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EFFECTIVENESS OF *BACILLUS THURINGIENSIS* SUBSP. KURSTAKI (BTK) AND DRIED *LANTANA CAMARA* L. FOLIAGE AGAINST POTATO TUBER MOTH (*PHTHORIMAEA OPERCULELLA*) UNDER LOCAL STORAGE CONDITION OF MEGHALAYA

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ABSTRACT: Potato Tuber Moth (PTM), *Phthorimaea operculella* (Zeller) is an important and widely distributed pest in field and stores in mid and high hills of Hindu Kush Himalayas of India, Nepal, Bhutan and Afghanistan. It causes huge economic losses to both table and seed potato. Seed potato in farmers' stores were subjected to two different doses of talcum-based *Bacillus thuringiensis* subsp. kurstaki (Btk), and chopped and dried *Lantana camara* shoots in three different locations in East Khasi Hills district of Meghalaya, India. All the treatments were significantly effective in reducing the incidence of PTM over control. Tubers treated with Btk doses 30g and 60g/kg of talcum had 14% and 64% fewer mines at Nongwah, 50% and 46% at Wahlyngkien and 67% and 63% at Mawgap over control. Tubers treated with *L. camara* showed 86%, 37% and 87% lesser mines over control at all the three locations which were statistically significant. The mines were very superficial in tubers treated with Btk as compared to those covered with Lantana and control. The use of Btk and *Lantana camara* as organic approach for managing PTM have been discussed.

KEY WORDS: *Bacillus thuringiensis*, *Lantana camara*, Potato Tuber Moth, potato, storage, Meghalaya, India

INTRODUCTION

Meghalaya produce 214,620 tonnes of potato in an area of 19,449 hectares with an average productivity of 11.0 t/ha which is well below the national average of 22.3 t/ha (DoH 2017). The East Khasi Hills district alone contributes 64% and 67% of total area and production of the State, respectively (FAO, 2017). Many insect pests cause damages to potato crop in Meghalaya but the damage to standing crop and stored potato is primarily (up to 70%) caused by Potato Tuber Moth (PTM) (Lal 1990). Farmers are compelled to store seed potato for subsequent season in the households. The prevailing temperature remains congenial for PTM and provides an excellent environment for PTM to complete several life cycles, and this represents a serious threat to stored seed tubers. However, potato growers in East Khasi Hills do not take any measures to control PTM in field and stores resulting in huge loss (Kadian *et al*., 2010).

In response to the Meghalaya's call for organic farming, International Potato Center (CIP) in collaboration with the Meghalaya Basin Development Authority (MBDA) has tested the effectiveness of some bio-agents. Several plants and plant parts, botanicals and bio-agents have been tested to control PTM population in the past as an alternative to reduce hazardous chemical insecticide use (Saour *et al*., 2017). Sorted and graded seed tubers were subjected to *Bacillus thuringiensis*

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subsp. kurstaki (Btk) under the commercial name of Lipel®. For uniform application and best result, dust formulation is commercially produced for the protection of PTM in several countries (Schuab and Kroschel, 2017). Dust formulation of Btk with different base substances or Bt commercial product Dipel® @15g mixed with one kg of talcum for protecting 200 kg of seed potatoes in the stores was recommended (Lancey and Kroschel 2009). Similarly, the efficacy of Btk was reported against PTM infestation (Arthurs *et al*., 2008). The powdery surface of the treated seed tuber contributes to the protection against the PTM, by inhibiting the adult to settle and lay eggs Mariy et al., 2000. In addition to the bacterium, previous research showed that dried *Lantana camara* leaves can also be used to protect from PTM infestation in stores. The PTM infestation can be reduced by 97.3 percent with Lantana extracts (Mariy *et al*., 2000). With the objective of comparing the Btk and lantana efficacy at villages of different altitudes of Meghalaya to protect against PTM was conducted at various locations.

MATERIALS AND METHODS

The seed was treated with Btk using plastic gunny bags to mix the tubers with the talcum-based formulations homogeneously. The fresh Lantana shoot was cut into small pieces (3-5 cm) and shade dried for 4-5 days prior to application. 50kg of seed tubers were covered uniformly with 1.5 kg of dried foliage of Lantana in each store. All the experimental stores were cleaned, and left-over tubers from previous storage season were discarded prior to storing sorted and graded seed.

The tuber infestation rate was measured by randomly sampling 100 seed tubers by observing larval excrement (frass) over the tubers. The infestation intensity was measured by counting the number of mines present in the tubers at the end of the storage *i.e*., during January 2019.

RESULTS AND DISCUSSION

The treatment 30g Lipel®/kg of talcum had significantly lower infestation *i.e.*11, 67 and 71 percent lower infestation as compared to control at Nongwah, Wahlyngkien and Mawngap villages, respectively (**Fig 1**). The seed treated with 60g Lipel®/kg of talcum got significantly higher protection with 56, 73 and 73 percent lower infestation of tubers as compared to control (**Table 1**). In terms of infestation intensity, the seed tubers treated with Lipel® *i.e.* 30g and 60g/kg of talcum presented 14, 64, 50 percent and 46, 67 and 63 percent fewer mines at the end of storage than control at Nongwah, Wahlyngkien and Mawngap villages, respectively (**Table 1**). The mines increased progressively until December and thereafter ceased because of extremely low temperature during January **(Fig 2).** The mines were found very superficial in the seed treated with both doses of Lipel® as compared to control and also the seeds treated with dried lantana shoot.

Lantana also provided significant protection against PTM *i.e.* 91, 41 and 87 percent lower infestation rate than control at Nongwah, Wahlyngkien and Mawngap villages, respectively (**Table 1**). However, the average PTM infestation and intensity were significantly higher at Wahlyngkien as this village is located at lower altitude where the warmer temperature favours the larval multiplication at faster rate. At the end of the storage period, Lantana treated seed potatoes presented 86, 37 and 87 percent fewer mines compared to control at Nongwah, Wahlyngkien and Mawngap villages (**Table 1**). The seed tubers treated

with the dried Lantana shoots showed lower infestation intensity than those treated with reformulated Lipel® at Nongwah and Mawngap villages but more mines were noticed at Wahlyngkien due to the higher temperatures during storage **(Fig 2)**.

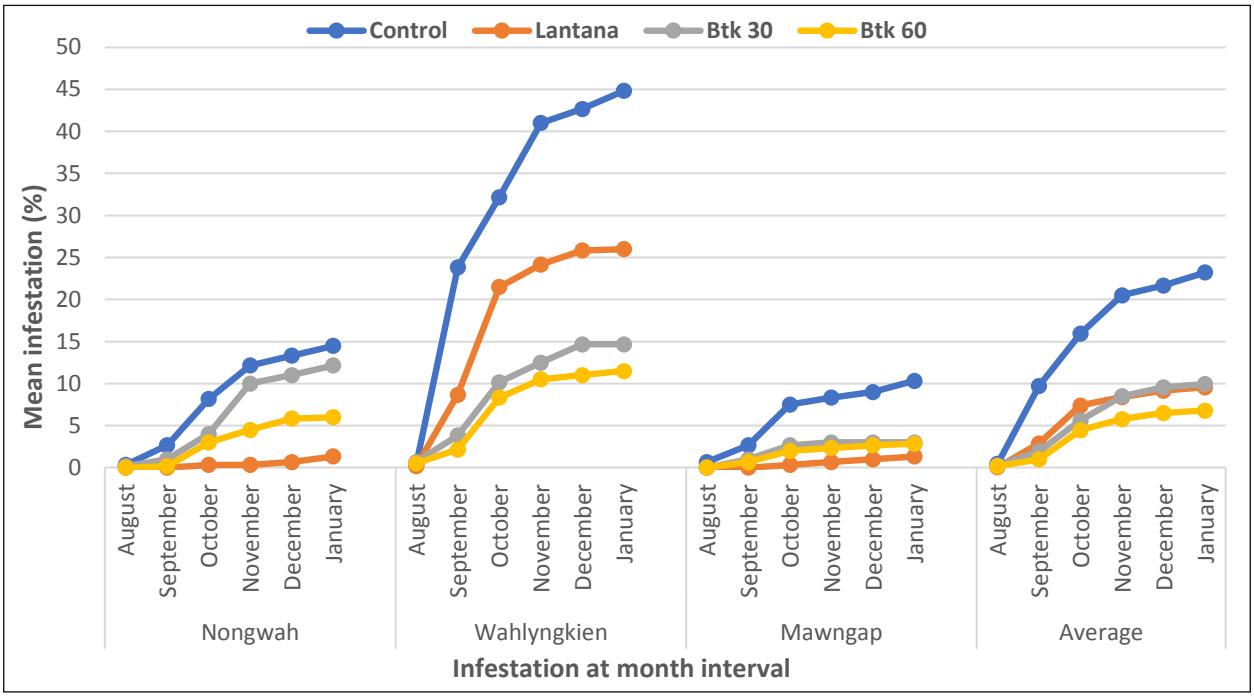

Fig 1: Infestation of PTM at different villages during the storage period

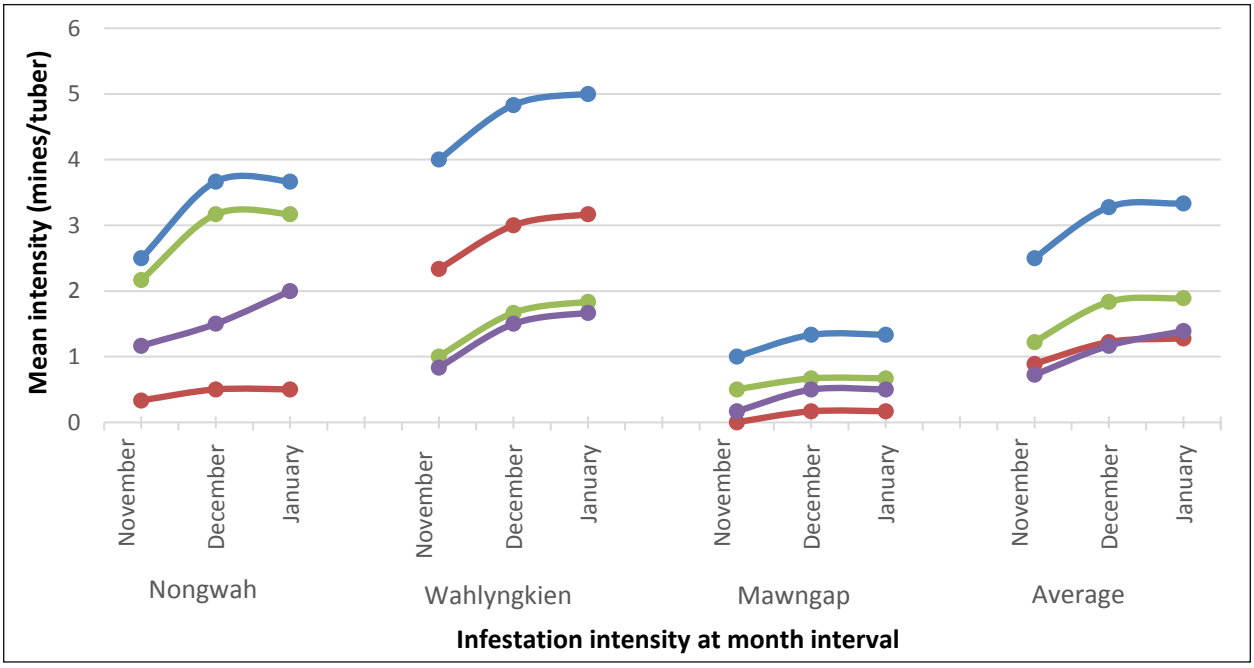

Fig 2. Average number of mines in the last three months of storage

Table 1. Mean infestation and infestation intensity at the end of storage period

Treatment	Percent tubers infestation during January			Percent infestation intensity during January		
	Nongwah	Wahlyngkien	Mawngap	Nongwah	Wahlyngkien	Mawngap
Control	14.50 (22.38)[a]	44.83 (42.03)[a]	10.33 (18.75)	3.67 (11.04)[a]	5.00 (2.35)[a]	1.33 (1.35)
L. camara	1.33 (6.63)[b]	26.00 (30.66)[ab]	1.33 (6.63)	0.50 (4.05)[b]	3.17 (1.91)[ab]	0.17 (0.82)
30g Lipel®/kg talcum	12.17 (20.41)[a]	14.67 (22.52)[b]	3.00 (9.97)	3.17 (10.25)[a]	1.83 (1.53)[b]	0.67 (1.08)
60g Lipel®/kg talcum	6.00 (14.18)[ab]	11.50 (19.82)[b]	2.83 (9.69)	2.00 (8.13)[a]	1.67 (1.47)[b]	0.50 (1.00)
SEM ±	3.15	4.67	2.73	0.17	0.17	0.11
CD (p= 0.05)	9.51	14.07	8.22	0.52	0.50	0.32
CV %	57.79	45.31	106.85	27.42	24.22	27.66

*Significant; Figures within parenthesis indicate the square root x+0.5 transformed value

CONCLUSION

The PTM infestation rate can be significantly reduced by treating seed potatoes with recommended dose of Btk before storage or by covering the tubers with dried shoot of *Lantana* immediately after the entry in the country stores. Furthermore, Btk and Lantana have been proven to be highly effective in reducing the PTM intensity rate. Several researchers have tested the dried shoots of Lantana as PTM repellent (Thakur and Chandla, 2013) under the rustic storage conditions. Therefore, these bio-agents offer major opportunities to support local farmers in their ongoing effort to shift towards organic farming. However, the effectiveness of the treatments is highly dependent on the climatic conditions and therefore recommendations of the best performing treatment should be location specific. This also calls for additional research to identify the most effective and cost-efficient combination of treatments to manage the utmost damaging potato insect pest in north-eastern India.

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REFERENCES

Anonymous (2017) District wise area, production and yield of horticultural crops for 2016-17, Directorate of Horticulture (DoH), Meghalaya, Shillong

Anonymous (2017) Food and Agricultural Organization of the United Nations (http://www.fao.org/faostat/en/#data/QC)

Lal L (1990) Insect pests of potato and their status in north-eastern India. University Library, University of the Philippines at Los Baños

Kadian MS, NE Lotha, BH Girish, S Ilangantileke, O Ortiz, U Sah, S Kumar, SK Pandey and S Dkhor (2010) A Baseline study on potato seed production systems in Meghalaya and Nagaland states of Northeast India. International Potato Center (CIP), Lima, Peru. Working Paper 2010-2. 21 p

Saour G, Al-Mariri A and Hashem A (2016) Evaluation of Bacillus thuringiensis cultured in waste water sludge against potato tuber moth (Lepidoptera: Gelechiidae) *Entomolagia Generalis* 36(**2**) 149-161

Schuab G and Kroschel J (2017) Developing a biocontrol strategy to protect stores potato tubers from infestation with potato tuber moth species in the Andean region. *Journal of Applied Entomology*, 142: 78-88

Lacey L and Kroschel J (2009) Microbial control of the potato tuber moth (Lepidiptera: Gelechiidae). *Fruit, Vegetable and Cereal Science and Biotechnology*, 3, 46-54

Arthurs SP, Lacey LA, Pruneda JN and Randon SI (2008) Semi-field evaluation of granulovirus and

Bacillus thuringiensis ssp. kurstaki for season-long control of the potato tuber moth, Phthorimaea operculella. *Entomol Exp Appl* **129:** 276-85

Mariy FMA, El-Sadaany GB, El-Wahed MSA and Ibrahim MY (2000) Efficacy of some biocides, plant extract and mass trapping on potato tuber moth. *Ann Agric Sci* **4:** 1511-19

Thakur M and Chandla VK (2013) Evaluation of biopesticides for potato tuber moth control Phthorimea operculella (zeller) under polyhouse and rustic storage conditions. *Potato Journal* 40 (2): 135-141