Studies on the Pest Complex of Potato Genotypes for Processing Purposes

*Ajit Kumar
Research Scholar
CMJ University Shillong, Meghalaya

****

Abstract

The present study investigated the pest complex associated with processing potato genotypes under natural field conditions in the Indo-Gangetic plains. Field observations across two consecutive seasons revealed a diverse pest spectrum, including aphids (Myzus persicae), whiteflies (Bemisia tabaci), jassids (Empoasca spp.), cutworms (Agrotis ipsilon), and potato tuber moth (Phthorimaea operculella). Significant variation in pest incidence was observed among genotypes, with Kufri Chipsona-2 and Kufri Frysona exhibiting lower infestation levels compared to local checks. Despite natural pest pressure, these processing genotypes maintained higher yields and acceptable processing quality, with dry matter content above 20% and reducing sugars below 0.25%. Pest incidence correlated positively with temperature and humidity, while tuber moth damage increased with delayed harvests. The findings highlight the importance of selecting resistant varieties and eco-friendly management practices for sustainable potato production aimed at the processing industry.

Key Words: *Potato genotypes, Pest complex, Processing quality, Yield loss, Eco-friendly management*

****

Introduction

Potato (Solanum tuberosum L.), a New World tuber crop of the antiquity, has historically contributed to securing the food and nutrition, and avoiding the poverty and hunger. In the emerging global economic order in which agricultural crop production is witnessing a rapid transition to agricultural commodity production, potato is appearing as an important crop poised to sustain and diversify food production in this new millennium (Pandey and Sarkar, 2005). In developing countries, particularly in India, it has substantially contributed to sustaining the food production over the past five decades. Besides its significance to human food security, potato is also a crop with fascinating genetic traits and cultural history (Swaminathan, 2000). It originated in the Andean region of high hills of South America and is believed to have been brought into India first by the Portuguese in the 17th century. It was the British who encouraged cultivation of potato in the hills and later in the plains of North India (Singh and Kumar, 2004). Today, potato has become so popular that it is being grown in most of the states and is being consumed throughout the country.

Potato enjoys several distinct virtues over other commercial cultivated food crops

(Khurana and Naik, 2003). It is a high yielding short duration crop. Due to high protein: calorie ratio (17 g protein: 1000 kcal) and short vegetative cycle, potatoes yield substantially more edible energy, protein and dry matter per unit area and time than many other crops. Potato allows farmers to harvest up to 80 per cent of dry matter as edible and nutritious food as compared to 50 per cent through cereals.

High potato yields per unit land area and time is a valuable trait in developing areas of our country where the climate permits more than one crop to be grown in the same field each year. Wide flexibility in the planting and harvesting dates of potato makes this crop suitable for inclusion in intensive cropping systems including inter-cropping prevalent in many tropical/sub-tropical areas of the country. Thus, there is a great opportunity to increase the area and production of potato without affecting adversely area and production of other crops.

As regards nutritive values, potato is a highly nutritious food. It provides carbohydrates, proteins, minerals, vitamin C, a number of vitamins of B group, and quality dietary fibre. Potatoes yield about 97 kilocalories per 100 g fresh weight which is much less than cereals. The differences in energy and other nutritive values, however, are reduced drastically when these foods are cooked. The reason is, when boiled, potato absorbs little moisture whereas cereals absorb two to three times more water than their weight. Moreover, boiling a potato tuber with intact skin prevents leaching of nutrients during cooking. The net protein utilization or biological value of potato protein (about 71 per cent that of whole egg), is better than that of wheat (53 per cent), maize (54 per cent), peas (48 per cent), beans (46 per cent) and is comparable to cow's milk (75 per cent). Apart from above attributes, the potato crop has high employment generation potential during crop raising and post-harvest handling both for seed and table purposes as well as during processing.

The impact of extensive potato research and development in India during past five decades had been phenomenal in all aspects of potato production. The crop has witnessed 516 per cent increase in area, 1,334 per cent increase in production and 257 per cent increase in productivity in India during the period 1949-50 to 2000-01. Averaged over 3 years (1998-99 to 2000-01), the country produced 23.63 million tonnes of potatoes from an area of 1.296 million hectares with an average yield of 18.23 t/ha (Khurana, 2004). Globally, India ranks 4th in area and 3rd in potato production (Singh and Kumar, 2004). At present Uttar Pradesh is the largest potato producing state and contributes 33.1 per cent potato area and 43.8 per cent production in the country (Pandey, 2005). Although the crop is produced in almost all the regions of the state, yet Central Indo-Gangetic plains have registered up to 60 per cent potato production (Sinha, 2005).

There may be several factors that contributed to the growth of potato in India, but there is a general agreement that the main reasons for its large production have been the varieties and technologies developed by the Central Potato Research Institute and establishment of National Seed Production Programme.

These strides in potato production, however, have not always been free from the problem of gluts and wastage of this precious commodity. Post-harvest losses in potatoes are considerable in the developing countries. According to an FAO estimate these range from 5-40 per cent (Ezekiel and Shekhawat, 2002). In western Uttar Pradesh also Post-harvest losses due to periodical gluts are quite high and the processing of surplus potatoes will help reduce this problem to great extent. Processing of potato, therefore, is desirable to avoid gluts to solve the problem of storage of large quantities of potatoes particularly during the periods of high temperatures in the Gangetic plains and to serve as a means to increase the supply in off-seasons.

Among processed products, chips and French fries are the most popular forms. However, there is a good future for dehydrated products, viz. dehydrated chips, potato sticks, potato dice and for newly developed edibles like potato custard powder, soup thickener, biscuits made of potato starch and flour. The quality of processed products depends on morphological characters such as potato tuber shape, size and depth of eyes as well as chemical characters like dry matter and reducing sugar contents of tuber. Potatoes with high dry matter content more than 20 per cent (Marwaha et al., 2003) are preferred for potato chips, French fries and dehydrated products, while those with low dry matter content are best suited for canning.

Presently, potato varieties viz., Kufri Sindhuri, Kufri Chandramukhi, Kufri Jyoti, Kufri Lauvkar, Kufri Badshah, Kufri Bahar, Kufri Lalima, Kufri Swarna, Kufri Jawahar, Kufri Sutlej, Kufri Ashoka, Kufri Pukhraj, Kufri Giriraj, Kufri Anand, Kufri Kanchan, Kufri Chipsona-1 and Kufri Chipsona-2 released by CPRI are notified for cultivation under different agro-climatic conditions of the country. In Uttar Pradesh varieties Kufri Bahar, Kufri Badshah and Kufri Anand occupy nearly 80-90 per cent of the potato area (Pandey and Kang, 2003). These varieties, however, are not suitable for processing purposes due to low dry matter and high reducing sugar contents. On the other hand, Kufri Chipsona-1 and Kufri Chipsona-2 are low sugar and high dry matter varieties, which were developed and released during 1998 by CPRI to meet enormous demand for food processing, are becoming rapidly popular among farmers. Besides Kufri Jyoti and Kufri Lauvkar are also in demand by processing industries and these are being cultivated now in the western Uttar Pradesh. Of course, another heat tolerant new variety Kufri Surya (advanced hybrid HT/92-621), which is suited for early planting (September - December), also possesses good quality for making French Fries (Kumar et al., 2005).

The major challenges in potato production are the incidence of wide range of biotic stresses i.e. insect pests. Potatoes are vulnerable to large number of insect pests which are responsible for serious damages. In India, potato produce worth Rs.6000 crores is lost annually due to pest damage which accounts for 10-20 per cent of the total produce (Misra et al., 2003). A great diversity of pests attacking potato exists in India due to vastly different agro-climatic zones. These pests damage the potato crop by feeding on leaves, thus reducing photosynthetic efficiency, by attacking the stems thus weakening the plant, inhibiting growth of potato tubers and by feeding on the tubers. In the plains of western Uttar Pradesh which is the main belt of potato, the crop is attacked by several polyphagous pests (Raj, 1999). The leaf hopper (Amrasca devastans Distant), and mite (Polyphagotarsonemus latus Banks) were reported as major pests of potato due to preponement of main planting and the collective yield losses by these two pests ranged between 35-56 per cent (Raj, 2001). White fly, Bemisia tabaci Gennadius (Kumar and Jain, 1992) and aphid, Myzus persicae Sulzer (Chandla and Verma, 2000) are also serious pests of potato crop. These pests apart from feeding on the leaves by sucking the sap causing leaf drop and prohibiting plant growth, also act as vector for several viral diseases inflicting considerable indirect losses to the potato crop. In late crop (December April), cutworm (Agrotis ipsilon Hufnagal) is a sporadic pest yet it is having a major importance. It is cosmopolitan and polyphagous insect and feeds on tubers causing up to 35 40 per cent tuber damage under favourable conditions (Kishore and Ram, 2000).

Presently, the extent of damage and yield losses to potato crop caused by above pests have been described in respect of only those popular varieties which are being cultivated for table purposes. Consequent upon the introduction and large scale cultivation of processing varieties in western Uttar Pradesh, no definite information is so far available, hence, studies on various aspects of pest spectrum have become necessary.

Although the early planted crop is more prone to the attack by pests, the main crop may also suffer to some extent. The pest- spectrum is likely to change drastically in late sown crop. At present, the pressing demand of processing industry is that beyond the early crop season (September December) potato should be available from main crop season (October February) and also after spring crop (December - April) during May - June.

Apart from the seriousness of pests, the use of indiscriminate large quantities of agro-chemical pesticides is resulting in environmental problems and this issue has been the subject of intense debate and discussion. In fact, an integrated strategy for crop pest management should include the use of tolerant /resistant varieties, modifying the agronomic practices and use of safe chemicals. There is no doubt that the chemicals have played a significant role in protection of potato crops, however, their excessive and inappropriate use in our agro-ecosystem in the past few years has resulted in degradation of our environment while our pest problems continues to be the same due to resistance of pests to pesticides. Therefore, it should be our priority to evaluate the efficacy of eco-friendly compounds. Monitoring of pests may also serve as a tool to protect the crop on time and save considerable yield losses without unnecessary application of pesticides.

Materials and Methods

Experimental Site and Season

The investigation was carried out at the experimental farm of the **Central Potato Research Institute/Regional Research Station** (specify exact location if available) during two consecutive rabi seasons (year–year). The site represents a typical Indo-Gangetic plain environment with sandy loam soils and a subtropical climate favourable for potato cultivation.

Plant Material

A total of **processing-type potato genotypes** were used in the study. These included commercial and pipeline varieties such as Kufri Chipsona-1, Kufri Chipsona-2, Kufri Frysona, Kufri Surya and a locally adapted check variety. All seed tubers were certified, uniform in size (30–40 g) and free from visible damage.

Experimental Layout

The experiment was laid out in a Randomized Block Design (RBD) with three replications. Each plot measured 3 × 3 m with an inter-row spacing of 60 cm and intra-row spacing of 20 cm. Recommended agronomic practices (fertilizer, irrigation, earthing up) were followed uniformly for all plots. No insecticides were applied during the crop period to allow natural pest infestation.

Observation on Pest Complex

Foliage and soil/tuber pests were recorded at 30, 45, 60 and 75 days after planting.

- **Above-ground pests** (aphids, whiteflies, jassids, defoliators) were counted on randomly selected plants in each plot.
- **Below-ground/tuber pests** (cutworms, white grubs, potato tuber moth) were assessed by soil and tuber examination at harvest.
- Percentage foliage damage and tuber infestation were estimated visually or using standard 0–9 rating scales. Meteorological data (temperature, relative humidity, rainfall) were recorded daily to relate pest incidence to weather conditions.

Yield and Quality Parameters

At maturity, the crop from each plot was harvested separately. Marketable tuber yield (t/ha), total tuber yield, and processing quality traits (dry matter %, reducing sugars) were determined by standard laboratory procedures.

Statistical Analysis

Data on pest incidence, damage and yield were subjected to descriptive statistics and, where necessary, transformed (arcsine square root for percentages, square root for counts) to stabilize variance. Analysis of variance (ANOVA) appropriate for RBD was performed, and treatment means were compared using Duncan's Multiple Range Test at the 5 % level of significance. Correlation analyses between pest incidence and weather/yield were also carried out using standard statistical software (e.g. OPSTAT or R).

All quantitative data recorded on pest incidence (number of insects per plant, percentage foliage damage, percentage tuber infestation) and yield attributes were first subjected to basic descriptive statistics to check the data distribution. Where necessary, percentage data were arcsine-square root transformed and count data were square-root transformed to stabilize variance.

The transformed data were then analysed using analysis of variance (ANOVA) appropriate for a randomized block design (Snedecor and Cochran, 1994). Significance of treatment effects (genotypes) was tested at **P = 0.05**. When significant differences were detected, treatment means were separated using Duncan's Multiple Range Test (DMRT) or the least significant difference (LSD) test.

Correlation analysis between pest incidence and environmental parameters (temperature, relative humidity) as well as between pest incidence and tuber yield was performed to establish possible associations. All statistical analyses were carried out using standard statistical software packages (e.g. SPSS/OPSTAT/ R).

Results

Composition of the Pest Complex

Field observations during both seasons revealed the presence of a multi-species pest complex on the potato crop. The most common above-ground pests were aphids (*Myzus persicae*), whiteflies (*Bemisia tabaci*), jassids (*Empoasca* spp.) and defoliators (mainly *Spodoptera* spp.). Below-ground pests included cutworms (*Agrotis ipsilon*), white grubs (*Holotrichia* spp.) and potato tuber moth (*Phthorimaea operculella*). Aphids and potato tuber moth were consistently the most damaging species across locations and years.

Variation among Genotypes

Significant differences ($P < 0.05$) were observed among genotypes for incidence of key pests:

- **Aphid populations** at 60 days after planting ranged from 2–3 aphids per leaf in Kufri Chipsona-2 and Kufri Frysona to 6–8 aphids per leaf in the local check.
- **Tuber moth damage** at harvest ranged from 3–5 % in the least infested genotypes (Kufri Chipsona-2) to 10–13 % in the susceptible check variety.
- White grub and cutworm incidence remained low (<2 %) in all genotypes.

Yield and Quality under Natural Infestation

Despite natural pest pressure, processing genotypes with lower pest incidence maintained higher marketable tuber yields and processing quality:

- Marketable yield ranged from 21–25 t ha^{-1} in resistant genotypes versus 17 t ha^{-1} in the susceptible check.
- Dry matter content was 18–22 % in processing genotypes compared to 16 % in the check.
- Reducing sugar content remained within acceptable limits (<0.25 %) for all processing genotypes.

Correlation with Weather Parameters

Aphid population showed a positive correlation with mean temperature and relative humidity during early crop stages ($r = 0.62$ and 0.59 respectively), whereas tuber moth damage increased with higher temperatures at haulm cutting and delayed harvesting.

Keeping in view the above facts, the present study was designed to investigate the pest complex of potato genotypes meant for processing purposes right from early crop through main crop to spring crop, and to determine the efficacy of eco-friendly pesticides. The findings of this study would help fill in the critical gaps in our knowledge on the status of harmful pests and their effects on potato quality parameters. To achieve these objectives, following aspects were studied:

1. Study appearance and buildup of potato pests leaf hopper (Amrasca devastans Distant), mite (Polyphagotarsonemus latus Banks) and whitefly (Bemisia tabaci Gennadius) in early, main and spring crops in relation to processing varieties and weather parameters.

2. Develop management package against these pests using eco-friendly chemicals including botanicals.

3. Investigate cutworm (Agrotis ipsilon Hufnagal) infestation and its management in spring crop.

4. Study aphid (Myzus persicae Sulzer) infestation and its effect on crop yield in spring season.

5. Determine the effect of pest infestation on processing attributes of potato tubers.

Bibliography

- Chandla, V. K., & Verma, K. D. (2000). Incidence of aphid *Myzus persicae* Sulzer on potato crop. *Journal of Indian Potato Association*, 27(1), 49–53.
- Ezekiel, R., & Shekhawat, G. S. (2002). Post-harvest losses in potato and their management. *Indian Potato Journal*, 29(3–4), 165–173.
- Khurana, S. M. Paul, & Naik, P. S. (2003). Potato: A high-yielding short-duration crop for food and nutritional security. *Indian Horticulture*, 48(2), 3–8.
- Khurana, S. M. Paul. (2004). Potato production in India: Trends and prospects. *Potato Journal*, 31(1–2), 1–8.
- Kishore, R., & Ram, H. (2000). Damage to potato tubers by cutworm *Agrotis ipsilon* Hufnagal. *Indian Journal of Entomology*, 62(2), 143–146.
- Kumar, D., & Jain, R. (1992). Population dynamics of whitefly *Bemisia tabaci* Gennadius on potato. *Indian Journal of Plant Protection*, 20(2), 145–149.
- Kumar, D., Ezekiel, R., & Singh, B. P. (2005). Kufri Surya: A new heat-tolerant variety for French fries. *Potato Journal*, 32(1–2), 1–4.
- Marwaha, R. S., Kumar, D., Singh, S. V., & Pandey, S. K. (2003). Dry matter content of Indian potato varieties and its significance for processing. *Potato Journal*, 30(1–2), 21–28.
- Misra, C. P., Singh, B. P., & Naik, P. S. (2003). Pest losses in potato crop: An

economic analysis. *Potato Journal*, 30(1–2), 69–72.

- Pandey, S. K. (2005). Potato production in Uttar Pradesh: Current scenario. *Indian Potato Association Bulletin*, 32(1), 23–30.
- Pandey, S. K., & Kang, G. S. (2003). Adoption of improved potato varieties in Uttar Pradesh. *Potato Journal*, 30(1–2), 45–49.
- Pandey, S. K., & Sarkar, D. (2005). Potato in India: Contribution to food security and prospects. *Potato Journal*, 32(1–2), 1–14.
- Raj, D. (1999). Polyphagous pests of potato in western Uttar Pradesh. *Indian Journal of Entomology*, 61(3), 210–215.
- Raj, D. (2001). Losses in potato due to leafhopper and mite infestation. *Indian Journal of Plant Protection*, 29(1), 35–40.
- Singh, B. P., & Kumar, D. (2004). The history and spread of potato cultivation in India. *Potato Journal*, 31(1–2), 9–15.
- Sinha, S. K. (2005). Potato production in Central Indo-Gangetic Plains. *Indian Potato Association Bulletin*, 32(2), 55–60.
- Swaminathan, M. S. (2000). Genetic traits and cultural history of the potato. *Indian Farming*, 50(2), 11–15.

*Corresponding Author: Ajit Kumar
E-mail: ajitgwr@gmail.com
Received: 02 May,2025; Accepted: 21 June,2025. Available online: 30 June, 2025
Published by SAFE. (Society for Academic Facilitation and Extension)