# Registration of a New "*Improved Huruta*" Shallot Variety with True Seed Production Potential

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**Abstract**: Shallot (*Allium cepa* var. ascalonicum Backer) is an important vegetable crop cultivated by smallholder farmers for consumption and income generation in Ethiopia. However, scarcity of high yielding varieties as well as lack of superior planting material seriously constrains productivity of the crop. The crop has degenerate seed production potential and it is usually established using bulbs. The perishability of the fleshy planting material and its sheer bulkiness and predisposition to fungal and viral disease creates difficulties in handling the material. What is more, large quantities of bulbs are required to plant a relatively small area of land, which exacerbates the problem of shortage of planting material. Also it is the edible part of the plant that is used for planting, which compromises the potential for consumption and marketing. Therefore, a research project was initiated aiming at producing true seeds from the non-seed producing *Huruta* variety. A series of experiments were conducted using the randomized complete block design to identify the appropriate planting date and plant growth hormone application (gibberellin acid, $GA_3$) for bolting and seed production. As a result, the original non-seed producing *Huruta* variety was essentially improved for production of true seeds and bulb through seed-to bulb to seed selection method. Thus, a shallot (*Allium cepa* var. *ascalonicum* Backer) variety with the original name *Huruta* (DZ-SHT-91) was tested. The variety was evaluated for production of bulbs and true seeds over several years (2010 to 2017) at 12 different locations as well as on fields of 28 farmers along with three onion varieties, namely, *Adama Red*, *Bombay Red* and *Kelafo* hybrid as well as three shallot (*Huruta* produced from bulb, *Atilase* and *Dz-94*) varieties. The performance of the shallot variety was evaluated against commercial onion varieties propagated by true seeds to verify its stability and superiority for bulb and seed productions. The shallot variety was more stable over locations and years. It had an average true seed yield advantage of about 321% over the three onion and shallot varieties. It had also average marketable bulb yield and marketable bulb weight advantages of 35 and 31%, respectively, over the three onion varieties. Therefore, this variety was selected, verified, and declared as *Improved Huruta* shallot variety with potential of producing true seed. Owing to its advantage over the tested commercial onion varieties for production of true seeds and bulb as well as many other superior bulb quality traits, this variety was approved for cultivation at mid and high altitude areas of eastern Ethiopia and similar agroecologies of the country. Therefore, the release of this new shallot variety will contribute to enhanced production of the crop not only owing to its high bulb yield but also because it affords farmers the opportunity to effectively and efficiently propagate the crop using true seed. Enhanced production of the cop will also lead to improved farmers' income and livelihoods.

**Keywords:** *Allium cepa* var. *ascalonicum* Backer; *Improved Huruta* Shallot Variety; Marketable bulb yield; Stability; True seed.

## 1. Introduction

Shallot and onion belong to the genus *Allium*. Shallot is formerly known as *Allium ascalonicum* L., a separate species from onion (George, 1999), but later it was identified that shallots are *Allium cepa* var. *ascalonicum* Backer as the most important subgroup of the Aggregatum group and the only one grown commercially (Rabinowitch, 1990). Shallots are known as vegetatively propagated varieties of *Allium cepa*. True seed production potential of shallot was tested in many countries of the World but the success history was not as good as that of onion and other crops. The vegetative propagation of shallot requires a large quantity of planting material as bulb (1.2 t $ha^{-1}$ bulbs) (Jackson *et al*., 1985) that can be used for consumption, which is expensive, bulky to transport and needs well ventilated storage. Bulbs keep for short periods of time and carry fungal diseases (Mengistu and Seid, 1990) and latent viruses (Proctor, 1987) from generation to generation. In contrast, the use of true seeds has an advantage of ease of propagation and solves the disease problems transmitted through bulbs as planting material. The use of true seed also increases the sizes of bulbs and enables genetic improvement through natural outcrossing and/or planned crossing programs. However, bolting does not occur readily and easily in



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many shallot varieties (Currah and Proctor, 1990). Therefore, production of true seeds from shallot requires great efforts to regulate flowering (Van Nocker, 2001) through application of plant growth hormones or identifying favourable season(s) for the flowering of the crop.

In Ethiopia, shallot is one of the most widely cultivated bulb crops under rain-fed conditions by smallholder farmers as an income generating spice crop. The crop has a wide range of adaptation to climatic and soil and is cultivated both under rain-fed and irrigated conditions (Kebede, 2003). Shallot is mostly produced at highland areas under rain-fed conditions (Shimeles, 2014), but the cultivation and distribution of the crop is being expanded to new areas (Lemma and Shimeles, 2003). The national average bulb yield of shallot is about 7 t $ha^{-1}$ (Shimeles, 2014) and it is substituted by recently introduced onion due to ease of propagation from true seeds. Many factors such as diseases, insects and lack of improved pre and post-harvest management practices contribute to low yield and quality (Getachew and Asfaw, 2004). The main constraint to shallot production in the country is the need of using 1.5 - 2 t $ha^{-1}$ of edible bulbs as planting material which comprise about 40% of the total cost of production compared to 4–5 kg $ha^{-1}$ of true seed (Lemma and Yayeh, 1994). Therefore, the production of true seeds from shallot has multiple advantages. Realizing this fact, Haramaya University initiated true seed production from *Huruta* shallot variety which was released in 1997/98 (MoANR, 2016) and entirely propagated by bulbs.

The seed production from *Huruta* shallot variety was started during 2004/2005 and the subsequent improvement of the variety was continued for 12 years. A series of experiments were conducted in which the first phase was focused on seed production using plant growth hormone ($GA_3$) and identifying appropriate locations and seasons for flowering and seeding. The second phase was evaluation of the bulb yield of the variety produced from true seeds and bulbs. As the third phase, the seed yield of *Huruta* was evaluated in comparison to other seed producing shallot varieties and onion variety over locations. The fourth phase was devoted to bulb yield evaluation of the variety from true seeds over locations and seasons in comparison to commercial onion varieties and at final the verification of the variety for yield was conducted in 2016. After a series of efforts, the original non-seed producing *Huruta* shallot variety was essentially improved for enhanced true seed and bulb production better than the seed production potential of commercial onion varieties through seed-to-bulb seed selection method and approved for cultivation.

## 2. Agronomic and Morphological Characteristics

The released variety was given the local name *Improved Huruta* shallot variety. The variety has nine leaves, 58.7 and 47.4 cm of plant height and leaf length, respectively. It produces a bulb with a deep red color with smaller proportions of unmarketable bulbs. It has large-sized bulbs with an advantage of 31.40% marketable bulb weight increase over the commercial onion varieties. The *Improved Huruta* shallot variety has been essentially improved for enhanced seed yield better than onion and shallot varieties with 95% average bolting. It has an average true seed yield advantage of 321.43% over three onion and shallot varieties. This will simplify production of reasonably high seed yield from the variety and enable researchers to improve the variety further through planned hybridization programs or through selection from populations created by natural outcrossing. Seedlings are grown in a nursery and transplanted 45-50 days after sowing. The variety requires 120 days for bulb and seed maturity after transplanting of seedlings and planting bulbs, respectively. Therefore, 8 and 10/11 months were sufficient to produce true seeds from bulb-to-seed and seed-to-bulb-to-seed methods, respectively. The detailed description of *Improved Huruta* shallot variety is presented in Table 1.

## 3. Bulb and True Seed Yields

The *Improved Huruta* shallot variety was evaluated for production of true seed in 2014 at five locations in parallel with one onion and two shallot varieties. The variety was evaluated for bulb yield for two seasons (2014/15 and 2015/16) at three locations along with three onion varieties. In addition, in 2015/16, the variety was evaluated for bulb yield at two locations on 28 farmers' fields under farmers' management practices. On average, the *Improved Huruta* shallot variety produced marketable bulbs with the mean weight 72 g with overall bulb yield advantages of 18.29% over three onion varieties. It produced 36.74 and 45.14 t $ha^{-1}$ of marketable and total bulb yields with the overall advantages of 35.03 and 22.37% over the three commercial onion varieties, respectively. The improved variety produced a mean true seed yield of 5.72 g per plant and 953.4 kg $ha^{-1}$ with an overall mean true seed yield advantage of 321.43% over the three check onion varieties. The seeds of the variety exhibit no dormancy and could be stored for two years with 98% average germination capacity four days after sowing the seed.

Table 1. Agronomic characters of *Improved Huruta* shallot variety.

| **Characteristics** | ***"Improved Huruta"*** **shallot variety** |
|---|---|
| **Adaptation area and management** | Medium to high altitudes of eastern Ethiopia (1600-2800 meters above sea level) |
| Rainfall (mm) | 760-1010 |
| Planting season for bulb production | All year round both under rain-fed and irrigation |
| Planting date for seed production | During the rainy season (early August) under Haramaya conditions |
| Seeding rate (kg $ha^{-1}$) | 2 to 3 at 15 and 40 cm between plants and rows/ridges (166667 plants/ha) |
| Spacing (cm) | 40 x 20 x 10 (double rows) |
| Fertilizer rate (kg $ha^{-1}$) | 46 kg $P_2O_5$ or 100 kg DAP and 64 kg N or 100 kg Urea + 18% N from 100 kg DAP |
| Fertilizer application time | All DAP at planting but half N rate at planting and half at active growth stage |
| Fertilizer application method | Drilling in row |
| Weeding | Weed free seed beds and farms throughout the plant life |
| Disease and insect control | Application of Ridomil and Mancozeb for downy mildew and purple blotch and Karate for thrips as per manufacturers recommended rates |
| Seedling transplanting after sowing (days) | 45-50 |
| **Harvesting and storage** | |
| Average bulb maturity for harvest (days) | 120 |
| Average maturity for seed production (days) | 120 |
| Average bulb to seed production (months) | 8 |
| Seed to bulb to seed production (months) | 10 to 11 |
| Bulbs for storage | Bulbs for storage harvested when 50% or more of the tops have broken over |
| Curing | Bulbs for storage cured and dried under shade thoroughly for one week before being placed in storage |
| Bulbs for immediate use | Bulbs undercut when 15 to 25 percent of the tops are down |
| Tops and roots cut | Tops and roots of bulbs removed during harvest |
| **Morphology** | |
| Plant height (cm) | 58.7 |
| Leaf length (cm) | 47.4 |
| Number of leaves | 9 |
| **Bulb yield and bulb character** | |
| Bulb color | Deep red |
| Marketable bulb weight (g) | 72 |
| Proportion of unmarketable bulbs (%) | 18 |
| Marketable bulb yield (t $ha^{-1}$) | 36.74 |
| Total bulb yield (t $ha^{-1}$) | 45.14 |
| Bulb dry matter content (%) | 13.5 |
| Total Soluble Solid (TSS) $^{O}$Brix | 14 |
| Average bulb storage period under ambient temperature (22 to 25$^{O}$C or at Haramaya condition) (month) | 2 |
| **Seed production** | |
| Bolting (%) | 95 |
| Seed yield (g/plant) | 5.72 |
| Seed yield (kg/ha) | 953.4 |
| 1000 seed weight (g) | 3.4 |
| Pure seed (%) | 97 |
| Seed germination (%) | 98 |
| Average seed germination period (days) | 4 |
| Seed dormancy | No seed dormancy |
| Average bulb sprouting period at Haramaya condition (month) | 2 1/2 |
| Sorting of mother bulbs | Bulbs checked when lifted for color, size and morphology to true to |

| | |
|---|---|
| | type, discard bloting, bull-necked, bottle shaped, split doubles, damaged or diseased bulbs |
| Bulb size | Medium-sized shallot bulbs are harvested, stored for some time in well ventilated storage houses and then replanted |
| Mother bulbs growing and amount | Mother bulbs grown in the same way as the crop for market and 1200 to 1500 kg bulbs/ha required |
| Isolation distances | About 1 to 2 km distance between other onion cultivars and other seed producing shallot cultivars |
| Seed producing area | Mid to high altitude (1600 to 2800 m.a.s.l.), coincide in month of low humidity & mild cool temperature during initial growth by increase in temperature at later stages of the crop and clear and bright days at flowering |
| Seed heads/Umbel harvest | Successive seed heads cut 10-15 cm of stem attached when heads turned to silver and seeds are dark black color |
| Seed extraction | Seed heads dried outdoor under sun, threshed after completely dried, seeds separated from their capsules by rubbing in the hand and seeds are collected after cleaning |
| Seed moisture | The seeds dried after extraction and cleaning to 12% moisture content or lower |
| Seed storage | For more than 2 years under cool dry condition |
| Release year | 2017 |
| Breeder/Maintainer | Haramaya University |

## 4. Bulb and Seed Yield Stability

The stability of the *Improved Huruta* shallot variety for bulb weight as well as bulb and true seed yields was tested along with three onion and two shallot varieties as checks. A regression data analysis method was employed, because this method is useful to explain a large part of the variation in total yield (Pompiliu *et al.*, 2009). The largest proportions of 95.57 and 96.71% variations for marketable bulb yield (Figure 1) and marketable bulb weight (Figure 2), respectively, were due the responses of the improved variety to the environments. Strong and significant correlations were observed between mean values of environments and the improved variety both for marketable bulb weight ($r = 0.984$) and marketable bulb yield ($r = 0.978$). As it could be visually observed from the scattered plot (Figure 1 and Figure 2), the improved variety was more stable and better in performance than the three commercial onion varieties both under favorable and unfavorable environments for marketable bulb yield and marketable bulb weight.

The *Improved Huruta* shallot variety produced lower total bulb and true seed yields than *Kelafo* onion hybrid (Figure 3) and the three onion varieties (Figure 4) ), respectively, under unfavorable environments. However, the differences under unfavorable environments were very low and more importantly the improved variety produced higher total bulb and true seed yields than other varieties under favorable environments with 95.26 and 93.46% coefficient of determination, respectively. The correlations between mean values of environments and improved variety for total bulb ($r = 0.976$) and seed yields ($r = 0.967$) were strong and significant. The high mean yields with a large proportion of the variation explained by the environment indicates that the variety responds better to favorable environmental conditions for both bulb and true seed yields than the check onion varieties.

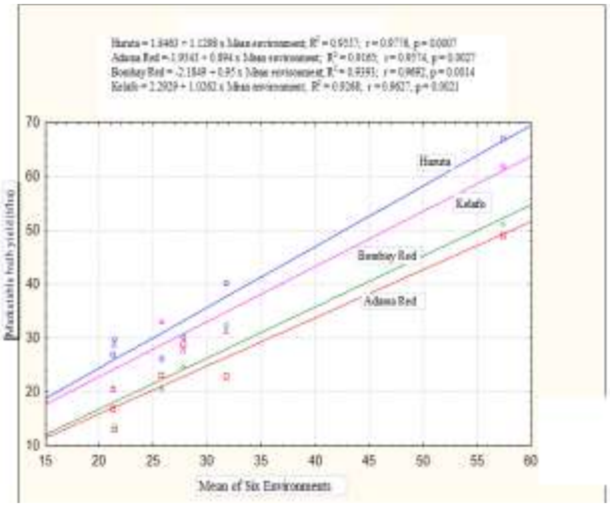


Figure 1. *Improved Huruta* shallot variety & three onion varieties response to six environments for marketable bulb yield (t/ha)

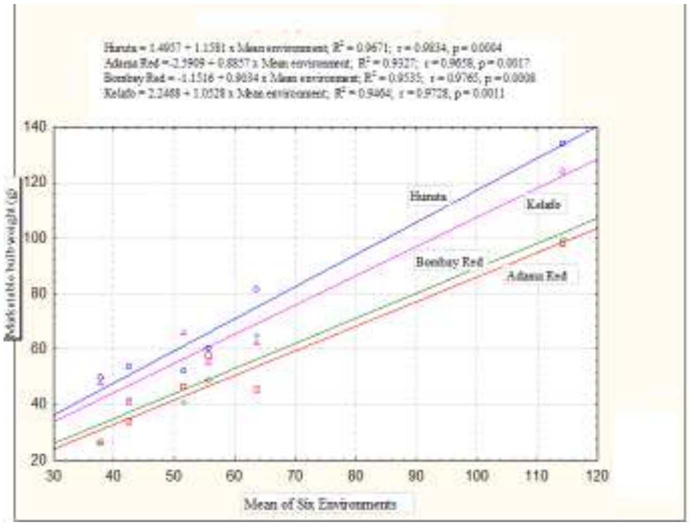


Figure 2. *Improved Huruta* shallot variety & three onion varieties response to six environments for marketable bulb weight (g)

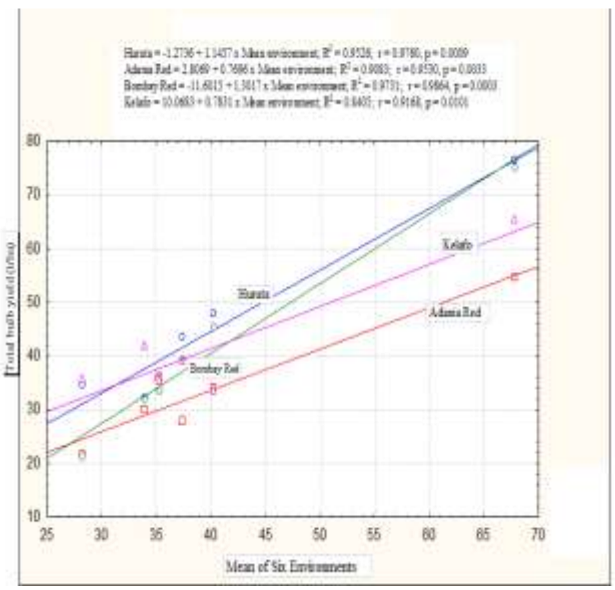


Figure 3. *Improved Huruta* shallot variety and three onion varieties response to six environments for total bulb yield (t/ha)

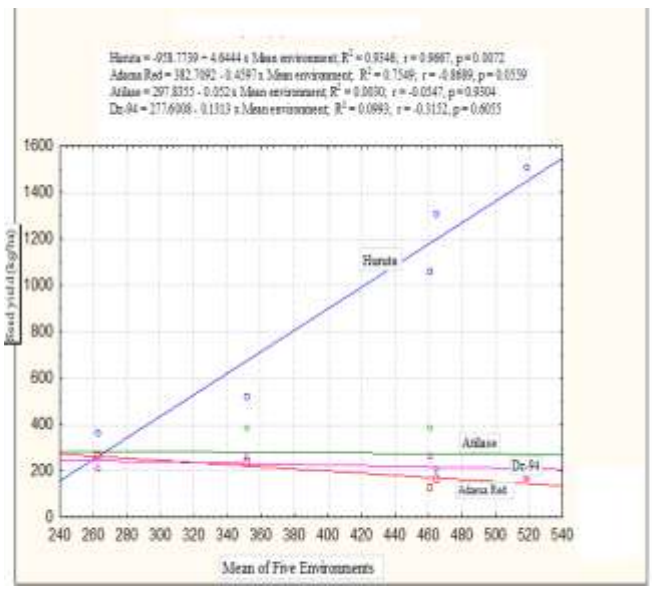


Figure 4. *Improved Huruta* shallot variety and three onion varieties response to five environments for seed yield (kg/ha)

## 5. Other Quality Attributes

The bulbs of *Improved Huruta* shallot variety had better shelf life than the onion varieties. The proportion of unmarketable bulbs of the improved variety was lower than that of the onion varieties. The improved variety may be preferred by consumers for its large bulb size, deep red bulb color, long shelf life, and high bulb dry matter content. Farmers were observed preferring it for its high seed and bulb yields as well as for its high bulb weight and low proportion of unmarketable bulbs.

## 6. Conclusion

The *Improved Huruta* shallot variety is stable and superior to the commercial onion and shallot varieties for bulb and true seed yields with desirable bulb and true seed quality attributes. The cost of true seed production is much reduced for smallholder farmers. Thus, using this variety addresses the serious problem of dearth and scarcity of planting material for shallot production. The high quality of the true seeds and high seed yield of this variety are also attractive for seed business enterprises and smallholder farmers to make substantial profit from seed selling because of the high price of shallot seeds in the world. The seed producing variety also enables breeders to further improve shallot through selection from variations created by deliberate and/or natural crossing. In conclusion, the newly released *Improved Huruta* variety can be cultivated profitably and sustainably in the mid and highlands of Hararghe zones and other places with similar agroecolgy, and could lead to enhanced income livelihood of smallholder farmers.

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