

Agro-techniques for quality seed potato production

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The quality of potato seed tubers is the key to financial success in potato field crops with guaranteed yield and increased quality. Good quality seed is almost universally considered a requirement for high productivity in all potato production systems. Much of the yield gap currently constraining productivity in low-income countries is attributed to poor seed quality.

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HEALTHY seed systems have been described as providing access to quality planting material, at the time needed, at a fair price, to all who need it. Access to quality seed is widely considered one of the main requirements for bridging significant yield gaps for potatoes in most low-income countries. Healthy seed systems also act to reduce the risk of disease outbreaks by keeping the spread of disease in check or even as part of a pest eradication plan. Conversely, seed systems without effective quality control can be very efficient at spreading seed-borne pathogens. Seed systems are also crucial for the diffusion of new varieties with beneficial traits and the maintenance of crop diversity in the landscape. In the case of a new or emerging pathogen in a region, the seed system acts as the conduit through which locally adapted resistant varieties can be distributed (if these are available). Arguably, the primary impetus for the development of seed systems in potatoes is the vegetative nature of crop propagation and the phenomenon of what is now referred to as degeneration. The importance and causes of seed degeneration, a process through which yield is lost in vegetatively propagated crops

through pathogen accumulation in consecutive cycles of propagation, are of particular concern to informal seed systems.

Access to high-quality seed potatoes

The production of elite seeds such as pre-basic and basic potato is in charge of public and private institutions with infrastructure and laboratories for the accelerated multiplication of potato cultivars with the highest demand in the market. Generally, the maintenance and management of a seed program involves high costs because it is a highly specialized activity. In many developing countries, these functions are often performed by public sector breeding programs. For this reason, the producers of seeds of certified, authorized and declared categories depend on the operational and logistical capacity of the institutions or companies that produce the pre-basic and basic seeds. Delays in the availability of adequate quantity and quality of seeds can cause large bottlenecks in the production of quality seeds. Therefore, it is necessary to promote the establishment of agreements or contracts between seed producer organizations and public improvement programs that

establish commitments to deliver seeds with quantity, quality and punctuality. Likewise, it is necessary to strengthen the capacities of producers and users of quality seeds with training methodologies where knowledge is gained through participatory and experiential practices.

Basic requirement for quality seed production

Basic requirements like suitable areas, soils, fertilizers, manures and suitable varieties etc. play a vital role in a successful seed production programme. A quality seed can be produced in areas and fields which are free from serious soil borne pathogens and pests. High hills above 7000 msl are suitable for nucleus and breeders seed potato production. Indo-Gangetic plains of Punjab, Haryana, North-Western parts of Uttar Pradesh, Madhya Pradesh and Bihar are suitable for seed production under low aphid period from October to March and are the primary source of high quality seed. Parts of North-western Uttar Pradesh, Madhya Pradesh, Bihar and entire West Bengal, Odisha, Rajasthan and Gujarat are only secondary source of seed production due to

brown rot and aphids. There are two seasons for seed production i.e. summer and autumn. In summer, seed is produced under long days and rainfed conditions in high hills from March to October, whereas, in autumn, the seed is produced in sub-tropical plains under short days and irrigated conditions from October to March. The optimum temperature for foliar growth is 18-22°C and 10-16°C is good for tuberization.

Selection of field: For raising a quality potato seed crop, soil should be free from perennial weeds and soil-borne pathogens such as scabs, brown rot, wart and black scurf and pests like cut worm (*Agrotis ipsilon*). For minimizing the perpetuation of soil-borne diseases, it is desirable to adopt 2-3 years crop rotations preferably with cereals. As far as possible, the seed crop should be grown in a field where potato has not been grown for last two years. A well-drained, light textured sandy loam soil with neutral to slightly alkaline soil pH is preferred.

Hot weather cultivation: In the Indo-Gangetic plains, opening the soil by deep tillage and keeping it exposed to extreme high temperatures during hot summers reduces the incidence of soil-borne diseases and controls weeds and cutworms. Deep ploughing the field in April end and keeping it open in May and June with one or two more ploughings serve the purpose of hot weather cultivation.

Green manuring: Raising and ploughing under the 45-55 days old green manuring crops of sunhemp (*Crotalaria juncea*) or dhaincha (*Sesbania aculeate*) during rainy season at least one month before potato planting in the plains and growing of French bean or other leguminous crops or oats in the hills as green manure is beneficial in reducing pest and disease incidence. Green manuring improves the soil fertility and water holding capacity to benefit growth and yield of potato.

Tillage: Potato seed production

demands minimal mechanical interference in the standing crop to check spread of viruses through physical contact. Therefore, field should be cleaned of stubble and perennial weeds by adequate tillage operation before planting. If the field is relatively free from weeds, minimum tillage can be practiced to save on the fuel, time and money to reduce cost of cultivation. Minimum tillage combined with chemical weed control is best suited for seed production as it ensures minimum interference in standing crop. Two/Three ploughings followed by planking's make the soil loose and friable suited for potato planting.

Isolation of seed plots: The seed crop should be separated from crops meant for ware purpose by a distance of at least 25 meters to avoid mixture and spread of viral diseases. Isolation is also required between different varieties of the seed crop.

Varieties: Zone-specific varieties and crop period for seed production are listed in Table 1.

Seed plot technique (SPT)

The technique of growing seed potato crop in Indo-Gangetic plains during low aphid period with healthy seed from October to first week of January coupled with the use of insecticides, roguing and dehauling in the last week of December or up to second week of January, was developed by the CPRI, Shimla in 1959 and is called

as Seed Plot Technique. Quality seed production was possible under this technique in sub-tropical plains by advancing the date of planting from December end to first week of October.

Characteristic features of SPT

- There should be a low aphid or aphid free period of 75 days after the planting of crop.
- Adopt 2-3 years crop rotation to take care of soil borne pathogens.
- Seed crop should be grown in isolation of 25 meters from ware crop.
- Seed should be procured from reliable sources and must be free from viruses and soil borne pathogens. Cold stored seed of right physiological age should be used.
- Crop should be planted by 10th October in Punjab, 25th October in Haryana, Rajasthan, Western Uttar Pradesh and 5th November in Eastern Uttar Pradesh, Bihar, West Bengal and Odisha.
- Systemic insecticide such as Thimet 10G to be applied in split doses of 10 kg/ha at the time of planting and earthing up against sucking insects.
- Pre-sprouted seed with multiple sprouts may be used, which ensures quick, uniform and early germination.
- Inspect the seed crop thrice at 45, 60 and 75 days during growing season to remove off type and diseased plants.
- Spray the crop with mancozeb

Table 1. Zone specific varieties for seed production

Zone	Crop period	Varieties
North-Western hills	Summer (15 th April – October)	K. Jyoti, K. Chandramukhi, K. Giriraj, K. Shailja, K. Himalini, K. Girdhari, K. Karan
North-Western plains	Autumn (1 st week October – March)	K. Jyoti, K. Chandramukhi, K. Badshah, K. Pukhraj, K. Khyati, K. Pushkar, K. Surya
North Central plains (Madhya Pradesh)	Autumn (3 rd week October – March)	K. Jyoti, K. Chandramukhi, K. Sindhuri, K. Lauvkar, K. Chipsona I & III, K. Ganga, K. Mohan, K. Lima
North Central plains (Uttar Pradesh)	Autumn (2 nd week October – March)	K. Bahar, K. Pukhraj, K. Badshah, K. Anand, K. Surya, K. Ganga, K. Mohan, K. Chipsona I, III & IV, K. Frysona, K. Gaurav, K. Khyati,
North-Eastern plains	Autumn (4 th week October – March)	K. Jyoti, K. Chandramukhi, K. Kanchan, K. Sindhuri, K. Lima, K. Manik, K. Ashoka, K. Pukhraj, K. Surya, K. Arun, K. Chipsona I & III

@ 2.5 kg/ha at 10 days intervals from 3rd week of November and spray Curzate M-8 @ 3.0 kg/ha as and when late blight is observed.

- Spray the crop with Rogor (1.25 L/ha) or Imidacloprid 17.8%SL (0.4 L/ha) alternatively at 15 days' interval from 1st week of December to control the insect vectors.
- Irrigation should be withheld in 3rd week of December i.e. 7-10 days before haulms killing in north-western plains and 1st week of January in north-eastern plains.
- Haulms killing to be done in the end of December in Punjab, Haryana, Western Uttar Pradesh; by 10th January in Central Uttar Pradesh, Madhya Pradesh and by 15th January in eastern Uttar Pradesh, Bihar, West Bengal and Odisha.
- Harvest the crop 15-20 days after haulms killing when the fields are in workable condition and tuber skin is hardened. Cure the crop in heaps in a cool shady place for about 15-20 days.
- Treat the produce with commercial grade Boric Acid 3% solution for 25 minutes to prevent surface borne pathogens. Dry in shade and fill in bags, seal and label properly and cold store.

Seed source: For on farm multiplication of quality seed by the farmers, it is essential to obtain healthy, disease free, true-to-type and treated seed from reliable source, preferably from a government agency. The foundation or certified seed tubers should be used to start with and stocks should be replaced every 3-4 years.

Pre-sprouting: The pre-sprouting treatment of the seed tubers before planting ensures multiple, stout and healthy sprouts, which helps in quick emergence, weed suppression, uniform stand and early maturity of the crop. For pre-sprouting, withdraw the seed tubers from cold store 10 days before planting. Keep it in pre-cooling chamber of cold store for 24 hours.

Planting method: Use of cut tubers is prohibited and only whole tubers are used for seed crop. In the plains, inter-row spacing for planting seed crop manually, bullock and tractor drawn implements may be kept at 40-45, 50-55 and 60 cm, respectively. Planting of seed-sized tubers of 30-40 g at 60 cm inter and 20 cm intra-row spacing is best for seed potato production. Plant the large size tubers by increasing the intra-row spacing from 20 to 30 cm depending upon the size of seed tubers. Small-sized tubers are planted at reduced intra-row spacing. The approximate intra-row spacing for <25, 25-60, 60-100 and >100g seed size is 15, 20, 25 and 30 cm with inter-row spacing of 60 cm, respectively. Seed tubers are placed at a depth of 5-7 cm from top of the ridges made manually or by tractor drawn implements.

Manure and fertilizers: Application of well rotten farmyard manure (FYM) @ 20-25 t/ha in absence of green manuring is beneficial for seed crop. It improves soil physical condition, soil fertility and water holding capacity of the soil. The FYM should be incorporated into the soil 20-25 days before planting. Nitrogen needs of seed crop are 25-30% lower than the ware crop. Excess N increases the yield of undesirable extra-large size tubers and produces dark green foliage, masking the symptoms of viral and mycoplasmal diseases and detection of infected plants becomes difficult during roguing. In the plains, the crop requires a basal dose of 75 kg N, 60-80 kg P₂O₅ and 100-120 kg K₂O/ha at planting, whereas, 100 kg each of N, P₂O₅ and K₂O is the recommended basal dose for the hills. Top dressing of 75 kg N/ha at earthing up in plains and 20 kg N/ha in the hills given through urea is adequate. The basal dose of N can also be applied through urea by incorporating it into the soil at least 48 hours before planting during the field preparation. It comes over the constraints in using costly nitrogenous fertilizers of ammonium sulphate (AS) and calcium ammonium nitrate (CAN).

Intercultural operations and weed control: The objectives of intercultural operations in potato are weed control, earthing up for firming up the ridges to prevent exposure of growing tubers and application of split dose of nitrogen and Thimet insecticide. However, operations involving human, animal and implement movement in standing seed crop should be minimal to prevent transmission of plant viruses through physical contact. It would be better if these operations are completed by 20-25 days after planting when plants attain the height of about 10-15 cm and foliage cover is still small. The split dose of nitrogen and Thimet should be applied at hoeing and earthing up about 5 cm away from the plants. The hoeing must not be delayed beyond 30 days in plains and 45 days in the hills after planting to avoid damage to the plant roots, foliage and stolons, which may adversely affect the number of tubers resulting in reduction in yield. Pre-emergence weedicides like Metribuzin @ 0.75 kg/ha, Oxyfluorfen @ 0.15 kg/ha, Linuron @ 0.5 kg/ha, Alachlor @ 1.5kg/ha and Isoproturon @ 0.75 kg/ha applied 2-3 days after planting are effective. Pre-emergence herbicides are most effective when applied in moist soil. Therefore, if soil is dry apply herbicides after first irrigation as soon as it is possible to enter the field. In case pre-emergence herbicides are not used, spray paraquat @ 0.5 kg/ha at about 5-10% plant emergence of potato provided sufficient weeds have appeared, as it kills only emerged weeds. Chemical weed control eliminates manual hoeing. Thus, full earthing up at planting combined with chemical weed control effectively minimizes undesirable physical intervention in standing seed crop.

Water management: Pre-sowing irrigation/ rains before land preparation are beneficial for early and uniform emergence. If pre-sowing irrigation is omitted at the time of field preparation, irrigate the crop immediately after planting. First irrigation following planting

should be light to minimize damage to the newly formed ridges. Heavy irrigation before emergence leads to anaerobic conditions resulting in rotting of seed tubers, gappy emergence and reduced tuber yield. Second irrigation is given a week after first irrigation. Subsequently, irrigate the crop at 7-10 days' interval depending upon the requirement. Avoid flooding over the ridges while irrigating and irrigate as far as possible in morning and evening hours. In a normal seed crop, 6-8 irrigations are required. Light and frequent irrigations are much better than heavy irrigations given less frequently. Excess moisture makes lenticels prominent due to rupturing and seed tuber quality is impaired. It also promotes certain diseases. Stop irrigation at about 10 days before dehauling in light soil and 15 days in heavy soils. Moisture stress restricts re-growths after dehauling and hastens curing of peel of seed tubers.

Plant protection: Additional plant protection measures against aphid and other vectors transmitting viral diseases are required in the seed crop. Application of granular systemic insecticide, Thimet 10G @ 10 kg/ha at the time of earthing up takes care of jassids, leafhoppers and white flies at early stages of growth up to 30-35 days. After appearance of aphids, two sprays of imidacloprid 17.8% S.L. @ 0.004% may be repeated at an interval of 12-15 days depending on duration of the crop and level of infestation. Drenching of the ridges with chlorpyrifos 20EC @ 2.5 litres/ha effectively controls cutworms attack during the early stages of the crop. In white grub prone areas, Chlorpyrifos 20EC @ 2.5 litres/ha should be applied either after mixing with sand or can be sprayed on the ridges before the final earthing up.

For control of early and late blight, one prophylactic spray of Mancozeb @ 0.25% is given. It may

be repeated at an interval of 7-14 days depending upon the weather condition. It will also take care of other foliar diseases like phoma blight etc. In case of persistent and severe attack of late blight, spray of systemic fungicides like curzate M-8 @ 0.3% or Ridomil @ 0.25% may be given and repeat the spray after 7-10 days if required.

Inspection and roguing: Inspection of the seed crop thrice at 45, 60 & 75 days (plains) and 50, 75 and 90 days (hills) during growing season to remove or rogue out the off type and diseased plants showing mosaic, mottling, veinal necrosis, crinkling and rolling of leaves, marginal flavescence and purple top roll symptoms is essential. At each roguing, make it sure to remove the tuber and tuberlets of rogued plants.

Dehauling: Removal of haulms of the seed crop is essential by 5-15 January in the plains before aphids (*M. persicae* and others) population reaches the critical level of 20 aphids/100 compound leaves. Cut the haulms by 15th August in the hills. Dehauling is done by manually cutting with the sickle close to the ground or by spraying non-selective herbicide Paraquat @ 0.5 kg/ha. In the plains, if haulms are removed manually, it is preferred to keep the vines/haulms on the ridges to protect exposed tubers from high temperature and direct sunlight. Re-growths of leaves if any are also cut after a week of dehauling, because the tender and succulent leaves are more attractive to aphid vector.

Harvesting and curing: Start digging 10-15 days after dehauling when peel is firm to withstand handling operations and the fields are in workable condition. In the Indo-Gangetic plains, potato digging beyond February promotes rotting due to soft rot and charcoal rot. Digging may be done either manually by spades or by

mechanical potato digger. Exercise care to avoid bruising of tubers during harvesting, handling and transportation. After harvesting, keep potato tubers in heaps on raised beds for about 15 days for hardening of peel and shedding of adhered soil from tubers surface. Heaps of about 1.5 m high and 3.5 m broad at the base and variable length as needed are convenient, effective and economical. Cover the heaps with paddy straw or tarpaulins.

Grading and seed treatment: Proper size grading of tubers in the produce of seed crop is beneficial. It also helps in controlling the seed rate effectively by adjustment of spacing according to tuber size. Before grading, surface dry the produce and sort out all cut, cracked and rotten tubers. Seed tubers are usually graded into four grades, viz. small (<25 g), medium (25-50 g), large (50-100 g) and extra large (>100 g). Seed tubers should be dip-treated with boric acid (3%) solution against tuber borne diseases like common scab and black scurf for 25 minutes. The fresh boric acid solution can be used for 20 times for treatment, provided tubers were washed clean with water. Dip treatment with organo-mercurial compound, Emissan 6 @ 0.25% for 20 min is also effective, but is considered hazardous and may be avoided. The treated tubers should be thoroughly dried in shade before bagging and storage.

Packing and storage: Keep the seed tubers in 50 kg bags and store in cold store (4°C) in the plains latest by the end of February. The produce in the hills can be stored in country stores by the mid November. The treated seed bags should be properly sealed and labeled — Poisonous to avoid human consumption mistakenly.

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Earth provides enough to satisfy every man's needs, but not every man's greed.

—Mahatma Gandhi