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# Participatory Evaluation of Improved Shallot (*Allium Cepa* Var. aggregatum) Varieties and Their Bulb Size Effect on Yield and Yield Traits in Wolaita Zone, Southern Ethiopia

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**Abstract**
The research was initiated with the objectives of identifying best shallot varieties with preferred horticultural characters for cultivation in Wolaita Zone of Southern Ethiopia, and selecting the appropriate bulb size that gives the most potential yield for each variety. Therefore, the performance of three improved varieties (Hurruta, Minjar and Negelle) and one local variety was evaluated participating farmers from the study area. Factorial combination of the four varieties with the three bulb sizes (small, medium and large) was assigned into randomized complete block design and replicated three times. Significant differences ($p<0.05$) among varieties were recorded for number of leaves per plant and marketable yields per hectare while plant height, number of non-marketable bulbs per plant and total yield (t/ha) were highly significantly ($p<0.01$) influenced by varieties. Number of tillers per plant, number of leaves per plant, number of marketable and non-marketable bulbs per plant and number of total bulbs per plant were among parameters that highly significantly ($p<0.01$) affected by bulb size. Farmers' overall evaluation indicated that the varieties Hurruta and Minjar were found promising under Wolaita Zone where the climatic conditions are suitable for shallot production although variety Minjar was not recommended by the researchers due to its high bolting problem. Therefore, the authors advised the two improved varieties, Hurruta and Negelle, for their good performance, adaptability, yielding capacity and absence of bolting problem in the study area.
**Key words:** Bulb size, participatory, shallot, varieties

## 1. Introduction

Ethiopia has enormous potential to cultivate horticultural crops in general and vegetables in particular on small scale as well as commercial scales. In most irrigated fields, farmers achieved better income by improving the production of vegetable crops. Alliums are the most important cultivated vegetable crops in the country. Shallots (*Allium cepa* var. *aggregatum*) are important Alliaceous crops cultivated in many tropical countries as a substitute for bulb onions (*Allium cepa* L. var. *cepa*). 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 (Kebede, 2003).

It is rare to get a dish without this vegetable in every meal of a day in Ethiopia (Awale *et al.,* 2011). It has long been growing in Ethiopia by subsistent farmers in the mid and high altitudes (1800 – 2200 meter above sea level) for flavoring of local foods and as a source of cash for the growers (Getachew *et al*., 2009; Awale *et al*., 2011). Although it has similar agro-climatic requirement with common onion it is better adapted to rain-fed and is relatively tolerant to leaf diseases which commonly affect the growth of bulb onion during rainy season (Awale *et al*., 2011).

Tropical and sub-tropical shallots are preferred for their tolerance to the hot and humid tropical climate and better tolerance to pests and longer storage life than common onion (Awale *et al*., 2011). Locally adapted cultivars are grown either for their special flavor, green leaves or curative effects in Europe, USA, and Asia (Fritsch and Friesen, 2002). Shallot has greater value per unit amount than common onion in our county also due to the mentioned reasons. Therefore, introduction and expansion of improved shallot varieties to the study area can improve the income of the farmers of the vicinity and has also contribution in the food security program.

Thus, the study was assumed to screen out suitable varieties and to produce very important information related to farmers' variety evaluation criteria and factors influencing adoption of improved shallot production package in the study area. Therefore, the objectives of the study were to identify best shallot varieties with preferred horticultural characters for cultivation in the study area, to select the appropriate bulb size that gives the most potential yield for each variety, and to enhance a participatory research approach in the area of the study in particular and in the country in general.

 

## 2. Materials and Methods

*2.1 Description of the study area*

The study was conducted in Wolaita Zone, Southern Ethiopia. The Zone covers an altitude range of 800 to 3500 m.a.s.l. Sodo Town, an administrative center of the Zone is located at 60 49'N and 370 45'E, at a distance of 383 km south of Addis Ababa. The area has mean annual rainfall and temperature of 1528.1 mm and 19.5 0C, respectively; and has a strongly acidic (Abay and Tesfaye, 2011) Nitosols (FAO/Unesco, 1973) soil type.

*2.2 Treatments and experimental design*

Improved varieties such as Hurruta, Minjar, and Nagelle and the farmers' cultivar, which is mainly cultivated as rain-fed under less intensive farming systems in southern Ethiopia were used. The improved cultivars are recent selections by Debre-Zeit Agricultural Research Centre (DARC), Ethiopia, from local landraces on the basis of yield merits under intensive management practices. Each varieties was grouped into three based on their bulb sizes [smaller sizes (<20 mm in diameter), medium sizes (20-50 mm in diameter), and larger sizes (>50 mm in diameter)] (Kebede, 2003). Either of the sizes was decided together with the farmers. The planting materials were propagated and maintained by vegetative means under uniform conditions at the experimental site. Factorial experiment was conducted by using Randomized Complete Block Design (RCBD) with three replications.

*2.3. Agronomic practices*

After cultivating and leveling of the field, bulbs were set upright at a depth of 2.5 cm. Nitrogen and phosphorus were applied using Urea and DAP at 150 and 200 kg $ha^{-1}$, respectively. Half urea and all DAP were applied as basal dose during planting, while the remaining half urea was top dressed 45 days after planting (Getachew *et al.,* 2009). The crop was kept weed free by manual hoeing. All other agronomic practices and plant protection measures were kept normal and uniform for all the treatments during the entire growth period. Bulbs were harvested when nearly 80% of the tops were withered.

*2.4. Data collection*

*2.4.1. Researcher data*

Plant height was measured from the surface of the soil to the tip of the leaf at maturity. The diameter and length (cross-sectional and proximal to distal length) of 10 sampled healthy matured bulbs of greater than 20 mm in diameter were measured by using digital caliper and expressed in mm. Tiller number per hill and leaf number per plant were counted at the maximum vegetative growth stage of the plants. Total number of bulb-lets per plant, marketable and non-marketable bulbs were counted and weighed (kg/plot) from the net area of each plot after curing of the bulbs for two days under shade, and they were converted into t/ha.

*2.4.2. Farmers' data*

Qualitative information such as on farm performance of the crop, disease resistance, vigorousity, and comparative estimation of bulbs per plant were collected by the selected farmers (Figure 1-5). Farmers' selection criteria were assessed using a semi-structured questionnaire with 20 farmers from Peasant Association (PA). Focus Group Discussions (FGDs) were held with randomly selected farmers from the PA. During the FGDs, crop and varietal diversity matrix and pair-wise ranking matrix were used.

*2.5 Statistical analysis*

The mean values of all parameters were subjected to analysis of variance (ANOVA) using the SAS package (SAS, 2002, version 9.2). Least significant difference (LSD) procedure was used to compare differences between treatment means.

## 3. Results and Discussion

*3.1. Growth response*

Growth parameters such as plant height was affected highly significantly ($p<0.01$) and number of leaves per plant significantly ($p<0.05$), respectively, by the variety but number of tiller per plant did not (Table 1). Comparatively, variety Hurruta attained a maximum height of 52.32 cm followed by variety Minjar. Hurruta also produced the largest leaf numbers (57 leaves per plant). Local variety attained the shortest height (43.70 cm), while Minjar variety produced small number of leaves per plant (47 leaves per plant). Number of tillers per plant did not statistically significantly affected by both main effect and interaction effects though variety Minjar produced maximum tillers per plant (8 tillers per plant). However, variety Hurruta produced small number of tillers per plant. Variety Minjar fully bolted (Figure 6) earlier and this might be contributed for its lower number of leaves production as it produced reproductive parts earlier. The variation in growth parameters among varieties may be due to their genetic differences. Similar result was reported by Ademe *et al*. (2012) in that shallot growth parameters were affected by variety.

Both number of tillers and number of leaves per plant were also affected highly significantly ($p<0.01$) by bulb size but not by the interaction effect (Table 1). Plants grown from large sized bulbs were produced large number of tillers and leaves per plant and followed by those from medium sized ones; whereas smaller bulbs produced smaller number of tillers and leaves. This might be due to the different amount of stored food and different

 

number of embryos found in the different sized bulbs. The result of the current study is supported by the findings of Hussain *et al.* (2001) and Ashrafuzzaman *et.al.* (2009).

*3.2. Yield and yield components*

*3.2.1. Yield components*

Variety Hurruta attained better average bulb number of 8.83 per plant. This increase in number could be attributed to its inherent traits and the best adaptability of this verity to the study area, which might have made it more productive. Similar result by Ademe *et al*. (2012) confirmed that Hurruta and Minjar gave higher bulb yields and yield components in their study of spacing and topped and un-topped bulb planting. Similarly, Cheema *et al.* (2002) also found highly significant differences among varieties.

Number of marketable bulbs were affected significantly ($p<0.05$) while non-marketable bulbs were affected highly significantly ($p<0.01$) by the different varieties but not by the interaction effect. This might be the real parameter that shows the superiority of variety Hurruta (Table 2). The reason for the variety Minjar to be inferior in producing number of bulbs per plant might be due to lower number of leaves produced as a result of bolting.

Obviously, the unimproved local variety produced lower number of marketable bulbs per plant but larger number of non-marketable bulbs per plant (Table 2). Similar result was reported by Awale *et al.* (2011) and Ademe *et al.* (2012) in that Negelle had the largest bulb following by Hurruta than the others.

Concerning the bulb size, it did affect the three parameters (number of marketable bulbs per plant, number of non-marketable bulbs per plant and number of total bulbs per plant) highly significantly ($p<0.01$) (Table 2). Larger bulbs did produce larger number of bulbs and followed by the medium bulbs. Lower number of bulbs was produced by the small sized bulbs. Similar results were stated by Jilani (2004), Mirshekari *et al.* (2008) and Mosleh ud-Deen (2008).

In general, there was a trend that total number of bulbs per plant got lower as the planting materials used were smaller and smaller in all the used varieties. The smallest total number of bulbs per plant (9.18) was recorded in plots of variety Minjar. Contrary to this study, Munoz *et al.* (1997) and Cheema *et al.* (2002) reported that use of small bulbs as planting material could successfully produce marketable onions. Ashrafuzzaman *et al.* (2009) also reported that large-sized bulb showed more number of tillers and smaller-sized bulbs produced fewer tillers compared to others.

*3.2.2 Marketable and non-marketable yields*

Marketable yield (t/ha) was affected significantly ($p<0.05$) whereas total yield (t/ha) was influenced highly significantly ($p<0.01$) by the varietal differences (Table 3). Variety Hurruta gave the highest (33.9 t/ha) yield and followed by variety Negelle; whereas local variety gave the least yield. All the three improved varieties exceeded the national shallot yield (25 t/ha) but the local variety gave lower bulb yield (23.80 t/ha). Bulb size did not significantly affect yield traits of the crop. The current study result also agreed with the report of Awale *et al.* (2011) and Ademe *et al.* (2012) in that Negelle gave the largest bulb yield following of variety Hurruta and their highest bulb yield per hectare was due to productivity and their large sized bulbs that would be a better source of food for the newly emerging entity during sprouting before starting photosynthesis. This can help the plant to grow fast and result in better returns in terms of yield.

*3.3 Farmers' participatory on-farm variety selection*

A preference for good performance, disease resistance, bulb size and bulb yield were among the mentioned choices by the farmers. Among the criteria mentioned by farmers during the interview, number of bulbs per hectare, bulb size and resistance to pests scored the highest responses.

During the farmers' participatory variety selection much criteria were assessed and farmers were encouraged to include their own selection criteria. They listed more than 10 criteria. Using pair-wise ranking matrix, participants prioritized and agreed on six of them. Pair-wise ranking is a structured method for ranking the selection criteria in priority order in a consensus-oriented manner (Tadese, 2009). All the 6 traits were tabulated in a matrix scoring (Table 4), and each selection criterion was compared with each other in a pair-wise manner. A matrix was prepared for the shallot varieties listed in the row and traits preferred by farmers in the column (Table 5). The ranking procedure was explained to participants then each criterion was ranked from 1 to 5 (1 = very good, 2 = good, 3 = average, 4 = poor and 5 = very poor) for each variety. Accordingly, farmers' overall evaluation indicated that Hurruta followed by Minjar was found the most promising varieties for bulb size and yield of shallot. The local variety was poor performing variety for various growth and yield characters even though it might be preferred for breeding purposes. During the evaluation, farmers indicated that their preference matched with researchers selection criteria for bulb size and yield.

## 4. Summery and Conclusion

Shallot is one of the most commonly cultivated vegetables in Ethiopia. Farmers in the study area produce shallot as a minor crop using local varieties simply buying from a local market with non-uniform planting materials (bulbs of different size). The present study was, thus, conducted to identify the best performing varieties by using different bulb sizes for good yield return, and to recommend the best variety with better bulb size for

 

farmers in the study area. Results showed that main effects of variety and bulb size had considerable influences on different growth and yield parameters.

Accordingly, planting of the varieties, Hurruta and Negelle by using their large sized bulbs had influenced the majority of yield and growth parameters and thus it is advisable to use these for the production of marketable bulb yields in the study area. Even though large sized bulbs are better for yielding, medium bulbs are recommended by the researchers to use the larger ones for the economical purpose. On the other hand, production of Minjar is not advisable in areas having similar conditions to the study area because of its high bolting nature and the resulting yield reduction though it gave similar yield returns with the two improved varieties.

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Table 2. Effect of varieties and bulb size on shallot growth parameters

| Treatments | Shallot growth parameters | | |
|---|---|---|---|
| | Plant height (cm) | No. of tillers per plant | No. of leaves per plant |
| *Varieties* | | | |
| Hurruta | 52.32 | 7.41 | 56.66 |
| Minjar | 52.23 | 7.88 | 46.98 |
| Negelle | 46.79 | 7.52 | 49.59 |
| Local | 43.70 | 7.51 | 49.11 |
| LSD (0.05) | 2.18 | NS | 6.43 |
| *Bulb size* | | | |
| Small | 47.98 | 5.40 | 40.95 |
| Medium | 49.25 | 7.82 | 52.42 |
| Large | 49.05 | 9.52 | 58.38 |
| LSD (0.05) | NS | 0.81 | 5.57 |
| CV (%) | 4.58 | 12.56 | 13.00 |

NS= non-significant

Table 3. Effect of varieties and bulb size on shallot yield components

| Treatments | Shallot yield components | | | | |
|---|---|---|---|---|---|
| | Bulb diameter (mm) | Bulb length (mm) | No of marketable bulbs per plant | No of non-marketable bulbs per plant | No of total bulbs per plant |
| *Varieties* | | | | | |
| Hurruta | 35.38 | 49.25 | 8.83 | 1.63 | 10.47 |
| Minjar | 32.98 | 49.56 | 7.21 | 1.97 | 9.18 |
| Negelle | 32.32 | 47.09 | 7.83 | 1.59 | 9.42 |
| Local | 31.89 | 45.66 | 7.31 | 2.50 | 9.81 |
| LSD (0.05) | NS | NS | 1.38 | 0.44 | NS |
| *Bulb size* | | | | | |
| Small | 34.10 | 47.86 | 6.42 | 1.70 | 8.12 |
| Medium | 31.52 | 46.99 | 8.42 | 1.67 | 10.10 |
| Large | 33.81 | 48.81 | 8.54 | 2.39 | 10.93 |
| LSD (0.05) | NS | NS | 1.20 | 0.38 | 1.29 |
| CV (%) | 13.99 | 10.45 | 18.13 | 23.22 | 15.66 |

NS= non-significant

 

Table 4. Effect of varieties and bulb sizes on shallot yields

| Treatments | Shallot yields | | |
|---|---|---|---|
| | Marketable yield (ton/ha) | Non-marketable yield (ton/ha) | Total yield (ton/ha) |
| *Varieties* | | | |
| Huruta | 33.90 | 1.50 | 35.40 |
| Minjar | 25.50 | 1.70 | 37.20 |
| Negelle | 27.70 | 1.60 | 29.30 |
| Local | 23.80 | 1.90 | 25.70 |
| LSD (0.05) | 7.70 | NS | 7.50 |
| *Bulb size* | | | |
| Small | 26.00 | 1.70 | 27.70 |
| Medium | 26.10 | 1.70 | 27.80 |
| Large | 31.10 | 1.70 | 32.80 |
| LSD (0.05) | NS | NS | NS |
| CV (%) | 15.48 | 50.91 | 13.56 |

NS= non-significant

Table 5. Pair- wise ranking of farmers variety selection criteria in Dalbo-Wagane Peasant Association; (n=20)*

| Criteria | Performance | Resistance | Bulb size | No of bulbs per plant | Bolting | Maturity | Total | Rank |
|---|---|---|---|---|---|---|---|---|
| Performance | | Performance | Bulb size | No of bulbs per plant | Performance | Performance | 2 | 4 |
| Resistance | | | Bulb size | Resistance | Resistance | Resistance | 3 | 3 |
| Bulb size | | | | No of bulbs per plant | Bulb size | Bulb size | 4 | 2 |
| No of bulbs per plant | | | | | No of bulbs per plant | No of bulbs per plant | 5 | 1 |
| Bolting | | | | | | Maturity | 0 | 6 |
| Maturity | | | | | | | 1 | 5 |

Table 6. Matrix ranking shallot varieties by selected farmers and Focus Groups in Dalbo-Wagane Peasant Association; (n=20)*

| Criteria | Performance | Resistance | Bulb size | No of marketable bulbs per plant | Bolting | Maturity |
|---|---|---|---|---|---|---|
| Hurruta | 5 | 5 | 4 | 5 | 1 | 4 |
| Minjar | 4 | 4 | 4 | 3 | 5 | 5 |
| Negelle | 4 | 4 | 5 | 4 | 5 | 4 |
| Local | 3 | 3 | 3 | 3 | 2 | 4 |

Rating of the performance of a variety for the criteria: 5= very good, 4= good, 3= average, 2= poor and 1 = very poor.

 

**Figure 1.** During field visit the discussion was held with farmers

**Figure 2.** After the discussion, farmers raised some doubts for clarity and the researchers were clarifying more for easily selecting the promising varieties

 

**Figure 4**. During field observation, farmers made discussion on each variety to select the promising ones

**Figure 5**. During field observation, the farmers were selecting the promising varieties

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