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Evaluation of Elite Hot Pepper Varieties (*Capsicum* spp.) for Growth, Dry Pod Yield and Quality under Jimma Condition, South West Ethiopia

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ABSTRACT
A field experiment was conducted at two locations under Jimma condition with the aim of investigating the performance of different varieties of hot pepper for growth, dry pod yield and quality, thereby, to recommend best adapting and high yielding variety/varieties for the farmers in the study area. The study was conducted from October 2009-March 2010, at JUCAVM experimental field and Seka Chokorsa woreda under irrigated condition using nine hot pepper varieties (Mareko fana, Bako local, Melka zala, Weldele, Melka shote, Oda haro, Dube medium, Dube short) and one local (Gojeb local) as a control. The experiment consisted of two factors (location and variety) and was laid out in a split-plot arrangement in a randomized complete block design with three replications. The result of the study showed significant interactions between location and varieties on days to 50% flowering, days to first harvest, mean number of flowers per plant, canopy diameter, mean number of branches (primary, secondary and territory), shoot and root dry weight (g), number of fruit per plant, number of seed per fruit, mean seed weight per fruit, marketable, unmarketable and total yield (t ha^{-1}), fruit dry weight (g), pericarp thickness, fruit length and fruit diameter. As a result, the earliest variety to attain days to 50% flowering was Gojeb local at Kechema site followed by Mareko fana at both locations. The variety to attain shortest days to first harvest was recorded from variety Gojeb local while the highest number of fruits per plant was from Weldele at Kechema site. On the other hand the highest primary, secondary and tertiary branches were recorded from variety Weldele at Kechema site. Similarly the thickest fruit size was obtained from Mareko fana at Kechema site, whereas, the widest fruit diameter was recorded from Mareko fana, Bako local, Dube medium and Dube short at Kechema site, respectively. The highest marketable yield (t ha^{-1}) of hot peppers was recorded from Varieties Weldele, Mareko fana, Dube medium and Dube short at JUCAVM and Kechema, respectively while the highest total yield (t ha^{-1}) was recorded from Weldele and Mareko fana at both locations. The high yielding capacities were attributed to their early flowering and maturity, days to first harvest, high marketable and total yield, dry weight content of the varieties as well as their reaction to disease.

Key words: Hot pepper, *Capsicum*, dry pod yield, quality parameters, jimma SW ethiopia

INTRODUCTION
The genus *Capsicum* is a member of the Solanaceae family that includes tomato, potato, tobacco and petunia. The genus *Capsicum* consists of approximately 22 wild species and five

domesticated species (Bosland, 1994). The five domesticated species include, *C. annum* L., *C. frutescens* L., *C. chinense*, *C. baccatum* L. and *C. pubescens* R. On the other hand, *Capsicum* species can be divided into several groups based on fruit/pod characteristics ranging in pungency, colour, shape, intended use, flavor and size (Smith *et al*., 1987; Bosland, 1992). Despite their vast trait differences most cultivars of peppers commercially cultivated in the world belong to the species *C. annum* L. (Bosland *et al*., 1988).

The exact time of introduction of peppers to Africa in general and Ethiopia in particular is not certainly known. But, its history in the country is perhaps the most ancient than the history of any other vegetable product (EEPA., 2003). Currently, it is produced in many parts of the country, because for most Ethiopians food is tasteless without hot pepper. The fine powdered pungent product is an indispensable flavoring and coloring ingredient in the common traditional sauce "Wot", whereas the green pod is consumed as a vegetable with other food items. In Ethiopia, pepper grows under warm and humid weather conditions and the best fruit is obtained at 21-27°C during the daytime and 15-20°C at night with the lowest at 15°C and highest at 32°C. Outside these limits, the yields tend to decline. Coupled with the temperature requirement, sandy loam to clay loam with high moisture capacity and pH of 6.5-7.5 is preferable (IAR., 1996).

Hot pepper is one of the major vegetable crops produced in Ethiopia. The country is one of a few developing countries that have been producing paprika and capsicum oleoresins for export market (Geleta, 1998). Because of it's widely use in Ethiopian diet, the hot pepper is an important traditional crop mainly valued for its pungency and color. The crop is also one of the important spices that serve as the source of income particularly for smallholder producers in many parts of rural Ethiopia. It is extensively grown in most parts of the country, with the major production areas concentrated at altitude of 1400 to 1900 m.a.s.l. (Geleta, 1998). The major pepper producing regions in the country includes: Amhara, Southern nations, nationality and people's regional government (SNNP) and Oromia.

In general, sweet pepper and hot pepper, like tomato and eggplant are rich in Vitamins A and C. It has been found that as hot peppers mature, the Pro-vitamin A (B Carotene) and ascorbic acid increase. Hot pepper can be used in the form of pickles, relish salads and dry powder. Thus, this study was undertaken to address the following objectives: (1) To investigate the performance of different varieties of hot pepper for growth, dry pod yield and quality under Jimma condition, (2) To find out the interaction effects between variety and growing environment for growth, dry pod yield and quality under Jimma condition.

MATERIALS AND METHODS

Description of the study area: The study was carried out at two locations, Seka Chokorsa (Kechema nursery site) and Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) experimental field. Seka Chokorsa district is located at about 374 km from Addis Ababa and 23 km to the south of Jimma town, at 7°36'41"N latitude and 36°44'12" E longitude (JICA., 2003). Altitude of the location ranges 1100-1600 m.a.s.l. and annual minimum and maximum rainfall ranges from1400-1601 mm, respectively. The mean maximum and minimum temperatures are 30 and 16°C respectively and the soil type of the site is Vertisols. On the other hand, Jimma University College of Agriculture and Veterinary Medicine (the second study site) is situated at about 356 km to South west of Addis Ababa. The college is located at about 7°42"N latitude and 36°5°"E longitude and at an altitude of 1710 m.a.s.l. The mean maximum and minimum temperature are 28.9 and 11°C respectively. The annual rainfall recorded is above 1500 mm. The soil is well drained clay loam to silt clay (BPEDORS., 2000).

Experimental material and design: Nine hot pepper varieties from three different agricultural research centers (MARC, BARC and JARC), i.e., Mareko fana, Melka zala, Melka shote, Weldele, Bako local, Oda haro, Dube medium, Dube short and Gojeb local (control) were evaluated at two locations under Jimma condition. The trial was conducted from October 2009 to March 2010 at Jimma University College of Agriculture and Veterinary Medicine and Kechema (Seka Chokorsa woreda) experimental site. A split plot arranged in a Randomized Complete Block Design (RCBD) with three replications was used in the experiment at each location.

Seeds were sown in October, 2009 on a seed bed size of 1×10 m. The seed bed was covered with a dry grass for 20 days. Then, beds were covered by raised shade to protect the seedling from strong sun shine and heavy rainfall until the plants were ready for transplanting. Watering was done every day with a fine meshed sprinkler and was hand weeded. Fungicides were applied once in the nursery. The plot size at each location was 1.5×3.5 m (with a total plot size of 5.25 m^2). Transplanting was done 54 days after sowing and the seedlings were spaced 30 cm between plants and 70 cm between rows (EARO., 2004). There were five rows per plot and five plants per row with a total of 25 plants per plot. Data was collected from the middle nine plants from central rows excluding the border rows and the rest of all response variables were recorded from the average of those nine selected sample plants per plot.

Data collected and statistical analysis: Data was collected from the middle nine plants from central rows excluding the border rows and the rest of all response variables were recorded from the average of those nine selected sample plants per plot at each location, based on the following parameters. Plant height, days to 50% flowering, number of flowers per plant, days to first harvest, number of fruits per plant, number of branches (primary, secondary and tertiary branches), marketable yield, nonmarketable yield, total yield, fruit length, fruit diameter, pericarp thickness, fruit dry weight and diseases incidence.

For each measured response variables analysis of variance (ANOVA) mean separation procedure was carried out. The classical fixed effect ANOVA model that includes the main effects of locations, varieties together with interaction effects of locations and varieties were used. In order to assess the associations between those measured response variables a Pearson correlation procedure was carried out. All the statistical analysis was carried out using SAS 9.2 statistical software package.

RESULTS AND DISCUSSION

Growth parameters

Plant height (cm): There was no interaction effect of locations with varieties in terms of plant height. However, the tallest plant height was recorded from variety Weldele (36.50) followed by Melka zala (29.57) and the shortest plant height was attained from variety Oda haro (22.16), even though, the measured heights differed among varieties (Fig. 1). The increase in plant height could mainly be due to better availability of soil nutrients in the growing areas, based on the varietal variability to absorb the nutrients from the soil (Vos and Frinking, 1997; El-Tohamy *et al*., 2006). The result of this study confirms the finding of Gonzalez *et al*. (2001), who reported that the presence of organic and inorganic nutrients at growth stage resulting in increase of growth variables including plant height.

Days to 50% flowering: The result indicated that, highly significant ($p<0.001$) interaction effect between varieties and location (Table 1). Accordingly, the earliest numbers of days to reach 50%

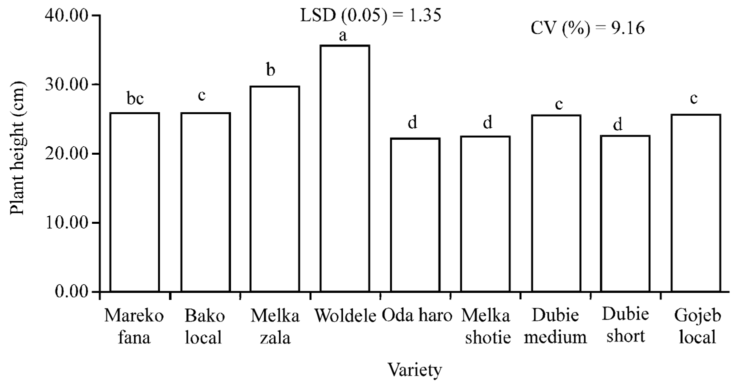

Fig. 1: Main effect of plant height on yield and yield components of hot pepper varieties

Table 1: Growth characteristics of nine hot pepper varieties as evaluated at jimma and kechema (South west ethiopia)

	Days to 50% flowering		No. of flowers per plant		Days to first harvest	
Varieties	Jimma	Kechema	Jimma	Kechema	Jimma	Kechema
Mareko fana	51.33^{ij}	50.33^{jk}	$93.67^{e\,430.89}$	50.33^{jk}	139.00^{ab}	139.00^{ab}
Bako local	59.33^{cd}	58.67^{efg}	95.33^{df}	54.23^{ij}	145.67^{ab}	145.67^{ab}
Melka zala	70.67^{a}	66.00^{b}	80.33^{f}	75.40^{de}	147.67^{a}	147.00^{a}
Weldele	56.67^{efgh}	60.33^{cde}	135.67^{b}	126.67^{c}	103.33^{f}	103.33^{f}
Oda horo	64.00^{bc}	60.67^{cde}	100.00^{d}	58.57^{i}	147.67^{a}	147.67^{a}
Melka shote	63.67^{bcd}	63.33^{bcd}	159.67^{a}	45.86^{k}	123.33^{cd}	123.33^{cd}
Dobe medium	53.67^{hij}	58.33^{efg}	99.78^{d}	72.25^{g}	148.33^{a}	148.33^{a}
Dube short	54.33^{ghij}	57.67^{efgh}	97.33^{bc}	66.05^{h}	149.00^{a}	149.00^{a}
Gojeb local	55.67^{fghi}	46.67^{k}	125.33^{c}	50.67^{jk}	134.00^{bc}	134.00^{bc}
p-value	ns**	***				
C.V (%)	4.59		16.63		13.75	

Values each column sharing same letter are not significantly affected at ($\alpha = 0.05$) ns: Non-significant, *: Significant, **: Highly significant, ***: Very highly significant

flowering was observed from variety Gojeb local (46.67 days) at Kechema experimental site, even though it is statistically similar with Mareko fana at both locations. While the longest days to attain 50% flowering was recorded from Melka zala (70.67 and 66.00 days) at Jimma and Kechema (Seka) respectively, where Oda haro and Melka shote at Jimma and Weldele at Kechema were intermediate.

Earliness or lateness in the days to 50% flowering might have been due to their inherited characters, early acclimatization to the growing area to enhance their growth and developments and/or due to the transplanting disturbance since it is subjected to loss of feeder roots during uplifting and consumed their energy to repair damaged organs and thus the process demanded them more time to resume shoot growth. Moreover, the earliness or lateness in days to flowering could also be affected by high temperature of the growing. This result, therefore confirmed the findings of Sam-aggrey and Tuku (2005), that reported earliness or slowness in flowering of pepper plants could be affected by the growing environment's temperature as well as the planting methods.

Number of flowers per plant: Interaction effect of location by varieties on number of flowers showed very highly significant ($p<0.001$) under this study (Table 1). Accordingly, the highest number of flowers per plant was recorded from variety Melka shote (159.67) at Jimma site, whereas, the least number of flowers per plant was also observed from the same variety at Kechema. But, as this indicated, the number of flowers did not commensurate the number of fruits per plant. Weldele and Gojeb local at Jimma and Weldele again at Kechema were intermediate and the rest were low.

These variations could be due to the flower inhibitory effect of high temperatures on flowering, lack of optimum soil moisture at the time of flowering of the crop especially at Kechema. Moreover, the primary cause of poor flowering and fruit set as well as marketable yield loss could be due to diseases, wind and heavy rain during flowering in decreasing effective pollination that resulting in loss of potential fruit, frost causes flower and fruit damage and loss of yield. This result is in agreement with the work of Faby (1997), Geleta (1998), Durner *et al.* (2002) and Sreelathakumary and Rajamony (2004), who indicated that, the inhibitory effect of high temperature should be considered during the flowering period.

Days to first harvest: The interaction effect of location by varieties indicated very highly significant variation ($p<0.001$) on hot pepper (Table 1) on days to first harvest. Accordingly, the shortest number of days to first harvest was recorded from variety Gojeb local (66 days) at Jimma experimental field. The longest day to attain days to first harvest was recorded from variety Dube short (149), though it is statistically similar with Oda haro (147.67), Melka zala (147.67), Bako local (145.67) and Mareko fana (139) respectively at Kechema nursery site which is in line with the works of MARC (2005), that reported cultivars like Melka zala are later than others to mature. The variations in days to first harvest (maturity) could be due to the differences in the growing environment climatic conditions and or due to the genetic make-up of the varieties. For best growth and fruit maturity and quality, it should be grown in an area with a temperature of (21-29°C day) and (15-20°C night) and soil pH of 6.5-7.5.

Number of primary, secondary and tertiary branches: The interaction effect of location by variety for the number of primary ($p<0.01$), secondary ($p<0.001$) and tertiary branches ($p<0.01$) indicated significant, very highly significant and significant variations between hot pepper varieties and location respectively (Table 2). The highest number of primary branches were attained from variety Weldele (11) but was not statistically different from Mareko fana (9.33), Bako local (9.15),

Table 2: Mean number of primary, secondary and tertiary branches as affected by the interaction of location with variety in 2009/10

	Primary branch number		Secondary branch number		Tertiary branches number	
Varieties	Jimma	Kechema	Jimma	Kechema	Jimma	Kechema
Mareko fana	9.33^{ab}	6.59^{cde}	8.00^{ghi}	13.02^{bc}	8.59^{fghi}	22.44^{ab}
Bako local	9.15^{ab}	4.69^{ef}	9.33^{fgh}	11.85^{cde}	7.46^{hi}	22.41^{ab}
Melka zala	8.67^{bc}	6.50^{cde}	8.00^{ghi}	12.48^{bcd}	8.08^{ghi}	9.45^{cd}
Weldele	10.67^{a}	6.71^{cd}	6.00^{ij}	22.33^{a}	11.99^{efg}	21.28^{bc}
Oda haro	4.27^{f}	9.00^{ab}	6.00^{ij}	9.51^{fgh}	8.99^{fghi}	22.64^{ab}
Melka shote	9.30^{ab}	5.67^{def}	5.33^{j}	10.11^{efg}	7.54^{hi}	12.82^{ef}
Dobe medium	5.67^{def}	5.51^{def}	6.00^{ij}	10.93^{cdef}	8.61^{fghi}	16.30^{de}
Dube short	8.00^{bc}	5.20^{def}	5.33^{j}	10.62^{def}	24.19^{ab}	9.71^{cd}
Gojeb local	8.00^{bc}	4.84^{ef}	7.67^{hi}	14.48^{b}	11.08^{fgh}	26.99^{a}
LSD (0.05)	1.93		2.24		4.32	
C.V (%)	16.63		13.75		17.59	

Values in each column sharing same letter are not significantly affected at ($\alpha = 0.05$)

Melka shote (9.30) at JUCAVM experimental field and Oda haro (9) at Kechema nursery site. Whereas the least number of primary branches was recorded from Oda haro (4.27) at Jimma, Bako local (4.69) followed by Gojeb local (4.84) at Kechema, respectively. The highest number of secondary branches was also recorded from variety Weldele (22.33) at Kechema, whereas the least number of secondary branches were observed from Melka shote and Dube short (5.33) at Jimma and Kechema respectively (Table 2).

Tertiary branch, the most important to extend harvest bearing later set fruits since it enables the crop to produce extra fruits was affected by the interaction of location and variety (Table 2). Accordingly, the highest number of tertiary branches were attained from variety Gojeb local (26.99) followed by Mareko fana (22.44) and Bako local (22.41) at Kechema nursery site and Dube short (24.19) at Jimma experimental field respectively. While the least territory branches were attained from Bako local (7.41) though it is statistically similar with Mareko fana, Oda haro and Dube medium at Jimma experimental field. The overall result regarding the tertiary branches was lower at Jimma.

Generally, the differences observed in branching of pepper plants might have been due to genetic variations existed between varieties and or due to favorable influence of organic and inorganic nutrients present in the soils or the growing environment which goes in line with the findings of (El-Tohamy *et al.*, 2006), that stated the presence of adequate amount of organic nutrients in the soil improves growth of pepper plants. Organic nutrients increase the biomass of pepper plants, as supported by report of Johnson and Johnson and Decoteau (1996) and Nonnecke (1996), who observed similar effects by application of different levels of organic manure into the hot pepper growing soils.

Yield parameters

Number of fruits per plant: Results of analysis of variance indicated a very highly significant interaction ($p<0.001$) among the varieties and location in terms of number of fruits per plant (Table 3). Variety Weldele had the highest number of fruits (72.3) at Kechema nursery site while the least number of fruits per plant was recorded from variety Bako local (24.55) at Kechema nursery site and Dube short (31) at Jimma experimental field respectively.

Table 3: Fruit characteristics of nine hot pepper varieties as evaluated at jimma and kechema (Seka woreda)

	No. of fruit per plant		Fruit length (cm)		Fruit width (cm)	
Varieties	Jimma	Kechema	Jimma	Kechema	Jimma	Kechema
Mareko fana	45.18^{def}	57.86^{ab}	8.01^{efgh}	15.65^{a}	1.68^{def}	2.77^{a}
Bako local	43.82^{efg}	24.55^{j}	9.17^{defg}	13.55^{ab}	1.44^{efgh}	2.22^{bc}
Melka zala	38.35^{gh}	52.55^{c}	6.78^{ghi}	10.70^{cd}	1.71^{de}	1.40^{efgh}
Weldele	61.33^{b}	72.33^{a}	6.33^{hi}	9.08^{defg}	1.50^{efg}	1.50^{efg}
Oda horo	52.40^{c}	48.55^{cdef}	5.06^{i}	9.69^{def}	1.48^{efg}	1.14^{h}
Melka shote	47.01^{cdef}	51.59^{cd}	7.08^{ghi}	10.37^{de}	1.23^{gh}	1.20^{gh}
Dobe medium	43.45^{fg}	51.48^{cde}	10.61^{d}	14.04^{ab}	1.98^{cd}	2.52^{ab}
Dube short	31.00^{ij}	29.29^{ij}	7.42^{fghi}	14.67^{ab}	1.37^{fgh}	2.54^{ab}
Gojeb local	52.55^{c}	47.40^{cdef}	6.73^{ghi}	13.17^{bc}	1.38^{efgh}	1.96^{cd}
p-value	***		**		**	
C.V (%)	8.80		15.43		12.70	

Values each column sharing same letter are not significantly affected at ($\alpha = 0.05$) ns: Non significant, *: Significant, **: Highly significant, ***: Very highly significant

The variations in fruit yield might be due to the influence of the growing environment's temperature, associated traits like canopy diameter that could limit the number of branches. Because, as a number of primary, secondary and tertiary branches increased, there could be a possibility of increasing the number of fruit producing buds which are the locations for fruit production. Moreover, the variations in fruit development among varieties at both locations could also be due to the temperature stress of the growing environment and the capability of each varieties to with stand the stress specially on the reproductive development which is more sensitive to high temperature stress (day and night temperature) than vegetative development. This result is inline with the work of Sato and Peel (2005), who reported that, the reduction of fruit set under moderately elevated temperature stress was mostly due to a reduction in pollen release and viability in tomato plant (*Lycopersicum esculentum* Mill.). On the other hand, number of fruit can be affected by fruit abortion and predation have all been proposed as factors explaining low fruit set in plants. This also is in agreement with Schemske (1980), who reported that, pollination can be the first factor limiting fruit production.

In general the interaction of location by varieties had relatively better effect on the number of fruits per plant as it has been observed at the two experimental sites. The relative earliness in flowering and maturity could also have enabled the varieties to produce more pods per plant which contributed for higher productivity of the varieties per unit area.

Marketable yield (t ha^{-1}): Interaction effect of varieties by locations exhibits a highly significant ($p<0.01$) differences on the marketable yield per ha (Table 4). The highest marketable yield was obtained from variety Weldele (1.93) at Kechema while the least obtained from Melka shote (0.51) at the same location. This result is in conformity with the work of MARC (2005) in which the marketable yield of Weldele and Mareko fana ranged between 1.5 and 2, respectively. The recorded variations of varieties in marketable yield could be due to their differences in genetic make-up and/or agro ecological adaptations compared to the locations in which they had evaluated which is in line with the findings of Mariame and Gelmesa (2006), who reported that the magnitude of genetic variability and heritability are necessary in systematic improvement of hot pepper for fruit yield and related traits.

Table 4: Yield components of nine hot pepper varieties as evaluated at jimma and kechema (South west ethiopia)

	Marketable yield (q ha^{-1})		Unmarketable yield (q ha^{-1})		Total yield (q ha^{-1})	
Varieties	Jimma	Kechema	Jimma	Kechema	Jimma	Kechema
Mareko fana	13.68^{bcde}	16.98^{ab}	5.17^{a}	3.07^{cd}	18.85^{abc}	20.05^{ab}
Bako local	10.51^{cdefg}	8.11^{fgh}	1.83^{fghi}	3.58^{bc}	12.34^{defg}	11.69^{efghi}
Melka zala	9.87^{defgh}	12.43^{bcdef}	3.58^{bc}	1.03^{ij}	12.05^{efgh}	13.46^{cdef}
Weldele	15.50^{abc}	19.27^{a}	4.68^{a}	2.53^{def}	20.18^{ab}	21.80^{a}
Oda horo	7.87^{fgh}	8.31^{fgh}	2.03^{efgh}	1.27^{ghij}	9.90^{fghi}	9.58^{fghi}
Melka shote	6.71^{gh}	5.11^{h}	0.47^{j}	1.17^{hij}	7.18^{ghi}	6.38^{i}
Dobe medium	12.51^{bcdef}	14.88^{abcd}	4.37^{ab}	2.28^{cde}	16.88^{abcde}	17.66^{abcd}
Dube short	10.28^{cdefgh}	14.58^{abcd}	3.63^{bc}	1.58^{ghi}	16.16^{bcde}	16.16^{bcde}
Gojeb local	5.54^{gh}	8.41^{efgh}	1.03^{ij}	0.43^{j}	8.84^{ghi}	8.84^{fghi}
p-value	***		*		**	
C.V (%)	12.87		15.69		8.95	

Values in each column sharing same letter are not significantly affected at (α = 0.05) ns: Non significant, *: Significant, **: Highly significant, ***: Very highly significant

The highest nonmarketable (t ha^{-1}) yield was obtained from Mareko fana (0.52) at Jimma while the least was Gojeb local (0.043) at Kechema. This unmarketable yield was recorded through subjective judgment based on shrunken shaped fruits, small sized and discolored fruits that were estimated to be due to the differences in the inherent characters of the varieties, those lacked uniformity when drying and or due to physiological disorders (bleaching) during the fruit set or due to the climatic conditions of the growing environment during harvesting.

Total yield (t ha^{-1}): A very highly significant ($p<0.001$) interaction effect was observed on total yield (Table 3). Accordingly, the highest total dry pod yield (2.18) was recorded from Weldele at Kechema while the least total dry pod yield was recorded from Melka shote (0.64) at the same location. Even though this study is a one season trial, the result disagrees with the evaluation trials undertaken at three locations by MARC (2005), which indicated that the highest dry pod yield was recorded from variety Melka zala (1.7) which produced a total dry pod yield of (1.35) in the study area (Jimma). This is much lower than the average fruit yield of the crop (2.53) reported by MARC (2005). This could be due to the climatic conditions (i.e., the temperature, the soil type, the altitude) difference in which the crop was evaluated.

Though this study is a one season trial, the result disagrees with the evaluation trials under taken at three location by MARC (2005), that has indicated as the highest dry pod yield was recorded from variety Melka zala (1.7 t ha^{-1}) which produced a total dry pod yield of (1.33 t ha^{-1}) in the study area. On the other hand, the increase in total pod yield could be due to variation in plant height, as well as formation of more primary, secondary and tertiary branches that increase potential of pod bearing buds and also leaf area that maximizes photosynthetic capacity and assimilate partitioning to the pods. This result is further consolidated by the findings of Sam-Aggrey and Tuku (2005), who reported positive impact of vegetative growth up on yield and yield components of hot pepper. Bosland and Votava (2000) also pointed out that primary and secondary branches were locations of fruit buds and thus foundations of new fruit bud development in bell peppers. Their report is in conformity with the present result, consolidating the role of branches in determining pepper total pod yield.

Quality parameters

Fruit length (cm): A highly significant ($p<0.01$) interaction was observed between varieties and location in terms of their fruit length. Consequently, the longest fruits were recorded from variety Mareko fana (15.65), followed by Dube short (14.67) and Dube medium (14.04) at Kechema. The shortest length was recorded from Oda haro (5.06), followed by Weldele (6.33) and Melka zala (6.78) at Jimma. The over all fruit length was shorter at Jimma. The result agrees with that of MARC (2005), which reported that the long fruit length of (15 cm) and the short fruit length with (7 cm) at similar variety trial. The variations were most probably being attributed to their inherited traits or the growing environment.

The overall fruit length was shorter at Jimma. The result agrees with MARC (2005), which reported that the long fruit length of (15 cm) and the short fruit length with (7 cm) at similar variety trial. The variations were most probably be attributed due to their inherited traits and or influenced by the growing environment.

Fruit diameter (cm): A very highly significant ($p<0.001$) interaction effect of location by variety was recorded on fruit diameter. The widest fruit was obtained from variety Mareko fana (2.77), followed by Dube short (2.54), Dube medium (2.52) and Bako local, at Kechema experimental site while the least fruit width was observed from Oda haro (1.14) at Kechema site. The variations in fruit diameter could be due to the difference in varieties inherited characteristics and or due to environmental conditions of the growing areas. This result is in line with MARC (2005) which showed that variety Mareko fana had a fruit diameter of 2 cm.

The pod width difference among varieties could be due to different dry matter partitioning ability of plants and the soil fertility status of the growing locations. Larger and wider hot pepper pods are considered to be the best in quality and have better demand for fresh as well as dry pod use in Ethiopian markets (Tadesse and Phillips, 2007). Therefore, subjectively this quality attribute, along with pod length and pericarp thickness could be of better preference to consumers over thinner and shorter pods.

Fruit dry weight (g): The analysis of variance on interaction effect of location with varieties showed a very highly significant difference ($p<0.001$) on fruit dry weight per plant. The highest fruit dry weight per plant was obtained from Melka zala (6.75) at Kechema. The increase in pod dry weight in this study is in conformity with the work of Hegde (1997) and Guerpinar and Mordogan (2002), who reported that pod dry matter content of peppers was directly related to the amount of nutrient taken from the soil which was proportional to the nutrients present in the soil or the amount of organic and inorganic fertilizers applied to the soil.

The least fruit dry weight (2.07) was obtained from variety Gojeb local, followed by Dube medium (2.18), Weldele (2.41), Mareko fana (2.60) and Melka shote (2.70) at Jimma experimental field. The variations in fruit dry weight among varieties may be due to the genetic make up of the varieties and or due to the agro-ecological variations in which the varieties were evaluated.

Fruit pericarp thickness (mm): The analysis of variance indicated a highly significant interaction effect of varieties with location ($p<0.01$) on fruit pericarp thickness. The thickest pericarp (1.32) was observed from Mareko fana at Kechema experimental site. On the other hand, the thinnest thickness was observed from Melka zala (0.11) and Weldele (0.13) at Jimma experimental field. These differences might be due to the fact that, the varieties assimilate partitioning capacity that might be resulted in thickest or thinnest fruit pericarp and or due to agro-ecological variations for the two study sites.

This result is in agreement with the work of Winch (2006), who reported that larger onion bulbs were the result of the accumulation of high photosynthetic products and high photo-assimilate partitioning ability of the crop that could be considered as one of the hot peppers' quality attribute among several factors in increasing the amount of powdered dry pod.

Pest and diseases incidence: Variety Melka shote, Melka zala and Bako local were observed to be infested by bacterial wilt at 15.36 and 5.3% (Agrios, 2005) at JUCAVM experimental field respectively. In contrast, the rest of varieties were not affected by any of the diseases and/ or insect/ pests at both locations.

CONCLUSION

Hot pepper is one of the major vegetable crops produced in South west Ethiopia, that serve as the source of income in many parts of the study area. The yield of the crop is affected by the cultural practices, their genetic make-up and the growing environmental conditions existing in the study area. The result of this study revealed that almost all of the parameters considered were significantly affected by the treatments or their interaction effects.

Variety Mareko fana and Dube medium which produced 1.368 and 1.251 t ha^{-1} marketable yield, respectively appeared to be better varieties at JUCAVM experimental field while Mareko fana, Dube medium and Dube short with marketable yield of 1.698, 1.488 and 1.458 t ha^{-1}, respectively, found to be better varieties at Kechema (Seka woreda) experimental site among the tested varieties. Such higher yield was attributed to the growing environment agro-ecological conditions (temperature, soil type, soil pH) and or due to the altitude difference or due to the heritable traits of these varieties. Moreover, the selection criteria of their marketable yield includes, long fruit size, thick fruit wall and dark-red pod color as a components of good quality which was highly demanded under Jimma condition. Furthermore, these varieties could be used for further research activities.

In general, the overall findings of this study indicated that the variety trial at different locations in the Jimma area substantially improve plant growth, dry pod yield and quality of hot pepper to the benefits of the large scale producers in general and small scale producers in particular in the study area. However, as the study was the first of its kind in the study area, it would be advisable to further evaluate the varieties at different locations in the Jimma belt to establish sound production system for the crop.

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