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Surveillance for potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelichiidae) in Kolar and Chikkaballapur district of Karnataka

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Abstract
Potato tuber moth (PTM), *Phthorimaea operculella* Zeller has become one of the most serious insect pests of potato (*Solanum tuberosum* L.) around the world, including in India. Field studies were conducted against PTM in *Rabi* seasons during 2019-20 in four and two taluks of Kolar and Chikkaballapur districts of Karnataka, respectively to understand the extent of foliage damage and leaf mines. Mean per cent infestation of PTM and number of mined leaves per plant during *Rabi* season of survey were highest with 4.47% and 8.31 mined leaves in Kolar district and it was least in Chikkaballpur district (2.51% and 2.95), respectively. Number of mines per plant was observed lowest (5.09) in Kolar district compared to Chikkaballapur district with 5.24 mines per plant. The above damage parameters like per cent PTM infestation and number of mined leaves per plant were not differed significantly whereas number of mines per plant was significantly different in Chikkaballapur district. On the other hand, all the damage parameters were significantly differed in Kolar districts during the survey in *Rabi* season 2019-20. In recent years, the temperature has been steadily rising due to climate change, and it is predicted that the occurrence of the PTM will continue to increase in the future. Therefore, the development of control technologies and intensive monitoring will be necessary for stable potato production as well as potato post-harvest.

Keywords: Potato tuber moth, *Phthorimaea operculella*, Survey, Kolar and Chikkaballapur.

Introduction
Potato (*Solanum tuberosum* L.) is a root vegetable native to America, a starchy tuber of the plant and a perennial in the family of Solanaceae. The potato is a staple food belonging to the tuber and root family and its one of the top four crops in the world after rice, wheat and maize (Ross, 1986; Douches *et al*., 2004) [9, 2]. Potato is an essential food in developing countries claiming fourth place after rice, wheat, corn. These countries produce approximately one-third of the worldwide production of potato. It is a fat-free food containing protein, vitamins, and minerals (Meyhuay, 2001) [7]. Unfortunately, severe losses may occur in storage, especially in the developing countries where, low-income farmers cannot afford cold storages.

A worldwide pest of potatoes is a major challenge that farmers are facing as they are intensifying their production techniques to satisfy the increasing demands of the international market. Among them, potato tuber moth (PTM), *Phthorimaea operculella* Zeller is a major pest of potato throughout the world, but prefer sub-tropical, tropical and Mediterranean climates. It is also known as potato tuber moth, potato tuber worm, potato tubeworm moth, potato moth, potato leaf miner, tobacco split worm and tobacco leaf miner. It is an oligophagous pest, feeds on crops belonging to the family Solanaceae (mainly potato, tomato, tobacco, brinjal, bell pepper, cape-gooseberry and other solanaceous weeds like black night shade, datura etc.). Earlier it was a minor pest of tobacco for more than 100 years, but recently over last five years in North Carolina, it has emerged as a problem in tobacco plantings. Also, it has been reported in tropical, subtropical and Mediterranean agro-zones (Flanders *et al*., 1999; Golizadeh and Esmaeili, 2012) [3, 5, 5].

PTM is the most economical potato pest in the mid-hills and plateau areas of India causing severe damage particularly in rustic, non-refrigerated stores during summer. Nearly 90 per cent of the production is kept in stores after harvesting.

Storage facilities are traditional, non-refrigerated, low cost "*kutcha*" stores allowing free access of PTM to stored potatoes. PTM damage in stores depends mainly on tuber infestation at harvest. Infected tubers brought into traditional stores are the primary source of infestation. Without control measures, tuber infestation can reach up to cent per cent (Chandel *et al*., 2001) [1]. Farmers depend heavily on non-selective pesticide applications to reduce storage losses from PTM. There is concerned to reduce pesticide usage and finding alternate control strategies and to integrate them for effective management of pest. Temperature is an important factor in the survival rate and development of PTM, so they are typically found in warmer climates, preferring subtropical and tropical habitats.

Materials and methods

The survey taluks were initially selected based on major potato cultivation areas. In total, 16 potato fields were surveyed in the four taluks and eight potato fields in two taluks of Chikkaballapur district of Karnataka in *Rabi* season (December to March) during 2019-20. Extents of damage in terms of per cent incidence are recorded for PTM. In each taluk, two villages were selected at random and in each village two plots were selected at random. From each plot, 10 plants at random were observed for detailed pest incidence. The extent of damage due to PTM was recorded in terms of number of leaves mined or number shoots bored or number of tubers damaged.

Per cent incidence was calculated by using the formula fodder collection.

$$\text{\% incidence} = \frac{\text{Number of plants infested}}{\text{Total number of plants observed}} \text{x } 100$$

For observations on tuber moth at each location, one meter row was randomly selected at three different sites in the field and observed for number of shoots showing mining symptoms and later calculated the per cent incidence.

Statistical analysis

All the collected data were précised and suggested to analysis of variance (ANOVA) for Complete Randomized Block Design (CRBD) using the OPSTAT analysis at 5 per cent level of significance after necessary transformations are required.

Results and discussion

4.1 PTM infestation in Kolar district during Rabi-2019-20

Survey in Kolar district during *Rabi*-2019-20 revealed that, minimum mean infestation by PTM was in Chowdadenahalli village of Malur taluk with 0.50 per cent infestation. Infestation was maximum (5.79%) in Tamaki (Kolar taluk), Chakanahalli (Malur taluk) and Marakalagatta (Mulabagal taluk) villages. There was significant difference among the surveyed villages, in terms of per cent infestation by PTM during 2019-20. The overall infestation by PTM in Kolar district was4.47 per cent (Table 1). It was significantly least (3.14%) infestation in Malur taluk compared to rest three taluks.

The number of mined leaves per plant ranged from a minimum of 2.00 (Chowdadenahalli village) to a maximum of 10.80 (Chakanahalli village) mined leaves per plant which varied significantly. Among taluks, it ranged from 4.18 (Bangarpet) to 7.65 (Mulabagal) mined leaves. There was no significant difference in terms of mined leaves per plant among the four taluks of Kolar district during *Rabi*-2019-20 (Table 1).

The number of mines per plant due to PTM infestation ranged from 3.00 (Gaddekannur village of Kolar taluk) to 8.50 mines per plant (Tamaka village of Kolar taluk) (Table 1). There was no difference statistically among the taluks of Kolar district and it ranged from 3.99 (Malur taluk) to 6.38 mines per plant (Banghart taluk).

PTM infestation in Chikkaballapur district during Rabi-2019-20

Survey in four villages and two taluks of Chikkaballapur district during *Rabi*-2019-20, there was no significant difference in terms of per cent infestation. It was minimum in Someshwara (1.98%) and maximum in Gyadarahalli (3.28%) villages of Gudibande taluk. Among the taluks, least infestation was in Chikkaballapur taluk and highest in Gudibande taluk with 2.39 compared to 2.63 per cent infestation, respectively (Table 2). The minimum and maximum number of mined leaves per plant was recorded in Someshwara village (Gudibande taluk) and Doddapyalagurki village (Chikkaballapur taluk) with 2.64 and 3.46 mined leaves per plant, respectively. Among the two taluks, Chikkaballapur and Gudibande taluks witnessed least and highest number of mined leaves per plant with 2.82 and 3.09 mined leaves, respectively (Table 2) and statistically there was no significant difference between them.

When the total mines per plant due to PTM infestation was considered, again there was no difference statistically observed during *Rabi*-2019-20 in Chikkaballapur district. It varied from 4.00 mines per plant in Gowdanahalli village to 5.60 mines per plant in Gyadarahalli

Table 1: Extent of damage by potato tuber moth, *P. operculella* in Kolar district during *Rabi*-2019-20

Taluk	Village	Per cent infestation by PTM*		No. of mined leaves / plant**		No. of mines / plant**	
		Per village	Per taluk	Per village	Per taluk	Per village	Per taluk
Kolar	Gaddekannur	4.50 (12.24)	5.15 (13.11)	6.28 (2.76)	7.64 (3.01)	3.00 (1.98)	5.75 (2.65)
	Tamaka	5.79 (13.92)		9.00 (3.25)		8.50 (3.17)	
Malur	Chakanahalli	5.79 (13.92)	3.14 (10.20)	10.80 (3.54)	6.40 (2.78)	4.22 (2.30)	3.99 (2.25)
	Chowdadenahalli	0.50 (4.05)		2.00 (1.66)		3.75 (2.19)	
Mulbagal	Avani	3.69 (11.07)	4.74 (12.57)	7.00 (2.90)	7.65 (3.02)	3.29 (2.06)	4.23 (2.31)
	Marakalagatta	5.79 (13.92)		8.29 (3.13)		5.17 (2.52)	
Bangarpet	Badamakanhalli	4.50 (12.24)	4.85 (12.72)	2.25 (1.75)	4.18 (2.29)	6.00 (2.70)	6.38 (2.78)
	Mittahalli	5.19 (13.16)		6.11 (2.72)		6.76 (2.85)	
Mean		4.47		8.31		5.09	
S.Em(±)		0.59		0.47		0.36	
CD		1.78		1.39		1.05	

Table 2: Extent of damage by potato tuber moth, *P. operculella* in Chikkaballapur district during *Rabi*-2019-20

Taluk	Village	Per cent infestation by PTM*		No. of mined leaves / plant**		No. of mines / plant**	
		Per village	Per taluk	Per village	Per taluk	Per village	Per taluk
Chikkaballapur	Gowdanahalli	2.03 (3.16)	2.39 (8.90)	2.71 (1.90)	3.09 (2.01)	4.00 (2.25)	4.88 (2.46)
	Doddapyalagurki	2.75 (6.24)		3.46 (2.11)		5.75 (2.65)	
Gudibanda	Someshwara	1.98 (3.01)	2.63 (9.33)	2.64 (1.87)	2.82 (1.93)	4.71 (2.42)	5.61 (2.62)
	Gyadarahalli	3.28 (9.20)		3.00 (1.98)		6.5 (2.80)	
Mean		2.51		2.95		5.24	
S.Em(±)		0.25		0.30		0.29	
CD		NS		NS		0.90	

village. Among the taluks of Chikkaballapur district, it varied from 4.88 in Chikkaballapur to 5.61 mines per plant in Gudibande (Table 2).

An intensive survey for the incidence of PTM on potato crops across 37 locations of South Korea during 2009-12 revealed that, the pest had expanded by 200 km into the northern parts within three decades. The main factor contributed for the expansion of PTM distribution was, increase in the mean temperature by approximately 0.9 °C during that time (Kwon *et al*., 2017) [6]. Potato tuber moth was prevalent throughout Nepal excluding three districts of high hill zone and was more predominant in mid-hills (March to October) compared to plains (March to July) (Giri *et al.*, 2014) [4]. They have made year-round pheromone trap caches to establish a sound basis for its management as the pest is spread throughout Nepal.

Rowing surveys conducted in Hassan district during *Kharif* 2016 and 2017 revealed no PTM infestation during vegetative stage. While at reproductive stage, the infestation was 0.23 larvae per plant during both 2016 and 2017 seasons with 3.94 and 4.33 per cent tuber infestation, respectively which further advanced at harvesting stage (5.28 and 7.08%, resp.) (Natikar and Balikai, 2018) [8].

Compared to the infestation reported by Natikar and Balikai (2018) [8], the infestation level of PTM in Hassan district during *Kharif*-2019 is very low which may be due regular and intermittent rains during the cropping period, compared to 2016 and 2017 cropping seasons. The regular and intermittent rains have restricted the pest buildup besides the heavy incidence of late blight. There was absolutely no tuber infestation documented during *Kharif*-2019 in Hassan district, it may be for lack of pest buildup during vegetative and reproductive stages due to intermittent rains.

Moreover, it has been documented that the Hassan potato fields were rich with diversity and density of insect natural enemies (Natikar and Balikai, 2018) [8]. The present documentation of PTM infestation on foliage and tubers forms the first of its kind from Kolar and Chikkaballapur districts which are relatively newer to potato.

Besides the cropping area of potato is being shrinking but, the season of cultivation is shifting to *Rabi* to harness various situations like locally available seed tubers, reduced blight incidence compared to *Kharif* crops and a relatively higher market price. In this background, regular monitoring of PTM incidence is the need of the hour, as the farmers being spraying a lot of insecticides along with fungicides unknowingly for the management of late blight. From the studies it was evident that, improvising the monitoring tools with pheromone traps is needed and should be on a regular basis to forewarn the PTM outbreak to suggest the suitable mitigation measures.

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