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# Experimental Methods for Potato Pest Evaluation

*Ajit Kumar
Research Scholar
CMJ University Shillong, Meghalaya

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**Abstract:** *The present study focuses on the systematic assessment of pests affecting potato (Solanum tuberosum L.) crops through standardized experimental approaches. The research emphasizes the identification, quantification, and analysis of pest incidence, intensity, and their subsequent impact on crop yield and quality. Various experimental methods—such as field surveys, randomized block design (RBD) trials, controlled laboratory bioassays, and statistical evaluation of pest population dynamics—are employed to ensure scientific precision. The study also integrates ecological and environmental variables influencing pest behavior and infestation patterns. By comparing traditional and modern pest evaluation techniques, including morphological identification and molecular diagnostics, this work aims to develop a comprehensive framework for effective pest management strategies. The findings are expected to contribute to sustainable potato cultivation practices, enhancing productivity and minimizing economic losses through informed pest control interventions.*

**Keywords:** *Potato pests, Pest evaluation, Integrated pest management, Solanum tuberosum*

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## INTRODUCTION

Potato (Solanum tuberosum L.) is one of the most important food crops worldwide and a vital component of India's agricultural economy. However, its productivity is greatly influenced by several insect pests and mite infestations that cause substantial yield and quality losses. The occurrence and intensity of these pests vary with the season, locality, and cultivar, thereby affecting both the quantity and processing quality of the harvested tubers.

Among the major pests infesting potato, leaf hopper (Amrasca devastans Distant), mite (Polyphagotarsonemus latus Banks), whitefly (Bemisia tabaci Gennadius), aphid (Myzus persicae Sulzer), and cutworm (Agrotis ipsilon Hufnagal) are of significant economic importance. These pests not only cause direct damage by feeding on plant tissues but also act as vectors for various viral diseases, leading to further yield reductions. The population buildup and appearance of these pests are strongly influenced by prevailing weather conditions such as temperature, relative humidity, wind velocity, and rainfall.

The present investigation was therefore undertaken to study the first appearance, population dynamics, and extent of damage caused by major pests of potato on different varieties under early, main, and spring crop seasons. The study also aimed to establish correlations between pest populations and weather parameters, and to assess the resultant yield and processing quality losses under natural and protected conditions. Such information is essential for developing integrated pest management (IPM) strategies and for selecting pest-tolerant varieties suitable for different agro-climatic conditions.

## MATERIALS AND METHODS

1. First appearance of the pests

Observations on first appearance of various potato pests, viz., leaf bopper (Amrasca devastans Distant), mite (Polyphagotarsonemus latus Banks), whitefly (Bemisia tabaci Gennadius), aphid (Myzus persicae Sulzer) and cutworm (Agrotis ipsilon Hufnagal) were recorded on six test varieties viz., Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti, Kufri Lauvkar, advance hybrid HT/92-621 (Kufri Surya) and Kufri Anand in early (September - December), main (October February) and spring (December April) crop seasons immediately after plant emergence. The experiment was laid out during 2003-04 and 2004-05 at CPRIC, Modipuram in randomized block design with four replications. The experimental plot measured 3.6 m x 2.4 m with a row to row spacing of 60 cm and tuber to tuber spacing of 20 cm. The crop was raised as per Recommended cultural practices for the region minus insecticidal sprays. Five plants were randomly selected in each of the four replications and were visually camined daily till the first appearance of the pests. Yellow water trap (Plate 7, Fig. 18) was used to observe the appearance of aphid (Verma and Chandla, 1999). The trap consists of rectangular tin dish of 46cm x 26cm x 8 cm size painted with yellow colour base and filled with water. There is a hole near the rim to drain the excess of water.

2. Leaf hopper (Amrasca devastans Distant)

Observations on the population buildup of adult leaf hoppers were recorded mall the six test varieties at five days interval in early, main and spring crop reasons with the help of a rectangular (45 cm x 30 cm x 30 cm) tin cage (Plate 6. Fig. 15) having a sliding glass sheet on one side. The counting of the pest was done on five randomly selected plants from each replication. The population was finally worked out on per shoot per plant basis. As regards the nymphs, these were counted on one shoot each of above five plants. The observations were taken till maturity of the crop after its first appearance.

3. Mite (Polyphagotarsonemus latus Banks)

The population of nymphs and adults of mite was counted at five days interval on six test varieties listed under section 3.1 on five randomly selected plants in each replication in early crop season. One central leaflet of one leaf each from the top, middle and bottom of a plant was plucked, and observations were recorded on the population of mite visually with a hand lens 10X (Mohapatra, 1996). The observations were continued till maturity of the crop

4 Whitefly (Bemisia tabaci Gennadius)

Observations on population buildup of whitefly were taken at five days itavad on five misdomly selected plants from cach replication on six test varieties listed under section 3.1 in early, main and spring crop seasons. The counting of whitefly was done with the help of a rectangular cage employed in case of leaf hopper under section 3.2.1 and continued till maturity of the crop.

5 Aphid (Myzus persicae Sulzer)

Observations on the population buildup of aphids (adults and nymphs) were taken during main and spring crop seasons at five days interval on the top, middle and lower leaves of five randomly selected plants from each replication in all the test varieties listed under section 3.1. The data were finally converted into number of aphids per 100 compound leaves as described by Simpson (1940).

6 Cutworm (Agrotis ipsilon Hufnagal)

All the plants in experimental plots were examined during spring crop season in each replication at weekly intervals. As there was no indication of cutworm on the plant parts, observations were recorded on the population of caterpillars of cutworm per plot in each replication at the time of harvesting by digging the soil of each plant up to a depth of 30 cm (Srivastava and Khan, 1962).

7 Correlation of pest population with weather conditions

The weather conditions are known to have a direct influence on the appearance and population buildup of the pests. Keeping this in view, data were collected daily from first week of October up to end of March on five weather parameters i.e. maximum and minimum temperatures (°C) at 2 pm and 8 am, per cent relative humidity at 8 am and 2 pm, wind velocity (km/hr) at 8 am and at 2 pm, sunshine hours (from sun rise to sun set) and rainfall in the morning at 8 am. The information collected on above weather parameters was subsequently utilized to correlate with the status of the pest population on test varieties during early, main and spring crop seasons for two consecutive years 2003-04 and 2004-05 using the statistical package 'IRRISTAT'.

8 Extent of damage by the pests

8.1 Leaf hopper and mite

The data on the extent of damage by leaf hopper and mite were recorded at five days interval from the first appearance of damaging symptoms in accordance with the method described by Das (1996) by randomly examining five plants in each of the four replications. For estimating the pest damage, the number of damaged leaves among six leaves (two from top, two from middle and two from bottom) in each plant was examined. The intensity of incidence was calculated on the basis of per cent damage as follows:

$$\text{Per cent damage} = \frac{\text{Number of plants affected} \times \text{Number of leaves damaged in affected plants}}{\text{Total no. of plants} \times \text{No. of leaves observed}} \times 100$$

8.2 Cutworm

In the case of cutworm, observations on the per cent damage were recorded in all the four replications at the time of digging of the crop. The number and weight of damaged tubers were recorded separately, and the data were converted into percentage.

8.3 Whitefly and aphid

Since there was no direct damage caused by whitefly and aphid to the crop, the cumulative extent of damage was taken into account for the purpose of cumulative yield losses in different crop seasons.

9 Assessment of yield loss caused by the pests

To assess the yield losses due to pest infestation, the six test varieties listed under section 3.1 were planted in two experimental sets. One set was left exposed to natural pest infestation which was used for recording the appearance and buildup of the pests, whereas in the second set, the crop was kept protected from the pest infestation by applying appropriate pesticides right from the appearance of test pests. Observations on yield losses were recorded on freshly harvested potato tubers. For this, the produce from pest infested and pest protected experimental plots was graded into two groups ups i.e. processing grade (tubers above 50 g) and non-processing grade (below 50 g). Subsequently, the number of tubers in each group was counted and their weighment was made. The yield (q/ha) was worked out by applying the following formula in vogue:

$$\text{Yield (q/ha)} = \frac{\text{Number of plants/ha Yield (kg) x 83,333 i.e.}}{\text{Number of plants harvested x 100 (kg)}}$$

**Subsequently, the yield loss was calculated by the following formula:**

$$\text{Yield loss (\%)} = \frac{\text{Yield (kg) in pest protected crop} - \text{Yield (kg) in pest infested crop}}{\text{Yield (kg) in pest protected crop}} \times 100$$

10 Effect of pest infestation on processing quality parameters

The crops raised as described under section 3.5 were used for this study. At the time of harvest in different crop seasons, tuber samples consisting of processing grade tubers were collected from each plot separately. Samples were brought to laboratory and analysed for eight quality parameters for processing viz., dry matter content, specific gravity, reducing sugar content, sucrose content, phenol content, total free amino acid content, chip colour and chip taste.

10.1 Dry matter content

Dry matter content was estimated using the method of Uppal (1999) and Pandey et al. (2004). Ten tubers were drawn from each sample and were cut longitudinally. Half portion of each tuber was selected and diced, mixed thoroughly to make a homogeneous sample and this sample was then distributed in three aluminum boxes so that each box contained at least 50 g of tuber material. The weighed boxes were kept in a hot air oven at 80° C for six hours and subsequently at 65° C till a constant weight was obtained.

**Subsequently, the dry matter content was calculated by the following formula:**

$$\text{Dry matter (\%)} = \frac{\text{Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$$

10.2 Specific gravity

The specific gravity was measured using the method of Sukumaran and Ramdass (1980). Processing grade tubers weighing 3.63 kg for each sample were used for estimating specific gravity using a Hydroscope.

10.3 Reducing sugar content

The reducing sugar content was estimated using the method of Nelson (1944), Sadasivam and Manikam (1992a) and Thimmaiah (2004b).

**Reagents**

**i. Alkaline copper tartrate:** It was prepared by mixing 25 parts of copper reagent A and 1 part of copper reagent B just before use.

A. **Copper reagent A**: 2.5 g anhydrous sodium carbonate, 2 g sodium bicarbonate, 2.5 g potassium sodium tartarate and 20 g anhydrous sodium sulphate were dissolved in 80 ml water and the final volume was made up to 100 ml.

B. **Copper reagent B:** 15 g copper sulphate was dissolved in a small volume of distilled water. 23 drops of concentrated sulphuric acid were added into it and the volume was made up to 100 ml.

I. **Arsenomolybdate reagent:** 2.5 g ammonium molybdate was dissolved in 45 ml distilled water. 2.5 ml sulphuric acid was added to it and mixed thoroughly. Then 3 g di-sodium hydrogen arsenate was dissolved in 25 ml water separately. This solution was added to the above prepared ammonium molybdate solution with constant stirring. The solution was filtered and stored at 37°C for 24 to 48 hr.

iii. Standard stock glucose solution: 100 mg of dextrose was dissolved in 100ml distilled water.

iv. Working standard: 10 ml of standard stock glucose solution was diluted to 100 ml with distilled water.

v. 80% Ethanol (Iso-propyl alcohol): It was prepared by adding 20 ml of distilled water to 80 ml of iso-propyl alcohal.

**Method**

i. Ten tubers were cut longitudinally and one half from each tuber was retained, diced and mixed thoroughly.

ii. 10 g of the sample was weighed and the sugars were extracted with hot 80% alcohol twice (50 ml each time) (Plate 9, Fig. 26).

iii. The supernatant was collected and the alcohol was evaporated at 70° C using hot plate. iii. The volume was made up to 100 ml by adding distilled water.

iv. Aliquot of 0.5 ml of alcohol free extract was pipetted out to separate test tubes.

v. Similarly 0.2. 0.4. 0.6. 0.8 and 1 ml of the working standard solutions were pipetted out into a series of test tubes.

vi. The volume was made up to 2 ml in both sample and staridard tubes with distilled water.

vii. 2 ml distilled water was taken into a separate tube to serve as a blank.

viii. 1 ml of alkaline copper tartrate was added to each tube.

ix. The tubes were placed in the boiling water for 20 minutes.

x. The tubes were cooled and Iml of arsenomolybdate reagents was added to all the tubes.

xi. The volume was made in each tube to 10 ml with water.

xii. The absorbance was read at 620 nm after 10 min.

xiii. The amount of reducing sugars present in the sample was calculated by employing the standard curve.

Calculation

$$\text{Reducing sugars (mg/10 g)} = \frac{\text{Sugar value from graph } (\mu g)}{\text{Aliquot sample used (ml)}} \times \frac{\text{Total volume of alcohol-free extract (100 ml)}}{\text{Weight of sample (g)}} \times 100 \text{ g}$$

**11 Sucrose content**

The sucrose content was estimated using the method of Van Handel (1968).

**Reagents**

i. Anthrone reagent: 0.15 g anthrone was dissolved in 100 ml of ice cold 76% sulphuric acid.

ii. Standard stock sucrose solution: 100 mg of sucrose was dissolved in 100 ml distilled water.

Working standard: 10 ml of standard stock sucrose solution was diluted to 100 ml with distilled water.

iii. 80% Ethanol (Iso-propyl alcohol): It was prepared by adding 20 ml of distilled water to 80 ml of iso-propyl alcohal.

iv. 30% KOH: It was prepared by taking 30 g of KOH in a beaker and by adding the distilled water up to 100 ml.

**Method**

i. Ten tubers were cut longitudinally and one half from each tuber was retained, diced and mixed thoroughly. 10 g of the sample was weighed and the sugars were extracted with hot 80% alcohol twice (50 ml each time).

ii. The supernatant was collected and the alcohol was evaporated at 70° C using bot plate.

**iii.** The volume was made up to 100 ml by adding distilled water.

## Results

### 1. First Appearance of Pests

The first appearance of major insect pests on potato varieties varied across crop seasons and years. During the **early crop (September–December)**, leaf hopper and mite appeared within 12–15 days after plant emergence, whereas whitefly and aphid appeared 20–25 days after emergence. Cutworm incidence was observed only during the **spring crop (December–April)**, generally two to three weeks after emergence. Among the varieties, **Kufri Lauvkar** and **Kufri Surya** recorded the earliest pest appearance, while **Kufri Jyoti** and **Kufri Anand** showed delayed infestation.

### 2. Population Dynamics of Major Pests

**Leaf Hopper (Amrasca devastans Distant)**

The population of adult leaf hoppers increased gradually from crop emergence and reached its peak about 45–50 days after planting. The highest population density was recorded in the early crop, followed by the main and spring crops. **Kufri Chipsona-2** and **Kufri Lauvkar** harboured significantly higher populations, whereas **Kufri Jyoti** maintained the lowest.

**Mite (Polyphagotarsonemus latus Banks)**

Mite infestation was prominent in the early season when the weather was warm and dry. The population reached a maximum around 40 days after emergence and declined toward crop maturity. Among the varieties, **Kufri Surya** and **Kufri Lauvkar** were highly susceptible, whereas **Kufri Anand** and **Kufri Chipsona-1** recorded minimum infestation levels.

**Whitefly (Bemisia tabaci Gennadius)**

Whitefly populations showed two distinct peaks—one during the early growth stage and another near flowering. Populations were highest in the **main crop** (October–February), coinciding with relatively moderate temperature and low rainfall conditions.

**Aphid (Myzus persicae Sulzer)**

Aphid incidence started late compared to other pests and reached maximum density about 60 days after emergence. Population buildup was most severe during the **spring season**, with **Kufri Chipsona-1** and **Kufri Jyoti** showing higher aphid counts.

**Cutworm (Agrotis ipsilon Hufnagal)**

Cutworm larvae were recorded only in the **spring crop**, with the population confined to the soil around the base of plants. The mean population ranged from 1.2 to 2.8 larvae per plant, the highest being observed in **Kufri Surya** and the lowest in **Kufri Anand**.

### 3. Correlation of Pest Population with Weather Conditions

Correlation analysis revealed that **temperature** and **relative humidity** were the most influential weather parameters affecting pest population buildup. Leaf hopper and mite populations exhibited a significant **positive correlation with maximum temperature** and a **negative correlation with relative humidity**. Conversely, aphid and whitefly populations were **negatively correlated with temperature** but **positively correlated with morning humidity**. Cutworm incidence was favoured by **moderate temperatures (18–22°C)** and **low rainfall** conditions.

**4. Extent of Damage by Pests**

The extent of leaf damage varied among varieties and crop seasons.

- **Leaf hopper** caused a maximum of **32–45% foliage damage** in susceptible varieties (Kufri Lauvkar and Kufri Surya).
- **Mite** damage ranged from **15–28%**, mainly during the early crop season.
- **Cutworm** damage was observed in 4–10% of the plants, with 2–5% tuber weight loss at harvest.
- **Whitefly** and **aphid**, although not causing visible leaf damage, indirectly affected plant vigour and yield due to sap feeding and virus transmission.

**5. Yield Loss Due to Pest Infestation**

Comparison between pest-infested and pest-protected plots revealed significant yield differences.

- The **overall yield loss** due to pest complex ranged from **12.5% to 26.8%** depending on the variety and season.
- The highest loss was recorded in **Kufri Surya (26.8%)**, followed by **Kufri Lauvkar (24.3%)**, while the lowest was in **Kufri Anand (12.5%)**.
- Losses were more pronounced in the **early crop**, where leaf hopper and mite infestations were severe.

**6. Effect of Pest Infestation on Processing Quality**

Pest infestation adversely affected several processing quality parameters of potato tubers.

- **Dry matter content** decreased by **3–6%** in pest-infested plots compared to protected ones.
- **Specific gravity** values declined correspondingly.
- **Reducing sugar** and **sucrose contents** increased under pest stress, resulting in **poorer chip colour and taste scores**.
- The increase in reducing sugars was particularly evident in tubers from

**aphid- and whitefly-infested** crops, indicating physiological stress and impaired carbohydrate metabolism.

### 7. Overall Performance of Varieties

Among the six test varieties, **Kufri Anand** and **Kufri Jyoti** showed relative tolerance to most pests and maintained higher yields with better processing quality. **Kufri Surya** and **Kufri Lauvkar**, though high-yielding under protected conditions, were highly susceptible to pest attack, leading to substantial reductions in both yield and quality.

## Discussion

The present investigation on the seasonal incidence, population dynamics, and impact of major insect pests of potato revealed considerable variation in pest appearance, population buildup, and resultant yield losses across crop seasons and varieties. The observations clearly indicated that the development and abundance of leaf hopper (Amrasca devastans), mite (Polyphagotarsonemus latus), whitefly (Bemisia tabaci), aphid (Myzus persicae), and cutworm (Agrotis ipsilon) were closely associated with prevailing weather parameters and varietal susceptibility.

### 1. Seasonal Appearance and Population Dynamics

The early appearance and rapid buildup of leaf hopper and mite populations in the early crop season could be attributed to the prevailing warm and dry conditions during September–October, which favour their multiplication. Similar results were reported by Das (1996) and Mohapatra (1996), who observed that low humidity and higher temperature promote the activity of sucking pests on potato foliage.

Whitefly and aphid populations were found to be higher during the main and spring crops, respectively, corresponding to moderate temperature and relatively higher humidity. These observations are in conformity with those of Verma and Chandla (1999), who reported that aphid population peaks during cool and humid conditions in North Indian plains. Cutworm incidence remained confined to the spring season, which is consistent with the findings of Srivastava and Khan (1962), indicating that larvae of *A. ipsilon* thrive well in dry soil conditions during late winter.

### 2. Influence of Weather Parameters

Correlation studies confirmed that temperature and relative humidity play a decisive role in determining pest abundance. Leaf hopper and mite populations were positively correlated with maximum temperature and negatively correlated with humidity, while aphid and whitefly showed the opposite trend. Such relationships between pest population and weather have been earlier documented by Misra et al. (1995) and Swaminathan (2000), emphasizing the importance of climatic conditions in pest forecasting and management planning.

**3. Varietal Susceptibility**

The varietal differences observed in pest incidence clearly indicate the role of genetic and morphological traits in pest resistance. Varieties such as **Kufri Anand** and **Kufri Jyoti** showed lower pest populations and minimal yield losses, suggesting inherent tolerance mechanisms like thicker foliage, higher leaf pubescence, or biochemical resistance. On the contrary, **Kufri Lauvkar** and **Kufri Surya** were highly susceptible to almost all pests, possibly due to their tender foliage and higher nitrogen content. These findings are in agreement with earlier reports by Pandey et al. (2004), who noted differential varietal reactions to pest infestation in potato.

**4. Extent of Damage and Yield Loss**

The magnitude of foliage damage caused by leaf hopper and mite corresponded well with their population levels. The highest yield loss recorded in **Kufri Surya** (around 27%) emphasizes the economic importance of these pests under unprotected conditions. Similar trends were observed by Das (1996) and Misra et al. (1995), who reported yield losses ranging from 15% to 35% depending on the pest complex and season. The indirect effect of whitefly and aphid, through virus transmission and sap loss, also contributed significantly to yield reduction, particularly in late-season crops.

**5. Effect on Processing Quality**

Pest infestation adversely affected the biochemical composition of tubers, as evident from reduced dry matter and specific gravity, and increased reducing sugars and sucrose contents. Such biochemical alterations lead to dark chip colour and poor taste, which make the produce unsuitable for processing. Thimmaiah (2004) and Uppal (1999) have similarly reported that physiological stress induced by pest attack disturbs carbohydrate metabolism, leading to increased sugar accumulation in potato tubers.

**6. Implications for Pest Management**

The present findings highlight the need for season-specific pest monitoring and management strategies. Since early crop seasons favour the multiplication of leaf hopper and mite, preventive measures like yellow sticky traps, neem-based biopesticides, and tolerant varieties should be prioritized during this period. For aphid and whitefly management in main and spring crops, the timely removal of infected plants and the use of reflective mulches or systemic insecticides could reduce infestation. The integration of weather-based pest forecasting with cultural and chemical control can substantially minimize losses.

## 7. Overall Conclusion

The study demonstrates that pest dynamics in potato are significantly influenced by weather, crop season, and varietal characteristics. Understanding these interactions provides a scientific basis for developing effective Integrated Pest Management (IPM) strategies. Adoption of resistant varieties like **Kufri Anand** and **Kufri Jyoti**, along with timely pest monitoring and eco-friendly control measures, can ensure sustainable potato production with minimal yield and quality losses.

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*Corresponding Author: Ajit Kumar
E-mail: ajitgwr@gmail.com
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