

Post-harvest management of potatoes

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Potato production in India has seen a steady increase over the years, making India the second-largest producer globally after China. This article emphasizes the significance of potatoes as a staple food crop in India and the importance of meticulous post-harvest management to meet domestic and international demand. With India currently producing 55 million tonnes of potatoes annually, effective post-harvest management is crucial to minimize losses and ensure year-round supply of ware and processing potatoes. The article discusses various aspects of post-harvest management, highlights the major factors contributing to post-harvest losses and provides insights into mitigating these losses through improved practices. Additionally, the article discusses different storage methods, including refrigerated and non-refrigerated options, and emphasizes the importance of proper ventilation, humidity control, and temperature management in preserving potato quality. Furthermore, it addresses specific challenges associated with storage at intermediate temperatures for processing and ware potatoes, including the risk of low-temperature sweetening and sprouting. The article concludes by underscoring the importance of adopting improved technologies and scientific approaches in post-harvest management to minimize losses and meet the diverse needs of farmers, consumers, and processors in India and beyond.

Keywords: Losses, Post-harvest, Storage, Technologies

INDIA'S potato production has been steadily increasing over the years and is the second-largest producer after China, which highlights the importance of potatoes as a staple food crop in India meeting both domestic as well as some of the international demand for this versatile vegetable. India currently produces 55 million tonnes of potatoes per year and is a significant contributor to the global potato production. Potato cultivation in India is widespread and major potato-producing states include Uttar Pradesh, West Bengal, Punjab, Bihar, Gujarat, Madhya Pradesh and Assam. The total area under potato cultivation slightly varies from year-to-year based on factors like market demand, prices and weather conditions. Potato is a semi-

perishable commodity with around 80% water and requires meticulous post-harvest management to maintain round the year supply of ware and processing potatoes to the consumers and industry besides keeping seed potatoes for next year's planting. This requires careful harvesting, handling and storage. Post-harvest management should ensure minimal loss in quantity and quality of potatoes over a period of 7-10 months till fresh potatoes become available.

The major factors contributing to post-harvest losses are diseases, respiratory losses and sprouting (dormancy release). In fact the precautions need to be taken right from crop growth to avoid biotic and abiotic stresses, which otherwise

lead to deterioration in quality and ultimately loss of produce. As per a rough estimate, post-harvest losses in India are 15-20%, therefore requiring post-harvest management as important as crop management. The potatoes grown in sub-tropical climates of India requires special care as harvesting in plains is followed by elevated temperatures followed by monsoon rains. In this article, some of the issues of post-harvest management have been discussed to reduce the post-harvest losses.

Crop management

As far as possible, crop should be taken care to avoid biotic and abiotic stresses. It starts from using disease free seed from reliable sources to avoid seed borne

diseases. Efforts should be made to take precautionary measures, under expert guidance, to control biotic stresses especially late blight and other diseases. Another aspect is to avoid the abiotic stresses to the extent possible. It includes optimum crop management practices like nutrient management, irrigation, weed management and proper earthing to avoid exposure of tubers to light.

Harvesting

The crop should be harvested at right maturity depending upon the end usage. The haulm cutting is done as per seed plot technique taking the cutoff date of the region. The ware and processing potatoes are harvested depending upon the physical or chemical maturity. The physical maturity refers to the stage, when the foliage starts turning yellow, while chemical maturity is applicable in processing varieties and refers to achievement of lowest levels of glucose and sucrose content. It is advised to stop irrigation at least one week before haulm cutting for proper skin curing of tubers and ease in harvesting. Harvesting is done manually or using mechanical equipment, here care should be taken to avoid cuts and bruises to the tubers.

Post-harvest handling

The harvested tubers, especially meant for storage, are kept in heap covered with crop straw for skin curing for around a week. This is applicable in areas with cooler climate. This aids in bringing down free sugar levels in processing potatoes besides the wound healing and skin curing. In areas with higher post-harvest storage temperature, curing period may be shortened and heap should be made in shade only. The potatoes in heap should be covered with the material to facilitate proper ventilation and avoid exposure to light. Light exposure leads to greening of tubers along with accumulation of toxic substance known as glycoalkaloids. After wound healing and proper skin curing, potatoes should be sorted for diseased, cut or damaged



tubers. The healthy and undamaged tubers may be sorted for different sizes, if required, as per end usage. The sorting is normally done with mechanical equipment's with the features to minimize the bruising and cuts. The tubers are then packed in bags or pallets depending upon the requirement and availability of facilities.

While handling the potatoes, right from harvesting to subsequent handling, the drop height should be as minimum as possible (preferably less than 2 meters) to avoid cracks and bruising in the tubers. The transportation of tubers for storage should be done preferably early in the morning or late in the evening to minimize the rise in tuber temperature. For long distance transportation, proper padding should be provided on the surface to avoid mechanical damage and potatoes should be covered properly to protect from sunlight and rain.

Storage

In India, the majority of potatoes are stored in cold stores and used for both seed, table/ware and processing purposes. The potatoes are stored in gunny or synthetic bags of 40-50 kg capacity. In the past, synthetic bags have become more popular because of better air exchange, temperature maintenance inside the bag and better percolation of fog (in case of specialized storage

other than seed). The cold storage provides long-term maintenance of quality and reduces post-harvest losses. At lower temperatures, the growth of microbes/pests is checked and respiratory and transpiration losses are minimized. The majority of the nation's cold storage capacity (around 75%) is utilized for storage of potatoes (National Horticulture Board). As per the latest data, there are 8,653 cold stores with a 394.17 lakh metric tonnes (MT) in the year 2023.

In certain parts of the country, farmers store potatoes in heaps and pits for a shorter period of 3-4 months. In the following section, different types of storage are discussed in brief.

Seed potato storage

Majority of potato crops are planted using whole tubers as seed material. As mentioned earlier, potatoes need to be carried up to next season in best possible condition to be used as seed. For this purpose, potatoes are normally stored at lower temperatures of 2-4°C with higher relative humidity of more than 90%. Further, optimum ventilation is done to bring down the excessive carbon dioxide build up in the storage. Under these conditions, potatoes remain viable and dormant along with minimum losses due to respiration, transpiration and diseases. Potatoes are normally stored in stacks of 6-8 bags, but

it is advisable to keep it up to 6 to minimize mechanical pressure on the lower layer. To maintain proper quality, potato bags are reversed after 3 months so that the lower stacks come on top, this avoids building up of small disease or anaerobic pockets as well as reducing the mechanical damages.

Before storage of seed potatoes, these are normally treated with boric acid for protection of diseases. The treated tubers are dried in shade, before storage. It is advisable to keep the potatoes in a pre-cooling chamber before shifting inside the cold store to avoid large fluctuation in cold store temperature. The seed potatoes are normally stored from March to September/October.

Ware/Table Potato Storage

Refrigerated storage

Potatoes are harvested during specific seasons, resulting in a glut in the market during peak harvest times and scarcity during off-seasons. Approximately 90% of the potatoes are produced in the Indo-Gangetic plains which is harvested generally in the months of February and March. Proper storage facilities help in managing this seasonal variability by storing surplus potatoes for consumption and sale during lean periods. Potatoes are perishable commodities prone to sprouting, rotting, and damage if not stored under appropriate conditions. Adequate storage facilities with controlled temperature and humidity help in preserving the quality and extending the shelf life of potatoes, thus reducing post-harvest losses on a long-term basis until the fresh crop next season becomes available. For long-term storage, ware potatoes are normally stored at 2-4°C and high relative humidity of more than 90%. All precautions and operations as mentioned for seed potatoes are taken except any treatment with chemicals. Storage at low temperature with higher humidity saves the potatoes from shriveling, rottage and spouting.

Non-refrigerated storage

Small-scale farmers may have limited options for storing

their potatoes without access to refrigerated facilities. In certain parts of the country, potatoes are stored in heaps and pits, with heaps being the more popular method of storage. Non-refrigerated storage methods can indeed be effective for storing potatoes for a certain period, typically up to three to four months, until around June. However, once the monsoon season begins, storing potatoes under non-refrigerated conditions becomes challenging due to increased humidity and the risk of spoilage. Storing potatoes in non-refrigerated conditions for three to four months can be beneficial for farmers as it allows them to avoid distress sales immediately after harvest when prices might be lower due to oversupply in the market. By holding onto their produce and selling it in May or June, when potato prices typically start rising due to decreased supply, farmers can potentially obtain better returns for their crops.

Non-refrigerated conditions are feasible when potatoes are dormant. Indian potato varieties typically have a dormancy period of around 6 to 8 weeks. Once the dormancy period is over, sprouting begins as a result of the resumption of metabolic activity in the tubers. During storage, weight loss in potatoes primarily occurs due to water loss from the tubers. However, when potatoes sprout, the weight loss can be much more significant. This increased weight loss is primarily attributed to water loss through the sprouts themselves. Studies have estimated that water loss through sprouts can

be significantly higher than that through the tuber skin, and could be up to 100 times more per unit area and time.

Heaps are a popular storage method in regions like Karnataka, Maharashtra, Gujarat, and Uttar Pradesh. In this method, potatoes are stacked in mounds or heaps, often covered with straw or other insulating materials to regulate temperature and moisture levels. Heap potato storage practice can be done under shade of tree or building keeping 1.5*1.5 meter (breadth and height) using perforated pipes for proper aeration.

Intermediate temperature storage for processing and ware potatoes

The major disadvantage of potato storage at 2-4°C is development of sweetening in tubers. The phenomenon known as 'low temperature sweetening' (LTS) results from conversion of starch into free sugars at low storage temperatures. The sweetened potatoes are unsuitable for making processed products and are not liked by the majority of the people for ware purpose too. For making fried or dehydrated products from potatoes, the sugar content should be low (< 0.1% on fresh weight basis) in the tubers. The processed products made from sweetened potatoes are brown in colour and bitter in taste. To keep the low sugar content in the tubers, storage at intermediate temperatures of 8-12°C is recommended (8-10°C for ware potatoes and 10-12°C for chipping potatoes, however exact



temperature for chipping potatoes may vary depending upon the duration of storage and time of storage). At these temperatures, there is equilibrium between starch and sugar conversion and net accumulation of sugars is low.

But, one of the major problems at these temperatures is sprouting in potato tubers. The dormancy of most Indian potato varieties gets broken after 8 weeks of harvest. Sprouting results in loss of dry matter and water from tubers and potatoes become shriveled and thus unsuitable for processing or table purpose. To check the sprouting in potatoes, during storage at elevated temperatures, potatoes are treated with a chemical known as *Isopropyl-N-(3-chlorophenyl) carbamate* (CIPC). In India, CIPC was registered for the first time in 1998. The chemical CIPC is formulated as liquid for fogging, liquid for spray and as dust. The most commonly used formulation for cold stores is a fog. The fog is applied through specialized equipment called foggers, which atomize CIPC at very high temperatures. The potatoes from the main season crop are usually stored in the intermediate temperature storages (ITS) along with CIPC treatment. The curing is essential, since CIPC being a mitotic inhibitor would interfere with periderm formation or wound healing and hence evaporative and microbial losses will be more. Grading is essential to sort out damaged or diseased tubers, as at elevated temperature of 10-12°C, losses can be very high. Potatoes should not be wet and should be free from soil etc. before loading into the store. Wet tubers can result in disease and adhering soil can interfere with uniform distribution

of CIPC and airflow resulting in high losses because of sprouting and deterioration in quality. Under west-central plains, it has been observed that potatoes to be kept at elevated temperatures with CIPC should be moved to stores before temperatures start rising >30°C i.e. before 20th of March. The store should never be overfilled as it can result in sprouting and diseases in potatoes.

The mode of storage plays a very important role in maintaining the quality of potatoes during storage with CIPC. In India, gunny bags are traditionally used for storing potatoes in cold stores. The major problem with gunny bags as far as CIPC treatment is concerned is absorption of CIPC by the bag material and poor penetration of CIPC fog inside the bag. The poor CIPC treatment, results in problems of sprouting as well as internal sprouting. Therefore, the potato storage in small bags of 40-50 kg capacity and made up of inert material have been found more suitable. Special arrangements have to be done to maintain higher relative humidity (RH) since maintaining higher RH at elevated temperatures is a bit difficult. The humidifiers can be used for achieving RH of more than 90%. The flushing of carbon dioxide at regular intervals is essential to avoid the development of sugar in potatoes. The flushing of carbon dioxide with minimum disturbance of store temperatures can be done by using a duct system. Further, the store should have strong electrical insulation as CIPC is highly inflammable. To apply the CIPC fog, an inlet duct is provided at the lowest floor of the cold store. The openings of the store should be sealable. The loading of potatoes in

the store should be completed in minimum time to avoid fluctuations in the holding temperature of the store due to frequent opening of doors. After loading of potatoes, the temperature of the stores should be gradually decreased (preferably 1°C per day) to give sufficient time for curing of potatoes and adjustment of metabolic equilibrium. The timings and number of fogging are dependent upon cultivar, duration of storage, holding temperature as per intended use of potatoes. The potatoes treated with CIPC should not be consumed within 3 weeks after the treatment. After three weeks, the CIPC residue levels in the tuber are very low and potatoes are safe for consumption in table as well as processing.

However, use of CIPC has been banned in several countries or residue level tolerance is brought to very low levels. This has led to use of alternative sprout suppressants and work is being carried out at ICAR-Central Potato Research Institute to identify safer alternatives to CIPC and some plant based volatile compounds/mixtures have been identified.

CONCLUSION

Post-harvest management is equally or rather more important than crop management to cater to the needs of farmers, consumers and processors with minimum loss of quantity and quality. Use of improved technologies and scientific approaches can provide this important commodity to the domestic market and for export purposes.

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