

## Enhancing Productivity and Production of Onion (*Allium cepa* L.) Through the use of Improved Varieties at North Western Zone of Tigray, Ethiopia

Research Article

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### Abstract

Field experiment was conducted to study the effect different varieties on yield, yield attributing character and postharvest storability of onion (*Allium cepa* L.) in Tselemti district, North western Zone of Tigray During 2007-2009 off season time. Four improved onion varieties namely: Bombay red, Adama red, Nasik red & Nafis including Shendi (imported from Sudan), were tested in Randomized Complete Block Design (RCBD) with four replications. Accordingly, treatments were assigned randomly to the experimental plot within a block. The results showed that the difference in variety had significant effect on all characters except the non-significant effect of variety on neck thickness and bulb diameter. Nasik red variety gave significantly highest in plant height, leaf number, leaf length bulb length and marketable bulb yield i.e 35588kg/ha that exhibited 18% and 36% advantages on the dominantly produced varieties bombey red and adama red respectively. The overall study revealed that growing Nasik red variety is not only significantly increased the marketable bulb yield, but also better shelf life. Therefore, it is recommended for onion producers of Tselemti wereda for profitable onion yield.

**Keywords:** Onion; Storability; Variety; Yield.

### Introduction

Onion (*Allium cepa* L.) is an important bulb crop, belonging to the family Alliaceae [11]. It is one of the most important and popular bulb crops cultivated commercially in nearly most parts of the world. Onions as food, medicine and religious object were known during the first Egyptian dynasty (3200 B.C.) [17]. It is important in the daily diets of human's in worldwide and Ethiopians as well (MoARD, 2006). Onion contributes significant nutritional value to the human diet and are primarily consumed for their distinctive flavor widely used in soups, meat dishes, salads, food dressings and sandwiches, medicinal purposes and is cooked alone as a vegetable. Its pungency is due to the presence of a volatile oil (Allyl propyl disulphide) (Malik, 1994).

Onion (*Allium cepa* L.) is a recently introduced bulb crop in the agriculture commodity of Ethiopia and it is rapidly becoming a popular vegetable among producers and consumers [4, 13]. It is more widely grown in Ethiopia for local consumption and for flower export [13]. It is valued for its distinct pungency or mild flavour and also consumed universally in small quantities

and used in many homes almost daily, primarily as a seasoning for flavouring of dishes, sauces, soup, and sandwiches in many countries of the world [8].

Onion is one of the most important vegetable crops in Ethiopia which is used almost daily as a spice and vegetable in the local dish regardless of religion, ethnicity, and culture [3]. The diverse agro-climatic conditions that prevail in the country provide the opportunity of producing onion bulb, seeds and cut flower for local use and export market [3]. Additionally, its higher yield potential, availability of desirable cultivars for various uses, ease of propagation by seed, high domestic (bulb and seed) and export (bulb, cut flowers) markets in fresh and processed forms is making the crop increasingly important in Ethiopia [21].

Ethiopia has enormous potentials to cultivate the vegetable crops at small as well as large commercial scale. The country has high potential to benefit from onion production, and the demand for onion is increasing from time to time for its high bulb yields, seed and flower production potential [13]. Statistics indicated that, the production of onion in Ethiopia during 2012/2013 growing

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season was in about 21865ha of land yielding a total production of 219919 tons with an average yield (10.06 tons/ha) which is too low as compared to the world average of 19.31 tons/ha (FAOSTAT, 2013).

There are a number of constraints that cause low productivity of onion in Ethiopia. The low yield of onion in the country is reported to be due to low fertility of soil, inappropriate fertilizer rate, lack of improved varieties, and poor management practices [13].

The use of proper agronomic practice has an undoubted contribution in increasing crop yield. The optimum level of any agronomic practice like plant spacing, plant population, planting date, harvesting time can bring desired results. The optimum use of spacing or plant population has dual advantages. It also avoids strong competition between plants for growth factor such as water, nutrient and light. Conversely, optimum plant population enables efficient use of available crop land without wastage [22].

The use of appropriate agronomic management practices is important to increase the productivity and production of the crop. However, in the country, intra-row spacing of 10 cm and inter-row spacing of 20 cm during transplanting to permanent field is used which was recommended before 20 years [22]. But, plant spacing as an important economic consideration in the production of onion should have to depend on type of variety (plant architecture, growth habit etc.), agroecology, production system etc. Therefore, for onion production, it is very difficult to give general recommendation to be applied uniformly in all agroecologies of the country [19]. Gupta et al., (1994) [10] and Lemma and Shimeles (2003) [13] suggested that to optimize onion productivity, full package of information is required for each growing region of the country.

Similarly, the success of onion production is also depend on soil nutrients. Different levels of nutrients affect the yield and taste of the bulbs even within a variety. Application of nutrients play a major role in increasing productivity of onion. Onions are weaker than most other crop plants in extracting nutrients from the soil, especially the immobile types because of their shallow and unbranched root system; hence they require and often respond well to addition of fertilizer [2]. Nitrogen and phosphorus are often referred to as the primary macro nutrients because of the probability of plants being deficient in these nutrients and because of large quantities taken up from the soil relative to other essential nutrients [14].

Generally, there are a number of constraints that cause low productivity of onion in Ethiopia. The low yield of onion in the country is reported to be due to low fertility of soil, inappropriate fertilizer rate, lack of improved varieties, and poor management practices [13]. Among these constraints, inappropriate use of mineral fertilizers, lack of improved and adaptable varieties and unproper plant spacing are the most limiting factors in our mandate areas.

Therefore the present study was conducted with general objectives of identifying adaptable onion varieties, assessing the effects of nitrogen and phosphorus fertilizer rates and different inter and intra row spacing on growth, yield and yield components of onion in the study area.

## Objective

To investigate the performance of different varieties of onion & identify the best agro ecological adaptive, high yielder and disease resistance onion varieties to the area.

## Methodology

The experiment was conducted at Tselemti Wereda Shire-Maitsebri (SMARC) experimental Station during 2007-2009 E.c off season periods. Four improved onion varieties namely: Bombyred, Adamared, Nasik red & Nafis including Shendi (imported from Sudan), were evaluated for their yield performance for the last three years. The field experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Accordingly, treatments were assigned randomly to the experimental plot within a block.

A plot size of 2 x 3 m (6 m<sup>2</sup>) was used. The blocks were separate by 1.5m, whereas plots within a block were 1m apart from each other. Each plot consists of 5 rows of 3m length, with a spacing of 40cm between rows & 10 cm between plants. Recommended amount of fertilizer (200kg/ha DAP & 100kg/ha Urea) were used. All management practices (ploughing, cultivation, watering, nursery and transplanting method, weeding and others) were applied uniformly to all plots as per standard recommendations for the crop. The experimental area was kept weed free by hand pulling throughout the cropping season. In addition to the field evaluation, simple postharvest evaluation also conducted for all the varieties. For this purpose 6kg representative bulbs were selected from each variety and kept under normal storage condition to compare their storability.

## Method of Agronomic Data Collection

All data relating to yield and yield components were collected from the central three rows by excluding plants from either end of the rows. For the purpose of crop data collection two (2) plants/row or six (6) plants/plot were selected randomly from each plot and observations on growth, yield and yield components of the crop such as: plant height, average leaf length, average leaf number, average neck thickness, average bulb length, diameter & yield were recorded.

**Plant height (cm):** Plant height was measured from the ground level up to the tip of the Longest leaf using ruler. Plant height of six randomly selected plants were measured in the central rows of each plot at physiological maturity stage of the crop and the average was Computed.

**Days to physiological maturity:** It was registered on plot basis as the actual number of days from date of transplanting to when about 75% of the leaves fell down and 2/3 leaves had turned yellow.

**Number of leaves per plant:** The number of fully developed leaves of six randomly selected plants was counted at the active green leaf stages and the average was computed to obtain number of leaves per plant.

**Leaf length (cm):** Leaf length was recorded as the average length of the longest leaves in six randomly selected plants at maturity.

**Bulb diameter (cm):** Bulb diameter was measured at right angles to the longitudinal axis at the widest circumference of the bulb of six randomly selected plants in each plot using vernier calliper [14] at harvest.

**Bulb length (cm):** Bulb length was the vertical average length of the matured bulb of six randomly selected plants in each plot which was measured by vernier calliper.

**Bulb neck thickness (cm):** The average neck thicknesses of six randomly selected plants in each plot were obtained by measuring the neck of bulbs at the narrowest point at the junction of bulb and leaf sheath using a vernier calliper.

**Marketable bulb yield (t/ha):** Marketable bulb yield was determined after discarding the unmarketable bulb, weight healthy bulbs and having nationally accepted marketable bulb weight of 60 g (Tegbew, 2011) [18] at harvest in each plot and converted to t/ha.

For postharvest evaluation six kg of onion from each variety were weighed and stored in a conventional storage room. Weight loss and number of sprouted bulbs were recorded in every two weeks for about 3 months, then finally at the end of the 3<sup>rd</sup> month weight and number of unsprouted bulbs were recorded and tried to compare the storability of each variety.

#### Method of Data Analysis

All crop data collected in this study were subjected to two way statistical analysis of variance (ANOVA) following a procedure appropriate to a randomized complete block design as suggested by (Gomez and Gomez, 1984). When the treatment were significant, least significance differences (LSD) by Dunken's multiple range comparison were used for mean separation at  $p = 0.05$ .

## Results & Discussion

The data in (Table 1&2) showed a significant ( $p < 0.05$ ) variability between the varieties in most of the traits.

#### Days to Bulb Maturity

Days to maturity was significantly ( $P < 0.05$ ) influenced by variety. Bombay Red and Shendi matured significantly earlier than the other varieties at about 124.9 & 127 and the next variety at about 134.2 days, whereas Nasik variety matured in about 16.8 days later than Bombay red (Table-1). The variation of maturity among onion varieties might be due to their genetic differences. Bombay Red variety was found to be the earliest, which matured 23 days earlier than Adama Red followed by Melkam which was earlier by 18 days than the Adama Red [20]. Similarly Azoom et al., (2014) [1] also reported significant differences among eight onion varieties for days to bulb maturity. Bombay Red and Adama Red matured by less than 120 or/and in between 110 to 130 days, respectively [5].

#### Leaf Length

The analysis of variance revealed a significant ( $P < 0.05$ ) effect of variety on leaf length. Both Nasik Red and Adama red showed the highest mean leaf length (40.27cm & 39.25cm). Nasik red had significantly higher leaf length by about 12.2% than Bombay Red (currently dominant variety in the testing area (Table-1). The difference of varieties in leaf length might be due to their differences in genetic makeup. In agreement with the current result, Yemane et al., (2014) [20] reported that Adama Red (40.75 cm) showed higher leaf length than Melkam (37.83 cm) and Bombay Red (35.17 cm). Similarly, Mondal et al., (1986) [15], Ghafoor et al., (2003) [9] and Jilani et al., (2010) [12] also reported the differences among cultivars with respect to leaf length.

#### Plant height

The analysis of variance showed that plant height was significantly ( $P < 0.05$ ) affected by Variety. The plant heights of Nasik red, Nafis and Adama red varieties attained maximum height of (45.9, 45.25 & 42.9 cm) respectively, which was significantly different than Bombay Red and Shendi variety (Table 1).

Although they have grown in the same environment the difference in plant height among the onion varieties could be due to the difference in their genetics make up that was differently influenced by the environment. Tegbew (2011) [18] indicated the mean plant height of Adama Red (62.25 cm) cultivar was significantly higher than Bombay Red (56.04 cm) cultivar. The result was similar to the finding of Ghafoor et al. (2003) [9] and Yemane et al., (2014) [20] who indicated the presence of significant differences among onion cultivars in plant height.

#### Marketable bulb yield

The variety had significant effect ( $P < 0.05$ ) on marketable bulb yield. Nasik red had significantly higher marketable bulb yield (35588Kg/ha) than Bombay Red and Adama which are the commonly produced varieties in the area (Table 2). A cultivar may performs differently under diverse agro-climatic conditions and various cultivars of the same species grown even at the same environment with different management often yield differently due to the genetic makeup of the cultivars and the interaction effects of genotype x environment or genotype x management [20]. Gautam et al., (2006) [7] indicated that yield of fresh onion bulb was significantly affected by varieties. In agreement with this finding Rajcumar (1997) [16], Jilani (2003) [9] and Geremew et al., [8] (2010) also reported significant difference within varieties for marketable bulb yield in onion.

#### Postharvest performance of the varieties

In addition to the agronomic performance simple postharvest evaluation was also carried out to evaluate the storability potential of each variety. For this purpose similar amount (weight) of onion from each variety was store for three months at a normal room temperature and the trial was repeated for two (2) years. Data like Number of sprouted bulbs, Weight of non-sprouted bulbs, Total weight loss e.t.c was recorded in every two weeks for about three months. The mean result showed that, there was a big difference in weight loss among the different onion varieties (Table-3 & 4). Maximum weight loss of (100%) & 97% was recorded at Adama

**Table 1. Effect of variety on days to maturity, plant height, number of leaf per plant and leaf length of onion.**

S/N	Variety	DM	Pht (cm)	ALN	ALL(cm)
1	Nasik red	141.7c	45.90a	10.881a	40.27a
2	Shendi	127.0a	37.16b	8.456 c	33.56c c
3	Bombey red	124.9a	30.23c	8.920bc	28.08 d
4	Nafis	134.2b	45.25a	10.057abc	39.52ab
5	Adama red	140.9c	42.90a	10.599ab	36.69bc
Mean		133.73	40.29	9.78	35.62
CV (%)		3.4	12.7	20.2	11.0
LSD		6.402	7.309	2.816	5.594

Variety: Means with in the same column followed by the same alphabets do not differ significantly at the 5 % level of significance; DM = Days to maturity; pht = plant height; ALN = Average leaf number; ALL = Average leaf length;

**Table 2. Effect of variety on Bulb diameter, Bulb length, Neck thickness and Marketable yield of onion.**

S/N	Variety	ANT(cm)	ABL(cm)	ABD(cm)	MY(Kg/ha)
1	Nasik red	1.424	5.546a	5.816	35588.0a
2	Shendi	1.207	5.674a	5.992	26119.6b
3	Bombey red	1.323	4.899 b	6.039	30005.1ab
4	Nafis	1.319	5.637a	5.863	26362.6b
5	Adama red	1.322	5.436aa	5.586	26099.4b
Mean		1.319	5.438	5.859	288349
CV (%)		27.3	7.6	8.9	27.4
LSD		ns	0.592	ns	112868.4

ns = non-significant at 0.05 probability level; Means with in the same column followed by the same alphabets do not differ significantly at the 5 % level of significance: ANT = Average neck thickness; ABL = Average bulb length; ABD = Average bulb diameter; MY = Marketable yield.

**Table 3. Simple postharvest performance of the different onion varieties (2007 cropping season).**

S/N	Variety Name	Initial no.bulbs	Initial wt.(Kg)	Wt.Non sprouted bulbs			Total Wt.loss	Total Wt.loss (%)
				1 <sup>st</sup>	2 <sup>nd</sup> M	3 <sup>rd</sup> M		
1	Shendi	43	3.5	2.5	1.8	1.4	2.1	60
2	Nafis	38	3.5	2.7	1.4	0.29	3.21	92
3	Adama red	47	3.5	2.7	0.89	-	3.5	100
4	Nasik red	43	3.5	2.9	1.4	0.4	3.1	88.5
5	Bombey red	55	3.5	2	0.53	0.1	3.4	97

**Table 4. Simple postharvest performance of the different onion varieties (2008 cropping season).**

S/N	Variety Name	Initial no.bulbs	Initial wt.(Kg)	Wt.Non sprouted bulbs			Total Wt.loss	Total Wt.loss (%)
				1 <sup>st</sup> M	2 <sup>nd</sup> M	3 <sup>rd</sup> M		
1	Shendi	70	6	5.05	4.54	3.58	2.42	40
2	Bomboy red	62	6	5.35	4.56	2.03	3.97	66
3	Adama red	63	6	4.316	1.701	0.545	5.455	90
4	Nasik red	56	6	4.95	3.995	1.307	4.693	78
5	Nafis	60	6	4.2	2.28	0.88	5.12	85

red in the 1<sup>st</sup> and 2<sup>nd</sup> year respectively followed by bombey red. Among the tested varieties minimum weight loss Was recorded from shendi. 60% in the 1st year and 40% in the second year were loss from the total initial weight in the three month period. This indicates that varietal difference have a great role in the postharvest and quality of onion bulbs (Table-3 & 4).

## Summary and Conclusion

Onion is widely recognized as an important vegetable condiment as a form of dry bulb and cash crop in Ethiopia. It is successfully produced under rained as well as irrigated conditions in different agro ecologies of the country by small holder farmers and commercial growers. However, the productivity of onion is not as expected due to many production constraints. The use of lower yielder and un adaptable varieties is among the many production constraints. So, selection of varieties that produce high yield is very critical to improve the yield of onion. Therefore; this study was conducted to evaluate the agronomic and postharvest performance of five onion varieties. The experiment was conducted at Shire-Maitsebri Agricultural Research center, Tselemti woreda, North western Zone of Tigray during 2007-2009 under irrigation. The experiment was laid out in randomized complete block design (RCBD) with four replications. Data were collected for phenology of the crop, growth, yield and yield components and analyzed accordingly.

The analysis of variance revealed the significant effect of variety on all the parameters except neck thickness and bulb diameter. Nasik red variety had superior plant height, Leaf number, leaf length, bulb diameter and marketable bulb yield than the other tested varieties. Nasik red had higher marketable bulb yield by about 18% & 36.35% than the dominantly produced bombey red and Adama red varieties respectively.

Regarding to the postharvest performance of the onion varieties, Minimum weight loss was recorded from Shendi variety followed by Nasik red variety. Total weight loss at the end the three month storage was recorded from the commonly produced varieties.

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