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(Research Article)

Evaluation of improved shallot (*Allium cepa* L. Aggregatum) varieties for yield and yield related traits in Gamo Zone, Southern Ethiopia

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Abstract

Shallot (*Allium cepa* var. ascalonicum Backer) is an important vegetable crop cultivated by small holder farmers for consumption in Gamo mid and high lands. However, its production and productivity is constrained by lack of improved shallot varieties in the study area. Field experiment was conducted in Gamo Zone during 2021 and 2022 cropping season. The objective of the experiment was to select well adaptive and high yielding shallot varieties for the study areas. Eight shallot varieties in two sets (bulb propagated sets and seed propagated sets) were evaluated in randomized complete block design with four replications by using double row spacing of 40cm x 20cm in Plot size of 2.4m x 2m. The combined analysis of the mean over years showed that there was a statistical significant mean difference (P<0.01) among the varieties for yield and some yield related traits. Among the bulb propagated varieties tested, the highest number of splits (13.75) per plant (bulb) was recorded by variety ''DZSHT-00/2" followed by "Minjar" (12.18). Similarly, "DZSHT-00/2" gave the highest bulb yield (21.22 t ha-1) followed by "Minjar" (19.27 t ha-1). On the other hand, the highest marketable bulb yield of 9.61 t ha-1 was recorded by variety "Tropics" followed by "DZSHT-157-21" **(**7.47 t ha-1). Hence, varieties "DZSHT-005/2" and "Tropics" are recommended for popularization and production due to their better yield and adaptability in the study area.

Keywords: Bulb yield; Evaluation; Minjar; Shallot; Seed propagated

1. Introduction

Shallot (Allium cepa var. aggregatum) belongs to the family Alliaceae and is believed to be originated from West Asia [1]. Shallot is primarily consumed for its unique favor or ability to enhance other foods' favors. However, in South East Asia as well as in some African countries such as Uganda, Ethiopia and Côte d‟Ivoire, where onion seed is hard to produce and where the growing season is too short for the production of bulb onion, the vegetatively propagated shallot is cultivated as an important substitute for bulb onion [2]. Although bulb onions can be grown in the tropics, farmers in tropical countries prefer shallot for its ability of vegetative propagation. Shallot is also preferred for its shorter growth cycle, better tolerance to disease and drought stresses and longer storage life than the common onion and for its distinct flavor that persists after cooking [3].

Shallot is one of the most widely cultivated bulb crops in Ethiopia. The production of bulb shallot is restricted to highland areas under rain-fed conditions. It is one of the most important cash crops and traditionally produced under rain-fed conditions in many regions of the country (Hararghe, Shoa, Arsi, Bale, Gojjam, Gamo, Gofa, etc.) by small farmers as income generating spice crop for flavoring local dishes [4]. It is mainly grown for the bulb, although the green tops may

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also be consumed. In Ethiopia, shallots and onions are used for flavoring the local stew, „*wot*" and are used in many households almost daily [5]. The national average yield of bulb shallot is about 7 t ha-1 and the bulb yield is characterized by poor quality of mixed varieties varying in size, color, shape and storability and in most cases the crops are grown in usually moisture-stressed areas and yield is commonly very low [4, 5]. Shallots have a wide range of climatic and soil adaptations and are cultivated both under rain-fed and irrigated conditions. Farmers in the area are cultivating shallot in smaller amount in areas to meet the demand of local market. Onion seed production requires two seasons with ambient conditions and this can't be done by farmers. Therefore, the vegetative propagated shallot can substitute bulb onion. Shallots are also preferred for their shorter life cycle, better tolerance to disease and drought stresses and longer storage life than the common onion. Besides, it can be cultivated in mid to high altitude areas where onions do not cultivated under rain-fed conditions. There is high demand of improved shallot in farmers in the study areas who are facing a challenge with very low yield and small sized bulbs. Hence, testing the released shallot varieties in the study area to increase the productivity of the crop has paramount importance. Therefore, this research is initiated with the following objective.

Objective

To evaluate improved shallot varieties for adaptability and better yield performance and select best adaptable and high yielder variety/ties.

2. Material and methods

2.1. Description of the study area

The experiment was conducted in Mirab Abaya woreda of Gamo Zone, Southern Ethiopia. The study site is found in an altitude range of 1001 to 3000 m.a.s.l. Mirab Abaya is located between 6^{0}38'- 6^{0}64'N latitude and 37^{0}54'- 37^{0}82'E.longitude with an average annual rain fall of 801-1600 mm. The area's mean temperature ranges between 15.1 – 25 ^{0}C.

2.2. Experimental Design and Trial Management

In this experiment, eight improved shallot varieties in two different sets namely, Bulb propagated set (set I): Minjar, DZSHT-005/2, Huruta & Negele and Seed propagated set (set II): DZSHT-157-21, DZSHT-91-2B, Tropics & Yeras were used as treatments. Treatments were laid in randomized complete block design with four replications. Seeds were sown in seedbed and grown at the nursery for 50 days. Uniformly grown seedlings of seed propagated set were selected, hardened and transplanted to the experimental field after attaining 13-15 cm height. On the other hand, bulbs of the second set were stored in diffused light storage (DLS) for 30 days and planted to experimental field. During the experiment, seedlings were planted at 40 × 20 cm between rows and plants, respectively. Plot size of 2.8 m x 2 m was used for both sets and spacing of 2 m was 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 were applied uniformly both at the nursery and experimental field as per recommendation.

2.3. Data collected

Data on establishment percentage, plant height (cm), days to 75% maturity, bulb length (cm), bulb weight (g) bulb (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.

2.4. Statistical Analysis

Although the experiment was conducted for two years, we used combined data for analysis. The mean values of all parameters were subjected to analysis of variance (ANOVA) using the SAS package [6]. Least significant difference (LSD) procedure was used to compare differences between treatment means at 5% probability level.

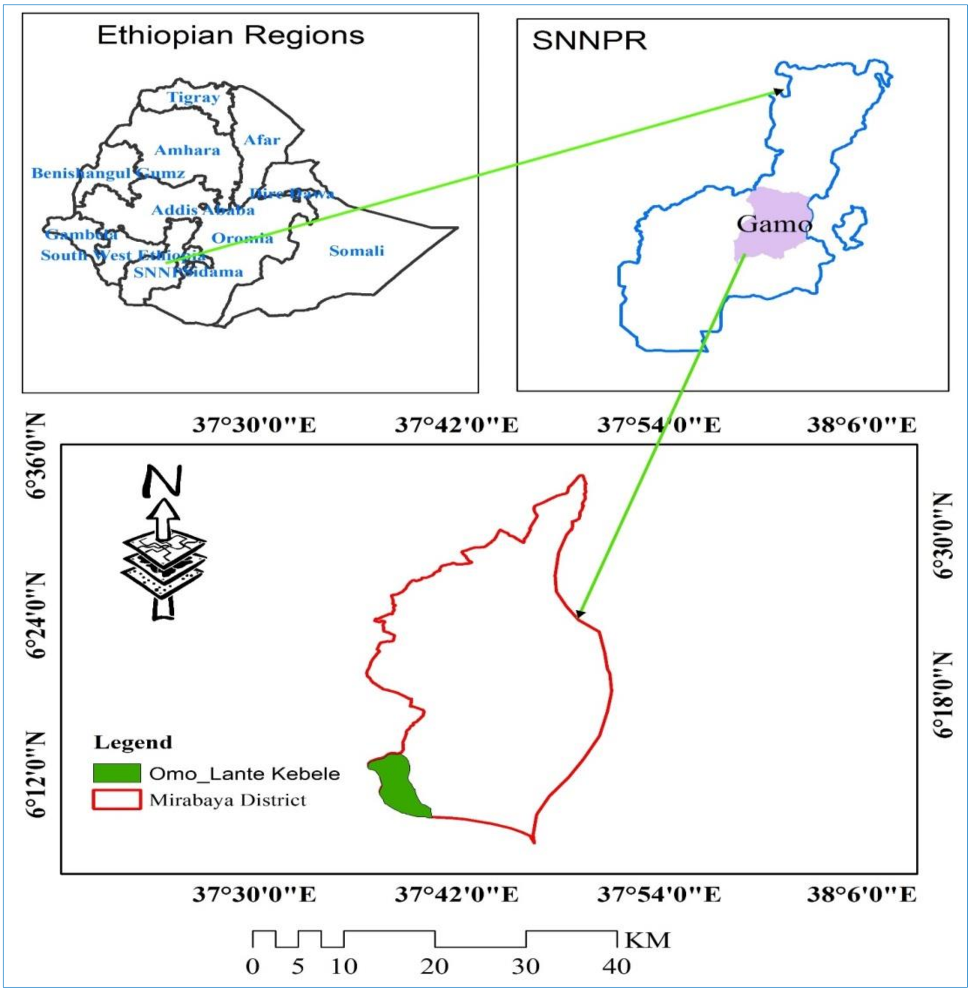

Figure 1 Map of the study area

3. Results and discussion

3.1. Analysis of Variance

Table 1 Analysis of variance (Mean squares) for the bulb propagated shallot varieties evaluated at Mirab Abaya woreda (2021-2022)

Source of Variation	Mean Square			P Value
	Replications (df=3)	Treatment (df=3)	Error (df=25)	
Stand count at $1^{1/2}$ month (%)	26.7909125*	18.55114583*	12.3379805	0.02379
Plant height (cm)	20.2675ns	1.40083333ns	21.17	0.9773
Stand count at harvesting (%)	45.5416667ns	320.375ns	75.645	0.010
Days to 75% maturity (days)	1.9166667ns	182.75ns	115.52	0.2187
Marketable bulb yield (t/ha)	44228808.7*	126314263.8**	12325576.3	0.0001
Bulb length (cm)	0.97197917ns	0.11697917ns	0.6391125	0.9069
Bulb diameter (cm)	2.38364583ns	0.5778125ns	1.1386125	0.6807
Bulb weight (g)	55.0270833ns	5.30125ns	13.26215	0.7544
Number of splits per plant	18.3828125*	24.40364583**	5.8878125	0.0100

Mean squares of the nine characters studied in shallot varieties are presented below (Table 1 and 2). Analysis of variance revealed that highly significant difference (at P≤0.01 level of probability) was observed among tested bulb propagated shallot varieties for marketable bulb yield and number of splits per plant. Similarly, a significant difference (at P≤0.05) among replications was shown for response variables, marketable bulb yield and number of splits per plant, while the rest were not significantly affected by varietal effect. On the other hand, significant difference was observed by marketable bulb yield and number of splits per plant among the tested seed propagated shallot varieties.

Table 2 Analysis of variance (Mean squares) for the seed propagated shallot varieties evaluated at Mirab Abaya woreda (2021-2022)

Source of Variation	Mean Square			P Value
	Replications (df=3)	Treatment (df=3)	Error (df=25)	
Stand count at $1^{1/2}$ month (%)	46.875ns	153.7083333ns	191.245	0.5036
Plant height (cm)	47.1253125ns	7.4086458ns	34.885312	0.8869
Stand count at harvesting (%)	90.0416667ns	55.4583333ns	345.855	0.922
Days to 75% maturity (days)	71.6979167ns	79.1145833ns	101.16125	0.5151
Marketable bulb yield (t/ha)	6.2213875ns	25.53614583*	7.8509635	0.0385
Bulb length (cm)	0.77208333ns	.22375ns	2.22885	0.959
Bulb diameter (cm)	6.06583333ns	3.43583333ns	6.80620	0.6825
Bulb weight (g)	141.839167ns	408.946667ns	1259.3393	0.8074
Number of splits per plant	0.13114583ns	0.59947917**	0.2796125	0.0100

3.2. Growth and Phonology Characteristics

3.2.1. Stand counts

Stand count after one and half month of transplanting was significantly (P>0.05 level of probability) influenced by varietal effect bulb propagated shallots. The, highest establishment percentage (87.05%) was recorded for variety Negele which was statistically non-significant with that of varieties Minjar and Huruta. On the other hand, the lowest stand counts one and half month after transplanting (83.36%) was observed by variety DZSHT-005/2.

3.2.2. Days to maturity

Analysis of variance indicated that days to 75% maturity was not significantly influenced by the varieties evaluated. However, Varieties Tropics (99.1 days) and Negele (99.75 days) took the longest days to reach physiological maturity while varieties DZSHT-005/2 (89.62 days) and DZST-91-2B (92.7 days) required less number of days to attain maturity compared to the remaining varieties. Early maturity is very important traits that help plants to escape moisture stress by enhancing their growth rate and cause 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, which results in more time requirement to complete its vegetative growth. Findings of [8] indicated that variations in days to maturity among onion genotypes which confirms the present study.

3.2.3. Plant height

In both sets of shallot varieties evaluated, plant height was not significantly influenced (P>0.05) by varietal difference. However, numerically longer plant height was recorded from Huruta (44.26 cm) and Yeras (45.5cm).

3.3. Yield and Yield related Traits

3.3.1. Bulb length

Analysis of mean values indicated that bulb length was not significantly influenced by the evaluated shallot varieties; however, maximum bulb length of 7.57cm and 6.23cm was recorded by Variety Tropics and DZSHT-005/2 respectively followed by variety Minjar (6.08cm). Similarly, variety Negele exhibited bulb length of 6.23cm (Table 3 and 4).

3.3.2. Bulb weight

Result in Table 4 showed that the highest fresh bulb weight (50.48g) was recorded from variety Tropics followed by Years (46.18g). In general, the performance of bulb propagated shallot varieties was lower than that of seed propagated shallot regarding bulb weight. This might be due to difference in genetic potential of the varieties.

3.3.3. Bulb diameter

Mean square values indicated that there was no significant influence (p>0.05) by varietal effect on bulb diameter of shallot varieties. But, the highest numerical value of 13.7cm and 10.06cm was exhibited by varieties Tropics and DZSHT-005/2 respectively followed by Years (13.53cm) and Huruta (9.68cm).

3.3.4. Marketable yield and Number of splits per plant

Combined analysis of result indicated that marketable yield and number of bulb splits per plant were significantly influenced (P<0.01) by varietal effect of the shallot. The highest bulb yield (21.22 t/ha) coupled with number of bulb splits per plant (13.75) was obtained in variety DZSHT-005/2 followed by Minjar (19.27 t/ha) and (12.18) respectively. On the other hand, a higher bulb yield of 9.61 t/ha coupled with number of splits per plant (2.52) was observed for variety Tropics followed by DZSHT-157-21 (7.47 t/ha). The result is in conformity with the works of [9] who reported significant difference among the shallot lines in marketable yield.

Table 3 Combined mean values for 9 traits of released shallot varieties (bulb propagated set) evaluated at Mirab Abaya woreda (during 2021-2022)

Variety Name	SC(%)	PH (cm)	SCH (%)	DM (days)	MYD (t/ha)	BL (cm)	BD (cm)	BW (g)	NSPP
Negele	87.05a	43.95	91.87bc	99.75	12.37b	6.23	9.41	18.10	10.50b
Minjar	85.28ab	43.37	88.25c	91.87	19.27a	6.08	9.65	17.75	12.18ab
Hururta	84.78ab	44.26	102.37a	97.75	15.28b	5.97	9.68	19.10	9.87b
Dzsht-005/2	83.36b	43.46	98.25ab	89.62	21.22a	6.23	10.06	19.47	13.75a
Grand mean	85.11	43.7	95.18	94.75	17.03	6.12	9.70	18.6	11.5
LSD (0.05)	3.6	NS	8.9	NS	3615.3	NS	NS	NS	2.49
C.V.	4.12	10.51	9.13	11.34	20.60	13.04	10.99	19.5	20.9

PH =plant height; SC=stand count after 11/2 month; DM= days to maturity; MYD=marketable yield; BL=bulb length; BD=buld diameter; BW=bulb weight; NSPP=no of splits per plant

Table 4 Combined mean values for 9 traits of released shallot varieties (seed propagated set) evaluated at Mirab Abaya woreda (during 2021-2022)

Variety Name	SC (%)	PH (cm)	SCH (%)	DM (days)	MYD (t/ha)	BL (cm)	BD (cm)	BW (g)	NSPP
DZSHT-91-2B	88.37	44.5	80.1	92.7	6.05b	7.46	12.33	34.73	1.95b
DZSHT-157-21	85.5	43.3	81.8	94.3	7.47ab	7.27	12.85	38.53	2.00ab
Yeras	83.3	45.5	79.1	98.6	5.65b	7.21	13.53	46.18	1.98ab
Tropics	78.0	43.7	75.6	99.1	9.61a	7.57	13.7	50.48	2.52a
Grand mean	83.8	44.2	79.1	96.2	7.2	7.3	13.1	42.4	2.1
LSD (0.05)	NS	NS	NS	NS	2.88	NS	NS	NS	0.54
C.V.	16.5	13.3	23.4	10.4	38.9	20.2	19.8	33.5	24.9

PH =plant height; SC=stand count after 11/2 month; DM= days to maturity; MYD=marketable yield; BL=bulb length; BD=buld diameter; BW=bulb weight; NSPP=no of splits per plant

4. Conclusion

Farmers in the study area are cultivating shallot in smaller amount to meet the demand of home consumption. Onion seed production requires two seasons with ambient conditions and this can't be done by farmers. Therefore, the vegetative propagated shallot can substitute bulb onion. Shallots are also preferred for their shorter life cycle, better tolerance to disease and drought stresses and longer storage life than the common onion. The research was conducted to introduce and evaluate improved shallot varieties for their adaptability and better yield performance so as to select best adaptable and high yielder variety/ties. The result indicated that most of the evaluated varieties adapted and produced better bulb yield than the national average yield (7 t/ha) of shallot. The combined analysis of the mean over years showed that there was a statistical significant mean difference (P<0.01) among the varieties for yield and some yield related traits. Accordingly, DZSHT-005/2 and Minjar have performed better number of splits per bulb. On the other hand, Tropics (9.6 t/ha) and DZSHT-157-21 (7.5 t/ha) produced better bulb yield. Thus, varieties DZSHT-005/2 and Tropics were found to be superior in yield and yield components and were suggested to be popularized for the growers in the study area.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

References

[1] Yebirzaf Yeshiwas , Zebyder Temsegen, Mengistu Wubie, and Tadessu Wagnew. **2023**. Effects of Varieties and Different Environments on Growth and Yield Performance of Shallot (Allium cepa var. aggregatum). International Journal of Agronomy Volume 2023, pp 1- 12 https://doi.org/10.1155/2023/3276547

[2] Rabinowitch, H.D. and Kamenetsky, R. **2002**. „Shallot (*Allium cepa* var *aggregatum*)". Allium crops science: Recent advances, In: Rabinowitch, H.D. and Currah, L. 409-430.

[3] Kebede, W. **2003**. Response of shallots to mulching and nitrogen fertilization. *Hortscience 38(2):217-221.*

[4] Shimeles, A. **2014**. The performance of true seed shallot lines under different environments of Ethiopia. Journal of Agricultural Sciences, 59 (2), 129-139.

[5] Woldetsadik, K. **2003**. Responses of Shallot (*Allium cepa var. ascolonicum*) to Plant Nutrients and Soil Moisture in a Sub-humid Tropical Climate. PhD Dissertation, Swedish University of Agricultural Sciences, Alnarp, Sweden. ISSN 1401-6249. ISBN 91-576-6195-2.

[6] SAS (Statistical Analysis System), **2008**. SAS Release 9.2 for windows, SAS Institute Inc. Cary, NC, USA.

[7] Pardeshi RG, Waskar DP. **2012.** Performance of improved onion (*Allium cepa L.*) varieties under Marathwada region in respect of growth and yield parameters *Asian J Hort*. 7:333-336.

[8] Masika, R.L., Jackson, J.E. and Currah, L. (1994). Selection of Onion Cultivars for Yield, Earliness in Cropping, and Storage Potential in Zimbabwe. *Acta Hortic*. 358; pp235-238 https://doi.org/10.17660/ActaHortic.1994.358.38

[9] Shimeles, A. and Lemma, D. 2015. The performance of true seed shallot lines under two methods of planting at different environments of Ethiopia. *Research Journal of Agriculture and Environmental Management*, 4(3), 174-179.

Author's short Biography

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