Plant
2022; 10(2): 40-43
http://www.sciencepublishinggroup.com/j/plant
doi: 10.11648/j.plant.20221002.11
ISSN: 2331-0669 (Print); ISSN: 2331-0677 (Online)

Participatory Variety Selection of Improved Onion (*Allium cepa* L.) Varieties at Wondo Genet and Heben Arsi, Southern Ethiopia

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To cite this article:

Dadi Tolessa Lemma, Habtamu Gudisa Megersa, Dejene Tadesse Banjaw, Damtew Abewoy. Participatory Variety Selection of Improved Onion (*Allium cepa* L.) Varieties at Wondo Genet and Heben Arsi, Southern Ethiopia. *Plant*. Vol. 10, No. 2, 2022, pp. 40-43.
doi: 10.11648/j.plant.20221002.11

Received: March 15, 2022; **Accepted**: April 15, 2022; **Published**: April 25, 2022

Abstract: Onion is a bulb vegetable crop produced for its nutritional and economic benefit worldwide. Also, this crop is widely produced in Ethiopia for domestic consumption and also generate income for the producers. Even though it is produced widely the producers use unimproved varieties which does not meet the market preferences lower in yield. So, participatory variety selection through demonstration of four onion varieties was conducted at Wondo Genet and Heben Arsi districts during 2019/2020 to 2020/2021. The experiment was done to evaluate the varieties through farmers' participation. It was conducted on station for researchers' data collection by replicating three times and non-replicated plot basis for farmers' evaluation. The Researcher data and farmers preferences toward the varieties were collected and analyzed using SAS software and pair wise ranking respectively. The result showed that there was significant difference among the varieties. The highest total bulb yield (38.57 t ha^{-1}) was obtained from Nafis and the lowest (31.28 t ha^{-1}) was from the Nasik red variety. Also, the maximum bulb diameter (5.26 cm) and bulb length (4.83 cm) were recorded from Nafis variety and the lowest bulb diameter and length was obtained from Nasik red variety. Pair wise raking of farmers preference also, shown that Nafis was the first and best variety according to their criterion at both locations. Therefore, based on the result obtained it is better and recommended to produce Nafis onion variety for the farmers of Wondo Genet and Heben Arsi districts and other similar agro-ecologies.

Keywords: Evaluation, Pair Wise, Participatory, Preference, Varieties

1. Introduction

Onion (*Allium cepa* L.) is one of important vegetable crop which is widely used for its nutritional, health and economic benefits [1]. It is mainly grown for food source and used as cousins and value addition for different dishes. The area under production of onion is at increasing rate globally due to its important benefit in the daily dish [2]. In Ethiopia also, the onion production is increasing in different agro ecologies of the country which is mainly produced in small-scale production system being as one component of commercialization for rural and urban peoples as income sources [3]. It can be cultivated both under irrigation and rain feed condition in different parts of the country twice per year [4]. According to CSA [5] reported, about 41286.88 ha of land was covered by onion with 338,086.56 ton in 2016/17 cropping season. Hence, the area under onion is increasing from time to time mainly due to its high profitability per unit area and ease of production, and the increases in small-scale irrigation systems.

However, the productivity of the crop remains lower (10.02t/ha) which is far below as compared to the world average (19.7 t/ha) due to the lack of improved varieties and inappropriate agronomic practices [2]. Comparing the national average onion yield with the yield obtained at the research (40 t/ha), there is about 30 t/ha yield difference [5]. Though a numbers of onion varieties were released for

different agro ecological areas of Ethiopia, most of the producers are using a poor planting materials [6].

To improve technology generation, dissemination and adoption, and to benefit from the available improved technologies, different stakeholders (researchers, extension officers, farmers, consumers and traders) have to be part of the breeding process right from its beginning. This can be done through participatory plant breeding in the identification of priority traits, on-farm demonstrations, popularization and re-evaluation of the technologies [7]. Participatory variety selection (PVS) is a powerful tool that involves farmers and other stakeholders to help orient breeding programs and to improve variety adoption [8]. It also assists plant breeders to develop technologies that fit into a specific production niche and the farmers' needs [9]. The conventional plant breeding scheme uses a narrow range of selection criteria that addresses issues related to yield, uniformity and stability. Traditional farmers, however, employ more diverse and complex selection criteria, revolving around stable crop performance over seasons and they grow a range of genotypes that meet their needs in very complex and heterogeneous environments [7]. The farmers' preferences, as well as the socioeconomic aspects, are often ignored by the conventional breeding programs. Farmer participation in setting breeding goals and varietal evaluation will remain critical for enhancing adoption and genetic diversity. Participatory variety selection can speed up the selection and fast-track the dissemination processes. In addition, it will eliminate a number of unacceptable varieties and save money and time [10].

An adoption of these improved onion technologies will provide an opportunity for improvement of nutritional status of farming family and community in the vicinity. It is also very important in creation of employment especially for jobless youths and woman in the production areas and it brings a diversification of farming and income source to the producers of respective districts. In order to provide the improved onion varieties for the producers of Wondo genet (Sidama Region) and Heben Arsi (West Arsi zone, Oromia region), four different improved onion varieties was evaluated at the study areas by participating the farmers. Therefore, this study was carried out to evaluate and select different onion varieties, suitable for the study areas and to identify the farmers' preference criteria for the varieties.

2. Material and Methods

2.1. Description of the Study Area

Two onion producing districts was selected in southern Ethiopia Wondo genet (low in volume of production from Sidama region and Heben Arsi (medium in volume of production) from Oromia region which have slightly different agro-ecologies and get the access to central markets. Wondo genet is located in Sidama region at the elevation of 1780 m.a.s.l with the minimum and maximum temperature of 12.02°C -26.72°C and 1128 ml average annual rain fall, respectively. Heben Arsi is located in the central rift valley of West Arsi zone of Oromia region state.

2.2. Varieties Used for Evaluation Purpose

Four varieties Nafis, Nasik red, Robaf and Bombay red were received from Melkassa agricultural research center for evaluation and participatory variety selection purpose.

2.3. Field Establishment and Management

The experiment was carried out as replicated for researcher data collection and non-replicated trial at farmer's farm for farmers' evaluation. The trial was arranged in a randomized complete block design (RCBD) with three replications on research station. The treatments were randomly assigned to each plot. The experimental plot had an area of 5.74m^2 (2.4m length x 2.4m width) and space between replications and plots were 1.5m and 1m, respectively. The space between double rows, rows and plants were 40cm, 20cm and 10cm respectively. Plants in the middle rows of the net plot was used as the sampling unit for data analysis. All field management activities were done as required as per recommendations.

2.4. Farmers' Selection and Participatory Evaluation of the Varieties

In this study, two groups of onion growers having 29 members (15= from Wondo Genet and 14= from Heben Arsi) were selected from the two districts with the help of development agents. Training was given to the farmers to create general awareness about the experiment. Group discussion and debates were made to observe and clear contradictory ideas on issue like farmers' preferences, criteria for evaluation and characteristics of good onion varieties. Evaluation criteria were set by farmers' prior to evaluation as; vegetative performance, bulb size, bulb shape, bulb color, market preference and tolerance to disease. According to the farmers, good onion varieties should have the following characteristics; vigorous and uniform, free from disease, higher in yield, red color and medium to large bulb size with oval shape. Therefore, the varieties were evaluated by the farmers using these criterion and analyzed using pair wise and matrix ranking.

2.5. Statistical Analysis

The mean values of all parameters (for researchers data) were subjected to analysis of variance (ANOVA) using SAS software [11], version 9.4. Least significant difference (LSD) procedure was used to compare differences between treatment means.

3. Results and Discussion

3.1. Researchers Evaluation

The results of this study revealed that, most of yield and yield related traits was affected by the varieties except

growth parameters like plant height and leaf numbers. As indicated in table 1 onion varieties significantly affected bulb diameter and bulb length. The maximum bulb diameter (5.26 cm) and bulb length (4.83 cm) were recorded from Nafis varieties which is statically similar with that of Bombay red variety while the lowest bulb diameter (4.12 cm) and bulb length (4.09 cm) were observed from Nasik red variety. This is due to the reality that varieties can have different genetic makeup that makes them different. Similar finding was reported by Demisie and Tolessa [12] as the genotypic difference in the varieties of onions affect bulb length and diameter.

Analysis of variance also showed that single bulb weight was affected by the varieties (table 1). The highest single bulb weight (103.63 g) was obtained from Nafis variety which is statistically similar with Bombay red variety. The lowest single bulb weight (82.63 g) was obtained from Nasik red which is statistically similar with that of Robaf variety. The result was in agreement with the findings of Kindeya *et al* [13] who reported that, Nafis variety was larger than other varieties. Similarly total yield per hectare was influenced by the varieties. The highest total yield per hectare (38.57 t) was obtained from Nafis variety. The lowest total yield per hectare (31.28 t) was obtained from Nasik red variety. The yield obtained from Bombay red and Robaf statically similar with that of Nasik red variety. Genetic difference/variation in each variety contributed to the yield difference among them. The present result is in line with findings of Demisie and Tolessa [12] who obtained the highest total bulb yield (36.28 t ha^{-1}) from variety Nafis than other varieties. Also, Fistum and Gadissa [14] reported that Nafis variety have yield advantage than other varieties.

Table 1. *Combined mean performance of onion varieties to selected parameters during 2020/21.*

Varieties	Plant height (cm)	Leaf number	Bulb Diameter (cm)	Bulb Length (cm)	Single Bulb Weight (g)	Total yield per hectare (t ha^{-1})
Bombay red	51.10	13.20	5.10^{ab}	4.76^{ab}	99.13^{a}	34.28^{b}
Nafis	49.15	12.05	5.26^{a}	4.83^{a}	103.63^{a}	38.57^{a}
Nasik red	50.80	14.00	4.12^{bc}	4.09^{bc}	82.63^{b}	31.28^{b}
Robaf	49.05	13.85	4.59^{bc}	4.39^{bc}	84.13^{b}	34.03^{b}
$LSD_{0.05}$	ns	ns	0.59	0.43	11.84	3.12
CV (%)	6.30	11.59	7.85	5.99	8.13	5.74

3.2. Farmers' Preference

Farmers' perception on the performance of onion varieties were tested at Wondo Genet and Heben Arsi districts and analyzed using matrix and pair wise ranking. As a result, the majority of participant farmers in the districts have good interest to produce improved onion varieties. The evaluated varieties preformed well as the farmers criterion. The performance of the varieties and farmers preference were similar in both districts. After discussions and debates farmers ranked the varieties based on their preference and degree of satisfaction by giving the values 1-5 [15]. Matrix ranking result showed that overall mean for all performance indicators/preference criteria at Wondo Genet district were higher for Nafis (4.57) followed by Nasik red (3.86) and Bombay red (3.71) table 2. On the other hand, the overall mean for performance indicators at Heben Arsi district were higher for Nafis (4.29), which is followed by Bombay red (3.85) table 2. The least preferred and with low performance variety according to farmers' preference criteria was Robaf variety.

Table 2. *Matrix ranking of onion varieties based on criteria selected by farmers at Wondo Genet (n=15) and Heben Arsi (n=14) during 2019/2020.*

Evaluation criteria	Wondo Genet				Heben Arsi			
	Robaf	Bombay red	Nafis	Nasik red	Robaf	Bombay red	Nafis	Nasik red
Earliness	3	4	4	4	3	3	5	3
Disease tolerance	4	3	4	4	2	4	3	3
Bulb shape (circular)	3	4	4	4	3	4	4	4
High yielder	3	4	5	4	3	5	5	4
Bulb size	4	4	5	3	2	3	6	2
Bulb uniformity	2	3	6	4	3	4	3	4
Market preference	3	4	4	4	3	4	4	3
Total preference	22	26	32	27	19	27	30	23
Overall mean	3.14	3.71	4.57	3.86	2.71	3.85	4.29	3.29
Overall rank	4	3	1	2	4	2	1	3

Rank: 5= very good, 4= good, 3= average, 2= poor and 1 = very poor.

Also, the farmers got chance to compare the varieties to each other based on the identified preference criteria. Using pair-wise ranking, participants/farmers' preference toward the varieties was summarized according to Boef and Thijssen [15]. The result showed that Nafis was the most preferred varieties followed by Bombay red and Nasik red (table 3). Farmers indicated that Nafis was selected due to its higher yield potential, good bulb size and moderately tolerant to disease. Also the variety was preferred since it has good skin color for its high marketability. The farmers gave lowest rank for Robaf due to its small bulb size and susceptible to disease compared to the other varieties. During the evaluation, farmers indicated that their preference matched with researchers' selection criteria for bulb size, marketability and higher yield.

Table 3. *Pair wise ranking on the overall preference of farmers toward different onion varieties at Wondo Genet and Heben Arsi.*

	Robaf	Bombay red	Nafis	Nasik red	Total score
Robaf					0
Bombay red	Bombay red				2
Nafis	Nafis	Nafis			3
Nasik red	Nasik red	Bombay red	Nafis		1

4. Conclusion and Recommendation

The study was conducted to identify the best performing varieties for good yield return, and to recommend the best variety with better bulb quality for farmers in the study area by incorporating the farmers' preference criterion. The result indicated that Nafis was high yielder and the most preferred onion variety by the farmers at Wondo Genet and Heben Arsi districts. Robaf variety was low yielder and least preferred variety since its bulb size and disease tolerance was lower than other varieties at both locations. Researchers selection and farmers selection was almost indicated similar result. Hence, planting of the Nafis variety had yield advantage and it is advisable to use these variety for the production of marketable bulb yields in the study areas. On the other hand, production of Robaf variety is not advantageous since it does not fulfill the farmers' preference criterion and low in yield and disease tolerance for the study area. So, the researchers recommends Nafis variety for both location and similar agro ecologies to get better yield and good bulb quality. Also, recently released improved onion varieties should be adapted to the areas and better variety should be selected and delivered to the users.

Acknowledgements

The experiment was conducted with the financial support from Ethiopian Institute of Agricultural Research. Therefore, the Authors acknowledges the institute for financial support (from capital budget) and Wondo Genet agricultural research center for facilitation and logistic support.

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