Evaluation of Hot Pepper Varieties (Capsicum species) for Growth, Dry pod Yield and Quality at M/Lehke District, Tigray, Ethiopia

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Abstract

A field experiment was conducted at Axum Agricultural Research Center, Rama irrigation site, to investigate the performance of different varieties of hot pepper for growth, dry pod yield and quality. The experiment was conducted from December 2013 to June 2014 under irrigated condition using five hot pepper varieties (Mareko fana, Melka Shote, Melka awaze, Melka zala and Melka eshet). The experiment was conducted on a randomized complete block design with three replication. The result of the study showed significant difference on days of 50% flowering, days to 50% maturity, fruit length, fruit diameter, fruit weight, number of fruit per plant, plant height, marketable yield, unmarketable yield and total yield (Qt/ha). As a result the earliest variety to attain days to 50% flowering was Mareko fana; the variety to attain shortest days to maturity were as Melka Shote and Melka zala, while the highest fruit number per plant was recorded at Melka Shote. On the other hand the widest fruit diameter was recorded at Melka eshet and Mareko fana varieties; where the thinnest fruit size of was attained at Melka Shote. The highest marketable yield (Qt/ha) of hot peppers was recorded for Melka Shote, Melka awaze, Melka fana, Melka zala and Melka eshet respectively, while the highest total yield and pest tolerance Melka Shote followed by Melka awaze. The highest yielding capacities were attributed to their early flowering and maturity, high marketable yield and total yield, dry weight content of the varieties as well as their response to disease and pests. Since this study was done two seasons at one location; it would be advisable to use Melka Shote and Melka awaze varieties to M/Lehke areas or on this given area to gain higher yield.

Keywords: Hot pepper; variety; fruit and yield

1 Introduction

Pepper is herbaceous, frost sensitive plants that in temperate areas are annual in growth duration, but in tropical areas may continue to grow and to produce yield over several years. They are the source of capsaicin, the most commonly used spice in the world. The world production of pepper is nearly 10 million metric ton of fresh pepper on 1.1 hectares and ranks in the middle range of vegetable in terms of popularity (FAO, 1992).

It grows well under warm and high humid conditions, but it requires dry weather at a time of maturity. It gives best green fruit yield and better seed set at 21°C to 27°C during the dry and 15 to 20°C at night. High temperature in combination with low humidity (40 to 50%) causes abscission of buds and flowers of poor fruit and subsequent low seed set. Pepper adapts well in sandy loam soil and well drained good clay loam (Lemma, 1998).

Pepper is one of the leading vegetables produced in the country that occupy about 44% of the total vegetable production area in the country with a total volume of production 770 thousand quintals (CSA, 2004 as cited in EHSS, 2006). It is important in the local dishes (as karia, berbere) and processing industrials (coloring agent) and export in the form of Oleoresin (red pigment) and ground powder.

Different types of pepper varieties are produced in Ethiopia. It varies in mode of growth in fruit characteristics such as fruit size, shape, color, and pungency. The degree of pungency varies considerably from mild
to hot. The fruits are erect or hanging depending on the variety.

In Tigray, the varieties Marakofana and Bako local were introduced to the farmers as early released cultivars through different organizations. Thus, the less production potential for pepper cultivars is among the limiting factors for pepper production in the region. But, pepper has become one of the most important vegetable crops in the region for different purposes.

The present situation indicates that in Central zone of Tigray Mereb Lehke woreda there are limited Capsicum species and varieties including both improved and the local ones. As a result, varietal information for the improvement of the crop for high fruit yield and quality in the existing agro-ecology is insufficient. There has also been no research on evaluation of hot pepper which enables the growers to select the best performing varieties in the study area. Evaluation of selected varieties was therefore one of the considerations to ease the existing problems of obtaining the desired varieties for which the output of this study was likely to assist and sensitize hot pepper growers and processors. Better adaptable and well performing variety (varieties) with improved cultural practices could be a possibility to boost quality and marketable production of the crop in the study area.

Furthermore, the information generated from the experiment at Mereb Lehke (Rama) experimental site; could serve as guidance to the producers to use varieties that could be best adaptable to the agro-ecology of the area for better production of the crop. This study was carried out to select better yielding pepper varieties that are tolerant/resistant to major biotic and abiotic stress at the specified area.

2 Literature review

2.1 Origin and Distribution

The origin of Capsicum species is extended from Mexico in the North to Bolivia in the South of Latin America, where it has been part of human diet since about 7500 BC (Purseglove et al., 1981). Spanish and Portuguese explorers spread pepper around the world. Pepper was introduced to Spain in 1493, England in 1548 and Central Europe in 1585. Then, from Europe it spread to Asia. Currently the crop is produced in various countries around the world including India, China, Pakistan, Indonesia, Sri Lanka, Thailand and Japan in Asia and Nigeria, Uganda and Ethiopia in Africa. India and Indonesia have been the largest producers. Currently China is the main producer and exporter in the world.

2.2 Taxonomy and Morphology

Hot pepper (Capsicum species) belongs to the Family Solonaceae, Genus Capsicum, and species frutescens L., group of vegetables. Cultivated peppers are all members of the world capsicum species. There are an estimated 1,600 different varieties of pepper throughout the world with five main domesticated species that includes C. annum L., C. frutescens L., C. Chinenses., C. baccatum L., and C. pubescens R. (Bosland et al., 2000). Capsicum peppers are commercially classified by the concentration of capsaicin (C18H27NO3) which determines a variety’s ‘hotness’, Capsicum species are diploid, most having 24 chromosome number (2n=24). But recent studies indicated the chromosome number for non-pungent species is n=13. They vary in size, shape, color, flavor and degree of hotness, from mild to very hot (Tong and Bosland, 2003).

According to Salter (1985), their production and consumption have steadily increased worldwide during the 20th century due to their roles as both vegetable and spices. Just like their Solanaceous cousins, tomato, and potatoes, peppers have rapidly become important components of diverse cuisine around the world. This is reflected in the large acreages devoted to their production in such countries as India, Mexico, China, Korea, USA and Africa. In addition, interest in both sweet and pungent types of peppers is growing in many countries not traditionally associated with spicy cuisine; protected culture has developed in northern latitude countries such as Holland and Canada and also in Mediterranean countries such as Spain, and Israel, to meet the increased demand (Wien, 1997).

Capsicum species have a solitary (single) flower that starts at the axils of the first branching node with subsequent flowers forming at each additional node. Flower differentiation is not affected by day length, but the most important factor determining differentiation is air temperature, especially at night. The Capsicum flower is complete, bisexual, hypogenous and usually pentamerous (Bosland and Votava, 2000). Depending on the environmental conditions and variety, the period of receptivity of the stigma is 5-8 days, from several days before anthesis to fewer days afterwards, with maximum fertility on the day of anthesis (Alee mullah et al., 2000).

The most actively growing organ of a pepper plant after flowering is the fruit. The fruit is ordinarily seeded, but parthenocarpic forms exist. The seed set affects development and subsequent growth of the fruit. On average there is a direct linear relationship between the number of seeds per fruit and final fruit size, until saturation at perhaps over 200 seeds per fruit (Marcel et al., 1997). Typically cultivated fruit reaches the mature green stage in 35-50 days after the flower is pollinated. The fruits are characterized as non-climacteric in ripening (Bosland and Votava, 2000).
2.3 Cultivation and Importance

Hot peppers like most other plants, prefer well drained, moisture holding loam soil (sandy loam) containing some organic matter (Lemma and Edward, 1994). A pH of 6.5-7.5 is suitable and the land should be level to 0.01-0.03 % slope to allow adequate drainage and prevent root diseases. Adequate water supply is essential. Water stress can cause abscission of fruit and flowers, especially when it occurs during flowering (Matta and Cotter, 1994) and reduces yield through reduced pollination. The extreme case can result in increased risk of diseases. Poorer soil types and water stress are believed to produce lower yields (Haigh et al., 1996).

Hot pepper (Capsicum species) is a vegetable crop at its green stage. It is a new world crop that belongs to the Solanaceae family (Poulos, 1993). It was supposed to be introduced to Ethiopia by the Portuguese in the 17th century (Haile and Zewde, 1989). The demand for specific hot pepper varieties is largely driven by consumer need and interest. The potential areas in the country for capsicum production is estimated to be about 59,991 hectares of land with the total production of 72,466 tone for dry pod and 4783 ha of land with production of 44,273 tones for fresh pod (CSA,2006).

Much of the recent attention focused on hot pepper can be attributed to their unique pungency that has made them an important spice in the cuisine of various countries. The proliferation of ethnic restaurants and food products from such as Mexico, India and Thailand has positively influenced the demand for peppers throughout the world. Both sweet and hot peppers are processed into many types of sauces, pickles, relishes and canned products.

According to Bosland and Votava (2000), sweet pepper and hot pepper, like tomato and egg plant are rich in Vitamins A and C and a good source of B2, potassium, phosphorus and calcium (Anonymous, 1998). It has been found that as hot peppers mature, the Pro-vitamin A (B Carotene) and ascorbic acid increase. It is a new world crop that belongs to the Solanaceae family (Poulos, 1993). Oleoresins of paprika sweet peppers contain more vitamin C than any other vegetable crops (Poulos, 1993). Plant breeders can selectively develop cultivars with varying degrees of pungency. Also, growers can somewhat control pungency by the amount of stress to which they subject their plants. Pungency is increased with increased environmental stress. More specifically, any stress to the hot pepper plant will increase the amount of capsaicinoid level in the pods. A few hot days can increase the capsaicinoid content significantly. In New Mexico, it has been observed that even after furrow irrigation, the heat level will increase in the pods. The plant has sensed the flooding of its root zone as a stress, and has increased the capsaicinoid level in its pods. If the same cultivar was grown in both a hot semi-arid region and a cool coastal region, the fruit harvested from the hot semi-arid region would be higher in capsaicinoids than that of the fruits harvested in the cool coastal climate (Lindsay and Bosland, 1995).

Capsicum fruits are consumed as fresh, dried or processed, as table vegetables and as spices or condiments (Geleta, 1998), because, it increases the acceptance of the insipid basic nutrient foods. The nutritional value of Capsicum merits special attention, because it is a rich source of vitamin A, C and E. Both hot and sweet peppers contain more vitamin C than any other vegetable crops (Poulos, 1993). Oleoresins of paprika and capsicum are the two important extracts of pepper (Bosland and Votava, 2000).

Medicinal use of Capsicum has a long history, dating back to the Mayas who used them to treat asthma,
coughs, and sore throats. A survey of the Mayan pharmacopoeia revealed that tissue of Capsicum species is included in a number of herbal remedies for a variety of ailments of probable microbial origin (I-San Lin, 1994). According to Bosland and Votava (2000), pepper is the most recommended tropical medication for arthritis. The pharmaceutical industry uses capsaicin as a counter-irritant balm (cream), for external application of sore muscles (Thakur, 1993). Creams containing capsaicin have reduced pain associated with postoperative pain for mastectomy patients and for amputees suffering from phantom limb pain. Prolonged use of the cream has also been found to help reduce the itching of dialysis patients, the pain from shingles and cluster headaches. It is not only their nutritional quality and medicinal value that makes peppers an important food crops, but peppers also stimulate the flow of saliva and gastric juices that serve indigestion (Alicon, 1984). It has been said that peppers raise body temperature, relieve cramp, stimulate digestion, improve the complexion, reverse inebriation, cure a hangover, soothe gout and increase passion. On the other hand among its many modern innovative uses it has been tried to use as a barnacle repellent. For example, anti-mugger aerosols with chilies pungency as the active ingredient have replaced mace and tear gas in more than a thousand police departments in the United States. The spray will cause attackers to gasp and twitch helplessly for 20 minutes (Bosland and Votava, 2000).

2.4 Production Status of Pepper in Ethiopia
In Ethiopia the total area under hot pepper production for green pod was to be about 54,376 hectares with the total production of about 770,349 quintals. However, the area of coverage in the country increased from 54,376 to 81,544 hectares through 2003/04-2005/06 production years. In recent years the total production has declined due to various reasons, but there is still enormous potential for its production in the country (MARC, 2005). In Ethiopia, the crop is cultivated at diverse ecological zones from sea level to 2000 m.a.s.l under rain fed and irrigated conditions. The crop is one of the most widely grown and plays major role in Ethiopian daily dishes as it has various home and industrial uses as well as good export potential. Whereas sweet pepper and chili are grown in lower altitudes relatively in warmer areas than for hot pepper and is mainly grown in state farms for export. Birds eye chili, which is the most pungent of all the peppers, is not in great demand, though few plants are commonly found around the homesteads in high rain fall warmer areas of the country (MARC, 2003).

The dry pod yield estimate in small farmer field was about 40 q/ha, in the state farm it ranged from 30 q/ha of dry pod yield and 150 q/ha of green pepper but the dry pod yield in experimental plot ranged between 25-30 q/ha. This indicates that hot pepper and other vegetable crops need intensive care and management for high return per unit area. Yield is dependent on varieties and varieties themselves are considerably depending on a number of factors. In Ethiopia hot pepper production for dry pod has been low with a national average yield of 0.4 t dry fruit yield/ha (Fekadu and Dandena, 2006). This variation in yield is brought about by lack of adaptable varieties with the existing agro-ecology and water during dry seasons which can lead to flower abortion and resulted in low productivity.

Much effort has been made and still continued to solve such production constraints nationally and internationally. As to the national efforts, there are a number of strong vegetable research programs across agricultural research centers throughout the country. In collaboration with regional research centers, and universities, the centers have generated a number of outputs including improved varieties, appropriate agronomic practices and crop protection measures for the vegetable production sector that could be grown in the country both under rain fed and irrigated conditions (Fekadu et al., 2008).

2.5 Effect of Varieties on Hot Pepper Production
Diverse hot pepper (Capsicum species) genotypes have been widely grown in tropics and typical tropical climate within Ethiopia over centuries. More than 100,000 tones (annual average) of dry fruit of hot pepper are produced in the country and used for export for worldwide market but substantial amount are consumed locally as spice which exceeds the volume of all other spices put together in the country. Nowadays there is serious shortage of dry fruits both for export and local markets partly due to very low productivity (0.4 t dry fruit yield/ha) of the crop (Lemma et al., 2008).

Though hot pepper has been cultivated for centuries in typical tropical climate within Ethiopia, the yield has remained very low due to limited improvement work on the crop. However, in the past three decades, diverse genotypes (more than 300) of the crop have been introduced from different regions of the world and local collections have also been made in the country. The genetic improvement of hot pepper is also lacking in the country due to non-availability of requisite genetic information. It is well recognized that the knowledge and understanding of the genetic basis of economic traits is important to enhance the progress in developing new varieties of the crop through breeding (Usman et al., 1991).
The varietal analysis techniques have been found to be the useful tools to obtain precise information about the types of gene actions involved in the expression of various traits and to predict the performance of the progenies in the latter segregating generations. Each variety has its own significant effect on yield and yield components, and each variety has its own traits that are part and parcel as quality parameters of the crop (shape, size, color, taste and pungency). The most important traits among others include, number of branches per plant (count), plant height, number of fruits per plant, days to maturity (count from days of transplanting), dry fruit yield per plant, fruit length and single fruit weight (Lemma et al., 1991).

Even though about a dozen hot pepper cultivars was released, in Ethiopian pepper research history, two cultivars, namely Mareko fana and Bako local, released in 1976, are being extensively produced in the commercial farms and by the peasant sector (Engels et al., 2008).

2.6 Varietal Studies and Achievements on Hot pepper in Ethiopia

Globally due to its economic importance, especially in Asian countries such as Thailand, China, and the Philippines, the Asian Vegetable Research Development Center (AVRDC) had begun the varietal evaluations to develop more productive and adaptive cultivars for the region. Accordingly, the AVRDC has chosen hot pepper as one of its principal crops. Subsequently, with collaboration from the International Board for plant Genetic Resources (IBPGR), at the very beginning was able to have a collection comprising 5,177 accessions from 81 countries/territories (Yamamoto and Nawata, 2005). The main emphasis of pepper work is centered on collection, multiplication, conservation, characterization, evaluation, documentation, and distribution in comparison with the local varieties which are specific to agro-ecological sites throughout Asia, with the help of evaluation trials, the activity which has not yet been widely and consistently strengthened in our case (AVRDC, 1993).

In Ethiopia Capsicums have been grown for a long time by local farmers and considered as an indigenous vegetable crop and due to a long period of cultivation in different part of the country a great deal of natural hybridization has occurred among different capsicum species. As a result many local genotypes have evolved with various plant and fruit characters as well as disease and pest reactions. Research on capsicum started with minor observation and mass selections from local materials in different experimental stations of Awasa and Bako (MARC, 2003). However, later strong research activities on varietal screening and cultural practices were started at Bako Agricultural Research Center. Major activities like varietal screening against diseases, adaptation studies and plant selections have been attempted at Nazret and Jimma Research Centers and at different trial cites in Bako area. In the last 30 years, extensive research has been conducted mainly on hot pepper in different research centers and in Ambo plant protection centers and Haramaya University. Some improved cultivars from each type have been developed and some management practices like spacing, sowing date, rate of fertilizer, planting method, seeding rate and disease and pest control measures were recommended (MARC, 2003). Currently different research activities are also in progress at different centers to alleviate some of the main production constraints and develop better productive varieties from local collections and imported materials.

In Tigray, the varieties Mareko fana and Bako local were introduced in to the farmers as early released cultivars through different organizations. Thus, the less production potential for pepper cultivars is among the limiting factors for pepper production in the region. But, pepper has become one of the most important vegetable crops in the region for different purposes. At present, there is a shortage of different varieties which are adaptable and high yielder to different agro-ecological zone of Tigray (AxARC, 2014). Farmers in M/Lehke district of Myweni irrigation schemes produce pepper widely. However, the yield and quality of the variety which are currently under production is low due to lack of improved varieties, poor management practices and prevalence of disease and pest; and are not introduced as much as the interest of small scale producers. Hence, introduction and adaptation of improved varieties from different regional and national research centers is the main solution for producers who are produced varieties of low yield, susceptible to many diseases and pests and low acceptability in quality of the local market (AxARC, 2014).

3 Materials and Methods

3.1 Experimental Design and Research Management

The trial was carried out in randomize block design (RCBD) having three replications in a gross plot size of 4.2m x 3m (12.6 m²) with a spacing of 1.5m between replications and 1m between plots. The treatments included five improved varieties of hot pepper. The varieties were Mareko fana, Melka eshet, Melka Zala, Melka awaze and Melka Shote variety.

Seeds were sown in October, 2013 on a seed bed size of 1x5m. 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
Variety | Maintainer | Adaptation m.a.s.l | Temperature (°C) | Rainfall | Seed Source
--- | --- | --- | --- | --- | ---
Mareko fana | MARC | 1400-2200 | 20/29 | 600-1337 | MARC
Melka eshet | MARC | 1200-2200 | 20/29 | 900-1200 | MARC
Melka zala | MARC | 1200-2200 | 20/29 | 900-1200 | MARC
Melka awaze | MARC | 1200-2200 | 18/29 | 900-1300 | MARC
Melka Shote | MARC | 1000-2200 | 15/27 | 900-1300 | MARC

Table 1 Pepper varieties tested

Rainfall until the plants were ready for transplanting. Watering was done based on climatic conditions with a fine watering can, and was hand weeded. Transplanting to the actual field was done when the seedlings attained 20 to 25 cm height and or at 54 days after sown. The Seedlings were spaced 30 cm between plants and 70 cm between rows. 200 kg/ha DAP as a side dressing during the transplanting operation and 100 kg/ha for UREA, half of it during the transplanting and half of it 15 days after transplanting was applied (EARO, 2004). There were four rows per plot and 10 plants per row with a total of 40 plants per plot.

3.2 Data Collection and Analysis
Data were collected from a net plot area of 2.8 m x 2.8 m containing five rows where the two most outer rows and 0.3 m length in both ends were left as border effects. Days to 50% flowering, days to 50% maturity, plant height (cm), fruit number plant$^{-1}$, fruit length (cm), fruit diameter (cm), fruit weight (gm.), and marketable dried pod yield (qt ha$^{-1}$)were collected and analyzed. Five plants from the middle rows were taken to collect data of plant height (cm) and five fruits from each these plants were also taken to consider fruit length (cm), fruit diameter (cm) and fruit weight (g) of each variety.

All the collected data were subjected to the analysis of variance (ANOVA) using the SAS computer package version 9.1 (SAS Institute, 2004).

4 Results and Discussion
4.1 Days to 50% flowering
Varieties showed significant difference on days to flowering. The highest (72.67) and lowest (60) days to flowering was shown in Melka Shote and Mareko fana, respectively (Table 2). This indicated that Melka Shote took longer days to flower while Mareko fana flowered earlier. Earliness or lateness in the days to 50% flowering might have been due to the inherited characters, early acclimatization to the growing area to enhance their growth and developments. This result was in agreement with the finding of Seleshi et al. (2014) who reported that days to flowering of hot pepper varieties was significantly affected by the interaction effect of variety and location which could be due to the temperature of the growing area and 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. Earliness to flowering may be due to inherent characters, different response of varieties to growing environments (e.g. temperature, rainfall, altitude, pests and diseases, etc.), and acclimatization to the growing area and/or due to transplanting disturbance (Sam-Aggrey and Bereke-Tsehai, 2005).

4.2 Days to 50 % Maturity
Significant (P≤0.05) variations were observed among the hot pepper varieties in the number of days plants attain 50% flowering and 70% physiological maturity. Melka Zala required the longest time (71.33 days) until 50% of the plants to flower and 122.67 days until they mature. Melka eshet required the shortest time (61.67 days) to flower and 105.67 days to mature. While Melka Zala and Melka Shote there is no significance difference. This result was in agreement with the finding of Lemma et al. (1994) also indicated a range of 96 to 99 and 100 to 126 days to flowering and maturity, respectively, for different Capsicum genotypes including varieties in the present study. Geleta (1998) also reported 74 to 97 days and 114 to 158 days for flowering and maturity, respectively, of 18 Capsicum genotypes grown at Melkassa Research Center. The results indicate that, the traits are affected by both genotype and environment.

4.3 Fruit Length
As fruit length of the hot pepper varieties significantly influenced (P≤0.05) due the varietal effect (Table 2), the highest and lowest fruit length of pepper variety was observed in Melka zala (12.67) and Mareko fana (9 respectively). The significant difference in fruit length among the hot pepper varieties attributed to the inherited traits and adaptability to the environmental condition of the study area. This current result was supported by the findings of Haileslassie et al. (2015) and Seleshi et al. (2014). Moreover, this finding was supported by the work of Tibebu and Bizuayehu (2014).
Variety | Days to 50% flowering | Days to 50% Maturity | Fruit length (cm) | Fruit Diameter (cm) | Fruit weight (gm.) | Plant Height (cm)
--- | --- | --- | --- | --- | --- | ---
1 Melka awaze | 64.33ab | 111.67b | 9.86bc | 1.2cd | 6.83d | 72.4b
2 Melka eshet | 61.67b | 105.67c | 11.16ab | 2.21a | 23.69a | 62.93c
3 Mareko fana | 60b | 111b | 9.0c | 2.82b | 12.67b | 70.67bc
4 Melka shote | 72.67a | 121a | 10.57bc | 0.98d | 6.54d | 70.47bc
5 Melka zala | 71.33a | 122.67a | 12.67a | 1.38c | 9.58c | 83.4a
LSD (5%) | 8.42 | 4.53 | 1.58 | 0.34 | 2.57 | 7.87
CV (%) | 6.78 | 2.1 | 7.9 | 10.68 | 11.52 | 5.81

Table 2: The mean values of Marketable yield and yield components of hot pepper varieties in 2014 cropping season at Mereb Lehke irrigation scheme

4.4 Fruit Diameter
Effect of variety showed highly significant difference on fruit Diameter (Table 2). The highest fruit Diameter was recorded from Marko fana (2.82) and lowest fruit diameter of pepper variety was observed in Melka Shote (0.9). This result was in agreement with the finding of likewise, Haileslassie et al., (2015) found that fruit diameter was significantly affected due to varietal effect. Similarly, this was confirmed to the finding of Tibebe and Bizuayehu (2014) which showed Marko fana produced the highest fruit diameter (1.98 cm). According to Beyene and David (2007), 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.

4.5 Fruit Weight
Table 2 revealed that dry pod weight was significantly (P<0.05) influenced due to the impact of varietal effect. Accordingly, the highest Fruit Weight was obtained from Melka eshet (23.69) pepper variety. However the lowest was from Melka Shote (6.54). The results indicate that, the traits are affected by both genotype and environment.

4.6 Plant height
Plant height significantly (P<0.05) influence due to Varieties. The mean plant height of the hot pepper varieties evaluated differed significantly with the tallest being the Melka zala variety (83.47) and the shortest being variety Melka eshet (60.93) (Table 2). This result was in agreement with the finding of MARC (2005), which reported Melka zala variety showed the tallest plant height (62 cm) among the evaluated varieties at three locations.

4.7 Fruit Number per Plant
According to Table 2, there was a significant difference in fruit number per plant of the varieties Varietal difference causes significant difference in fruit number per plant. The Melka shote variety produced more number of fruits and was statistically superior to the others. Nevertheless, Marako fana and Melka eshet produced less number of fruits and statistically inferior than the others. The highest fruit number in Melka Shote variety was most likely due to the fruit bearing capacity of the variety and more branch formation nature which leads to contain high number of fruits per plant. In line with this result, Amare et al. (2013) found different fruit number per plant due to variety differences. Furthermore, Seleshietal (2014) reported that number of fruits per plant was highly significantly affected by the interaction of variety by location. These authors also stated that fruit number difference might be due to the associated traits like canopy diameter that could limit the number of branches, the temperature stress of the growing environment and the capability of each varieties to with stand the stress especially on the reproductive development, which is more sensitive to high temperature stress (day and night temperature) than vegetative development.

4.8 Marketable Yield (Qt/ha)
Regarding marketable yield of pepper, variety exerted significant (P<0.05) influence on marketable yield of hot pepper plant. The highest and lowest dry marketable yield was observed in Melka Shote and Melka zala which is 30.95 qt/ha and 24.60 qt/ha in dry marketable yield pepper respectively. The variation of marketable yield of these varieties could be due to difference in genetic characteristics and agro ecological adaptability nature which is in line with the findings of Fekadu et al. (2008) and heritability is necessary in systematic improvement of hot pepper for fruit yield and related traits.

4.9 Unmarketable yield (qt/ha)
The varieties showed significant difference (p<0.05) on unmarketable yield. The highest unmarketable yield was obtained from Melka eshet (7.4 qt/ha), while the
<table>
<thead>
<tr>
<th>Variety</th>
<th>Fruit no. per plant</th>
<th>Marketable Yield (Qt/ha)</th>
<th>Unmarketable Yield (Qt/ha)</th>
<th>Total yield (Qt/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Melka awaze</td>
<td>46.67ab</td>
<td>28.57ab</td>
<td>3.5b</td>
<td>27.19</td>
</tr>
<tr>
<td>2 Melka eshet</td>
<td>25.07b</td>
<td>25b</td>
<td>7.5a</td>
<td>26.94</td>
</tr>
<tr>
<td>3 Mareko fana</td>
<td>32.87b</td>
<td>25b</td>
<td>3.4b</td>
<td>26.52</td>
</tr>
<tr>
<td>4 Melka Shote</td>
<td>60.2a</td>
<td>30.95a</td>
<td>1.86b</td>
<td>27.21</td>
</tr>
<tr>
<td>5 Melka zala</td>
<td>41.8ab</td>
<td>24.6b</td>
<td>2.6b</td>
<td>26.78</td>
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<tr>
<td>LSD (5%)</td>
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<td>5.54</td>
<td>3.3</td>
<td>ns</td>
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<tr>
<td>CV (%)</td>
<td>30.48</td>
<td>10.97</td>
<td>48.91</td>
<td>11.24</td>
</tr>
</tbody>
</table>

Table 3 The mean values of Marketable yield and yield components of hot pepper varieties in 2014 cropping season at Mereb Lehke irrigation scheme

least was Melka shote (1.86 qt/ha). This result is in Argue with the work of MARC (2005) in which the marketable yield of Marko fana ranged between 1.5 and 2. The result of marketable yield also shows that the variety Melka shote had the highest unmarketable yield (0.1053) while the least unmarketable yield was recorded from variety of Melka awaze (0.088). 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. Additionally due to disease and vertebrate pests like birds.

4.10 Total Dry Fruit Yield (Qt/ha)
As indicated in Table 3, non-significant difference was observed on total dry fruit yield of different pepper varieties. The highest and the lowest total were observed in Melka Shote and Mareko fana which is 27.21 qt/ha and 26.52 qt/ha respectively.

5 Conclusions and Recommendations
Hot peppers are important crops in many developing countries. However, lack of research on Adaptability and improper or inadequate crop management practices can result poor crop yields and high production costs in Ethiopia particularly to the Mereb Lehke districts where hot pepper is among the highest acreage and values of low elevation vegetables lack of best performing variety is the major bootticks for farmers and growers due inefficient research work in the area. Therefore, the main target of this research work in the area was to come up with best adapting and disseminating this technology to local producers.

An adaptation trial is one of the most important mechanisms to select best varieties and demonstrate and disseminate the technology to the farmers easily. Based on this result, it can be concluded that Melka zala variety was late maturing and gave lower yield. However, Melka shote, Melka awaze, Marako fana and Melka eshet varieties gave the highest yield and Mareko fana and Melka awaze were early maturing varieties. However, Melka shote and Melka zala were late in maturity relatively as compared to Mareko fana and Melka awaze. In general among these varieties the Melka shote and Melka awaze variety are the most outstanding variety because of its highest biomass, disease tolerant, fruit number, yield and repeatable harvesting which leads to high yield per hectare, but with small fruit size. Therefore, Melka shote performed well agronomically and was recommended for production by growers in the study area.

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References


