity of anthracnose were collected. Besides, the disease progress curve (AUDPC) and yield components were recorded before and after harvest. The data showed that the incidence of anthracnose disease and yield parameters such as dry fruit weight per plant, number of fruit per plant, pulp weight per plant, unmarketable fruits weight per plant, fruit length and days to 50 percent maturity, differed significantly among the tested genotypes at both locations. The majority of the genotypes were rated as moderate resistant to susceptible ones and none of the genotypes was free from the disease at both locations. Total yield per plant was higher at Alaba than Maraqo. This variation is related to the level of disease intensity, which was higher at Maraqo. After thorough multi-location researches, the identified sources of resistance were recommended to be utilized in future pepper breeding programs.

Key words/phrases: AUDPC, Fruit weight, Resistance, Screening, Yield.

INTRODUCTION

Chili pepper (*Capsicum frutescence* L.) is the leading vegetable crop produced worldwide. The total area devoted to hot pepper worldwide is estimated at four million hectare with an average annual increase of 5% (Weiss, 2002). People consume pepper to enhance food intake and supplement their dietary needs. It is also one of the major income generating crops for most households in the pepper producing areas (Roukens, 2005).

In Ethiopia, the national production of green and dry hot pepper was 2,541,883.97 and 412,503.57 tones with average productivity of 66.88 and 23.31 tones ha^{-1}, respectively (CSA, 2013). The average daily consumption

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of hot pepper by Ethiopian adults is estimated 15 g, which is higher than tomatoes and most other vegetables (MARC, 2004). Notwithstanding the importance of pepper to the economy of Ethiopia, it suffers from low yields. According to CSA (2006), hot pepper production system for green and dry pod has stayed as low input and low output with a national average yield of 7.6 tons ha^{-1} for green pod whereas it was 1.6 tones ha^{-1} for the dry pod, respectively. Thus, *Capsicum* productivity in Ethiopia is far below the world and suffers from steady decline in production that strongly demands immediate productivity improvement.

The decline of hot pepper production in the country is mainly attributed to lack of improved, good quality and well adapted varieties, nutrient depletion (poor soil fertility), inappropriate fertilizer utilization (due to an increase in the price of fertilizers), poor agronomic practices, poor disease and pest management and poor harvesting and post-harvest practices (Fekadu Marame and Dandena Gelmesa, 2006; Alemu Hailiye and Ermias Abate, 2000).

Chili anthracnose is one of the most important fungal diseases that drastically reduces yield, deteriorates fruit quality, and hence gives low returns to the farmers. It has been reported that pre-harvest and post harvest losses account for more than 50 percent in severe cases (Pakdeevaraporn *et al*., 2005). Conventional disease management practices are often inadequate to control the diseases. Moreover, pesticide residue has become the major constraint to meet the stringent requirements of the importing countries. Hence, one of the most economical ways to minimize crop losses is to cultivate resistant varieties/hybrids.

The hitherto observations did not show sufficient research work on evaluation of hot pepper which enables the growers to select best performing varieties in the study area.

Evaluating selected varieties for their agronomic performance is one of the most important considerations to ease the existing problems of obtaining best adaptable varieties for which the output of this study was likely to assist and sensitize hot pepper growers and processors. Currently, resistance of chili variety/hybrid against anthracnose pathogen is measured employing fruit puncture and spray inoculation methods, at greenhouse and field conditions, respectively, without considering the mode of anthracnose development on fruit surfaces. Development of an effective ideal screening method is an important requirement to minimize crop losses by identifying the anthracnose resistant chili varieties/ hybrids. Therefore, this research was initiated in order to evaluate the performance of some pepper genotypes for anthracnose (*Colletotrichum* species) resistance in SNNP region of the country.

MATERIALS AND METHODS

Description of experimental sites

This field study was carried out at two important pepper growing locations (Alaba and Maraqo) whereas identification of the *Colletotrichum* spp was undertaken in the Department of Microbial, Cellular and Molecular Biology laboratory, College of Natural and Computational Sciences, Addis Ababa University. Alaba and Maraqo are located at1680 and 1800 m above sea level, respectively. These areas are characterized by dry sub humid climate. Alaba has monthly mean minimum and maximum air temperature of 15°C and 29.5°C, respectively, and rain fall of 900-1300 mm/year. On the other hand, Maraqo has annual rain fall of 1500-1850 mm/year and minimum and maximum temperature of 8°C and 26.5°C, respectively. Both locations are hot spot areas for anthracnose (*Colletotrichum* spp) (Belete *et al*., 2012; Tameru Alemu *et al*., 2003; Simon *et al*., 2009).

Treatments and experimental design

The current investigation was carried out between April 2013 and January, 2014 using 10 known pepper genotypes in the country obtained from Melkassa Agricultural Research Center (MARC). These included Melka zala, Maraqo fana, Melka shote, Weldele, Bako local, Oda haro, Dube medium, Dube short and Gojeb local. The genotypes were diverse with respect to their collection sites too. For comparison, seeds of the local races were obtained from the local farmers. Seedlings were raised in seed beds and transplanted to an open field at the 4-5 leaves stage. The experiment was conducted in randomized complete block design (RCBD) with three replications. The plot size was 4.2 m X 4 m with four rows to accommodate 56 plants per plot. Intra-row spacing of 0.3 m and inter-row spacing of 0.70 m were used for the experiments (EARO, 2004). Crop management practices were carried out as per needed or recommended (Belete *et al*., 2012).

Data collection and analysis

Disease intensity and genotype reactions

Starting seven days after transplanting, plants in each plot were monitored for diseases symptoms and infection. Anthracnose incidence on each experimental plot was recorded by counting number of diseased plants and calculating as the proportion of the diseased plant over the total number of stand count on the plot. Each plant within each plot was visually evaluated for percent foliar infection (severity). Further, disease severity data were converted to a 1 to 9 rating scale based on the method suggested by Ngugi *et al*. (2002), where 1 = no disease, 2 = disease affecting 1 to 4% area of top 5 leaves, 3 = 5 to 9%, 4 = 10 to 19%, 5 = 20 to 29%, 6 = 30 to 44%, 7 = 45 to 59%, 8 = 60 to 75%, and 9 = >75% of leaf area affected.

Yield components

The fruits were harvested when they reached full maturity. Harvesting started at the end of December 2013 and lasted to the end of January 2014. Ten plants, which had been randomly chosen from the middle row of each plot, and the mean values were used to represent each experimental unit. The traits recorded include: number of fruits per plant (count), dry fruit yield per plant (g), fruit length (cm), single fruit weight (g), and pulp weight per plant (g) and non-marketable fruit yield per plant (g). The standardized moisture content of the chili seed yield was 12%. That was determined based on the method explained by Apraku *et al*. (2012). The formula used for adjusting the yield to standardized weight was:

Yield (at 12% seed moisture) = Seed yield × (100 – Actual Seed Moisture %)/88

That was the moisture level to which the seed was converted in this experiment.

Data analysis

The data on disease severity were converted to area under disease progress curves (AUDPC), mean value of disease incidence, disease severity and yield components were subjected to repeated measures of analysis of variance (ANOVA) to evaluate treatments effect. The analysis was done using the general linear model of statistical analysis using SAS computer package (SAS Inc., 2003). Means for different treatments were compared using least significant difference test at 5% significance level (LSD 5%).

RESULTS

Reaction of Capsicum genotypes to *Colletotrichum capsici*

This study demonstrated that the intensity of Anthracnose differed significantly ($p<0.05$) among the tested genotypes at both location (Table 1). Infections of the pathogens were first observed in the most susceptible varieties with a continuum of infection on highly resistant varieties. Accordingly, in 2013, the incidence of the disease was 13.51% recorded on the genotype Oda haro and 50.86% on the Bako local variety; and from 25% on Maraqo fana to 50.71% on Bako local variety at Alaba and Maraqo sites, respectively.

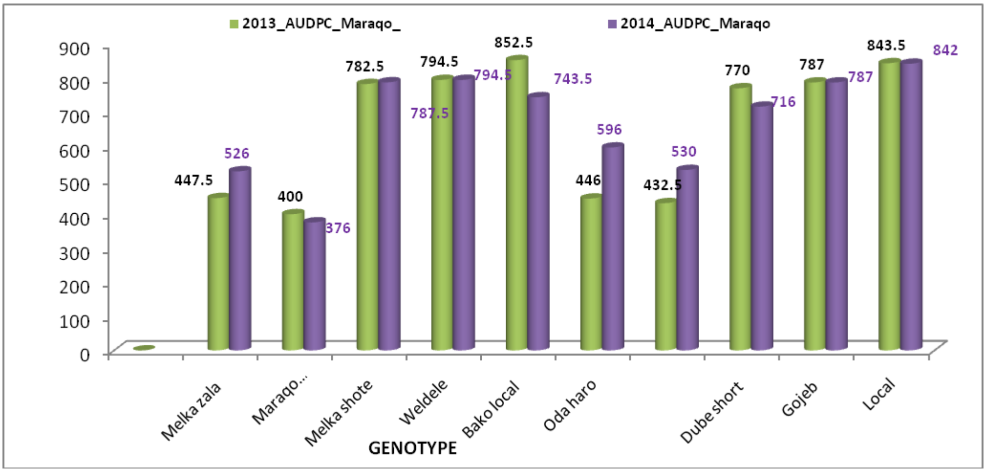
Table 1. Incidence and severity of *C. capsici* on pepper cultivar at Alaba and Maraqo in 2013 and 2014.

Genotype	Alaba				Maraqo			
	Incidence		Severity		Incidence		Severity	
	2013	2014	2013	2014	2013	2014	2013	2014
Melka zala	15.14b	19.29a	22.67b	21.00b	27.86b	32.29c	32.67c	21.00 b
Maraqo fana	22.14c	23.57b	21.33a	24.00d	25.00a	23.71a	28.33°	24.00d
Melka shote	48.29ef	47.57e	26.33c	19.67a	47.14c	47.14 f	36.33d	19.67°
Weldele	46.43d	47.43e	26.33c	21.00b	47.43e	47.43 f	38.67e	21.00b
Bako local	50.86g	50.71f	38.67f	22.67c	50.71g	43.00e	38.67e	22.67c
Oda haro	13.51°	23.00b	34.67e	41.67g	28.00b	35.14d	44.67f	41.67i
Dube medium	22.14c	26.43cd	38.33f	38.67 h	27.14ab	32.14b	36.33d	38.67h
Dube short	46.86d	46.86e	28.67d	27.00f	45.71d	42.29g	36.33d	37.00g
Gojeb	47.43de	47.43e	22.33b	34.00i	47.43e	47.43f	29.00b	34.00e
Local	49.29f	49.3f	30.67d	25.67e	49.29e	48.86f	42.33 g	35.67f
LSD (5%)	1.44	2.54	0.59	0.54	2.56	2.11	0.55	0.509
CV%	9.14	14	14	18.1	6.8	7.8	1.44	1.77

*Means followed by the same letter in the same column are not significant difference at P<0.05

In 2014, the incidence of the disease was 19.29% (Melka zala) and 50.71% on (Bako local; and from 25% (Maraqo fana) to 50.72% (Bako local) at Alaba and Maraqo, respectively. Generally, at Maraqo, the incidence of Anthracnose was significantly higher than Alaba site. In addition, the disease occurred at the early stage in Maraqo as compared to Alaba site. In general, severity data showed variations ranging from 21.33% (Maraqo fana) to 38.67% (Bako local) and 28.33% (Maraqo fana) to 44.67% (Oda haro) at Alaba and Maraqo, sites, respectively, indicating the incidence and severity were closely related for most plant genotypes.

Most genotypes were moderately resistant to susceptible to *C. capsici*, while the disease response of the control plants remained constant at each test (Table 2). At both locations maximum disease incidence and AUDPC was recorded on Maraqo fana variety, whereas the pattern was severe in Maraqo than Alaba (Fig. 1). At Maraqo, 5, 10, 50, 20 and 15% of the tested genotypes were found to be highly resistant, resistant, moderately resistant, susceptible and highly susceptible to Anthracnose, respectively (Table 2) while at Alaba, 5, 5, 45, 35 and 10% were highly resistant, resistant, moderately resistance, susceptible and highly susceptible to Anthracnose, respectively (Table 2). The basis of theses categorization were disease severity data that were originated from an average rating scale according to affected leaf area, as proposed by Ngugi *et al*. (2002).



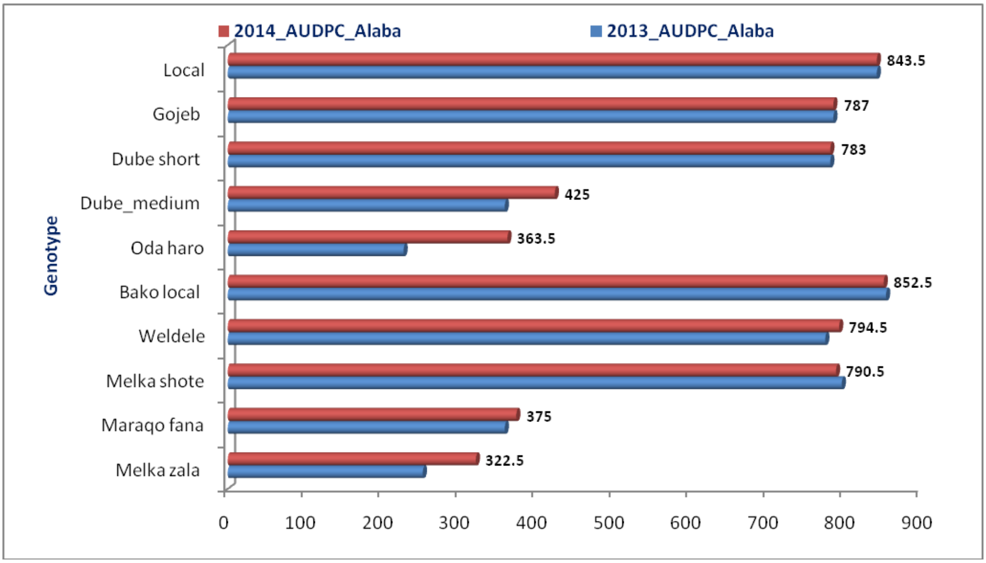


Fig. 1. AUDPC in Maraqo (above) and Alaba (below) in 2013 and 2014.

Table 2. Number and percent types of pepper evaluated against *C. capsici* at Alaba and Maraqo.

	Alaba		Maraqo	
Disease reaction	**2013**	**2014**	**2013**	**2014**
Highly susceptible	2(10%)	4(20%)	3(15%)	1(5%)
Susceptible	7(35%)	6(30%)	4(20%)	6(30%)
Moderately resistant	9(45%)	7(35%)	10(50%)	11(55%)
Resistant	1(5%)	1(5%)	2(10%)	1(5%)
Highly resistant	1(5%)	2(0%)	1(5%)	1(5%)

Yield and yield components of chili pepper genotypes

There were significant variations among the tested genotypes in terms of the dry fruit weight per plant; marketable fruit weight per plant; fruit length, and total yield in 2013 and 2014 growing seasons (Table 3 and Table 4). The result showed that dry fruit/plant record was in the range from 25.33 g (Local variety) and 57.67 g (Weldele) and 23 g (Melka shote) and 37.3 g (Maraqo fana). Likewise, marketable fruit/quintal of 1.47 (Oda haro) to 5.33 (Local variety) and 3.27 (Maraqo fana) and 4.67 (Melka zala and Weldele varieties) were recorded.

With regard to fruit length, the varieties showed variations from 5.0 cm (Local variety) to 12.0 cm (Maraqo fana) and 5.33 cm (Gojeb) and 9 cm (Melka zala). The data also showed significant variations with total yield/quintal/ha; and 9.0 (for Maraqo fana, Melka shote and Oda haro varieties); 11.33 q/ha (Dube medium and Melka zala) and 4.33q/ha (Bako local) and 11.0 q/ha (Maraqo fana and Melka shote varieties, respectively.

Table 3. Yield and yield components of pepper accessions at Alaba (2013 and 2014).

Genotypes	Dry fruit wt/pl (g)		Marketable fruit (q/ha)		Fruit length (cm)		Total yield (q/ha)	
	2013	2014	2013	2014	2013	2014	2013	2014
Melka zala	45.67e	30.67e	3c	4.67e	11.67g	9ef	11.33e	9.67g
Maraqo fana	27.67a	32.67f	2.17b	3.33a	12h	6.67b	9a	11h
Melka shote	49.67f	23a	4d	4.33d	11f	5.67a	9a	11h
Weldele	57.67h	24b	2.5b	4.67e	9e	8.33de	10.33d	8.67e
Bako local	51.67fg	37.33h	2.17b	3.27a	5.67b	8d	8.67a	4.33a
Oda haro	26.33°	35.33g	1.47°	4.33d	7.67c	8.67e	9a	8d
Dube medium	42.67d	32.67f	4.17e	3.83bc	8d	7.67cd	11.33e	7.33c
Dube short	32b	26.67cd	4.67f	4.33d	9e	8.33de	9.67c	9de
Gojeb	41.67d	27.67cd	5.17g	3.67b	8d	5.33a	9a	6.33b
Local	25.33a	33 g	5.33g	4.17cd	5a	6.33b	9.33bc	10.33f
LSD(5%)	2.91	1.55	0.38	0.3	0.53	0.45	0.57	0.57
CV%	19	5.4	7.7	4.9	7.3	5.6	8.3	9.1

* Means with the same letters are not significantly different

In Maraqo experimental site, there were also significant variations among the tested genotypes in terms of dry fruit weight per plant (g); marketable fruit (q/ha); fruit length; total yield (q/ha) in 2013 and 2014 growing seasons (Table 4). The results showed that dry fruit per plant ranged from 18.67 g (Melka zala) to 22.67 g (Gojeb) and 12.0 g (Local variety) and 22.0 g (Melka zala); for marketable yield from 1.8 g (Oda Haro) to 5.85 g (Gojeb) and 2.17 g (Oda haro and Dube short) to 5.17 g (Weldele); fruit length of

8.0 cm (Weldele) to 12.67 cm (Melka shote) and 8.0 cm (Maraqo fana) and 11.67 cm (Melka zala) for fruit and total yield; 6.0 q/ha (Weldele) to 11.33 q/ha (Bako local) and 6.0 q/ha (Bako local) and 11.0 q/ha (Maraqo fana).

Table 4. Yield and yield components of pepper accessions at Maraqo (2013 and 2014).

Genotype	Dry fruit wt/pl (g)		Marketable fruit (q/ha)		Fruit length (cm)		Total yield (q/ha)	
	2013	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Melka zala	18.67a	22.00h	5.33e	3.83b	11.67f	10.00cd	12.67g	7.00b
Maraqo fana	22.00d	19.67fg	2.50ab	4.00c	10.67e	8.00a	8.33b	11.00e
Melka shote	21.33d	16.67d	4.33d	4.17d	12.67h	11.67ef	10.67e	10.67de
Weldele	20.67c	20.33g	2.50ab	5.17e	8.00a	9.67c	6.00a	8.00c
Bako local	19.00b	17.00de	2.33a	3.83b	12.00g	11.33e	9.00c	6.00a
Oda haro	19.00b	13.33bc	1.80a	2.17a	10.67e	8.67ab	10.33de	8.33c
Dube medium	19.67b	18.33ef	3.33c	4.33cd	8.67bc	11.00de	10.00d	8.00c
Dube short	22.00d	13.67c	5.00de	2.17a	9.00c	8.33 a	9.00c	8.67c
Gojeb	22.67e	20.00g	5.85f	2.67ab	12.67h	8.67ab	11.33f	8.67c
Local	19.33b	12.00a	6.00f	4.83de	9.67d	9.67 c	10.67e	10.33d
LSD (5%)	1.23	1.50	0.80	0.73	0.64	0.83	0.58	0.69
CV%	9.8	5.7	7.8	8.2	8.4	5.5	9.6	6.9

Means followed by the same letter in the same column are not significant difference at $P<0.05$

In another multi-locational, consecutive trial conducted in Alaba and Maraqo, there were significant variations among the tested genotypes in terms of days to 50% maturity and days to first harvest in 2013 and 2014 (Table 5). The result showed that for days to 50% maturity the varieties displayed differences ranging from 54.0 (Bako local and Oda haro) to 63.67 (Melka zala) and 52.67 (Maraqo fana) to 65.33 (Weldele); 99.67 (Melka shote) to 108.0 (Weldele) and 96.67 (Maraqo fana) to 106.33 (Dube medium). Regarding days to first harvest, the result showed a range of 50.0 (Oda haro) to 68.0 (Weldele) and 50.0 (Oda haro) to 60.67 (Dube medium) and 100.67 (Melka shote) and 108.33 (Weldele); for days to 50% of maturity; 98.67 (Dube medium) to 106.67 (Melka zala). The overall result implied that the commonly used varieties such as Maraqo fana and Oda haro were more susceptible than the other varieties implying that resistance is being developed fast in well distributed and least known varieties. Thus, the most frequently planted varieties were more susceptible to *Colletotrichum capsici* than others.

Table 5. Growth performance of hot pepper varieties in 2013 and 2014 cropping season.

Gen. Code	**Alaba**				**Maraqo**			
	Days to 50% maturity		**Days to First Harvest**		**Days to 50% maturity**		**Days to 1st Harvest**	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Melka zala	63.67f	57.67c	106.00d	99.67b	57.00d	54.00c	103.33d	106.67g
Maraqo fana	56.00b	52.67a	102.00bc	96.67a	54.67b	46.67a	103.00d	100.33ab
Melka shote	61.00cd	58.67cd	99.67a	100.33b	57.67de	54.00c	100.67a	99.00a
Weldele	62.00e	65.33ef	108.00f	102.67cd	68.00h	54.00c	108.33g	106.00f
Bako local	54.00a	60.67de	102.00bc	103.33d	56.67d	50.00b	104.33ef	100.33ab
Oda haro	54.00a	54.00ab	102.67bc	100.67b	50.00a	47.67a	102.33bc	99.67a
Dube medium	59.67c	63.00e	101.00b	106.33f	60.67g	60.67f	102.67c	98.67a
Dube short	61.67d	51.67°	106.33d	103.67de	61.00g	59.67ef	106.00f	102.33cd
Gojeb	63.00e	56.33b	106.33d	100.00b	55.67c	57.67de	104.33ef	102.67d
Local	60.67cd	57.33bc	107.00ef	104.00e	58.00ef	60.00f	104.67f	102.00c
LSD (5%)	1.78	2.32	1.60	1.42	2.32	2.12	1.41	1.62
CV%	6.7	8.7	3.1	2.5	7.4	1.00	2.4	3.2

*Means followed by the same letter in the same column are not significant difference at $P<0.05$

DISCUSSION

The current study revealed that half of the tested chili genotypes were resistant to anthracnose. Susceptibility of the varieties was higher at Alaba than Maraqo in which, none of the genotypes was highly resistant to Anthracnose. Genetic resources for a cultivated species are generally regarded as a gene pool of cultivars, species and genera that can be utilized as sources of additional genetic variation for crop improvement. The study also indicated that anthracnose disease caused by *C. capsici* was recorded more or less throughout the year. The incidence and severity of disease depends on local agronomical conditions, pepper genotypes, cultural practices and season. The results also showed that highest incidence was recorded at Maraqo as compared to Alaba. Several researches indicated that the average disease incidence varied in different locations in different genotypes owing to varied agro climatic conditions and inoculum potential (Belete *et al*., 2012; Dikshit *et al*., 2006; Chakravorty *et al*., 2003; Sudheendr, 2005).

C. capsici isolates from SNNP in pepper growing regions posed epidemiological and management challenges for broad ranges of crops. This agrees with the general description of *C. capsici* as having a very large host range (Sharma *et al*., 2014). All sweet pepper hybrids are classed as susceptible to *C. capsici* (Torres-Calzada *et al*., 2011). A more or less similar result were obtained by Belete *et al*. (2012), who reported that 5.8, 23.5, 58.8, and 5.8% of the 17 hot pepper genotypes were resistant, moderately resistant, susceptible and highly susceptible to Anthracnose, respectively. In Maraqo, 0, 5.8, 17.7, 47.1 and 29.4% of the tested genotypes were highly resistant, resistant, moderately resistant, susceptible and highly susceptible to Anthracnose, respectively.

In this study, none of the 20 genotypes were free from infection which strengthens the results from Belete *et al*. (2012) and Park (2007) who reported that none of the commercial cultivars of *Capsicum annuum* have yet developed resistance to the pathogens that cause anthracnose. Current research is focusing on evaluation of resistance onto susceptible commercial cultivars of *C. annuum* based on the methods coined by AVRDC (2003) and Pakdeevaraporn *et al*. (2005).

Mongkolporn *et al*. (2004) studied the inheritance of resistance to anthracnose specifically caused by *Colletotrichum capsici*, in a *Capsicum annuum* population established from a cross between accession ‘83-168’ and cv. ‘KKU-Cluster’, and their progenies. They observed a promising dominant gene responsible for the resistance to *C. capsici*. Voorrips *et al*. (2004) found one main QTL with high significance and strong resistance against *C. gloeosporioides* associated with chilli anthracnose disease. No genotypes were reported as free from anthracnose (Belete *et al*., 2012).

Belete *et al*. (2012) determined the relationship between characters affecting optimum output is very important for increasing yield components in pepper genotypes. Larger fruit dimensions are desirable for both farmers and consumers. To this end, this study revealed the relationships between yield and yield components of the pepper. Accordingly, dry fruit weight per plant; fruit length; marketable fruit, and total yield were the most influential factors in this relation. This variation may be related to the level of disease intensity, which was higher at Maraqo.

According to Fekadu Marame *et al*. (2003) and Shaban (2007), most of the yield parameters are mainly influenced by genotypic variations and less influenced by environment. The yield may be highly affected by insufficient cultural practices and especially environment factors. Yield alone may not be sufficient criteria to describe the performance of a certain genotype, since it does not indicate the relative performance with other genotypes over different environments (Yayeh Zewdie and Poulos, 1995). So, it is essential to grow these types at different locations to explore genotype and environment interaction effects.

Solanki *et al*. (1986) and Basavaraj (1997) reported that fruit length, total fruit weight, and quality parameters have strong positive correlations with yield. In line with this, Oda haro, and Melka shote varieties had shown relatively superior average production in both locations. These varieties also exhibited the highest performance in marketable yields, lower disease incidences, and total number of green and ripe pods, yield and other yield components. Therefore, they are recommended for farmers' use.

CONCLUSION

Based on the results obtained from this work, it can be concluded that the yield and yield components of chili varies with different cultivars and localities. Oda haro and Melka shote varieties showed relatively lower disease reaction and superior performances in both locations. These varieties also exhibited the highest performance in marketable yields, lower disease incidences, and total number of green and ripe pods, yield and other yield components and are therefore recommended for farmers' use. The severity and incidence of different genotypes of chilli to *Colletotrichum capsici* varies at Alaba and Maraqo in the two growing seasons. Accordingly, plots of Oda haro variety had shown the lowest resistance reaction at both locations and seasons justifying that they had the highest resistance against anthracnose disease. Melka zala variety showed the second lowest disease reaction (severity and incidence) andthis indicates that they had resistance reaction to *C*. *capsici*. The local landraces which the farmers usually used for production were with the highest susceptibility in both locations and seasons. By the same token, plots of Bako local variety were categorized as the highly susceptible in comparison to the other varieties.

RECCOMENDATIONS

Sources of resistance are recommended to be studied and utilized in future pepper breeding programs. On the other hand, selection and husbandry of best performing cultivars shall be done focusing on local landraces across the various regions of the country and therefore the resistance development plan is highly recommended. Overall, integrated use of resistance and other ecologically compatible management is recommended. Conventional fungicides will ultimately be replaced by antagonists and botanicals. This will improve crop quality and growth; maximize profitability of chili and fundamental sustenance.

Future work should also focus on gene marking of tolerant genotypes as a way through for germplasm introductions. Continuous characterization local chili cultivars must be initiated against anthracnose and comparison among the existing selections must be done by cross inoculation in a variety of cultivars and environmental conditions that can be of practical value in development of local or global disease management strategies.

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REFERENCES

Alemu Hailiye and Ermias Abate (2000). Horticultural crops production and associated constraints in Northwest Ethiopia. Working paper. Agricultural Economics Research Division. Adet Agricultural Research Center, Ethiopia.

AVRDC (Asian Vegetable Research and Development Centre) (2003). AVRDC Progress Report for 2002. Asian Vegetable Research and Development Centre, Taiwan, China.

Badu-Apraku, B., Fakorede, M.A.B., Menkir, A. and Sanogo, D. (eds.) (2012). Conduct and management of maize field trials. IITA, Ibadan, Nigeria.

Basavaraj, N. (1997). **Genetic Variability and Genetics of Quantitative and Quality Characters in Green Chili (*Capsicum annuum* L.) Genotypes**. PhD. Thesis, University of Agricultural Sciences, Dharwad, India.

Belete, N., Alemayehu, C., Girma, T.G., and Teferi, G.E. (2012). Evaluation of farmers' "Markofana–types" pepper genotypes for powdery mildew (*Leveillula taurica*) resistance in Southern Ethiopia. *Int. J. Basic Appl. Sci.* **1**(2).

Chakravorty, R., Neog, K., Das, R. and Datta, R.K. (2003). Seasonal incidence of major foliar fungal diseases of mulberry in North East India. *Indian J. Sericulture* **42**(2): 122–127.

CSA (Central Statistical Authority of Ethiopia) (2006). Agricultural sample survey. Report on area and production of crops. Statistical bulletin, 1:361. Addis Ababa, Ethiopia.

CSA (Central Statistical Authority of Ethiopia) (2013). Agricultural sample survey. Report on area and production of crops. Statistical bulletin, 1:532.

Dikshit, B.K., Dash, B.D. and Purohit, K.M. (2006). Studies on the incidence of mulberry foliar diseases in agro-climatic conditions of Koraput district in Orissa. Proceeding, RSRS, CSB, Dehradun. pp. 109-111.

EARO (2004). Crop Varieties. Issue No. 12. Progress Report Addis Ababa, Ethiopia.

Fekadu Marame, Lemma Desalegne and Ravishankar, H. (2003). Study on variability in tomato germplasm under conditions of central Ethiopia. *Vegetable Crops Res. Bull.* **58**: 41–50.

Fekadu Marame and Dandena Gelmesa (2006). Status of vegetable crops in Ethiopia. *Ugandan J. Agric.* **12**(2): 26–30.

MARC (Melkasa Agricultural Research Center) (2004). Progress Report Addis Ababa, Ethiopia.

Mongkolporn, O., Dokmaihom, Y., Kanchana-udomkarn, C. and Pakdeevaraporn, P. (2004). Genetic purity test of F1 hybrid Capsicum using molecular analysis. *J. Hortic. Sci. Biotechnol*. **79**: 449–451.

Ngugi, H.K., King, S.B., Abayo, G.O. and Reddy, Y.V.R. (2002). Prevalence, incidence, and severity of sorghum diseases in western Kenya. *Plant Dis*. **86**: 65–70.

Pakdeevaraporn, P., Will, B.S., Taylor, P.W.J. and Mongkolporn, O. (2005). Inheritance of resistance to anthracnose caused by *Colletotrichum capsici* in Capsicum Spp. *Plant Breeding* **124**(2): 206–208.

Park, H.G. (2007). Problems of Anthracnose in Pepper and Prospects for its Management. In: **Abstracts of the First International Symposium on Chilli Anthracnose,** pp. 19 (Oh, D.G. and Kim, K.T., eds.). National Horticultural Research Institute, Rural Development of Administration, Republic of Korea.

Roukens, O. (2005). Export potential of Ethiopian Oleoresins. Ethiopian Export Promotion Department, Ethiopia.

SAS Institute. (2003). Statistical analysis software, version 9.1. Cary, North Carolina, USA.

Sharma, K., Goss, E.M. and van Bruggen, A.H.C. (2014). Isolation and identification of *Colletotrichum cordylinicola* causing anthracnose on Cordyline (*Cordyline fruticosa*) in Florida, USA. *Hortic. Sci.* **49**: 911–916.

Simon, A., Tameru, A., Ferdu Azerefegn and Temesgen, A. (2009). Population dynamics of aphids and incidence of Ethiopian pepper mottle virus (EPMV) in the rift valley part of Ethiopia. *Crop Prot.* **28**: 443–448.

Solanki, S.S., Sexena, P.K., Pandey, I.C. (1986). Genotypes and phenotypic paths to fruit yield in chili (*Capsicum annuum* L.). *Prog. Horticulture* **18**: 227–229.

Sudheendra, A. (2005). **Studies on Loss Assessment, Epidemiology and Management of Anthracnose of Chili caused by *Leveillula taurica* (lev.)**. Ph.D. Thesis. University of Agricultural Sciences, Dharwad.

Tameru Alemu, Hamacher, J. and Dehne, H.W. (2003). The increase in importance of Ethiopian pepper mottle virus (EPMV) in the rift valley part of Ethiopia; time to create awareness among researchers and extension workers. Paper presented at Deutsches Tropentage, October 18-21, 2003. Gottingen, Germany.

Tameru Alemu (2004). **Characterization of Pepper (*Capsicum* spp) and Sweet Potato (*Ipomea batatas*) from Ethiopia**. Ph.D Thesis. University of Bonn, Germany

Torres-Calzada, C., Tapia-Tussell, R., Quijano-Ramayo, A., Martin-Mex, R. and Rojas-Brito, D. (2011). A specifies-specific polymerase chain reaction assay for rapid and sensitive detection of *Colletotrichum capsici*. *Mol. Biotechnol*. **49**: 48–55.

Voorrips, R.E., Finkers, R., Sanjaya, L. and Groenwold, R. (2004). QTL mapping of anthracnose (*Colletotrichum* spp.) resistance in a cross between *Capsicum annuum* and *C. chinense*. *Theor. Appl. Genet.* **109**(6): 1275–1282.

Weiss, E.A. (2002). World Production and Trade. CABI Publishing, CAB International, Wallingford, UK.

Yayeh Zewdie and Poulos, J.M. (1995). Stability analysis in hot pepper (*Capsicum* sp). *Eggplant Newsletter* **14**: 39–42.