

INTEGRATED MANAGEMENT OF DISEASE VECTORS FOR RICHER HARVEST OF QUALITY SEED POTATOES IN THE NORTHERN PLAINS

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ABSTRACT

This deals with the origin of Potato, Solanum tuberosum L. —God's gift to the mankind ; its importance as support to people across diverse cultures during war and peace and also help in reducing the calamities of famine ;important insect and mite pests damaging this ubiquitous crop ; a brief history of potato research in India ; pre-requisites for locating areas suitable for healthy seed production and healthy (virus free)seed production technologies for helping the farming community of Northern plains so that they could grow their own seed potato crop and successfully curtail the cost of production by saving the money up to 50% spent in the purchase and transportation of seed potatoes from distant places.

Keywords : *Potato, Solanum tuberosum L. Vectors, Virus, Aphid, Myzus persicae (Sulzer), Aphis gossypii Glover ,PLRV ,PVY, Seed Plot Technique, Indo-Gangetic Plains Dormancy , Indigenous, Degeneration ,Systemic Insecticides , Pesticides , Haulm.*

INTRODUCTION

The English word "Potato" comes from Spanish patata which is a compound word of Taino batata (sweet potato) and Peruvian papa (potato). Another common name is pomme de terre in French meaning 'ground fruit'. In Persian, it is called seeb -i- zameen meaning 'ground apple'. In Hindi, Nepali and other Indian languages the potato is called alu or aloo, while in Marathi and Gujrati, it is called batata or batata.

The potato originated in Peru-Bolivian Region (South America) about 8,000 years ago, has come a long way to become the most favourite culinary item of the billions of peoples of the world. It is believed that Spanish conquistadors first encountered the potato when they arrived in Peru in 1532 in search of gold. Spanish explorer and conqueror, Gonzalo Jimenez de Quesda (1495-1579) took the potato to Spain in lieu of the gold (Source: Linda Stradley, History of Potato, 2004). The Spanish

conquerors took the potato from Peru to Europe during the later half of 16th century. Soon the British, Portuguese, Spanish, French, Dutch and Belgian colonialists carried the potato to Asia, Africa and the South Pacific.

As regards its introduction in India, it is believed that although the Portuguese traders first took it to India during the late 16th to early 17th century but it was the English who took the crop to the length and breadth of the country. The first written mention of potato in India occurs in Edwards Terry's account of a lavish banquet hosted by Abdul Hassan Asaf Khan (elder brother of Nur Jahan and father of Mumtaz Mahal) who was the Governor of Punjab under the Mughal Emperor Jahangir, in honor of the British Ambassador Sir Thomas Roe in 1615 at Ajmer.

Now potato has come up as world's third most important food crop after wheat and rice with 314 million tones fresh-weight produced in 2006 (FAO Stat.). It is being grown in more than 148 countries in a wide variety of soils and

climates. It produces more nutritious food more quickly on less land and in harsher climates than most other crops. Besides, its adoptability to a wide variety of farming systems is also noteworthy. Its short, flexible cycle and high yields within 100 days means it fits well within rice or wheat in double cropping system and is suited for intercropping with crops like sugarcane, maize or soybeans. It is on the record that potato supported the people across diverse cultures during war and peace and also helped in reducing the calamities of famine.

POTATO PRODUCTION AND ITS NUTRITIVE VALUE

Potato crop duration in the plains is 90-100 days and a good crop can produce 30 t/ha.

About 20% of a potato tuber is dry matter and rest is water. Even with 20% dry matter, potato produces more dry matter per unit area time than the staple cereals. The dry matter production in potato is 47.6kg/ha/day, whereas in wheat and rice, it is 18.1 and 12.4 kg/ha/day, respectively. Similarly, potato produces 3 kg of edible protein per ha per day as compared to 2.5 and 1.0 kg in wheat and rice, respectively. The approximate contents of major tuber constituents are shown in following Table-1

Table 1. Major constituents of potato tuber

Constituents	Content (%)
Water	75-80
Carbohydrates	16-20
Crude protein	2.5-3.0
Fibre	0.6
Fat	0.6
Minerals	1.0

Potato is so nutritive that a man in Scandinavia is reported to have lived healthy for 300 days on potatoes with a bit of margarine. We have our own man Mr. Satyanarayan Aggarwal, who lives in village Chandia of Madhya Pradesh. He is more than 90 years of age and has lived a healthy life by eating only potatoes since 1950.

Gone are the days, when India was struggling for food in the sixties and now the problem is of plenty. India produced 25 million MT potatoes from 1.25 million ha during 2004-2005 that made it the third largest producer in the world after China (75 million MT) and Russia Federation (37 million MT). There has been a phenomenal increase in area, production and per capita availability of potato in India in the last 50 years. As per projections for the year 2020, the area under potato is expected to rise up to 2 million ha and the production is likely to touch 50 million MT. It is, therefore, essential that potato consumption is increased to sustain this increase in production and to ensure remunerative price to the farmers.

INSECT AND MITE PESTS

This ubiquitous crop, being grown under a wide range of climatic conditions prevailing from sea shore to snow level in higher hills and round the year in one part of our country or the other is subject to depredation by several pests both in the field and the storage which in accordance with their food habit and habitat are grouped into - (i) soil pests (cutworms, white grubs, wireworms, termites, lunate fly, red ant, mole cricket, nematodes and field rats), (ii) Foliage feeders or defoliators (various types of leaf-eating caterpillars, epilachna beetles, flea beetles, ash grey weevil and blister beetles), (iii) sucking pests or sap feeders (aphids, leaf hoppers, broad mite, green bug, whiteflies, thrips and bulb mite) and (iv) storage pests (potato tuber moth, mealy bugs and tuber mite).

ROLE OF APHIDS AS VECTOR OF VIRAL DISEASES IN POTATO CROP

Among the category of sap feeders, the aphids popularly known as plant lice or green fly are of paramount significance, especially on crops being grown for seed purposes. Over 4,500 species of aphids have been reported world over. Of these, about 700 species occur in India. Further, out of 14 aphid species reported on potato from India, green peach potato aphid, *Myzus persicae* (Sulzer), native of Europe, is most dangerous causing not only direct damage to potato by sucking plant sap but also is responsible for transmitting over 100 viral diseases on crops, the chief among them on

potato crop are potato leaf roll virus (PLRV) and potato virus Y (PVY). In India the losses in potato yield due to PLRV and PVY are estimated to be 20-50% and 40-85%, respectively. These losses may go still higher if infested tubers are further used as seed for subsequent crop. Continuous use of virus-infested seed potatoes for many years leads to a stage where tuber yield becomes uneconomical and such a seed stock is called "degenerated". Besides *M. persicae*, cotton aphid, *Aphis gossypii* Glover, have also been reported as a weak vector of viral diseases in potato crops. As a result of their direct feeding, especially when their population is quite high, the leaves of affected plants curl downward, turn yellow, become wrinkled and ultimately die. However, such situation is quite uncommon.

POTATO VARIETIES, ESTABLISHMENT OF POTATO RESEARCH IN INDIA AND SEED PRODUCTION TECHNOLOGIES FOR NORTH INDIAN PLAINS

In the beginning, India was meeting its seed requirement partly through import and partly by its multiplication in the higher hills till 1939. Import stopped in 1939 due to World War II. A potato seed supply system from hills to plains was, therefore, used to address potato seed supply. This plan also proved unsatisfactory because: (i) Non-availability of varieties adopted to both long days of hills and short days of plains, (ii) Dormancy of hill seed which was fit for planting during spring and degenerated very fast due to high pressure of aphid vectors of viral diseases during spring and (iii) limitation of land in the hills.

A need, therefore, was felt to have indigenous varieties and technologies suiting to sub-tropics to have a viable potato industry in India. Keeping these points in view, initiation of Indigenous Variety Development Programme started in 1935 with the establishment of Potato Breeding Station at Shimla (Himachal Pradesh), Seed Certification Station at Kufri (district Shimla, Himachal Pradesh) and Potato Multiplication Station at Bhowali (Uttarakhand). Later on, these stations were merged with Central Potato Research Institute. As a result, Central Potato Research Institute came in existence in 1949 at Patna and later on Headquarters shifted to Shimla in 1956 in order to facilitate hybridization work and better management of seed health.

By 2008, CPRI had released 45 indigenous varieties (7 short, 27 mid and remaining 11 late duration varieties maturing, respectively, in 70-90, 91-110 and 111-120 days). Of these, suitable varieties for North Indian plains, particularly for Uttar Pradesh include Kufri(K) Safed, K.Sindhuri, K.Bahar, K.Lalima, K.Sutlej, K. Ashoka, K.Pukhraj, K. Chipsona 1 to 3, K.Anand, K. Arun,

Degeneration of seed stocks when grown during spring in the plains was established to be due to viruses mainly spread by aphid, *Myzus persicae* (Sulzer). Its reproduction was observed at its peak at temperatures between 20°C and 25°C while lower and higher temperatures retarded its build-up. This aphid does not survive when the temperature in Indian plains exceeds 38°C from May onwards. Under such conditions, it is believed that *M. persicae* migrates towards mid and higher hills where mild temperatures and suitable host plants are available. A detailed survey of a number of locations in the plains during 1956-60 for the population dynamics of *M. persicae* during the crop of period was undertaken to identify the locations ideally suitable for raising seed crop potatoes in the plains (Pushkarnath, 1967). It was found that the vector (*M. persicae*) population in the North Indian Plains (Indo-Gangetic Plains) remained either absent or very low during October-December which was sufficiently long a period to grow healthy seed crops in the plains. This information formed the basis of seed production in the plains through the technique called "Seed Plot System of Seed Production". Initially, it comprised (i) planting of seed crops during September end to mid-October, (ii) planting at close spacing on not too rich a soil to ensure large percentage of seed size tubers, (iii) two inspections of the crop to remove off-types and virus-infested diseased plants, (iv) restriction of irrigation from mid-December onwards and (v) Dehauling the crop in the end of December or before reaching *M. persicae* population to critical level of 20 aphids/100 compound leaves.

Areas suitable for seed production are limited to a few states in the north-west and northern Indo-Gangetic plains which meet the following requirements of certified seed production:

- Availability of sufficiently long period of about 75-90 days virtually free from aphid vectors and suitable for crop growth and tuberization, this period is from September end to last week of January,
- Freedom of soil from soil pests/soil-borne diseases like cyst nematodes, bacterial wilt, powdery scab, wart, ring rot and any other quarantined pests/diseases, and
- Good productivity of the crop.

STEPS FOR SEED PRODUCTION TECHNOLOGY

Because of the development of "Seed Plot Technique", the major centre of disease-free seed production shifted from the hills to plains. The seed produced in plains not only gave 30-40% higher yields but was also free from many soil and tuber-borne diseases and pests. As such, the farmers could produce healthy seed potatoes in plains and obtained higher yields by adopting refined "Seed Plot Technique" developed at CPRI (Garg, 2008). This includes:

- Use of hot weather cultivation and adaption of 2-3 years crop rotations to avoid build-up of soil-borne pathogens,
- Procurement of good quality healthy (virus-free) seed potatoes of right physiological stage of variety recommended for the region from governmental/semi-governmental/cooperative agencies,
- Isolation of minimum 25 meters of seed crop from the ware potato crop. Aphids developing on the primary hosts are free of potato viruses. Infection may be acquired from weed hosts or volunteer potatoes. Home gardens in which non-certified seed potatoes are grown can be important source of potato viruses,
- Use of pre-sprouted large sized healthy tubers (40-80 g) with multiple sprouts to ensure a large proportion of seed-sized tuber. Pre-sprouting ensures quick and uniform emergence of crop, early tuberization and maturity,
- Planting of seed crops by 15th October in Punjab, by 25th in Haryana, Rajasthan, Western Uttar Pradesh and 1st week of November in Eastern Uttar Pradesh and Bihar.
- Initially use systemic granular insecticides like Phorate 10 G or Carbofuran 3G @ 1.5-2.0 kg a. i. (active ingredient)/ha at planting or in two equal split dosages i.e. half at planting and remaining half at first earthing against sucking pests and white grubs. White grubs problem is quite serious in hilly regions where potatoes are grown as rain-fed crop during long days in summer-rainy season. One-two sprayings with any systemic foliar insecticides viz. oxydemeton-methyl, dimethoate, thiometon, monocrotophos etc. (0.03% concentration) may be given during the later part of the crop if vectors are seen in spite of granular insecticides application. Alternatively, two sprayings with imidacloprid (0.04 kg a i /ha/spray treatment), first after 30 days and second after 60 days of planting have also been found quite effective against aphids and other sucking pests/vectors,
- Full earthing at planting and use of herbicides for controlling weeds and preventing the spread of contagious viruses,
- Inspection of seed crop three times at 50, 65 and 80 days after planting during crop season to remove the off-types and diseased plants along with their tubers,
- Protection of crops from late blight to prevent seed-borne infection,
- Protection of crop from vectors towards the maturity of crop,
- Withhold irrigations in the third week of December i.e. 7-10 days before haulms (foliage) killing in north-western plains and first week of January in north-eastern plains,
- Haulms killing with Grammaxone @ 2.5-3.0 litre/ ha or mechanically pulling them to kill. Re-growth in cut plants coming after haulms killing should also be checked periodically and be removed .
- Harvesting of crops 15-20 days after haulms killing when the fields are in workable condition and tuber skin is hardened.,

- Curing of produce by keeping the heaps in cool shady place for about 2-3 weeks,
- Treatment of produce with commercial grade 3% boric acid to prevent surface-borne diseases, and
- Drying of treated seed potatoes in shade and then filling in the bags, sealing, labeling and cold-storing.

A flow chart of the seed plot technique is presented in Fig. 1 (c.f. Garg, 2008)

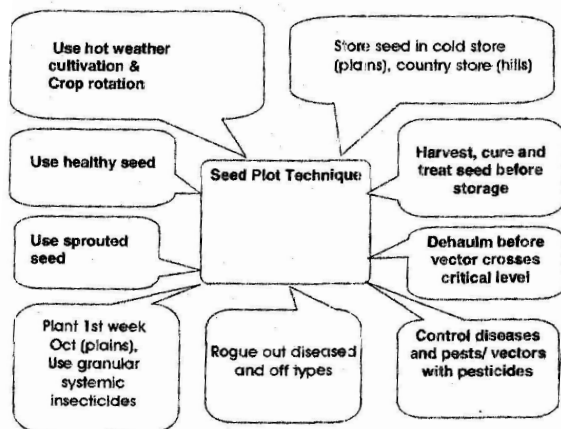


Fig. 1 : Important components of seed plot technique

The systemic insecticides applied for managing the aphids - principal vectors of viral diseases will simultaneously take care of other vectors as well such as thrips, Thrips palmi (transmitting Tospovirus), white flies belonging to the genus Bemisia - vector of Gaminivirus and the leaf hoppers, Alebroides nigroscutulatus Dist. & Seriana equata Singh transmitting micoplasmal diseases viz. purple top roll (PTR) and marginal flavescence (MF), respectively. However, if need arises 1-2 additional spraying with any foliar systemic insecticide like oxydemeton-methyl (0.03% concentration) be given for managing these insect vectors.

CONCLUSIONS

The farming community will immensely be benefitted by adopting the above suggested economically effective, eco-friendly and sustainable potato seed production technology for managing the vectors effectively leading to bumper production of healthy (disease-free) seed

potatoes. Once, the farmers start producing their own crop of seed potatoes in Northern plains, unnecessary dependence on outside seed will be solved and almost 50% cast of cultivation i.e. the money spent on the purchase and transportation of seed potatoes from outside and distant places will automatically be curtailed.

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