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Full Length Research

The performance of true seed shallot lines under two methods of planting at different environments of Ethiopia

Shimeles Aklilu[1]* and Lemma Dessalenge[2]

[1]Adama Science and Technology University, School of Agriculture, P.O. Box, 436 Nazret, Ethiopia.
[2]Melkassa Research Center, P.O. Box, 436 Nazrete, Ethiopia

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Six true seed shallot lines were compared under bulb to bulb and transplant to bulb planting methods at lowland areas of Melkassa and highland areas of Arsinegele for two year. *R*andomized complete block design with split-plot arrangement at four replications was used in each location for bulb yield potential and important quality parameters. Planting methods were arranged at Main plots and shallot lines at subplots. The analysis of variance showed significant difference among the shallot lines and planting methods in bulb yield under transplant to bulb production practices at $p<0.05$ at both location. The combined analysis of planting methods over locations was also significant at $p<0.05$. Shallots grown from transplants to bulb produced overall mean total yield of 14.4 t.ha^{-1} with the overall range of 12-15 t.ha^{-1}. From shallot lines Roxa and Tropix gave consistently significantly highest total yield. The quality of bulb is also high TSS% (11-14) and mean number of split of more than 3.5 per plant was obtained with attractive color using this method of planting. However, the overall mean yield of bulb to bulb planting method was 12-17t.ha^{-1} with over all mean of 15.2t.ha^{-1} and except Roxa all shallot lines produced high yield and this was significantly different. Atlas and Vethalam gave consistently high yield under bulb to bulb methods at both locations. Shallot crops grown from transplants producing better yield of 18.2-22.5t.ha^{-1} with good quality TSS% (13-17) and good number of split of not more than 4 per plant under sandy loam soils of Melkassa than bulb to bulb method at Arsi negele with yield potential of 9-17.1 t/ha^{-1} with combined over all mean of 15.3t.ha^{-1}. Therefore, as there was no significant yield advantage between the two methods farmers can grow shallot from true seed in the low land areas around Melkassa.

Key words: Shallot, environment, genotypes, true seed, yield

INTRODUCTION

Shallot (*Allium cepa* var. *aggrigatum*) is one of the most widely cultivated bulb crops in Ethiopia. The crop has a wide range of climatic and soil adaptation and cultivated both under rain-fed and irrigated condition. It is one of the most important cash crops and traditionally produced in some regions of the country (Hararge, Shoa, Arsi, Gojjam etc.) by small farmers as income generating spice crop for flavoring local dishes. It is mostly produced and adapted in areas where the climate is humid (rainy season) and where the growing season is short for their being relatively tolerant to purple blotch disease. Shallot has very short growing season of not more than 3 months, which allows it to be grown between other crops or during the short rains in the dry season of Rift Valley areas (Getachew and Asfaw, 2004).

Unlike onion, shallot is grown from bulbs (sets) mostly by small farmers and the main constraint to shallot cultivation is the need of high amount of planting material. 1.5-2 t.ha^{-1} of edible bulbs which comprises about 40% of cost of production compared to the 4 kg.ha^{-1} of true onion

Corresponding author: Email: shimiakl@yahoo.com

transplant (Lemma and Yayeh, 1994). There is high scarcity of planting material during peak planting time, and sometimes the cost of bulb transplant shows fivefold fluctuation in price and usually difficult to obtain during peak planting time. Therefore, to tackle this problem research effort was made at Melkassa to grow shallot from true transplant. In the early preliminary studies research has been conducted on the testing of transplant production potential of shallot lines at Melkassa. All Shallot lines have been found to produce about 0.4-0.5t.ha^{-1}of transplant yield under normal growing period (MARC, 2005) . Shallots from true transplant has promising benefit, in terms of the amount of planting materials, in reducing the cost of production and, give growers the chance to easily handle planting materials and it also avoids the problems of transporting and storing large quantity of bulbs, which was difficult to manage by small farmers (currah and proctor)

It is important to investigate the bulb performance of transplant progenies in order to address one of the barriers to produce the crop and to investigate shallot bulb yield and quality potential from true transplant and to find out problems associated with such production constraints and find out if there is any differential responses between shallot lines in the region.

Therefore, the objectives of the experiments were to compare the conventional production practices (bulb to bulb) and (transplant to bulb) and to identify adaptable true transplant shallot lines with high yield and quality bulbs under rain fed conditions in two potential production belts.

MATERIALS AND METHODS

Six true transplant shallot lines (Tropix, Atlas, Roxa (from Holland), Vethalan, (Srilanka) GS-106 (state enterprise) and Local selection (Dz-94) were tested at Melkassa and Arsi Negle. Arsi Negele is a high rainfall, humid area which mainly rain fed shallot production belt where as Melkassa is a low rainfall and drier areas predominately irrigated crops production belt.

The shallot lines were compared for dry bulb yield and quality under transplants to bulb and bulb to bulb production methods. In transplant to bulb production method, transplanting were raised on nursery bed and transplanted 45 days after sowing. Whereas, in bulb-to-bulb method, bulbs were produced ahead of time and standard bulb lets were selected for planting and all treatments were planted at the same time on a plot size of 2.8 × 3m (7.4m^2) with the recommended spacing of using double rows of 40cm between water furrows, 20cm between rows on the bed and 10cm between plants. All cultural practices were given as recommended for shallot. .

Fertilizer Diammnium Phosphate (DAP) was applied at the rate of 200 kg/ha during planting and split application of urea at the rate of 100 kg/ha was used, half (50kg) during transplanting and the rest side dressed one and half month after planting. The two common diseases Purple blotch (*Alteranaria porri*) and Downey mildew (*Pronospora distructor*) were controlled by applying Ridomil MZ at the rate of 3 kg/ha every 8 days interval. The common insecticide Celecron at the rate of 0.5 l/ha was used to control thrips (*Thrips tobaci*). Harvesting was done when 75% of the tops had fallen down. The harvested bulbs were cured for 3 days in the field before cutting the necks. Parameters like flower stalk and leaf number, bulb yield (Marketable and Total), Nº of bulb splits and TSS% (Total soluble solid) were recorded.

A randomized complete block design with split-plot arrangement at four replications was used in each location. Planting methods were arranged at Main plots and at subplots shallot lines were arranged at random. The analysis of variance over years and location was computed using (SAS Institute Inc., Cary, NC, USA). Mean separation was done using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Total Dry bulb yield were significantly different between shallot lines and planting methods in each tested sites.

At Melkasa, the analysis of variance showed significant difference among the shallot lines in total and marketable yield under transplant to bulb production practices at $p<0.05$. All shallot lines produced total yield range of (18.2-22.5t.ha^{-1}) for the shallot lines Gs-106 to Tropix. Shallot lines Tropix (22.5t.ha^{-1}), Roxa (21.2t.ha^{-1}) and Vethalam were superior in yield compared to the local lines and other introduced materials. There was similar trend for the shallot lines Tropix and Roxa in marketable yield in which they gave significantly highest yield from the rest of the shallot lines. The over all marketable yield range of the shallot lines was from 14-19t.ha^{-1},different bulb color and single shape of the bulbs accounted for high un marketability of the bulbs that caused such big difference in marketable and total yield.

At Arsi Negele, though there was significant difference among the lines the total yield potential of the shallot lines was lower (7.5-9.8t.ha^{-1}) than Melkassa under transplant to bulb method (18.2-22.5t.ha^{-1}). However, Roxa, Tropx and Vethalam were significantly superior to any of the lines tested at this site. In marketable yield similar trend was observed from Roxa, Tropx, and Vethalam which were superior to the rest of the lines. The number of split bulbs (2.7-3.3) and TSS% was not very much different between the lines. Shallot, as a plant belonging to the *Aggregatum* Group when grown from bulbs, can produce clusters with a large number of daughter bulbs, whereas when it is grown from seeds or seedlings clusters contain on average 1–3 bulb lets or plants produce only a single bulb like onion (Sumanaratne *et al*., 2002; Tendaj, 2005; Tendaj and

Table 1. Altitudes, temperature, rainfall and soil types of experiment sites.

Location	Altitude (m)	Mean temperature (°C)		Rainfall (mm)	Soil type
		Min	Max		
Melkassa	1550	14	28	770	Sandy loam
ArsiNegele	1980	10	27	900	Brownish clay soil

Mysiak, 2012).

There was a big mean yield difference at both locations in which high mean yield of 19.8t.ha^{-1} was produced at Melkassa as compared to ArsiNegele 8.8t.ha^{-1}which was mainly due to severe diseases incidence in early stage of the crop in all the lines that could not be controlled with regular spraying of recommended fungicide Redomil MZ in every 5 days interval. However, tolerating this problem shallot lines Athlas, Vethalam and Tropix were found superior in yield as compared to others.

At Melkassa, there was high number of bolters (61-110/plot) where Atlas produced the highest number of flower stalks per plants compared to others. Great differences were also observed in total soluble solid content (12-17) in which the local lines GS-106 produced the highest percent followed by Roxa and Vethalam in that order.

True seed Shallot lines when grown from transplants producing better yield with good quality of high TSS% (13-15), bigger bulb sizes with a mean number of split of not more than 4 per plant with attractive color under sandy loam soils of Melkassa compared to Arsi Negle. From the shallot lines Roxa, Vethalam and Tropix were found consistently highest yielder at both locations under transplants to bulb method. According to the study of Brink and Basiku (2012) using different planting methods, TSS-cultivars were giving a higher yield than the bulb varieties and was also producing bigger bulbs than the bulb varieties and hence the productivity of the TSS cultivars 'was much higher than bulb cultivars.

Using the conventional shallot bulb planting method (using edible bulbs as planting materials), there was no big mean yield difference recorded between the two location in which the total mean yield at Melkassa (14.8t.ha^{-1}) compared to Arsinegle (15.7t.ha^{-1}). The shallot lines Tropix and Athlas were superior in bulb yield to all other lines. In marketable yield, Tropix, vethalam and Athlas was high yielder and this was significantly different from the rest of the lines.

However, unlike at Melkassa, the overall bulb yield at ArsiNegle was high under bulb to bulb (12-18t.ha^{-1}) compared to transplant to bulb method (7.5-9.4t.ha^{-1}). Shallot lines GS-106, Vethalam and Atlas were superior to the check and others. Moreover, these lines also produced large number of split bulbs and high number of flower stalks per plants than those produced under seed to bulbs method. At humid condition of Arsinegele the yield performance of the shallot lines were poor from transplants to bulb however the performance of the lines under bulb to bulb method of production gave better mean total yield of 15.7t.ha^{-1} which indicated that under unfavorable wet condition using bulbs as planting material has got an advantage of tolerating disease incidence and producing good bulb yield. But the problem of growing true seed shallot lines under bulb to bulb method in cooler areas, was early development of large number of seed stalks as in any biennial crops (onion) was observed that caused shift of assimilates from bulb to the flower stalks which caused high unmarketable yields that resulted in low quality bulbs that is not appealing for the consumers. The study of Dereje *et al* (2012) showed that the production of easy bolting variety is not advisable in areas having cooler conditions, because of its high bolting nature and the consequent in yield and quality reduction unless there is inhibition of the flower stalk production using different cultural practices.

The lines were also differed in response to early flower stalk initiation and development at both locations. High number of seed stalks was counted at cooler high land areas of Arsi negele (360-582)/plot as compared to Melkassa 320-470/plot under bulb to bulb method. From the shallot lines Vethalam and Athlas gave high number at both locations under bulb to bulb method of planting. The study of Tabor *et al*. (2005) and Anisuzzaman *et al*. (2009) proved that in plants of the cultivars with older plants before the beginning of vernalization, the higher the percentage of bolting.. Such a correlation was found in shallot plants obtained from the sensitive varieties of seedlings also produced the largest number of seed stalks.

However, Vethalam gave high number of flower stalks at both locations under bulb to bulb method of planting that could be used as good example from all the lines that gave high total and marketable bulb yield difference after grading at both locations. Therefore this line could not be recommended for this method of production but highly suitable for seed to bulb production at Melkassa area as it is highly sensitive to flowering at both growing condition.

From the shallot lines Vethalam, Roxa and Tropix was found consistently highest yielder at both locations under transplants to bulb method. Whereas, the shallot line Tropix gave consistently high total yield under both methods at both locations. Whereas, Gs-106 and Athlas can be recommended for high land ArsiNegele area using bulb to bulb planting method, however, Vethalem

Table2. The performance of shallot lines at two Production methods (transplant- bulb (T-b) and bulb to bulb (B-b) at two locations (Melkassa and Arsi negele).

Shallot lines	No. of leaves		No. of bolters		No. of split bulb		TSS%		Marketable yield t.ha^{-1}		Total yield t.ha^{-1}	
Transplant-bulb	**MARC**	**ArsiNegle**	**MARC**	**ArsiNegle**	**MARC**	**ArsiNegle**	**MARC**	**ArsiNegle**	**MARC**	**ArsiNegle**	**MARC**	**ArsiNegle**
GS-106	18.7	14.2	85.3	14.2	4.5	2.7	16.5	11.0	14.8c	6.5b	18.2b	7.5b
Roxa	16.8	14.5	61.4	14.5	4.5	2.1	14.0	11.5	17.5a	8.4a	213a	9.4ab
Atlas	14.2	10.6	110.5	10.6	4.5	2.7	12.5	11.0	14.5c	6.1b	18.3b	8.9b
Vethalan	15.8	8.8	39.2	8.8	5.0	3.3	13.5	10.5	14.1c	7.2a	19.9a	9.ab
Tropics	19.6	11.3	89.9	11.3	4.5	2.7	12.5	11.0	19.1a	6.6b	22.a	9.2a
DZ-94 (check)	16.1	10.3	75.8	10.3	3.5	2.7	13.0	12.0	16.4b	7.8a	18.6b	8.8b
Mean	16.9	11.6	77.0	11.6	4.4	2.7	13.7	11.2	16.1	7.1	19.8	8.8
Bulb-bulb												
GS-106	27.7	21.5	455.7	495.0	5.5	4.7	14	11.5	13.3b	14.6a	13.9b	17.8a
Roxa	19.9	20	421.9	390.5	4	3.6	14	11.5	11.6c	11.9c	12.7c	12.7c
Atlas	20.6	16.5	320.8	560.5	3	3.6	16	11.5	15.8a	13.2b	16.4a	16.7a
Vethalan	25.8	20	473.0	557.5	6	5.1	14.5	12.0	14.6a	11.7c	15.8ab	17.1a
Tropics	26.7	25	434.3	427.5	4.5	4.7	14	11.5	14.8a	13.9ab	16.1a	16.7b
DZ-94	20.7	15.5	341.5	374.1	4	3.7	14	13.0	12.4b	13.4b	14.b	14.3b
Mean	**23.6**	**19.7**	**407.9**	**467.5**	**4.4**	**4.2**	**14.4**	**11.8**	**14.4**	**13.0**	**14.8**	**15.7**

and Tpropix can be recommended to grow widely at Melkassa using both methods. However, growing shallot from transplant could not recommended for the high land areas of Arsinegele.

Considering the Quality of the bulb the number of split bulbs and TSS% was not very much different between the lines however, the mean number of split/plant ranged from 2.1-3.5 for the line Roxa to Dz-94. This character was very good measurements for high shallot yield and a good indicator for differentiation shallots from single bulb onion.

At Arsi Negelle, unlike at Melkassa, high TSS% was demonstrated in the local selection Dz-94, Vethalaln, and Tropix under bulb to bulb planting method. However, all lines had produced good large number of split bulbs than those produced under transplant to bulbs method in both locations. The combined analysis of main plot effect (planting methods) over locations was also significant at $p<0.05$. Shallots grown from transplants producing overall mean total yield of 14.4t.ha^{-1} with the overall range of 12-15t.ha^{-1}. From shallot lines Roxa and Tropix gave significantly highest total yield under this method. The overall mean yield of bulb to bulb planting method was 12-17t.ha-^{1} with over all mean of 15.2t.ha^{-1} and except Roxa all shallot lines produced high yield and this was significantly different whereas Atlas and Vethalam gave consistently high yield under bulb to bulb method at both locations. The number of split bulbs and TSS% was not very much different between the two methods. However, the overall combined yield analysis indicated that shallot lines Roxa and Tropix were found consistently highest yielder under transplant to bulb method, Whereas, Athlas and Vethalam gave significantly high yield using bulb to Bulb methods of planting.

Conclusion

Six Introduced and locally selected true seed shallot lines were compared at two production methods at two locations using split plot design in four replication. The analysis of variance showed significant difference among the shallot lines in total and marketable yield under transplant to bulb production practices at $p<0.05$ at both location and.all shallot lines produced total yield range of (18.2-22.5 t.ha^{-1}) for the lines Gs-106 to Tropix at low land area of Melkassa.

Table 3. Combined yield over location and year of shallot from true transplant and from bulb.

Shallot lines	No. of leaves	No. of bolters	No. of split bulb	TSS %	Marketable yield t.ha-1	Total yield t.ha-1
Transplant-bulb method						
GS-106	16.8	67.8	3.5	13.8	10.6	12.6bc
Roxa	15.3	49.3	3.3	13.1	12.8	15.3ab
Atlas	14.5	81.5	3.5	11.8	10.3	13.6b
Vethalan	14.8	39.8	4.2	12.1	10.8	14.9bc
Tropix	17.5	62	3.6	11.8	12.8	15.6ab
DZ-94	13.9	43	3.1	12.5	12.2	13.7b
mean	15.5	57.2	3.5	12.5	12.1	14.3
bulb-bulb method						
GS-106	24.5	457.8	5.2	12.8	14.1a	15.6b
Roxa	19.8	394.3	3.8	12.8	11.7c	12.7c
Atlas	18.3	421.5	3.4	13.8	14.9a	16.1a
Vethalan	22.8	498.5	5.5	13.3	13.1bc	16.9a
Tropix	27.5	419	4.6	12.8	14.1a	15.7b
Dz-94	22.2	386.4	3.6	12.4	13.1b	14.4bc
mean	22.5	429.6	4.4	13.1	13.5	15.2

Under bulb to bulb production method the total yield ranged between (12.7-16.4 t.ha^{-1}), which was lower than bulbs produced from transplants. However, shallot lines Tropix and Athlas were superior to the local selection Dz-94 and others.

At Arsi Negelle, unlike at Melkassa, the overall bulb yield was high under bulb to bulb (9-17.1t.ha^{-1}) compared to seed to bulb method (7.5-9.8t.ha^{-1}) and shallot lines GS-106 and Atlas were superior to the check.

From shallot lines, Vethalam and Tropix were found consistently highest yielder at both locations Under transplants to bulb method. Atlas and Vethalam was consistently highest yielder under bulb to bulb methods at both locations. Shallot crops grown from transplants also producing better quality of bulbs with high TSS% (13-17) with good number of split of not more than 3.5 per plant and bigger bulb sizes under sandy loam soils of Melkassa. Then it seems that growing true seed shallot highly fit for low land areas to grow widely at Melkassa using Vethalam, Roxa, and Tropix for producing better yield with good quality of bigger bulb sizes under seed to bulb method to augment onion production so that Alliums bulbs can be available throughout the year.

The main advantage of these shallot lines is that it flowers freely and produces viable seeds satisfactorily under local conditions without any vernalization and produce high bulb yield with bigger and uniform bulb size which is highly preferred by the consumers. As there was no significant yield advantage between the two methods farmers can grow shallot from true seed in the low land areas of Rift Valley and similar areas in the country. As the seed production technology is now available for onion, farmers can produce their seed requirement in their own fields. Shifting from cultivation of shallot from bulb to seed producing shallot can help the farmers to overcome the high cost of production and the need of long time for propagation and storage constraints to shallot planting material in the country.

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