Seed Production Guideline
for
Tomatoes, Onion and Hot Pepper

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Ethiopian Institute of Agricultural Research
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INSTITUTE OF AGRICULTURAL RESEARCH
Seed Production Guideline for Tomatoes, Onion and Hot Pepper
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Acknowledgments

Researchers in IAR who participated in the tomato, hot pepper and onion research are duly acknowledged.
The diverse climatic conditions of Ethiopia are suitable for the production of a number of vegetables. Several varieties are cultivated commercially and in the homesteads mainly as sources of income and food. More than 90,000 ha. are under various vegetable crops in the country (Semeret 1994). The crops are produced by small farmers both under rainfed and irrigation. Irrigated vegetables production is common throughout the country, the main concentration being the Upper Rift Valley, the Rift Valley Lakes Region, eastern Ethiopia and around small dams in various regions. About 2.86 million tons of fresh vegetables is produced annually (Tahal consulting Engineering 1989). Substantial amount is exported in fresh and processed forms.

For successful production of vegetables, quality seed should be available sufficiently. Vegetable seed production is generally influenced by environmental factors such as lights, temperatures, rainfall, wind, soil and varietal differences. Some vegetables have specific physiological requirements such as vernalization (low temperature treatment), which is important for flower stalk initiation and seed set where as some others fit to diverse growing conditions. Therefore identification of environments for high quality seed production is essential.

In Ethiopia, among the vegetables grown from true seeds tomato, hot pepper, onion, shallot, cabbages, carrot, beet root, swiss chard and melons are produced by small farmers and commercial growers. The seed supply of these crops is not as sufficiently require by producers. Vegetable growers depend mainly on imported seeds in which most of
the varieties are introduced by charity-based NGOs in a form of gift, while merchants are importing a small amount of seeds. Most of the seeds available in the market are poor in germination and uniformity and are also susceptible to diseases.

Nowadays, the seeds of onion (cultivar Adama Red) is produced by state enterprises and some farmers are extracting vegetable seeds such as tomatoes to be used for one or two production seasons. However, Farmers/growers normally sale the best produce in the market and use rejected fruits (damaged, undersized, diseased and cracked) onion bulbs (undersized, off quality and inferior umbel) pepper pods (off color and diseased) for seed production. Such poor production technique is favorable for heavy disease incidence, low yield and quality subsequently complete crop losses. This indicates that, vegetable producers should be able to meet a number or requirements for seed production, not commonly found among ordinary farmers, such as developing technical as well as practical skills.

In the last few years, seed production research has been conducted to identify the production potential of various vegetable cultivars in different agro-climatic regions of the country and some promising results have been obtained. High quality seeds of most of the currently produced vegetable crops can successfully be produced in the country. Harvesting, processing, drying and storage conditions are fundamental operations. The seeds should be extracted at appropriate time for higher yield and better quality and must be dried carefully and immediately. The storage condition such as temperature and moisture and packaging materials are important aspects for long storage periods. Moreover, maintaining the
genetic purity and raising high quality seed through selecting superior plants or produces is important for sustainable and profitable seed production system.

This seed production guideline includes specific production practices of tomatoes, onion and hot pepper that are propagated by true seed. With the growing irrigated agriculture, high domestic and export demands, the seed production technology of these vegetables is becoming very important.
Different types of tomato varieties are produced in the country. These include the tall set (indeterminate), erect and bushy types with fairly thin or thick stem, and the short set (determinate) with strong or weak stem. The determinate types produce more flowers within a given length of vine within short period than the indeterminate ones, which produce fruits and higher yield for long time. Tomato seed production requires a special attention because seeds are wet at time of harvest. The seed production could be either a commercial operation or an additional production during industrial processing of tomato.
Growth Requirement

Tomato requires warm, clear, dry conditions, and altitudes ranging between 700 and 2000m. The optimum growing temperature in the central lowlands ranges between 24 and 28°C during the day and 14 and 17°C at night. This is favorable for high quality fruit production and subsequent seed set. High temperature above 40°C during the day and 22°C at night can cause flower drop, poor fruit set and poor quality seed. In addition to temperatures, friable and sandy loam soil with pH of 5.8 to 6.8 is favorable for high fruit yield and better seed set.

Cultivars

Different tomato improved varieties are released/recommended in the country. The description of some of the cultivars is given in the following table.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Growth habit</th>
<th>Fruit shape</th>
<th>Weight (g)</th>
<th>Growing Period (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh market</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marglobe</td>
<td>tall</td>
<td>globular</td>
<td>120-140</td>
<td>100-110</td>
</tr>
<tr>
<td>Money Maker</td>
<td>tall</td>
<td>round</td>
<td>70-80</td>
<td>110-120</td>
</tr>
<tr>
<td>Heinz 1350</td>
<td>short</td>
<td>round</td>
<td>60-75</td>
<td>75-90</td>
</tr>
<tr>
<td>Person A-I</td>
<td>Semi-determinate</td>
<td>globular</td>
<td>100-125</td>
<td>100-120</td>
</tr>
<tr>
<td>VFN-138</td>
<td>Semi-determinate</td>
<td>globular</td>
<td>80-90</td>
<td>100-120</td>
</tr>
<tr>
<td>Marglobe Improved</td>
<td>tall</td>
<td>globular</td>
<td>120-140</td>
<td>100-110</td>
</tr>
<tr>
<td>Processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roma VF</td>
<td>short</td>
<td>pear</td>
<td>50-60</td>
<td>95-100</td>
</tr>
<tr>
<td>Napoli VF*</td>
<td>short</td>
<td>pear</td>
<td>50-60</td>
<td>95-100</td>
</tr>
<tr>
<td>Serio</td>
<td>short</td>
<td>pear</td>
<td>40-50</td>
<td>100-120</td>
</tr>
<tr>
<td>Read pear***</td>
<td>short</td>
<td>cylindrical</td>
<td>70-60</td>
<td>100-120</td>
</tr>
</tbody>
</table>

* has strong stem and higher fruit yield than marglobe
** possesses low fruit total soluble solid (TSS) (4.2%)
*** has high fruit TSS (5.0-5.5%)
Cultural Practices

The field culture of tomatoes for seed production is identical whether they are grown for fresh market or processing. It is grown under irrigation in the dry season. Rainfed production is not preferred due to heavy disease incidence and poor seed set. About 250-300 g of seed is raised on nursery bed and good once be transplanted to the field at 3 to 4 true leaf stages, i.e., 28 to 35 days after emerging at spacing of 100 cm between rows and 30 cm between plants.

Tomatoes should be grown on the same field ones every 2 to 3 years. Related crops such as potatoes and hot pepper should not be used in the years rotation to avoid diseases build up. Frequent watering, weeding, frequent cultivation, disease control and pest incidence are essential for good seed yield.

Diseases affecting tomatoes occur in large number at one time. For
common leaf diseases Ridomil MZ 63% (3.5 kg ha$^{-1}$) or Mancozeb (3.5 kg ha$^{-1}$) and for insect as African Ball worm Cypermethrin (100 g a.i. ha$^{-1}$) can be applied.

Staking is important for tall set varieties to facilitate management practices and to produce high quality seed, whereas short set cultivars could be grown without support. Depending on cultivars high quality fruits could be harvested from 90 to 120 days after transplanting for about 4 to 5 times for short set and about 6 to 7 times for tall set cultivars.

**Rouging and Isolation**

Careful removing of off type plants before flowering is important for seed production. Plants should be thoroughly examined for vegetative growth and fruit characteristics. Plant affected by diseases must be eradicated immediately. Though tomatoes are self pollinated, therefore, it would be important to isolate different varieties to be able to prevent varietal mixes and avoid the extent of cross pollination that may occur, especially where pollinators such as bees are present.

**Harvesting, Processing and Drying**

Good fruits selected from healthy and true to typical plants should be collected for seed extraction. The fruits must be free from diseases, any physical damage and must be typical to the variety in color, size, shape, etc. The fruit should be red ripen as seed extract from unripe green fruits will have low germination percentages and the seed will be not easily
separated from the pulp. Rejected fruit should not be used for seeds.

Since tomato seeds are embodied in a jelly-like substance, their extraction requires special care. Different extraction methods can be used depending on availability of facility, technology and the amount of seed to be extracted.

Under commercial seed production, extraction will be economical if it combines fruit processing operation. If seed could be separated from the pulp at the different processing stage, however, seeds must not be exposed to heat when boiling the fruit. High heat has a significant effect on seed quality. Under small-scale farming, i.e., when seed is obtained without making use of the juice, fruits can either be crushed or squeezed, or the fruits are cut with a knife and then seed will be separated from the pulp by fermentation processes. In this process, the mass of the fruits are squeezed and crushed in a container on a bucket. It is then stirred at least 3 times daily to maintain minimum of fermentation in the container and to avoid discoloration of the seeds as well as prevent fungus growth. The process of fermentation could be for two days (36 to 48 hours) under room temperature (24 to 32 °C). If it is cooler, the process can continue for one more day, i.e., for a total of 72 hours, but it has to be continuously monitored for unwanted seed germination which eventually affects seed quality. Generally, when cottony growth is observed covering the pulp, the fermentation is about completed. The seed is then washed 2 to 3 times with tap water until it is free from pulps. During the process, the seed will sink to the bottom and clean seed will be collected after the pulp is drained off. Then the seed should be spread on suitable tray or mat or molonite (cloth bags and dried in the
sun or under shade for about two days to bring down the moisture content between 7 and 9%. The seed should be put in plastic bag, so that it will not absorb moisture from the air. The fermentation processes is effective in controlling seed borne disease such as bacterial canker.

Fruit can also be squeezed in a container such as tray and directly dried without fermentation. However such practice will not control seed borne diseases.

**Seed Yield**

Temperature, rainfall, cultural practices and characteristics of cultivars which include number of fruits per plant and number of seeds per fruit affect seed yield of tomatoes. Small fruited varieties produce about 8 to 10 fruits, while large fruited produce 3 to 4 fruits per cluster. This makes differences in the amount of seed yield. In addition, practices like shaking or disturbing the plant when the anther has dehisced helps pollen transfer to the stigma which will eventually increases seed set. Besides the yield of tomato seed also vary considerably with varieties. The ratio of fruit to seed yield could vary from about 200 to 300 to 1 and even less for some. Seed yield can be between 90 to 125 kg ha\(^{-1}\). The 1000 seed weigh is about 2.3 to 2.7 g, with 92 to 97 germination percent and a germination rate of about 6 to 8 days.

**Seed Storage**

Under local conditions, the dried seed can be stored in plastic or cloth bags under cooler conditions or hanged in shade in open air untill the
new planting season. Under commercial production, tomato seeds could be better stored in a sealed container. The seed can retain full viability for about 3 to 4 years when stored at room temperature, at low moisture content of about 7 to 9% and relative humidity up to 70 percent.
Different types of hot pepper (*capsicum sp.*) are produced in Ethiopia. It varies in mode of growth and in fruit characteristics such as fruit size, shape, color and pungency. The degree of pungency vary considerably from very mild to hot. The fruits are erect or hanging, depending on the variety.

**Growth Requirement**

Hot pepper (berbere) grows well under warm and humid conditions, but it requires dry weather at the time of maturity. It give best green fruit yield and better seed set at 21 to 27°C during the day and 15 to 20°C at night. High temperature in combination with low humidity (40 to 50%) cause abscission of buds and flowers of poor fruit and subsequent low seed set.

Hot pepper adapts well in sandy loam soil and well drained good clay loam.

**Pollination**

*Capsicum* is a self pollinated crop (Tay 1988) in which cross pollination occurs in the range of 5 to 40% due to insect activity (Tindall 1987). An out crossing of 11 to 64% is observed at Melkasa. Such high percentage of cross pollination is due to large population of pollinating insects and its floral morphology. In addition, prior to dehiscence the stigma is
receptive to pollen transmitted from other plants. If different varieties are to be produced, it is essential to isolate varieties by a distance barrier between 200 and 300 m or by a tall screen of another crop. This will prevent seed contamination and deterioration.

**Cultivars**

*Mareko Fana*

It is a dark red, thick fleshed, pendulous in position, very pungent and most accepted in local markets.

*Bako Local*

It is a light colored, thin skinned, less pungent and smaller than Mareko or Fana.

**Cultural Practices**

The crop is produced under rainfed and irrigation but it is commonly produced under rainfed. About 500 to 700 kg of seeds should be raised in a nursery bed and transplanted to the field after 45 to 55 days. Appropriate spacing (60 x 40 cm for rainfed, and 80 x 60 cm for irrigated), proper watering, manuring and proper weedings should be followed as a routine berber production practices. Hot peppers susceptible to various diseases, therefore, affected plants should not be used to produce seeds. In addition, similar rotation pattern and proper sanitation to tomato should be used to avoid disease build up in the soil. The pest control measures that are applicable to tomatoes should be used. Pods will be ready for harvest in 5 to 6 months after transplanting.
Isolation

A considerable amount of cross pollination takes place in hot pepper. It is, therefore, necessary that different varieties grown for seed production are separated by a barrier for at least 200 meters. This to prevents seed contamination through cross pollination as well as mechanical mixing of the seed during harvest. If seeds of different varieties are to be produced in a limited space, mainly for experimentation or basic seed production purpose, the seed can be obtained by enclosing a plant or group of plants in an insect proof cages. However, under commercial seed production, it is better to concentrate on one or two standard varieties.

Rouging

Frequent field inspection is necessary to ensure varietal purity. Plants of other varieties, any diseased plants, and plants outside the acceptable limits of desirable characters should rouged out before flowering.

Harvesting and Processing

The pods are picked when they are at red ripen (leathery stage), i.e., when the fruit color is well developed. The pods can be harvested through several hand pickings. Then they should be dried in the sun or on artificial batch for 10 to 15 days depending on the weather conditions. Fruits can be either split open with a knife and seeds removed or the dried fruits are hand opened to extract the seeds. The seed can be dried in the sun on screen-bottom trays or canvas or any locally available material. Further seed separation is done by winnowing or in a screen
cleaner. The split fruit can be consumed and can be used as a by-product.

Seed Yield

Depending on cultivars and conditions of cultivation, an average yield of 100 to 160 kg ha\(^{-1}\) seed can be obtained with germination percent of 90 to 96\% and 1000 seed weight of 6 to 7 g.

Storage

Under small scale local condition, hot pepper can be stored with the pod under shade or in cool and airy conditions until the next planting season. In commercial conditions, the seed should be dried to low moisture (7 to 9\%) and stored under cool conditions in bags or in vapor-proof containers.
Onion is a biennial crops usually grown as an annuals for bulb, but it takes two seasons for seed production. During the first season bulbs are formed, stalks and seeds are developed in the second season. It passes from the vegetative phase to reproductive phase for flower stalk development and seed set. The development of seed stalk is influenced by storage conditions of the mother bulbs and temperature during the growing period.

Onion cultivars also vary in their susceptibility to flower stalk development, depending on climatic conditions and the potential of the cultivar. Onion varieties are generally maintained in a more complicated manner, as they are hardly collections of genetically similar plants.

**Growth Requirement**

Temperature greatly influences the flowering activity of onion. Cool condition with an adequate moisture supply are most suitable for early growth of onion, followed by warm, drier conditions for maturation. Low temperature (9 to 17°C) is required for flower stalk development. In the Upper Awash and the Lake region, during September to February with temperatures of 26 to 28°C during the day and 11-18°C night supplemented with low humidity are good conditions for flower stalk emergency and satisfactory seed set for easy bolting varieties. Drier and low humid condition with ample sun shine and the absence of strong wind are suitable for seed maturity, ripening and harvesting. Excessive
rainfall and cooler conditions during flowering leads to diseases and poor fruit set and ripening and makes the harvesting of seed difficult. It also delays seed maturity and results in poor quality seed. A fertile loam soil with pH of 6.0 to 7.0 is suitable for higher yield.

**Pollination**

Onion is highly cross pollinated (Tiniall 1987). The intensity varies between 30 to 94% depending on availability of pollinators (Voss 1979). The pollen usually sheds before the female part is receptive (proteandry). This makes self-pollination impossible without bagging or caging the flowers. Various insects are involved to carry pollen between flower. The availability of suitable pollinators such as bees, which feed on nectars and transfer pollen within an umbel and between different plants is very important. Honey bee hives could be placed on the farm to effect seed setting.

**Cultivars**

Different high yielding and quality cultivars are recommended are released in the country. The cultivar Adama Red is the standard one.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adama Red</td>
<td>Dark red, puny ears, easily bolting, used for flower and bulb production</td>
</tr>
<tr>
<td>Bombay Red</td>
<td>Medium red, medium size, easily bolting</td>
</tr>
<tr>
<td>Murmuru Brown</td>
<td>Light brown, larger size, easily bolting</td>
</tr>
<tr>
<td>Red Cerole</td>
<td>Medium red, less susceptible to bolting</td>
</tr>
<tr>
<td>Pusa Red</td>
<td>Red, bigger than Red Cerole, easily bolting</td>
</tr>
<tr>
<td>N-53</td>
<td>Light red, about the same size to Pusa Red and easily bolting</td>
</tr>
</tbody>
</table>
Methods of Production

The two common methods of seed production of onion are described below.

Bulb to Seed Method
The method has the advantage of maintaining seed quality. It allows roguing of off color, misshapen, splits, rotten and sprout bulbs. Several stalks are formed per bulb. It takes 10 to 12 months to produce seeds using this method.

Seed to Seed Method
This method misses the above advantages, but it could be used alternately (every other year) with the other method to speed up the production practices without affecting the varietal quality. It takes about 7 to 8 months to produce seeds.

Under Melkasa and other similar climatic conditions, in the bulb to seed method, a bulb crop will be grown from February to June and typical mother bulbs will be selected and stored for one to two months. The bulbs will be planted in the cooler period (early September to October) which is conducive for flower stalk development and subsequent seed set. Large and well developed umbels are developed which are favorable for high quality seed production. The bulb to seed method which is the most common one follows a similar practices to bulb production.
Cultural Practices

About 3.5 to 4.0 kg of about 92 to 95% germinating seed should be raised on a seed bed and transplanted to the field after 45 days at 40 x 20 x 10 cm spacing, (i.e. 40 cm bed including furrow, 20 cm. between rows on the bed and 10 cm between plants). The bulbs will be ready for harvest after four and a half months after transplanting. Large or medium mother bulbs (5 to 6 cm), uniform, typical size and color, free from diseases, insects and other injuries should be selected and stored for about two months and planted. The size of the bulb determine the vigor of vegetative phase and number of reproductive shoots which is directly related to the number of seed stalks and yield. The number of flower stalks or bulbs under Melkasa condition vary from 1 to 15 and a terminal number of 50 to 200 flower produced per umbel (flower head) depending on the number of shoot axis.

The optimum mother bulb planting time is be between August and
October. August, September and October bulb planting can give high number of flower stalks and seed yield due to warm temperatures, low rainfall and low disease pressure during flowering, fruit set and harvesting. Double row plantings of 50 x 30 x 20 cm with 125,000 bulb per hectare (80 to 90 qha\(^{-1}\)) should be used for Melkasa and similar climatic condition.

Purple blotch (*Alternaria porri*) is a very severe disease of the seed crop mainly in wet seasons. The affected stalks do not produce seeds and the seed is usually shriveled. Onion thrips (*Thrips tabaci*) is the most severe pest during dry warm weather. It feeds on inflorescence and causes poor seed set. Spraying chemicals, Cypermethrin 100 g a.i ha\(^{-1}\) or 500 ml ha\(^{-1}\) and Mancozeb 3.5 kg ha\(^{-1}\) checks the pest and disease respectively. Weeding, intercultivation, and regular water application are essential as routine operation for bulbing onion. Onion should not be planted in the same field more than once in 2 to 3 years. So as to prevent disease problems and maintain varietal purity.

**isolation**

All the flowers in one umbel do not open and mature at the same time. In addition, the male and female parts of the flowers do not mature at the time, therefore, cross pollination is very common (30 to 94%).

In order to get pure seed, varieties should be separated by a distance of at least 600 m to 800 m as a barrier to reduce the chances of carrying pollen of one variety to the other. If there are many varieties, similar to hot pepper, varieties must be covered with insect proof cages to avoid seed
contamination. In a commercial production, it would be advisable to concentrate on one or two varieties.

**Harvesting and Processing**

Since all the umbel in a plant do not mature at the same time, it would be desirable to harvest the field 3 to 4 times before shattering occurs. The seed is ready for harvest when the first formed seed in the head begins to shatter or expose the black seed. The heads are cut by hand using shear with part of the stem attached and left to dry on canvas in ventilated sheds or in the sun. Although much of the seed fall from the capsule during drying, the seed can be fully separated by rubbing over canvas or by light pounding with pestle and mortar for about 10 to 15 minutes. Trashes and poorly developed seeds can be removed or cleaned by immersing seed in clean water for about 15 minutes. Then after seeds should be immediately transferred to canvas or trays and dried in sun or under shade for 3 to 5 days.

**Seed Yield**

A great variation was found in seed yield among the promising open pollinated cultivars. The cultivar, Adam Red, produces the highest seed yield or about 12 q ha	extsuperscript{-1}. The cultivars, Adam Red and N-53 also shows a similar trend. Red Creole does not set seed using the standard storage practice. Storage of this variety under cool condition in the range of 5 to 10°C for six weeks is effective in flowersalk development and seed set. Such practice improves seed yield from 2 to 6 q ha	extsuperscript{-1}. The overall onion seed germination varies between 80 and 95% with 1000 seed weight of about 3.5 to 4.0 g.
Onion seed deteriorates faster than any other vegetable seed. It deteriorates quicker under warm conditions (room temperature) such as at Melkasa climatic condition. Optimum care must be taken to dry the seed properly and protect it from excessive heat under conventional storage. For temporary storage the seed moisture content should be reduced to about 7 to 9%. Once the seed dries, it must be sealed in a moist-proof container otherwise it will regain moisture and deteriorates rapidly. Under local conditions it should be better stored in paper or cloth bag under dry and ventilated conditions for at least one year.
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Like many vegetable crops, tomatoes, hot pepper and onions as much for their flavoring and nutritional values as for their cash income to growers, processors and traders.

Vegetable seed production has been a less-regarded activity -- or is it the growers toughest cultural practice? The author reports the fundamental issues and techniques for enhancing vegetable seed production performance across the agroecologies suitable for tomatoes, hot pepper and onions.

As with the contents of this guideline, understanding the issues is as important as applying the techniques.