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Role of Roguing in Healthy Seed Potato Production

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Abstract

Producing high quality seed is utmost important for higher productivity and best returns to the potato growers. Seed plot technique is the well developed technology for seed potato production in India. Roguing is one of the most important practices for producing high quality seed in potato. Virus-vector relationship is to be taken into consideration which affects the rouging process and quality of the seed potato. It provides an effective means to break infection cycle. Proper identification of rouge, following the step by step process and taking prequationary measures is very much important for high quality seed production which will pass through certification process.

1. Importance of Healthy/Quality Seed In Potato

In potato cultivation, seed is the highest cost-bearing input accounting for 40–50% of the total cost. Since, potato is a vegetatively propagated plant, fungal, bacterial and especially viral diseases easily affect seed tubers. Viral diseases are mainly responsible for degeneration of seed tubers. If they are planted in further generations, they reduce yield further showing 'degeneration' or senelity. Such senelity acts as a major constraint in producing disease free potatoes. Potato production is constrained mainly by non availability of quality/healthy seed as efficiency of other inputs revolves round seed. Since, the crop is multiplied vegetatively using tuber as seed; it gets degenerated very fast necessitating replacement after every four years.

2. Seed Potato Production Through Seed Plot Technique (SPT)

In India, seed production is being done by well-developed seed plot

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technique. Growing seed potato crop during low aphid period (Figure 1) with healthy seed from October to first week of January coupled with the use of insecticides, **rouging** and dehaulming in the last week of December or up to second week of January, was developed by the ICAR-CPRI, Shimla and is called as "Seed Plot Technique" (Figure 2). 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. Due to seed plot technique, it became possible to grow healthy seed in the plains, consequently, the North Western plains emerged as important areas of high quality seed production. Seed produced in the plains is stored in cold stores. During the storage, it becomes non-dormant and sprouts quickly when taken out of cold stores. Thus, it attains an ideal physiological stage for planting in the early or main crop in the plains (Sharma et al., 2021).

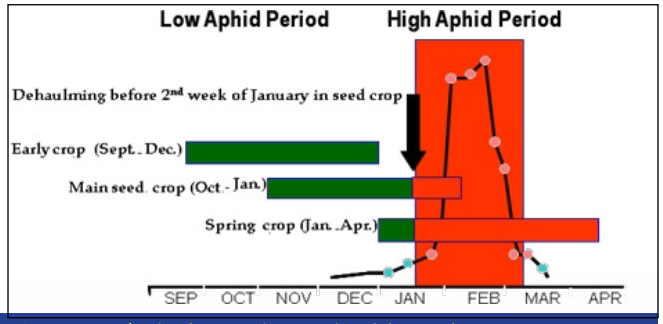

Figure 1: Aphid population build-up during potato crop season in north Indian plains

Figure 2: Components of seed plot techniques

3. Influence of Viruses and Vectors in Seed Potato Production

Tubers attacked by pathogens undergo gradual degeneration. The degeneration of tubers negatively affects their quality and leads to a yield reduction in subsequent cycles. Potato diseases are caused by fungi, bacteria and viruses, which adversely affect the productivity and quality of the produce. While insects cause direct damage to the crop, they also play an important role in the transmission of viruses. Aphids, leaf hoppers, thrips, white flies, mites, potato tuber moth etc. are the typical pests of potatoes.

Essentially, the potato seed production programme is based on elimination of the prevalent viruses in a given region from the seed stock and its further multiplication under vector free / low vector pressure conditions. Earlier six viruses (PVS, PVX, PVA, PVM, PVY, PLRV) and new strains of PVY (PVY^{n}, PVY^{NTN}) have either been introduced or developed through mutations are major cause of potato plant and tuber degeneration through vector *Myzus persicae*. These potato viruses found to infect the potato crop alone or in combination of two or more in India. Due to change in climate, cropping pattern and intensity, expansion in trade and increase in potato acreage has led to drastic change in virus and vector profile. Newer viruses like, potato yellow vein virus, potato yellow dwarf virus, tobacco streak virus, tomato spotted wilt virus, PSTVd were introduced from outside the country. Viruses like apical leaf curl disease of potato and stem necrosis have jumped over from other hosts mainly through overlapping of vector populations (Singh and Sharma, 2018). Fourteen aphid species have been recorded on potato crop in India (Annonymous, 2015) while 65 aphid species have been reported worldwide (Lacomme et al., 2017). Viruses infect potato leaves, stalks and tubers. Two or more viruses may infect a plant simultaneously to cause mosaic symptoms.

Whiteflies are known to transmit *Tomato leaf curl New Delhi virus-potato* (ToLCNDV-potato), also known as potato apical leaf curl virus, posing serious threat to healthy seed potato production in India. What is more worrisome is that whiteflies are present in nature right from the crop emergence itself. Their population starts declining only after the appearance of Myzus *persicae*. This indicates that virus vectors are present throughout the crop season leaving no growing window for seed production (Singh and Sharma, 2018).

Viruses can only be eliminated by eradication of infected plants through roguing in seed production programme. Virus infections are not always visible on plants. Mild

infection (mild mosaic symptoms) shows little symptoms which are not easily visible by normal person. It need very experienced and trained person to identify the infected plants who is well trained in identification of virus symptoms (Figure 3). In Severe mosaic (Figure 4), various leaf and plant deformities, stunting and poor growth, or yellowing or mosaic or mottling pattern in the leaves. Leaves may be crinkled or wavy. The plants infected with severe mosaic can be easily identified. However, it should be identified and removed by a experienced person (Figure 5).

Figure 3: Mild mosaic

Figure 4: Severe mosaic

4. Roguing

Under Seed Plot Technique, roguing is an essential practice/ control technique and important component of seed potato production where fields are carefully

Figure 5: Healthy seed crop

examined and in which infected plants and off-type plants are identified, dug up, removed from the field, and destroyed this or buried below soil opening a pit which ensures the desired genetic identity of the subsequent generation that will be used for propagation. These plants are selected based on visible symptoms. It is routine process by seed producers to eliminate diseased plants.

The affected plants which are showing visual symptoms may be diseased, another variety, or simply different are rogued. Roguing is particularly important in producing seed potatoes because the crop is clonally propagated. That is, last year's tubers are planted to produce this year's crop. Disease infection during the season, on the other hand, can move to the new tubers and perpetuate the problem. Roguing infected plants breaks this disease cycle, making possible the production of healthy seed potatoes. Since roguing is based entirely on visual symptoms, fields should be in good condition. The crop should be healthy, actively growing, relatively free of weeds, and show no symptoms of frost or herbicide injury, fertilizer deficiency, or water excess stress; dew and irrigation droplets on the leaves also tend to mask mosaic symptoms.

4.1. Why Roguing is Important in Seed Potato Production?

The health of potato plants, particularly of the seed tubers, is a critical factor in potato production. Because tubers are part of the plant's vegetative system, systemic infections within the potato plant, especially virus infections, move easily into the newly formed potato tubers. When infected tubers are used as seed, the subsequent plant also becomes infected, establishing a serious disease cycle which can lead

to complete degeneration of formerly healthy seed. Once infected tubers are introduced into a field, the disease spreads quickly to healthy plants, either by insect vectors or mechanical/physical contact. If the disease is not controlled, a healthy potato crop can become completely infected within a few years by a process known as "degeneration." Production of basic seed requires more thorough roguing than production of commercial seed. Because of economic reasons, farmers are often reluctant to eliminate plants, even those with serious diseases.

4.2. Identification of Plants as Rogue

Two basic criteria should be considered in the roguing process: plant health and varietal purity. Rogue plants fall into the following 3 categories:

• **Diseased Plants:** Certain symptoms of systemic viral, bacterial, and fungal diseases should alert you to the possibility of infections. These symptoms include variations in leaf color— especially mosaic symptoms— leaf deformations, stunting, necrosis, and wilting.

• **Atypical/Offtype Plants**: Atypical/offtype plants or plants of other varieties ("mixtures") affect varietal purity. Identifying varieties is easy when plants are in 45-50 days stage. At other growth stages, better familiarization is required with varietal characteristics such as growth habit, leaf type and color, and stem shape and color.

• **Volunteer Plants:** Volunteer plants grow from tubers that remain in the ground from previous seasons. These plants affect varietal purity, and are sources of infection and hosts to the first insects that appear in a field. Volunteer plants are easy to detect because they usually emerge earlier than the planted variety.

4.3. Roguing Steps

To be effective, roguing should begin immediately after infected or undesirable plants are detected, usually a few days after emergence. The sooner the infected plants are removed, there less chance is of disease being spread to healthy plants. As per SPT developed by ICAR-CPRI in India, the first roguing is done 30 days after planting. Second roguing is done after 50-55 days after planting and the third is done 75-80 days after planting or 3-4 days before dehaulming. At each roguing, make it sure to remove the newly formed tubers and tuberlets of rogued plants (Sharma et al., 2021).

Generally, roguing should be done in the morning hours from 10 AM after drying of dew until evening hours up to 3 PM. Light intensity is to be taken into consideration for better identification of mild mosaic symptoms. In addition to this, the direction of movement of person involved in roguing is also important. The person carrying out roguing should always move in the direction of sunlight so that the shadow of his body will help him to judge and identify the diseased plants.

o **Identification of Plants to Be Rogued:** When identifying plants to be rogued, familiarize yourself first with the characteristics that a variety displays under your field conditions (**Figure 6**). Stay at least one row away in order to compare differences within groups of three to five plants. Once you detect differences, move closer to verify the specific symptoms. Also, avoid changing the staff who do the roguing. Responsibility should remain with the same experienced staff. Individuals who routinely check the fields will notice more easily the subtle changes in a plant. Successful roguing requires experience that is gained through constant practice.

o **Dig Up Plants, Including The Tubers and Stolons:** Once a plant is infected, the disease spreads to all its vegetative parts. Therefore, all parts of the plant should be removed — including the smallest tubers and stolons, as well as the mother tuber. If not, regrowth from these plant parts may become a new source of infection. Use a kurpi (Trowel) when digging up the plant; do not remove the plant by hand, as parts may break off and remain in the soil. Sometimes it is sufficient to rogue only the infected plant.

o **Remove Plants From The Field:** To avoid disseminating infective (viruliferous) aphids, carefully place rogued plants in aphid-proof bags to be removed far from the potato field. This prevents aphid vectors from reinfesting the crop.

o **Destroy Plants:** Place rogued plants and tubers in plastic containers or gunny bags and dispose them of well away from the field. Diseased plants left in the field could possibly reroot and serve as a source of infection while diseased tubers and seed pieces could re-sprout or end up in storage with the good seed (Cortbaoui, 1984) (Figure 6).

4.4. Factors Affecting Roguing Process

Following factors affect identification of plants to be rogued:

o **Crop Uniformity:** Undesirable plants are relatively easy to recognize in a uniform crop. However, roguing is difficult in an irregular crop. To achieve a uniform crop when only, group the tubers according to size and plant the groups separately. Undesirable plants are relatively

Figure 6: Roguing under seed potato production plots

easy to recognize in a uniform field.

o **Moisture:** Disease symptoms are difficult to detect on wilted plants. Roguing should be done at optimum moisture condition in the field which makes walking in the field easier.

o **Light Conditions:** Changes in leaf color, especially mosaic symptoms, are easiest to detect under uniform light. Therefore, the best time to rogue is when the sky is uniformly cloud-covered. Shadows from direct sunlight increase the difficulty of distinguishing changes in leaf color. If you cannot avoid roguing on sunny days, cast your own shadow over the plants by roguing with your back to the sun.

o **Wind:** You should rogue in calm weather, because disease symptoms are difficult to detect when plants are moving in the wind.

o **Dirt:** Foliage should be free of spray residues or dirt, which make recognition of diseased plants difficult.

o **Foliage Damage:** Disease symptoms are difficult to detect on foliage that has been damaged by hilling or insects. Leaf spots or wilts caused by pathogens also hinder accurate roguing.

o **Weeds:** Weed infestation in the field makes it difficult to compare plants. If herbicides are needed, apply them carefully to avoid phytotoxic effects that may be confused with disease symptoms. Moreover, weeds harbour insect, pests and diseases.

4.5. Precautionary Measures to Be Taken for Rouging

Following precautionary measures should be followed to reduce vector and contact transmission of viruses.

o Vector transmission is caused mainly by insects. Roguing is ineffective when insects, especially aphids, are disseminated over the entire field. Vectors disturbed by roguing move to other plants and, consequently, spread the infection. To control this problem, combine roguing with the use of an effective insecticide as suggested in SPT. Use formulations that leave no visible residues on the foliage. Apply insecticides two to three days before roguing.

o Contact transmission results from direct contact with diseased plants. Because hands and clothes become contaminated during roguing, touch only the plants to be rogued, so that the infection is not transmitted to healthy plants. To reduce transmission of viruses when walking through a field, try to rogue before the spaces between the rows are covered with foliage.

o Try to do all the seed production intercultural operations mechanically or least use of labors to avoid the contaminations

4.6. Point of Consideration under Rouging

• A good and often-quoted rule of thumb stresses "***when in doubt, take it out***." Remove any plant which appears to be diseased or otherwise obviously different from its neighbours.

• Early roguing is especially important for controlling insect- transmitted viruses. The earlier the infected plants are removed from the field, the less chance for infection of healthy plants also tubers may not yet have formed, reducing the need for digging.

• Assigning specific seed field or section of field to individuals can improve performance and may prevent re-roguing the entire acreage.

• Begin roguing when plants are still small to prevent the spread of diseases by plant-to- plant contact. As the normal plants enlarge, remove suspect smaller plants which could become hidden by their vigorous neighbours.

5. Potato Seed Certification

As per the national policy of seed multiplication, the multiplication phases of seed have been grouped into three categories i.e. i) breeder or basic seed; ii) foundation-I and II and iii) certified seed. The breeder seed is considered to be pure, disease free and no tolerance limit is fixed while for foundation (FS-I and FS-II) and certified seed

the tolerance limits for viruses off-type, tuber-borne diseases and grades have been fixed by Government of India. Minimum isolation distance of 5 meter is to be given for foundation-I, foundation-II and certified seed crop from the fields of other varieties and also the fields of the same varieties not confirming to varietal purity requirements for certification. The certification is done by concerned state certification agency in each state. Producing agencies or farmers certifying their seed should maintain the health of the seed potato (Table 1) as per the class of the seed so that it can be certified by seed certification agency (Anonymous, 2013).

Table 1: Minimum permissible limits for the certification of potato seed

Factors	Stage	Maximum permissible limits		
		Foundation -I	Foundation -II	Certified
Off -types	1st and 2nd inspection			
Mild mosaic	1st and 2nd inspection	0.05%	0.05%	0.10%
Severe mosaic, leaf roll and yellows	1st and 2nd inspection	1.0%	2.0%	3.0%
*Total virus	1st and 2nd inspection	0.5%	0.75%	1.0%
**Plants infected by brown rots	1st and 2nd inspection	1.0%	2.0%	3.0%
***Re -growth of plants after haulms cut/destruction	4th inspection	None	None	3 plants per

*: Of the two inspections, the higher virus percentage will be considered for the purpose of the specified limit of tolerance; **: The presence of brown rot infected plants within the specified limits of tolerance shall be permitted in the areas known to be infected with this disease. In case of plants suspected to be infected with brown rot, the neighboring plants, one on the either side also are to be rogued along with tubers; ***: Standards for re-growth after destruction of haulms shall be met at 4th inspection to be conducted about 10 days after haulms cutting. Seed plot should not be more than 10.0% gaps and haulms must be destroyed as close to the ground as possible before the date specified by the certification agency. Failure to destroy haulms in time shall be render the crop liable for rejection.

6. Conclusion

Roguing is important aspect in seed potato production. Thorough and timely rouging as per standard set by seed plot technique is very much important under seed potato production for obtaining high quality seed. Knowledge of virus vector relationship is necessary for elimination of the prevalent viruses in a given region from the seed stock. Maintaining seed certification standards through proper identification of rouge, following the step by step rouging is important in seed potato production.

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