SEED PRODUCTION OF ONION

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Bulb onion botanically known as *Allium cepa* var *cepa* belongs to family Alliaceae. It is an important vegetable for domestic consumption and foreign exchange earnings (73% of total vegetables) in India. Though, India shares 21.5% area (8.04 lakh ha), but production share of the world is 12.2% (81.78 lakh MT) only. The productivity is 10.1 MT/ha compared to 17.9 MT/ha of the world average. Though, onion is cultivated all over the country, but 50% area is in Maharashtra, Karnataka and Gujarat. These states predominate for production and supply of onion seed in the country also. The annual requirement of onion seed in the country is more than 6000 tonnes, out of which less than 10% area is under approved varieties and rest under unapproved populations saved by the farmers and traders. Seed is the basic input to enhance the productivity and poor longevity of onion seed demands, hence strengthening of seed production programme of improved varieties in the country is required.

**Plant habit:** Onion is biennial, foetid, scapigerous, glabrous herb, usually grown as an annual from seed or bulbs. Roots are adventitious at the base of tunicated bulb. The 'true' stem is much reduced in size, hard, erect with condensed internodes and flat bottom in form of disc. Bulbs formed by thickening of leaf base a short distance above true stem, solitary, or in clusters, depressed globose to ovoid or oblate, up to 20 cm in diameter, variously coloured. The 'pseudostem' is found above the ground, constituted of tubular leaf sheaths. The leaves distichously alternate, glaucous, with tubular sheath; blade D-shaped in cross section, hollow up to 50 cm long, acute at apex and parallel venation. A terminal cymose spherical umbel on a long, erect, terete, hollow scape usually inflated below the middle; umbel initially surrounded by a membranous spathe splitting into 2-4 papery bracts. Its fruit is a globular capsule, splitting loculicidally and have up to 6-seed. The major portion of seed is endosperm. The spirally twisted cylindrical embryo, which is embedded in the endosperm, is made up mostly of the cotyledon. Onion seed is small, black, irregularly shaped and grooved at the narrow end. Outer seed coat is called testa and inner endosperm. The embryo is slender, curled within the seed and consist of a short root below the shoot apex, which is located with the trimordium of the first leaf at the base of a slit as the lower end of a cotyledon.

**Climatic requirements:** Onion requires cool season and grows well under mild climate without extreme heat or cold or excessive rainfall. The ideal temperature requirement is 13-21°C for vegetative growth before bulbing and 15.5-25°C for bulb development. Very low temperature during early stage favours bolting, whereas, sudden rise in temperature force early maturity
and resulted in small sized bulbs. Onion is a photo-thermo sensitive crop for bulb development and biennial for seed production. Based upon day length requirement, it is grouped into long (>14hr), intermediate (10-12hr) and short day (8-10hr) types. In India, major onion growing area (Karnataka, Maharashtra and Gujrat) falls between 15 - 25 °N latitude, where short day cultivars are grown. Under north Indian plains (28 - 33 °N latitude) genotypes requiring intermediate day length are most suitable for higher productivity.

Methods of Seed Production

Onion seed is produced through biennial and annual method of seed production. Biennial approach is called bulb to seed and annual as seed to seed method. Bulb-seed method provides opportunity of bulb selection every year for maintaining high genetic purity particularly for bolting and sprouting tolerance, bulb size colour and shape.

Biennial Method: Onion is biennial in nature and complete seed cycle in two seasons through conventional approach. Wherein, during first season mother bulbs are produced, upon maturity are harvested, sorted, stored and cured. For production of bulbs 8-10 kg seed is required to raise nursery of one hectare. Before sowing mix well-rotten FYM @125kg/marla and irrigate at least 10 days before sowing to allow germination of weeds. Prepare 15-20cm high beds in 20 marla (500m²) and sow seeds thinly at one to three cm depth in lines. Before sowing, treat the seed with Captan or Thiram @ 2-3 g/kg of seed. After sowing, cover the seeds with thin layer of ash or FYM and apply water with sprinkler. Sowing of nursery from mid-October-mid November and transplanting from the middle of December to middle of January are most suitable for rabi season crop. The bulbs are ready for harvesting in May. The selected bulbs are stored upto October-November for planting and seed harvesting in May. This approach followed for seed production of rabi season varieties like Punjab Naroya, PRO-6, Punjab Red Round, Pusa Red, Pusa Ratnar, Nasik Red, Hisar-1, Hisar-3, AFLR, Patna Red, Bellary Red, Early Grano, Arka Kirtiman, Arka Lalima, Arka Pragati, Bhima Super, Bhima Supreme and other rabi season varieties. Whereas, for kharif season varieties like N-53, ADR and Arka Kalyan nursery is sown in June-July, nursery is transplanted in August and bulbs are harvested in November. After curing for 15-30 days these bulbs are again planted in December for seed production. Seedlings and bulbs health plays significant role for higher seed yield and should be taken care. Cutting of one-third top portion of the bulb helps in removing diseases spores resting in neck, examination of number of axis of growing center and uniformity in emergence. This method is widely practiced and it allows to examine the bulb characteristics and rouging of undesirable bulbs to maintain genetic purity. Treatment of bulbs with carbendazim (1g/litre) and corbosulphon(1ml/litre) helps in controlling bulb and soil borne pathogens.

Annual Method: The storage of bulbs in bulk for five months, two-season cycle and crop failure due to diseases are the major limitations with biennial method. It results in purchase of seed from open market of unrecommended varieties, which lower the bulb yield, either due to bolting or small sized bulbs. To counter these issues annual or In-situ method called seed to seed can play significant role. In seed-to-seed method seedlings are left and allowed to bolt and flower in the same field where the transplanting is done earlier Experiments on direct bolting to complete seed cycle in one-year were conducted at PAU for many years and the Research Evaluation Committee recommended this technology for commercial seed production of onion. In this, seed is sown in the nursery in last week of August to first week of September and seedlings are transplanted in last October or first week of November. Bolting i.e. initiation
of seed stalk starts in Feb-March and seed is ready for harvesting in May under north Indian conditions. In this method cost of seed production is lowered, time is saved and diseases risk is evaded. This approach should be followed for the production of seed, which is to be used for commercial bulb production of onion. To avoid genetic drift in the variety towards bolting, the stock seed in seed to seed method should be produced by bulb to seed approach.

**Soil and Agronomic Practices:** The soil for onion production should be deep friable, well-drained, loam soils, rich in organic matter, free from diseases, and weeds. It does not grow well on alkaline and low-lying soils. The optimum pH should be is 5.8-6.5 for growth and development of the plants and bulbs. Generally, onion seed is produced in two phases viz in first bulbs are produced and in second bulbs are planted to produce seed. For bulb production seedlings should be transplanted in **wattar** conditions soon after uprooting from the nursery beds at 15 cm spacing between rows and 10 cm between plants for getting maximum bulb yield. Onion requires 50 tonnes of FYM, 100 kg N (225 kg urea), 50 kg P₂O₅ (325kg Super Phosphate) and 50kg of K₂O (87.5kg Muriate of potash) per hectare. Apply whole FYM, P₂O₅, K₂O and half of N before transplanting and remaining dose of nitrogen one month later as top dressing.

Weed control in onion essential as it is closely spaced, shallow rooted and poor weed competitor crop. Shallow hand weeding is generally practiced, but once the vegetative growth of the plants is complete, hand weeding becomes very difficult and expensive also. Therefore, chemical weed control by spraying Stomp 30 EC (Pendimethalin) @ 2.5 l/ha or Stomp 30 EC @ 1.875 l/ha followed by one hoeing after 45 days is recommended. Goal (Oxyfluorfen 23.5% EC) @ 0.980 l/ha can also be applied within a week after transplanting or after first irrigation.

Irrigation or water requirement depends upon the growth stage of plant, soil type and climatic conditions. First irrigation should be given immediately after transplanting for proper establishment of seedlings. Irrigate the crop at 7-10 days interval depending upon weather. Total number of irrigations can be 10-15. Since, it is a shallow rooted crop and water requirement is critical at the time of bulb development. Water stress at this stage can affect the yield drastically. Irrigation should be stopped 15 days before harvesting to prolong the storage life of bulbs. The high water stress during bulb sprouting and beginnings of the anthesis reduce the number of umbels and flowers/plant. However, in practice, the soil surface should not be continuously wet because it will predispose the crop to infection to root rot/damping off. The methods of irrigation also greatly influence the seed yield and seed quality of onion. Drip method of irrigation gave higher seed yield (894.94 q/ha) than the surface irrigation (648.94 q/ha) in onion. The seed vigour index was also high in drip (876.49) than surface (663.71) irrigation in onion.

**Harvesting, Curing, Cleaning, Grading and Storage of Bulbs:** Bulb crop is ready for harvesting, when more than 50% plants show neck fall or drying of the leaves in the month of May under north Indian conditions. Crop should be harvested when the weather is dry. After harvesting, bulbs are windrowed for 3-5 days for field curing and again cured under shade for 10-15 days. The purpose of curing (drying) is to remove the excessive moisture from the outer skin. When the bulbs show sign of rattling, cut the leaves keeping 1-2 cm length. Neck should be tight enough to reduce infestation of disease. Curing helps in minimizing storage losses and colour development of bulbs. After curing, bulbs should be cleaned, graded, marketed or stored. Cured bulbs should be stored in a well-ventilated and dry place. The pre-harvest spray of
carbendazim 0.1% at 30, 20 and 10 days before harvesting lower the decay and sprouting losses. Spraying the bulbs with 0.2% Difolatan check the storage rot also. Well-ventilated and damp proof rooms with racks having 2-3 layers of bulbs are ideal for storage. Turn the bulbs once in a fortnight during storage and sort out and discard injured ones. Exposure to light during storage will cause greening of the outer scales.

**Field and Isolation Requirements** : The field to be used for seed production of onion should be free from volunteer plants. Although onion seed crop can be grown nearly in all types of soil from sandy loam to heavy clay soil, but clays are not satisfactory unless well supplied with humus to lighten them. The soils pH should preferably be 6.0-6.8. Onion field shall be isolated from contaminants viz fields of other varieties and the fields of the same variety not confirming to varietal purity should be away at least by 5 m for mother bulb production; 1000 m for foundation and 500 m for certified seed production. However, the maximum permissible limit for bulb not confirming to the varietal characteristics is 0.10 percent and 0.20 percent (by numbers) for foundation and certified seed during mother bulb production. The maximum permissible limit of off-types is 0.1% and 0.2% for FS and CS at and after flowering during seed production, respectively. Onion seed crop should also be isolated from any flowering multipliers types of onion and shallots.

**Agronomic Practices for Planting of Mother Bulbs and Pollination** : The time of planting significantly influence the seed yield and incidence of the disease in onion. Conditioning of plants/bulbs is necessary for seed stalk formation. Temperature of 4.5 to 14 °C is favorable for conditioning. Longer period of vernalization is also correlated with more number of stalks and flowers per plant. Low humidity is desirable for development of good seed. Whenever, the seed crop is planted in first fortnight of October, it is subjected to the heavy incidence of diseases and results in poor seed yield. It has been observed that planting of mother bulbs in middle of November gave highest yield (5.8 q/ha). However, varietal and bulb size difference has also influenced the seed yield in onion. The increases in bulb weight increased the seed yield. Although with more weight and size of bulb seed yield is increased, but large sized bulbs (> 90 g) increased the bulb seed requirement to 60 q/ha. Bulbs of 4-6 cm diameter of true to type colour and shape conforming to varietal purity are ideal in seed production of onion and 25-30q Bulbs of medium size are enough to plant one hectare. Planting of bulbs at 45 x 30 cm spacing gave highest seed yield (10.5 q/ha) than the 60 x 30 cm or 60 x 60 cm. However, flat or ridge plating does not make any difference in seed yield, but earthing up of plants prevents the lodging of seed stalks. Depending upon soil and season, application of FYM @ 25 to 50 tonnes, nitrogen 50 to110 kg, phosphorus 25 to 135 kg and potash 50 -110 kg/ha are required for onion seed crop. Pendimethalin (Stomp) @ 2.5 l/ha or Oxyfluorfen 23.5%EC (Goal)@ 0.980 l/ha can also be applied within a week after planting of bulbs for controlling the weeds in seed crop.

Maintenance of adequate moisture throughout the crop growth keeps special significance in onion seed production, as water stress during pollination and seed development reduces the yield drastically. Irrigation at 15 days interval in winter and 7 days in summer is necessary for proper seed development. Field should not be saturated for longer period to avoid increase in incidence of diseases. Foliar application of growth hormones like GA₃ @ 50 to 75 ppm at initiation of flower stalk significantly increase the seed yield of onion.

Onion is a cross-pollinated crop, where, anthesis occurs in early morning (6-7 hrs), dehiscence is between 7.00 and 17.00 hr and on next day also with peak between 9.30 and
17.00 hr. Pollen fertility and stigma receptivity is highest on the days of anthesis. Depending upon growing conditions the duration of anthesis lasts for 3 to 4 weeks on individual umbel. The anthesis begins from outer flowers and goes centrally in succession. The flower is protandrous in nature and stigma becomes receptive when shedding of pollen is over. Onion is cross-pollinated in nature and bees, flies and other insects do pollination. It is essential to ensure that there is sufficient population of pollinating insects to achieve the full potential of onion seed. It is also possible in some situation to encourage the development of increased blowfly population by distributing suitable carrier or dried fish among the flowering crop. The insecticides safe for the pollinators should be sprayed on seed crop of onion.

**Hybrid Seed Production**

Hand emasculation and pollination is not economical due to very small sized flower, androgynous, very few seeds with per cross-pollination. Hence, male sterile lines (CGMS and CMS) are used for F₁ hybrid seed production of onion. The male sterility in onion is due to the interaction of cytoplasm and nuclear gene. Three parental lines, namely A, B and C, are involved in this process. A-line is male sterile having the genetic constitution of S<sub>msms</sub>, B-line is maintainer with genotype N<sub>msms</sub> and C-line is fertile and diverse pollen parent or inbred used for F₂ hybrid seed production with A-line. The hybrid seed is produced in the open in an isolated field. The bulbs of A (male sterile or female line) and C (pollen parent) lines are planted alternately in a ratio of 4 rows of the A-line to 1 row of the C-line. Sometimes 8 rows of the A-line are alternated with 2 rows of the C-line. The flowering in A and C lines must be synchronized for high seed yield. If it does not, it can be accomplished by adjusting planting dates of the parents. Rogueing of pollen shedders and other off-types plants from male sterile and pollinator is essential to avoid contamination through pollination. At maturity of seed, C-line should be harvested before the A-line to prevent physical contamination in the hybrid seed. The seed harvested from the female (male sterile) line is the F₁ hybrid seed and further used for commercial bulb production. The seed of male sterile (A) line is maintained by crossing with the maintainer (B) line by growing in isolation. The conventional and molecular approaches can be followed for development of male sterile and maintainer lines.

**Field Inspections, Seed Maturity, Harvesting, Cleaning, Grading and Storage**

To maintain genetic purity plants not conforming to the variety are removed based upon foliage, colour, inflorescence and flower characters. Field inspections should be done before flowering, during flowering, during seed set and maturity stages. The mechanical harvesting of onion seed should be at 60-70% dry matter content and can also be assessed upon visibility of 1-3% mature black seed in the umbel. In general for manual harvesting 10% of head should have black seed exposed. The physiological maturity of seed is generally attained 65 days after anthesis, when seed attained maximum fresh and dry weights, is associated with germination and vigour index. Further harvestable maturity is attained after 7 to 10 days of physiological maturity. The optimum moisture content should be 10-15% at the time of harvesting. The umbel should be cut off at 4-5 days intervals along with 10-15 cm stalk and cured for 2-3 days. The seed heads are dried on canvas or specially built drying trays. The seed heads may be stirred occasionally during the first few days after picking to bring about uniform drying, prevent molding and over-heating. The dried umbels are thrashed manually with pliable bamboo stick and cleaned to remove dirt and inert material. Onion thrasher can also be used for seed extraction from the umbels. Care should be taken to avoid chipping of seed in the
Onion seed can be cleaned using regular screens, fanning mills or gravity separators. Parts of pedicels or seed heads may further be cleaned through carter disc or superior separator. The water tub can also be used to float trashes and light seed. The increase in number of thrashing by more than 4-times lowers the quality of onion seed. On an average 5 to 8 q seed yield can be harvested from one hectare.

The onion seed is graded using BSS 10 x 10 wire mesh sieve and the seed retained by this sieve is recommended for sowing/storage. It can further be upgraded with gravity separator to have heavy seed for better vigour and viability. The upgradation of seed lot by IDS (Incubation 12 hr – Drying 3 hr – Separation) improved the germination of onion seed by 36%. Immediately after cleaning and grading seed should be dried to 7-8% moisture level. The adequately dried onion seed could maintain good germination for more than two years. The sealed glass bottle gave good results than 700 gauge polythene and cloth bags. The moisture impervious containers such as aluminium foil could maintain better viability and vigour than the moisture previous. Onion seed can be stored up to 7 years, if dried to 6.5% moisture content and packed in aluminium foil laminated pouches along with silica gel and stored at -20°C. The loss in seed viability of onion is due to rapid peroxidation associated with the increased formation of malonyldialdehyde and reduced artifact of free radical scavenging enzymes.

The seed standards for foundation seed of onion includes pure seed (minimum) -100%, inert matter (maximum)-2.0%, other crop seeds (maximum)-5/kg, weed seed (maximum)-5/kg, germination (minimum)-70% and moisture (maximum)- 8.0%. The maximum seed lot size is 10,000 kg, submitted sample size 70g and working sample size 7g. Top of Paper (TP) and Between Paper (BP) methods are used for germination test and first count is taken on 6th and second on 21st day of sowing.