International Journal of
Basic and Applied Sciences

(A peer reviewed International Journal)

Evaluation of farmers' "Markofana–types" pepper genotypes for powdery mildew (*Leveillula taurica)* resistance in Southern Ethiopia

International Journal of Basic and Applied Sciences, Vol. 1 No. 2. pp. 103-108   2277-1921. 2012

ISSN *2277 – 1921*

Article type *Full Length Research Article*

Submission date 15 February *2012*

Acceptance date *30 March 2012*

Publication date *15 April 2012*

Article URL *http://www.crdeep.org/category/ijbas*

Authors *Belete Negash [1*], Alemayehu Chala [2], Girma Tegegn [3] and GBG Pananjay K. Tiwari [4]*

Center for Rural Development Ecology and Environment Protection

CRDEEP Head Office:
315/10, Kaulagarh Road, Rajendranagar, Indervihar, Dehradun, 248001, Uttrakhand, India.

International Journal of Basic and Applied Sciences Vol. 1 No. 2. 2012. Pp. 103-108

Full Length Research Paper

Evaluation of farmers' "Markofana–types" pepper genotypes for powdery mildew (*Leveillula taurica)* resistance in Southern Ethiopia

Belete Negash [1*], Alemayehu Chala [2], Girma Tegegn [3] and GBG Pananjay K. Tiwari [4]

1. Department of Horticulture, Debre Markos University, P.O. Box 269, Debre Markos, Ethiopia
2. College of Agriculture, Hawassa University, P.O. Box 05, Hawassa, Ethiopia
3. Ethiopian Agricultural Research Organization, Mellkassa Agricultural Research Center, Adama, Ethiopia
4. Department of Natural Resource Management, Debre Markos University, Debre Markos, Ethiopia

****Corresponding author: Belete Negash***

ABSTRACT
Epidemics of powdery mildew due to Leveillula taurica is an increasing problem in pepper production areas of Ethiopia, particularly in the central rift valley part of the country. The current study was conducted with the major objective of identifying sources of resistance hosts against the powdery mildew diseases. A total of 17 pepper genotypes were evaluated in field experiments at two locations, Hawassa and Mareko. Starting seven days after transplanting, plants in each plot were monitored for diseases symptoms and infection. Data were collected on incidence and severity of powdery mildew. Besides the area under disease progress curve (AUDPC) were calculated. Yield components were also recorded after harvest. Powdery mildew disease and yield parameters differed significantly among the tested genotypes at both locations. The majority of the genotypes were moderately resistance to susceptible to L. taurica, none of the genotypes was found to be immune at both locations. Significant variations were also obtained among the genotypes for all yield components, namely dry fruit weight per plant, number of fruit per plant, pulp weight per plant, unmarketable fruits weight per plant, fruit length and single fruit weight. The identified sources of resistance can be utilized in future pepper breeding programs after further testing in multilocations.

Key words: *Leveillula taurica, Host resistance, Pepper*

INTRODUCTION

Cultivated peppers are members of the genus *Capsicum spp*. Their production and consumption have steadily increased worldwide due to their roles as vegetable and spice. Production systems have been developed in many countries to supply the increased demand for pepper and its products (Bosland, 1996). Hot pepper is the most common type of *Capsicum* in Ethiopia. Since its introduction in the early 17th century by the Portuguese (Huffnaga, 1961), pepper has been grown as important spice and vegetable in the country and has gained economical and traditional importance.

At present, the yield of pepper in Ethiopia is very low (0.4 tones fruit yield/ha) (Fekadu *et al*., 2008). The production of pepper in the country is impeded by several factors among which lack of improved varieties and poor crop management practices are the major ones. Several diseases affect the production and marketability of pepper in Ethiopia (Agronvsky, 1993; Yaynu, 2001; Tameru, 2004). Potyviruses such as Ethiopian Pepper Mottle Virus and Potato Virus *Y* appeared to be very important in the rift valley parts of Ethiopia (Yaynu *et al*., 2001; Tameru *et al*., 2003). Currently, outbreak of powdery mildew caused by the fungus (*Leveillula taurica)* is occurring in major pepper producing areas of southern Ethiopia, causing a significant decline in quantity and quality of pepper yield.

In Ethiopia, pepper is growing in different agroecological region, and there exists high variability of growing conditions and cropping system, which encourage diversity of the crop genotypes. In the past decades, diverse genotypes (>300) were introduced from different regions of the world (Fekadu *et al*., 2008) adding to the diversity of the crop in Ethiopia. Pepper is an outcross crop and huge genetic variability is expected even in a single farmer's field. In addition, most farmers grow mostly local selection because there are shortages of improved varieties. Seed lots are often mixtures of different varieties in a single field favoring the diversity of the crop.

Among the pepper cultivars widely spread in the country, the "Markotype" pepper cultivars are the most popular types due to their large and long pod size; and brown pod color when matured and their flavor and pungency, which is high demand for consumers and spice industry. However, the cultivated Markotypes that farmers grow locally in different regions have shown to be divers not only between farmers but also in a single farmer field in different districts and even in the improved "Markotypes" developed by research center. However, due to its excellent market quality, the Markofana types continue to dominate the system of pepper production and marketing in Ethiopia. Nevertheless, the huge variability that exists in Ethiopian Markofana types has not been exploited to develop disease resistant cultivars. This genetic variability that exist in the "Markotypes" could play an important part to select resistance to important pepper diseases and help develop improved cultivars that meet the demand of the end users in the future. Relatively few studies involving screening against viral disease have been conducted, but no effort was made to screen pepper genotypes for powdery mildew disease resistance. Moreover, the variation among the "Markotypes" in terms of disease resistance and hence yielding ability is not known. To summarize, it has often been suggested that use of resistant cultivars has been the backbone of integrated disease management strategies in several patho-systems. Based on this assumption, the objectives of this research were to:

- determine the reactions of parental "Markotypes" *L. taurica* under natural infection
- compare the Markofana pepper types in terms of yield and yield components

MATERIALS AND METHODS

Description of experimental sites

The investigations were conducted at two important pepper-growing locations (Hawassa and Mareko) in the central rift valley parts Ethiopia. Hawassa and Mareko have altitude of 1680 and 1600m above sea level, respectively, and both locations are characterized by dry sub humid climate. Hawassa has monthly mean minimum and maximum air temperature of 10.4°C and 27.5°C, respectively, and rain fall of 900-1300mm/year. On the other hand, Mareko has annual rain fall of 1500-1850mm/year and minimum and maximum temperature of 8°C and 26.5°C, respectively. Both locations are hot spot areas for powdery mildew and wilts (Tameru *et al*., 2003; Simon *et al.*, 2009).

Treatments and experimental design

The current investigation was carried between April-December 2010 using 17 genotypes of the pepper type Markofana. Seed sources are Ethiopian local "Markofana" collections at the department of Plant and Horticultural Sciences, Hawassa University, and Horticultural division, Mellkassa Agricultural Research center (MARC). The seeds of each genotype were derived from a single plant. The genotypes are also diverse with respect to their collection sites. For comparison, seeds of the improved Markofana variety were obtained from MARC.

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 4.2m X 4m with four rows to accommodate 56 plants per plot. Intera-row spacing of 0.3m and inter-row spacing of 0.70m were used for the experiments. Crop management practices were carried out as per needed or recommended. Moreover, during flowering, single flower caging (50 mesh net of 0.78X0.26 hole size) was practiced to prevent the chance of out crossing (Fekadu *et al.*, 2008). Natural infections were used to initiate epidemics of the diseases.

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. Powdery mildew 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 rating scale according to affected leaf area, proposed by (Ullasa *et al*., 1981), where: 1 – highly resistant, no symptoms; 2 – resistant, with 10% of the leaf area affected; 3 - moderately resistance, with 11-20% of the leaf area affected; 4 - susceptible, with 21-50% of the leaf area affected and 5 – highly susceptible, with 51% or more of the leaf area affected.

Yield components

The fruits were harvested when they reached full maturity. Harvesting started at the end of September and lasted to the end of October (the investigated genotypes have the same harvest periods). Measurements were done on 10 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). Weighing has been done with 12% moisture.

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 version 9.11 (SAS Institute Inc, 2003 version). Means for different treatments were compared using least significant difference test at 5% significance level ($LSD_{5\%}$).

RESULTS AND DISCUSSION

RESULTS

Reaction of *Capsicum* genotypes to *Leveillula taurica*

Results of the current study demonstrated that the intensity of powdery mildew differed significantly ($p<0.05$) among the tested genotypes at both location (Tables 1). Colonies were first observed in the most susceptible materials. The examination of all 17 tested genotypes indicated a continuum of reactions to powdery mildew, ranging from highly resistant to highly susceptible. The incidence of diseased plant ranged from 17% (G5) to 65.3% (G17) and from 24.3 (G15) to 66.7% (G5) at Hawassa and Mareko, respectively generally, at

Mareko, the incidence of powdery mildew was significantly high as compared to Hawassa. In addition, the disease occurred at the early stage in Mareko as compared to Hawassa site (Data not shown). Severity data also ranging from 10 to 56.7% and 8.3 to 85% at Hawassa and Mareko, respectively the incidence and severity were closely related data for most plant genotypes. Most genotypes were moderately resistance to susceptible to *L. taurica*, while the disease response of controls remained constant at each test (Table 2). At both locations maximum disease severity was recorded on G12. At Mareko, 0, 5.8, 17.7, 47.1 and 29.4% of the tested genotypes were found to be highly resistant, resistant, moderately resistant, susceptible and highly susceptible to powdery mildew, respectively, (Table 2) and Hawassa, out of 17 genotypes, none were highly resistant, while 5.8, 23.5, 58.8, and 5.8% were resistant, moderately resistance, susceptible and highly susceptible to powdery mildew, respectively, (Table 2).

Table 1. Mean intensity of powdery mildew diseases on pepper at Hawassa and Mareko, south Ethiopia, 2008/09.

Genotypes Code	Intensity of disease (%) Hawassa Incidence	Severity	AUDPC	Mareko Incidence	Severity	AUDPC
G1	31.33^{fgh}	10^{h}	145.25^{e}	38.67^{efg}	8.3^{h}	206.69^{f}
G2	48.67^{bcd}	23.3^{def}	401.33^{cd}	51.67^{bcd}	36.67^{ef}	492.33^{e}
G3	44.33^{cde}	40^{c}	690.67^{b}	52.67^{bcd}	31.67^{f}	401.45^{e}
G4	33.67^{efgh}	28de	376.83^{dc}	41d^{ef}	30.67^{f}	421.28^{e}
G5	17^{i}	15^{gh}	182.23^{e}	24.3^{h}	11.67^{gh}	162.4^{f}
G6	52.67^{bc}	30^{d}	510.07^{c}	57^{abc}	38.3^{ef}	534.92^{de}
G7	53^{bc}	46.67^{bc}	742^{b}	62.67^{b}	56.67^{cd}	728^{c}
G8	18^{i}	15^{gh}	257.13^{de}	26.67^{gh}	16.67^{g}	192.85^{f}
G9	27.67^{igh}	25^{def}	390.95^{cd}	36.3^{efgh}	18.3^{g}	207.9^{f}
G10	41^{def}	45^{bc}	812.12^{ab}	47.67^{cd}	60^{c}	872.67^{b}
G11	46.33^{dc}	25^{def}	490^{c}	55.33^{abc}	50^{d}	693^{c}
G12	22.67^{ih}	56.67^{a}	952^{a}	33.3^{fgh}	85^{a}	1193.5^{a}
G13	23.67^{igh}	20^{fg}	251.3^{de}	31^{fgh}	55^{cd}	737.454^{bc}
G14	30^{gh}	30^{d}	453.28^{dc}	37^{efg}	31.67^{f}	397.83^{f}
G15	58^{b}	48.67^{b}	934.5^{a}	67.67^{a}	75^{b}	1149.17^{a}
G16	34.67^{efg}	20.67^{efg}	423.73^{cd}	52.6^{abc}	36.67^{ef}	492.45^{e}
G17	65.33^{a}	43.3^{bc}	928.67^{a}	67.6^{a}	41.67^{e}	675.5^{dc}
LSD (5%)	11.5	7.81	174.55	12.5	8.078	142.81
CV%	17.98	13.12	19.95	16.3	10.73	15.26

Means in a column followed by the same letter are not significantly different according to LSD at 5%.

Table 2. Number and percent of Markofana- types of pepper evaluated against powdery mildew (PM) during 2008/9 at Marko, Southern Ethiopia.

Disease reaction	Hawassa	Marko
Highly susceptible	1(5.8)	5(29.4)
Susceptible	10(58.82)	8(47.07)
Moderately resistant	4(23.52)	3(17.64)
Resistant	1(5.8)	1(5.8)
Highly resistance	0	0

Yield and yield components of pepper genotypes

In this research**, 17** genotypes were evaluated there were significant variations among the tested genotypes in terms of the number of pod per plant; dry fruit weight per plant; non marketable fruit weight per plant; fruit length; single fruit weight; and pulp weight per plant (Table 3, 4). The results showed a range of 7.67 (G3) to 22 (G15) for number of pods per plant; 17.3 g (G3) to 126 g (G16) for dry fruit weight per plant; 6.43 g (G10) to 26 g (G1) for non marketable fruit weight per plant; 7.13 cm (G8) to 12.7 cm (G13) for fruit length; 3.56 g (G5) to 6.3 g (G16) for single fruit weight; and 8.8 g (G5) to 88.26 g (G16) for pulp weight per plant.

Table 3 Number of fruit per plant (count), dry fruit weight per plant (g), pulp weight per plant (g), unmarketable fruit weight per plant (g), single fruit weight (g) and fruit length (cm) at Mareko, Southern Ethiopia, 2008/09.

Genotypes Code	No of fruit/ Plant	Dry fruit Wt/plant (g)	Pulp wt/ Plant(g)	Unmarketable Fruit wt /plant(g)	Single Fruit wt(g)	Fruit Length(cm)
G1	16. 3^{abcd}	62.5^{d}	38^{cd}	26^{a}	5.5^{abc}	11.7^{ab}
G2	11f^{g}	24^{gh}	14.1^{hi}	11.66^{ce}	3.9^{fgh}	7.6^{ef}
G3	9g	17.1^{h}	10.16^{i}	9^{defg}	4.26^{efgh}	8^{e}
G4	11f^{g}	28.5^{efg}	17.2^{hi}	9.6^{defg}	4.8^{cde}	7.8^{ef}
G5	10fg	18^{i}	8.86^{i}	7.33^{fg}	3.56^{h}	6.1^{g}
G6	16.3^{abcd}	55.9^{d}	32.86^{def}	13.667^{c}	4.9^{cde}	9.6^{d}
G7	15.6^{cde}	58.3^{d}	34.06^{de}	20^{b}	5.4^{abc}	10^{cd}
G8	9.3^{g}	17. 3^{h}	8.86^{i}	10.35^{cdef}	4^{fgh}	6.5^{fg}
G9	20.7^{a}	57^{d}	31.6d^{efg}	18.3^{b}	3.6^{gh}	7^{efg}
G10	12.3^{defg}	36.9^{ef}	23.26^{fgh}	6.433^{g}	5.03^{bcd}	8.1^{e}
G11	20^{ab}	81.3^{ab}	47.3^{abc}	11.167^{cde}	5.06^{bcd}	10.3^{dc}
G12	14.3^{cde}	41.5^{e}	23.7^{efgh}	8.367^{efg}	4.4^{def}	11.5^{ab}
G13	17.3^{abc}	72.6^{bc}	45.63^{bc}	11^{cdef}	5.9^{a}	12.1^{a}
G14	11.3^{efg}	36.26^{ef}	21.9^{hg}	9.33^{defg}	5.6^{abc}	11.3^{abc}
G15	20.3^{a}	64^{cd}	38.7^{cd}	11.667^{cde}	4.36^{defg}	10.4^{bcd}
G16	19.7^{ab}	87.06.^{a}	56.8^{a}	12.533^{cd}	5.8^{a}	10.6^{abcd}
G17	19^{ab}	80.93^{ab}	53.4^{ab}	9.16^{defg}	5.7^{ab}	11.56^{ab}
LSD	4.56	12.45	10.3	3.67	0.74	1.4
CV%	18.3	10.229	20.84	18.25	9.3	9.32

Means in a column followed by the same letter are not significantly different according to LSD at 5%.

DISCUSSION

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. Prospects are good for the further improvement of all cultivated species of *Capsicum* through breeding (Pickersgill, 1997). The strategy of the *Capsicum* breeder is to assemble into a cultivar the superior genetic potential for yield and improved quality (Bosland, 1993). Powdery mildew disease caused by *Leveillula taurica* 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 presented here shows that highest incidence recorded at Mareko as compared to Hawassa. Dikshit *et al.*, (2006) observed high incidence of powdery mildew during August-December and lesser incidence of disease during March-June, because of prevalent dry weather conditions. Similarly, Chakravorty *et al.*, (2003) reported high incidence of disease from second week of August which reached its peaks during the last week of September and October, Sudheendr (2005) reported that the average disease incidence varied in different locations in different genotypes owing to varied agro climatic conditions and inoculum potential.

The broad host range of the *L. taurica* isolate from Distrito Federal poses epidemiological and management challenges. This agrees with the general description of *L. taurica* as having a very large host range (Palti, 1988). All sweet pepper hybrids are classed as susceptible to *L. taurica* (Dixon, 1978). A more or less similar result were obtained by Ullasa *et al*.(1981), who reported range of resistance classes among 162 hot pepper genotypes 8·5% were immune or highly resistant; 18% were resistant; 15% moderately resistant; 15·5% moderately susceptible; and 43% highly susceptible. In addition, Daubeze *et al*. (1995), working with *Capsicum* line H3, defined the synthetic resistance class 'zero' to represent plants with 'no visible sporulation and no leaves infected'. Two progenies of H3, namely HV- 12 and 4638, both conformed to the zero resistance class. In a breakdown by host plant species, incidence of susceptible host genotypes among *C. annuum* was very high, while resistance prevailed among materials of *C. baccatum*, *C. chinense* and *C. frutescens*. A more recent study by Lima & Café-Filho (2001), examining a different sample of 104 *Capsicum* genotypes, found a frequency distribution similar to that reported here, with 15% resistant or highly resistant (all *C. baccatum* and *C. frutescens*) and 76% moderately to highly susceptible (mostly *C. annuum*). No genotypes were reported as immune.

Table 4. Number of fruit per plant (count), dry fruit weight per plant(g), pulp weight per plant(g), unmarketable fruit weight per plant(g), single fruit weight(g) and fruit length(cm) at Hawassa, southern Ethiopia, 2008/09.

Genotypes Code	Number of fruit/plant (count)	Dry fruit wt/plant(g)	Pulp wt/ Plant(g)	Unmarketable Fruit wt/plant(g)	Single fruit Wt /plant(g)	Fruit length (cm)
G1	17.33^{bcd}	97.2^{cd}	60.4^{cde}	22^{a}	5.6^{bcd}	11.8^{ab}
G2	$11f^{g}$	46.96^{jk}	28.13^{ij}	13.33^{bc}	4.23^{gh}	7.76^{de}
G3	7.67^{g}	35.86^{k}	21.86^{ij}	10.4^{cde}	4.53^{fg}	8.16^{d}
G4	10.33^{fg}	53.5^{ij}	33.6^{hi}	11.467^{bcde}	5.2^{cde}	8.2^{d}
G5	10.67^{fg}	38.6^{jk}	21.33^{j}	13.167^{bc}	3.6^{i}	6.46^{e}
G6	16^{bcde}	81.4^{efg}	49.2^{efg}	13.667^{bc}	5.06^{def}	9.63^{c}
G7	16.3^{bcde}	95.9^{cde}	54.03^{def}	20^{a}	5.8^{ab}	10.73^{bc}
G8	8^{g}	33.73^{k}	21.467^{ij}	12.13^{bcd}	4.26^{gh}	7.13^{de}
G9	21.667^{a}	$85.2d^{ef}$	47.36^{fg}	14.3^{b}	3.93^{hi}	7.4^{de}
G10	13.3^{def}	69.3^{gh}	44^{fgh}	9.1^{de}	5.2^{cde}	8.46^{d}
G11	18.33^{abc}	103.83^{bc}	66.76^{bc}	11.5^{bcde}	5.53^{bcd}	11.33^{b}
G12	14^{cde}	65.967^{hi}	$42.^{3fgh}$	8.367^{e}	4.73^{efg}	11.9^{ab}
G13	16^{bcde}	100.16^{bcd}	65.9^{bcd}	11^{bcde}	6.23^{a}	12.7^{a}
G14	12.33^{efg}	74.73^{fgh}	41.6^{gh}	9.33^{de}	5.6^{bcd}	11.16^{bc}
G15	22^{a}	100.4^{bcd}	63.93^{bcd}	11^{bcde}	4.6^{fg}	11.13^{bc}
G16	21.33^{a}	126.7^{a}	88.26^{a}	12.2^{bcd}	6.3^{a}	11.46^{ab}
G17	20^{ab}	115.26^{ab}	74.6^{b}	8.633^{e}	5.73^{abc}	10.13^{b}
LSD	4.869	15.3	12.165	3.486	0.586	1.354
CV%	19.4	11.8	15.07	16.84	7.1	8.29

Means in a column followed by the same letter are not significantly different according to LSD at 5%

Determining 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 has revealed the relationships between yield and yield components of the pepper. Number of pod per plant; dry fruit weight per plant; non marketable fruit weight per plant; fruit length; single fruit weight; and pulp weight per plant was the most influential factors in this relation. Generally numbers of pods per plant were higher at Hawassa than Mareko. This variation may be related to the level of disease intensity, which was higher at Mareko. According to Fekadu *et al*. (2003) and Shaban (2007), number of pods per plant differences was mainly based on genotypic variations and less influence 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 (Zewdie and Poulos, 1995). So, it is essential to grow these types at different locations to explore genotype x environment interaction effects. Solanki *et al*. (1986) and Basavaraj (1997) have reported that fruit length, fruit width, number of fruits per plant and total fruit weight have strong positive correlations with yield. Therefore, the results obtained from this work will advance plant breeding practices by reducing the negative effect of disease and research on yield components by guiding *Capsicum* breeders in selecting the best plant characters in peppers production. In conclusion, this will lead to an increase in desirable yield values by decreasing the number of studied characters, which will in turn increase selection efficiency in pepper production.

ACKNOWLEDGEMENT

I would like to thank Ministry of Education and SOS SAHL project, which has support the research fund.

REFERENCES

Agranovsky, A.A. 1993. Virus diseases of pepper (*Capsicum annuum* L) in Ethiopia. Phytopathololy 138:89-97.

Alemayehu Chala and Tameru Alemu. 2007. The efficiency of different fungicides against pepper powdery mildew in Hawassa and Ziway. Report submitted to General chemical trading for Registration in Ethiopia.

Basavaraj. N., 1997. Genetic variability and genetics of quantitative and quality characters in green chilli (*Capsicum annuum* L.) genotypes. PhD. Thesis, University of Agricultural Sciences, Dharwad, India.

Bosland, P.W., 1993. Breeding for quality in *Capsicum*. Capsicum Eggplant Newslett., 12: 25-31.

Bosland, P.W. 1996. Capsicums innovative uses of an ancient crop. Progress in new crops ASHS press Arlington. Pp. 479-487.

Chakravorty,R., Neog,K.,Das,R and Dutta,P.K.2003. Seasonal incidence of major foliar fungal diseases of mulberry in North East India. Indian Journal of Sericulture, Central Sericultural Research and Training Institute, Central Silk Board.

Daubeze, A.M., Hennart, J.W. and Palloix, A. 1995. Resistance to *Leveillula taurica* in pepper (*Capsicum annuum*) is ligogenically controlled and stable in Mediterranean regions. Plant Breeding 114: 327-332.

Difonzo, C.D., Ragsdale, D.W., Radcliffe, E.B., Gudmestad, N.C., Secor, G.A., Ebesu, R.H. 1996. Crop Borders reduce potato virus Y incidence in seed potato. Annual Review.23p

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.

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

Fekadu Marame, 2008. Genetic Components and Heritability of Yield and Yield. Related Traits in Hot Pepper. Adama, Ethiopia. 25p

Huffnagel, H.P. 1961. Agriculture in Ethiopia. Food and Agriculture Organization (FAO), Rome, 24.

Lima, M.L.P. and Café-Filho, A.C. 2001. Resistance to *Leveillula taurica* in the genus *Capsicum* .Horticultura Brasileira 19:287-289

Palti,J. 1988. The *Leveillula* mildews. The Botanical Review 54:423–535.

Pickersgill, B., 1997. Genetic resources and breeding of *Capsicum* spp. Euphytica 96: 129-133.

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

Simon, A., Tameru, A., Ferdu. A. and Temesgen, A. 2009. Population dynamics of aphids and incidence of Ethiopian pepper mottle virus (EPMV) in the rift valley part of Ethiopia .crop protection 28: 443-448.

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

Sudheendra, A. 2005. Studies on loss assessment, epidemiology and management of powdery mildew of chilli caused by *Leveillula taurica* (lev.). Ph.D Thesise. 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 an extension workers. Pepper presented at Deutsches Tropentage, October 18-21-2003. Gottingen, Germany.

Tameru Alemu. 2004. Characterizition of pepper (*Capsicume spp*) and sweet potato (*Eabatatas*) from Ethiopia .Ph.D Thesis. University of Bonn, Germany

Ullasa, B.A., Rawal, R.D., Sohi, H.S. and Singh, D.P. 1981. Reaction of sweet pepper genotypes to anthracnose, cercospora leaf spot and powdery mildew. Plant Disease 65: 600-601.

Yaynu, H. 2001. Characteristics of isolates of *Pseudomonas solanacearum* in Ethiopia. Ethiopian Journal of Agricultural Science 11:7-13.

Yosef Haile and Yayehu Zewide. 1988. Hot Pepper research recommendation and Strategies. In; Proceedings of the nineteenth crop improvement conference. April 22-26, 1987. Addis Ababa .pp 344-356.

Zewdie, Y. and Poulos, J.M. 1995. Stability analysis in hot pepper. Capsicum Eggplant Newsletter 14: 39-42.