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# Evaluation of the efficacy of some management tactics against tomato fruitworm *Helicoverpa armigera* (Hubner) in Nangarhar, Afghanistan

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**Abstract**
Tomato is an economically important vegetable grown worldwide for fresh fruits and processing. This vegetable is attacked by a variety of serious insect pests that greatly reduce the yield. Tomato fruitworm is a destructive pest of this crop which causes great losses in tomato yield. The application of conventional insecticides is one of the most commonly measures practiced by farmers to control this pest. However, insecticide application causes a number of serious problems in human health, environment, and economy. A possible solution to the problems is the adoption of the integrated pest management (IPM) tactic. In the present study, a number of environmentally safer pest management options and safer insecticides were tested against tomato fruitworm in open field tomato. In total, 6 treatments including control were evaluated using Randomized Complete Block (RCB) design with each treatment replicated three times. The results showed a varying degree of fruit damage caused by tomato fruitworm in different treatments on different dates. Although all the tested materials reduced fruit damage to some extent, the damage observed in the treatments with emamectin benzoate and spinosad was lower than in the control plot, suggesting the effectiveness of these insecticides for the control of tomato fruitworm. Potential of considering these insecticides under IPM program is discussed.

**Keywords:** *Solanum lycopersicum* L., tomato fruitworm, *Helicvoerpa armigera*, integrated pest management, yield

## 1. Introduction

Tomato (*Solanum lycopersicum* L.) is the second most consumed vegetable in the world after potato. It is a native to Latin America, and was introduced to Europe in the early sixteenth century (Bai & Lindhout, 2007). [2] Tomato is rich source of minerals and vitamins and provides many health benefits (Dorais, *et al*., 2007; Giovannucci, 1999) [14]. This vegetable is produced on a large scale globally. China was the top country with a harvested quantity of 50.0 million tons in 2012, followed by India of 17.5 million tons and the USA of 13.2 million tons. These countries contributed 49.9 % of the total world tomato production in 2012 (Testa, *et al*., 2014) [32]. Tomato is also grown in Afghanistan, especially in the eastern zone both at a commercial and home consumption scale. It is a good source of income for Afghan farmers, although its productivity seems to be lower in Afghanistan.

Tomato is one of the most vulnerable crops against pest attacks both in the field and after harvest. Despite the crop protection techniques practiced presently, the persistent losses of crop production worldwide remains a matter of grave concern (Dhaliwal, Jinadal, & Dhawan, 2010). [7] Throughout it growing season, tomato is attacked by a variety of insect pests and diseases, greatly reducing its yield Clark, *et al*., 1997; Gajanana, *et al*., 2006 [21]; Nault & Spees, 2001 [18]. The tomato furitworm, Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae) a worldwide distributed insect (Darren, 2015), is one of the most destructive pests of this vegetable, and can cause a loss of 20-60 % (Ravi, 2008) [24].

The damage caused by the tomato fruitworm adversely affect the height of plants, number of leaves, weights of fruits and yield (Singh, *et al*., 2017) [18]. To control this pest, farmers overly rely on insecticides application. These insecticides usage is detrimental to environment, human health and economy (Joshua, 2016; Pementel, 2005; Sande, *et al*., 2011; Sheikh, *et al*., 2011; Wasim *et al*., 2009) [34]. Furthermore, the tomato fruitworm has been reported to have already developed resistance against some of the commonly used insecticides (Martin, 2002; Srinivas, 2004) [30]. Thus, in order to minimize the problems stated, there is a stringent need to determine and test environmentally safer and effective pesticides for the control of *H. armigera* in the context of Afghanistan which could be incorporated in the integrated pest management program.

Integrated pest management (IPM) is a promising strategy aimed at reducing pesticide application and enhancing crops production. This strategy seeks simultaneous management of multiple pests by combining a variety of pest control tactics (Ehler, 2006) [9], leading to the control of pests in such a way that is more eco-friendly, economic and healthy. A number of studies have been conducted on IPM practices in tomato fields in the world Picanco, *et al*., 2007 [21]; Gajanana, *et al*., 2006 [21]; Pottorff, 2009 [23]; Motta, *et al*., 2005 [17]; Trumble & Rodriguez, 1992 [33]. For instance, Reddy & Tangtrakulwanich (2014) [25] have found a significantly higher yield in the fields of tomato where IPM packages like biopesticide and neem oil were applied compared to traditional insecticides and the control plot. However, no studies have been conducted in Afghanistan to evaluate safer pest control options against tomato fruitworm which could be compatible with IPM. Therefore, we aim at the present study to evaluate the efficacy of some newer and safer pesticides as a control option against tomato fruitworm in Afghanistan.

## 2. Materials and Methods

### 2.1 Field design and lay out

The study was carried out at the agricultural experiments farm of Nangarhar university, located in Daronta, Nangarhar, Afghanistan in 2018. The experimental plots were laid out in a randomized complete block design (RCBD) comprising six treatments including control with each treatment replicated three times.

### 2.2. Materials used

In total, there were six treatments including control plot as shown in the table 1. Each treatment was replicated three times. Weed control in the experimental plots was performed mechanically and irrigation took place as needed in accordance with the local agronomical practices. The treatments were applied in the field using a knapsack sprayer at the first appearance of the pest insect. Care was taken to avoid pesticides drift from one experimental unit to the other.

**Table 1**: Set of material assessed in different treatments

| No. | Treatment | Material applied |
|---|---|---|
| 1 | T1 | Emamectin benzoate |
| 2 | T2 | Spinosad |
| 3 | T3 | Fenvalerate (Belt SC 480) |
| 4 | T4 | Cypermethrin |
| 5 | T5 | Metaguard (bio-agent) |
| 6 | Control | No intervention, water only |

### 2. 3. Data collection, sampling and statistical analysis

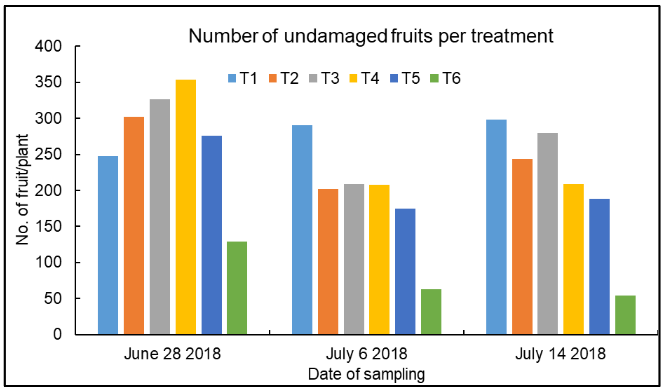
The data on the study were collected on a time interval soon after the appearance of tomato fruitworm. Five plants were randomly chosen from each plot and the number of damaged fruits, undamaged fruits, weight of the damaged fruits and undamaged fruits was recorded. Observations were recorded on a data collection sheet. Subsequently, the data collected during the survey were summarized and calculation was done using Microsoft excel.

## 3. Results and Discussion

### 3. 1. Fruit damage:

There was different level of fruit damages by H. armigera according to the different treatments, figure 3. As shown in the graph, the fruit damage caused by tomato fruitworm was higher in the control plot where no treatment was applied compared to all five treatments during every sampling date figure 3, B. Although the number of undamaged fruits was to some extent close to each other in all five pest control methods, emamectin benzoate has shown somehow better results followed by spinosad indicating the effectiveness of these treatments in the control of tomato fruitworm.

**Fig 2:** Pest occurrence observed during the field survey and data collection



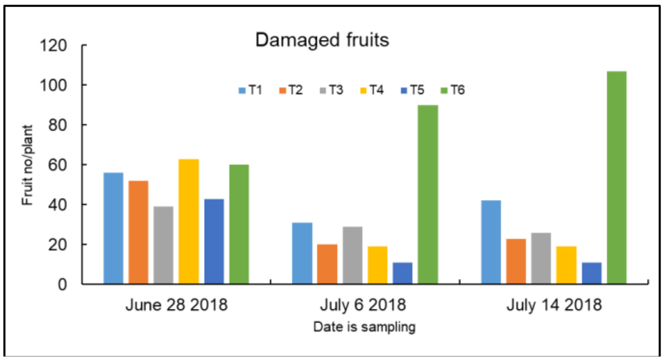




**Fig 3:** Number of intact (A) and damaged (B) fruits observed in different treatment on various sampling dates.

**3.2. Fruit weight loss:** In accordance with the number of fruits damaged, the weight of damaged fruit was higher in the control plot in comparison with all five treatments. Although the weight of undamaged fruit was relatively higher in treatment 5 still the difference does not seem to be very high. Similarly, the weight of undamaged fruits has consistently remained lower over the sampling period in relation to the treatments, showing the efficacy of the treatments used, figure 4.

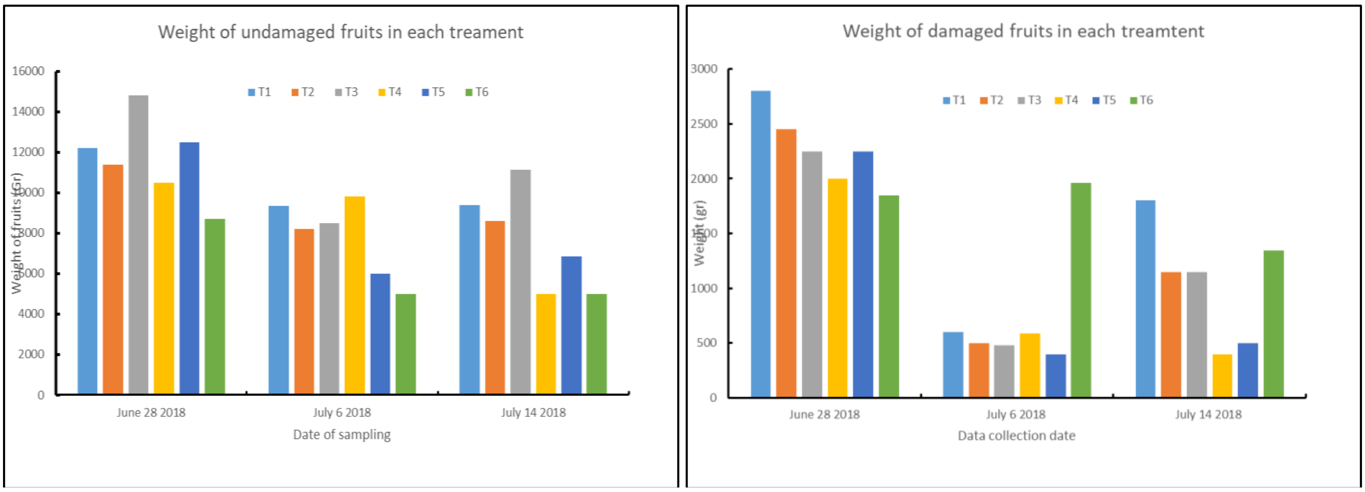



**Fig 4:** Weight of intact (A) and damaged (B) fruits recorded in different treatments on various sampling dates.

## 4. Discussion

Tomato fruitworm is a destructive pest of tomato and causes severe yield loss. In an effort to determine a promising, safer and effective pest control option for this pest, a number of treatments were evaluated for their efficacy. The results revealed a varying degree of tomato fruitworm damage in different treatments indicating the effectiveness of the treatments used. These results are in concordance with other studies Amjad Usman, 2015 [1]; Patil *et al*., 2018 [20]; Deshmukh *et al*., 2010 [6]; Gadhiya *et al*., 2014 [11]; Singh *et al*., 2012 [29], who have reported significant effects of different control options used for the control of *H. armigera*.

The number of damaged fruits and weight was higher at beginning of the survey. This relatively higher number of damaged fruits and fruit weight at the beginning of the survey might be because of the time interval after the application of the treatments since the first survey was conducted soon after the treatments were applied. However, in the second survey the number of damaged fruits greatly decreased, revealing the impact of the treatments.

Out of the treatments tested, emamecting benzoate was more effective followed by spinosad. The results conform to those reported by Dagar & Kumar (2018) [4] who have found emamectin benzoate effective in terms of its larvicidal and antifeedant activities against *H. armigera*. Emamectin benzoate is selective against tomato fruitworm, employing of which can confront non-target effects making it suitable to be included in the IPM programs. Furthermore, emamectin benzoate is reported to significantly reduce the fecundity of *H. armigera* population (Parsaeyan *et al*., 2013) [19], making it an effective control agent for *H. armigera*. Deploying this insecticide can confront the issue of pest resistance and resurgence (Fanigliulo & Sacchetti, 2008) [10].

Our study also suggests that efficacy of spinosad for the control of tomao fruitworm which is an agreement with those reported by Singh *et al.* (2012) [29] who have found this insecticide to effectively control tomato fruitworm. This insecticide is slightly to moderately toxic and is safer for beneficial organisms and environment (Mossa *et al*., 2018; Gentz *et al*., 2010) [13], making it further important to be included in integrated pest management program. Both of these insecticides can be recommended to be used on farm level in Afghanistan to control the tomato fruitworm. Future studies are needed to look into the cost-benefit ratio of these control option more precisely.

## 5. Conclusion

The results of the present study clearly demonstrated the effectiveness of the tested material for the control of tomato fruit worm under open field condition. In general, the amount of damage recorded in control plot was greater compared to the treated plots, demonstrating the efficacy of the tested treatments against tomato fruitworm in the agro-climatic conditions of Nangarhar, Afghanistan. Although all the tested options for tomato fruitworm control were found somehow effective in this study, emamectin benzoate and spinosad were found to be highly effective against tomato fruitworm as compared to other treatments. Hence, considering their efficacy, selectivity and relative safetym both of these insectcides could be recommended to tomato growers across the country.

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