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Adaptation and Evaluation of Improved Onion (*Allium cepa*) Varieties at Arba Minch, Southern Ethiopia

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ABSTRACT

Smallholder farmers of are involved in onion production in very small amount. Even if the onion production techniques generate very high income, productivity is being threatened because of limited introduction of improved onion varieties. Therefore, this study was conducted to evaluate yield performance of improved onion varieties under supplementary irrigation. The treatments consisted of five varieties namely, Adama red (standard check), Bombay red, Nasik red, Nafis and Robaf using a randomized complete block design with three replications. Results of combined data analysis revealed that the highest fresh bulb weight of 126.4 g and121.8 g was observed in the Bombay red and Nafis varieties respectively, which differed significantly from standard check. Similarly, the highest bulb diameter was observed from variety Nafis (20.4 cm. The highest marketable yield per plot was obtained from variety Bombay red (10.8 kg) which was not significantly differed from other varieties. On the other hand, the highest total yield (12.13 t/ha) was obtained from variety Bombay red; which however, was statistically at par with variety Nafis with the total yield of 11.68 t/ha. From the results, Bombay red had better yield performance with the lowest unmarketable yield. Therefore, variety Bombay red can be used for better production in the study area and similar agro-ecologies.

Key words: *Adaptability; Marketable yield; Performance; Varieties; Yield related traits*

Introduction

Onion (*Allium cepa* L.) is one of the most important vegetables which belong to the family Alliaceae [1]. It is originated in central Asia between Turkmenistan and Afghan where some of its relatives still grow as wild plants. However, the leading onion producer countries are China, India, USA and Turkey. It is a recently introduced crop to Ethiopia from Sudan and then distributed to different parts of the country and now became important vegetable crop for markets and in a daily life of people of the country [2]. Onion is valued for its distinct pungency or mild-flavored form of essential ingredients of many dishes. Fresh onion has about 86.6% moisture, 11.6% carbohydrate including soluble sugars, 1.2%protein, 0.1% fat, 0.2-0.5% Ca, 0.05% P, traces of Al, Cu, Fe, Mn, Zn and vitamin A, B and C [3]. It is consumed universally in small quantities almost daily in many homes primarily as a seasoning for flavoring of dishes and sandwiches in the world [4]. It has nutritional value that helps alkaline reaction in our body and importance in neutralizing the acid substance produced during digestion of meat, cheese and other foods [5]. Recently, onion crops are the most important cultivated crops in the agricultural community of Ethiopia and it is rapidly becoming a popular vegetable among producer and consumer [4].

According to the Central Statistical Agency (CSA) report, a total of 31,673 hectares of land was under onion cultivation in the country and productivity was about 9.28 t/ha in Ethiopia. In Southern Nations, Nationalities and Peoples Region (SNNPR) the area covered by onion was 1,297.6 ha and production in quintals was 132,699.7 with the productivity of 10.25t/ha in 2017/18 Meher season. Although the productivity of onion in the SNNPR and Gamo Zone (study area) is better than the national, it is still by far low as compared to the productivity potential of the crop (23.5-37.2 t/ha). Low accessibility of improved onion varieties, poor irrigation systems and diseases and insect pests are among the major constraints that resulted in the low productivity of the crop in the study area. Therefore, there is a need to tackle these problems by evaluating improved varieties for adaptability and yield performance in the study areas before

dissemination and large scale production of the varieties. The present investigation was therefore aimed to evaluate adaptability and yield performance of improved onion varieties in the study areas.

Materials and Methods

Description of the Study Site

Field experiment was carried out at Gamo Zone (Arba Minch Zuria and Mirab Abaya Districts) in 2017 and 2018 cropping seasons under irrigation condition. Mirab Abaya District is located between 6064'N latitude and 37082'E longitude with an altitude of 1200 m.a.s.l. Average annual rain fall and temperature of the district is 900 mm and 21ºC respectively. On the other hand, Arba Minch Zuria District is situated in 604'N latitude and 37036'E longitude with an altitude of 1300 m.a.s.l. The average annual rain fall and temperature of the area range from 1000-1400 mm and 20.1-25ºC respectively.

Experimental Design and Trial Management

In this experiment, five onion varieties namely, Adama red (standard check), Bombay red, Nafis, Nasik red and Robaf were used as treatments. Treatments were arranged in randomized complete block design with three replications. Onion seeds were sown in seedbed and grown at the nursery for 50 days. Uniformly grown seedlings were selected, hardened and transplanted to the experimental field after attaining 13-15 cm height. The seedlings were transplanted to experimental field having a recommended plot size of 3 m width and 3 m length. During the experiment, seedlings were planted at 40 × 10 cm between rows and plants, respectively. A spacing of 2 m was also maintained between replications. Five plants from the middle rows were randomly taken for sampling and data analysis. Recommended fertilizer rate of 200 kg/ha DAP and 100 kg/ha Urea was applied to each plot. All appropriate agronomic practices such as weeding, watering and hoeing were conducted uniformly both at the nursery and experimental field.

Data Collection

Data on establishment percentage, plant height (cm), days to 75% maturity, bulb length (cm), bulb weight (g) bulb diameter (cm), marketable yield (kg/plot), unmarketable yield (kg/plot) and total yield (kg/ha) were collected and measured using five randomly selected and pre-tagged plants per plot.

Establishment Percentage, Growth and Phenology Parameters

Number of leaves per plant: Fully developed leaves of five randomly selected plants counted from the middle rows of the net plot size at physiological maturity, and the average was computed for each plant.

Leaf length (cm): The length of the longest leaves of five randomly selected plants was measured using measuring tape at physiological maturity and their averages were computed.

Leaf width (cm): It was taken from the widest parts of leaves of five randomly selected plants by using veneer caliper (model 141) at physiological maturity and the average value was calculated.

Plant height (cm): Plant height was measured from the ground level up to the tip of the longest leaf using a measuring tape. It was measured using five randomly selected plants from the two central rows of each plot at physiological maturity of the crop and the average values competed.

Yield Components and Bulb Yield

Bulb length (cm): The vertical average length of matured bulbs of five randomly selected plants in each plot was measured by veneers caliper.

Bulb diameter (cm): Bulb diameter was measured at right angles to longitudinal axis at the widest circumstance of the bulb of five randomly selected plants in each plot by using veneer caliper (model 141).

Average bulb weight (g): The average bulb weights of five randomly selected bulbs from the net plot was taken and calculated as the mean fresh bulb weight after harvesting.

Marketable bulb yield (t/ha): Marketable yield was recorded as kg/plot and converted to t/ha.

Total bulb yield (t/ha): The yield that includes both marketable and unmarketable bulb weight and expressed as kg per plot and converted into t/ha. Clean, disease free and undamaged bulb with a weight greater than 21 g was considered as marketable bulb yield.

Data Analysis

Although the experiment was conducted in only two locations, homogeneity of variance between the locations was checked using F-test. In this test, the error variance became homogeneous (F-calculated was less than F-table value). Therefore, we used combined data for analysis and the analysis was employed by using SAS version 9.0 procedures. Least Significant Difference (LSD) test was used for mean separation at 5% probability level.

Results and Discussion

Analysis of Variance

Analysis of variance revealed that highly significant difference was observed among tested varieties for establishment percentages (stand count after a month of transplanting and stand count at harvesting), days to 75% maturity and total yield. Similarly, highly significant difference was observed for all the variables except establishment percentages between years and locations. But establishment percentages (stand count after one month of transplanting and stand count during harvesting) showed significant difference ($p<0.05$ level of probability) while the rest showed non-significant difference in treatment location interaction.

Establishment Percentage (%)

Stand counts: Stand counts both after one month of transplanting and at harvest were significantly ($P>0.001$) affected by varietal difference of the onion. Thus, higher establishment percentage (95.2% and 93.2%) was recorded for Nasik red and Nafis, respectively. Haile-Selassie et al, reported similar establishment for the same varieties [6]. These traits can be considered for enhancing production and productivity. On the other hand, the lowest stand count after transplanting (85.2%) was observed by variety Robaf and lowest stand count at harvest (77.3%) was recorded at variety Adama red. This result is in agreement with the works of Pardeshi and Waskar [7].

Growth Parameters

Days to maturity: Analysis of variance indicated that days to 75% maturity was significantly (at $P<0.001$) influenced by the varieties. Variety Robaf showed the shortest days to 75% maturity (137 days) while varieties Nafis and Nasik red required non- significantly less number of days to attain maturity compared to the remaining varieties. The probable reason for early maturity of varieties might be enhanced transfer of photosynthetic materials from the leaves to bulbs that enhancing the growth rate of onion causing early initiation of bulbs, early maturity and finally early harvesting [7]. The more number of days required for maturity might be due to less photosynthesis efficiency, resulting in more time requirement to complete the vegetative [7]. The results of the present study are supported by the findings of Masika et al. and Sharma and Sain who reported variation in days to maturity among onion genotypes [8,9].

Plant height: Plant height was not significantly influenced ($P>0.05$) by varietal difference. However, somewhat higher plant heights were recorded from Nafis (46 cm) and Nasik red (45.7cm).Whereas to some extent lower values were obtained at the varieties of Robaf (41 cm) and Bombay red (42 cm). The result is in contrast with the findings of Haile-Selassie et al. [6] in which higher plant height (57.40 cm) was recorded from Nafis and (66.26 cm) at Nasik red. This greater plant height might be due to favorable soil and climatic conditions during the season.

Bulb weight: Onion bulb weight was not significantly ($p<0.05$) affected by varietal effect. But, highly significant difference ($p<0.01$) was recorded across years and locations. Higher fresh bulb weights of 126.4 g and 121.8 g were observed from varieties Bombay red and Nafis respectively, which differed insignificantly from varieties Nasik red (119.5 g) and Robaf (115.5 g). The lowest dry bulb weight of (102.8 g) was observed in standard check variety (Adama red). According to Sirajo and Namo the genotypes with higher bulb weight had higher total bulb yield, implying that dry bulb weight is a major determinant of fresh bulb yield in the onion. Dry matter content has been reported to contribute largely to the firmness and tunic thickness of some local onion variety in India. Dry matter content is also believed to influence long storage period in the onion in India as well as in Nigeria. Genotypes with high dry matter have longer shelf-life and are recommended for industrial processing.

Yield and Yield Component Traits

Bulb diameter: Mean square values indicated that there was no significant influence ($p>0.05$) by varietal effect on bulb diameter. But, the highest bulb diameter was observed in the variety Nafis (20.4 cm) and Bombay red (20.1 cm), but this did not differ significantly from other varieties. Onion genotypes with high bulb diameter are known to have large bulbs and small neck diameter attributes, which are believed to make them not to store well. Bulb diameter contributes to bulb size and shape index.

Marketable yield: The combined analysis of data indicated that marketable yield was significantly influenced ($P<0.05$) by varietal effect of the onion plants. The highest bulb yield per plot was obtained in varieties Bombay red (10.8 kg) and Nafis (10.2 kg) which were not significantly differed from other varieties but superior compared to the standard check under study. The more increase in marketable yield appeared due to increased bulb weight and bulb diameter. Pardeshi and Waskar reported the increase in marketable yield appeared due to increased growth of plants with respect to height of plant and number of leaves per plant [7]. In this case, our result is in contrary to their findings. Higher rate of photosynthesis might have produced more food material, thereby increasing in size of bulbs as indicated by diameter and average bulb weight which are important yield contributing characters. The yield differences can also be attributed to difference in genetic makeup of different varieties [8-10].

Unmarketable yield: Unmarketable yield was highly significantly ($P<0.01$) influenced by year and location effects. Similarly, it was also significantly ($P<0.05$) affected by the onion varieties. Variety Nafis had produced significantly higher unmarketable yield (2.5% of its total yield) while Bombay red had produced significantly lower unmarketable yield (0.7% of the total yield). This indicated that Bombay red had better adaptability and yield performance. Similar result was reported by Haile-Selassie et al. for the some onion varieties.

Total yield: The highest total yield (12.13 t/ha) was obtained from variety Bombay red; which however, was statistically on par with the total yield of Nafis (11.68 t/ha). On the other hand, despite its higher unmarketable yield, higher total yield of 11.68 t/ha was recorded by Nafis which was not significantly differed from the rest varieties. The difference in total bulb yield of onion varieties depends on variation in genotypes, climate, cultural practices and their interactions. The present result is in agreement with findings of Simon et al., who obtained the highest total bulb yield from variety Nafis than other varieties.

Conclusion

The result indicated that all the evaluated varieties performed better in bulb yield and well adapted compared to the standard check (Adama red). Bombay red had better adaptability and yield performance with the lowest unmarketable yield and better bulb weight. Similarly, variety Nafis showed better yield performance with relatively better bulb weight. Thus, Bombay red and Nafis varieties can be used for cultivation and better production in the study area and similar agro-ecologies.

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