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Effect and Control measures adopted for Tomato Leaf Miner (*Tuta absoluta)* in Nuwakot, Nepal

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ABSTRACT

The introduction of South American tomato pinworm Tuta absoluta in Nepal is rather recent. The study was carried out in Shivapuri and Panchakanya Rural Municipalities of Nuwakot district from January to May, 2018 to understand effects and control measures adopted in addressing this insect. Seventy households which were involved in tomato cultivation were selected through the simple random sampling and semi-structured questionnaire were used for primary data collection. Tuta leaf miner was one of the most problematic insects of tomato farmers. The study revealed that 97.1% of total farmers have had Tuta absoluta infestation in their tomato crops. The infestation of Tuta has increased within a year in case of study area. The highest percentage of farmers using Tomato Leaf Miner lure suffered the loss in the range of 10-20% while the majority of farmers not using TLM lure suffered loss in the range of 40-60%. About 53% of the farmers had knowledge on Integrated Pest Management and have been using IPM based control measures. This signifies level of awareness among farmers and IPM plays vital role in technology and control measure adoption. The best mechanical method adopted in the study area to control Tuta was found to be TLM Lure. This study indicates that IPM strategies using combined chemical and mechanical method for the control of this pest could be effective among some farmers.

Keywords: adoption, management, TLM lures, control measures, mechanical

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the various potential vegetables cultivated in subsistent to commercial scale from Terai to Hills of Nepal. It is the fourth most important vegetable crop with total

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production of about 331,736 tons from 19,725 hectares (ha) of land with productivity 17 tons /ha (MOAD, 2016). Tomato production can improve economic and living standard of both farmers adopting commercial and peri-urban farming as it is the vegetable with high per capita consumption rate in Nepal (Simkhada, Thapa, Bajracharya & Regmi, 2018). Similarly, the area, production and productivity of tomato in Nuwakot district are 110 ha, 2140 tons and 19.5 tons/ha respectively (DADO, 2016). Participating farmers shared that various factors including diseases, insects, weed, and challenged and erratic weather pattern have been affecting attainable yield and fruit quality of tomato crop.

South American Tomato Leaf miner (*Tuta absoluta*) is a relatively new pest in Nepal's tomato farms. It was recorded first in 1917 and as tomato pests in 1960s in Peru (Seplyarsky, Weiss, & Haberman, 2010). It was first reported in Nepal and identified as *Tuta absoluta* in May, 2016 from a farmer's field in Kathmandu (Bajracharya et al., 2016). NARC (2016) reported that more than 50% infestation was obtained from Tarakeshwor-9 of Kathmandu district and Kamalbinayak-4 of Bhaktapur District and this insect is spreading from Kathmandu valley into its vicinity. After its introduction to India, the chance of invading to Nepalese's tomato farming was always existed because of an open border, weak quarantine and import of tomato from India (Bajracharya et. al, 2016). Due to the insect's proliferating nature, it has been predicted that the tomato pest management cost will go up by $500 million per year if the rest of the world got infested by *Tuta absoluta* (Muniappan, 2015). The quantity and quality of tomato will be reduced by the feeding of *Tuta absoluta*, that punctures on the fruits facilitating the entrance of secondary pathogens (Kaoud, 2014) and the effect can be observed throughout the plant.

Its effect has been studied in various parts of the country but not in the Nuwakot district. This has made the need of this research to assess the effect and management practices adopted by tomato cultivators for *Tuta absoluta* in Panchakanya and Shivapuri Rural Municipalities of Nuwakot, incidently a vegetable zone under Nepal's Prime Minister Agriculture Modernization Project (PMAMP).

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2. METHODOLOGY

Study site and time frame

The areas under vegetable zone implementation unit of PMAMP were selected purposively. The government of Nepal through this long term project has been putting efforts to achieve self-sufficiency in vegetable commodities in various districts of Nepal. These study sites consists of majority of farmers who have started tomato farming in commercial scale and were more prone to *Tuta* infestation. The study was carried out in Shivapuri Rural municipality, ward no 6, 7, 8, and 9 while ward no 3,4,5 of Panchkanya Rural Municipality were selected as shown by stars in the Figure 1 below. The study was carried out during the months of January to May, 2018.

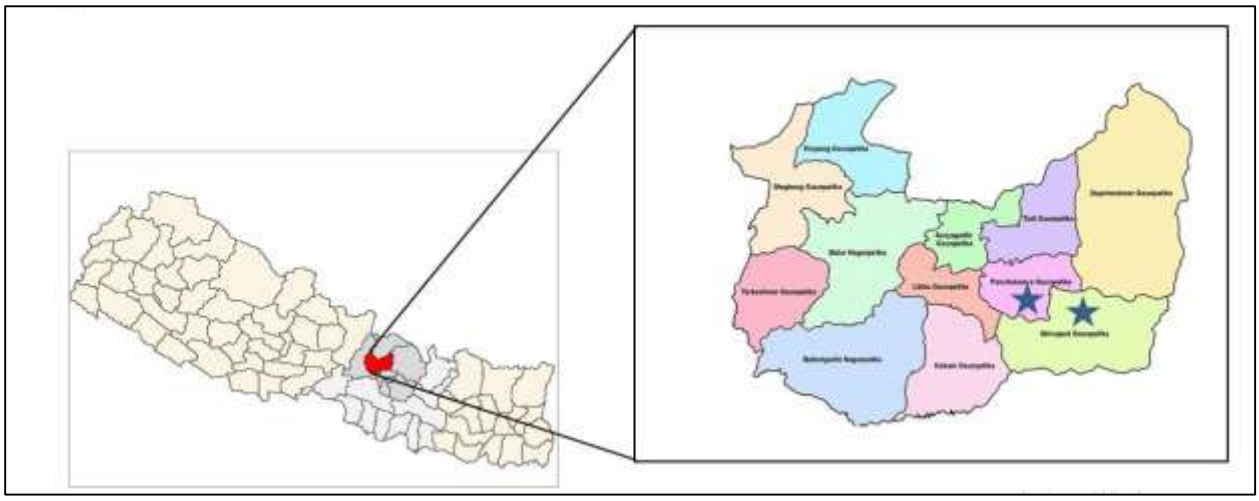

Figure 1: Map of Nepal showing Nuwakot district and study sites

Research design

The research was based on the household survey, key informants interview with progressive farmers, tomato cultivators, government technical officials and focused group discussion with members of agricultural cooperatives.

Data collection and type:

The data was primarily based on the survey from 70 tomato growing farmers selected

via simple random sampling using pre-tested semi-structured questionnaire. Secondary data was retrieved from statistical data of Agriculture Service center, VDC profile, journals, magazines, District Agriculture Development Office, Ministry of Agriculture, Land Management and Cooperatives, and Central Bureau of Statistics (CBS).

Data analysis techniques

The various assistive media for the qualitative and quantitative analysis of gathered data were statistical package for social science (SPSS) version 22 and Excel.

Problem ranking

On the basis of respondent frequencies, index values were calculated for the analysis of farmer's perception on the extent of problems prevalent in farmer's field for tomato production. Then the indexes of influence for the problems were calculated in order to draw valid conclusion and making reasonable decision. The index of influence was computed by using the formula as explained by Kothari (1990);

$$I_{inf} = \Sigma (Si \times Fi) / N$$

where,

I_{inf}= Index of influence,

S_i= Scale value,

F_i= Frequency of influence given by respondents and

N= Number of respondents

3. RESULTS AND DISCUSSION

3.1 Socio Demographics:

The study was conducted involving 65.71 % (46) male and 34.29% (24) female respondent of total population. Majority of the respondents were Hindu (80%) followed by Buddhist (14.28%) while Christian were in minority (5.72%), whereas major ethnicity were Brahmins (42.9%) followed by Janajatis (28.6%), Chhetri (17.1%) and Dalit (11.4%). The major occupation of 80% households was reported to be agriculture, followed by service holder (8.58%), business (5.71%) and others (5.71%) which includes foreign employment and remittance.

3.2 Tomato cultivation system

Most of the farmers cultivated tomato in plastic tunnel (82.86%) only whereas 10% farmers cultivated in open field. Out of them, only 7.14% of the farmers grew tomato in both open field and

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plastic house (Table 1). Similarly, 70% of total farmers grew tomato crops in two seasons of the year while 30% of the farmers grew only in one season in a year. Mostly tomato cultivation was done in both in season (February/March) and off season (June/July), 35% farmers cultivated tomato only in off season and 7% farmers only in season.

Table 1: Frequency of tunnels

No. of tunnels	0	1	2	3	4	5	8	10	14	17
Frequency (n=70)	7	15	18	13	6	4	2	1	3	1

3.3 Varieties of tomato cultivated

Altogether 5 major varieties were reported to be in cultivation practice among farmers. The following diagram shows the frequency and varieties adopted by farmers.

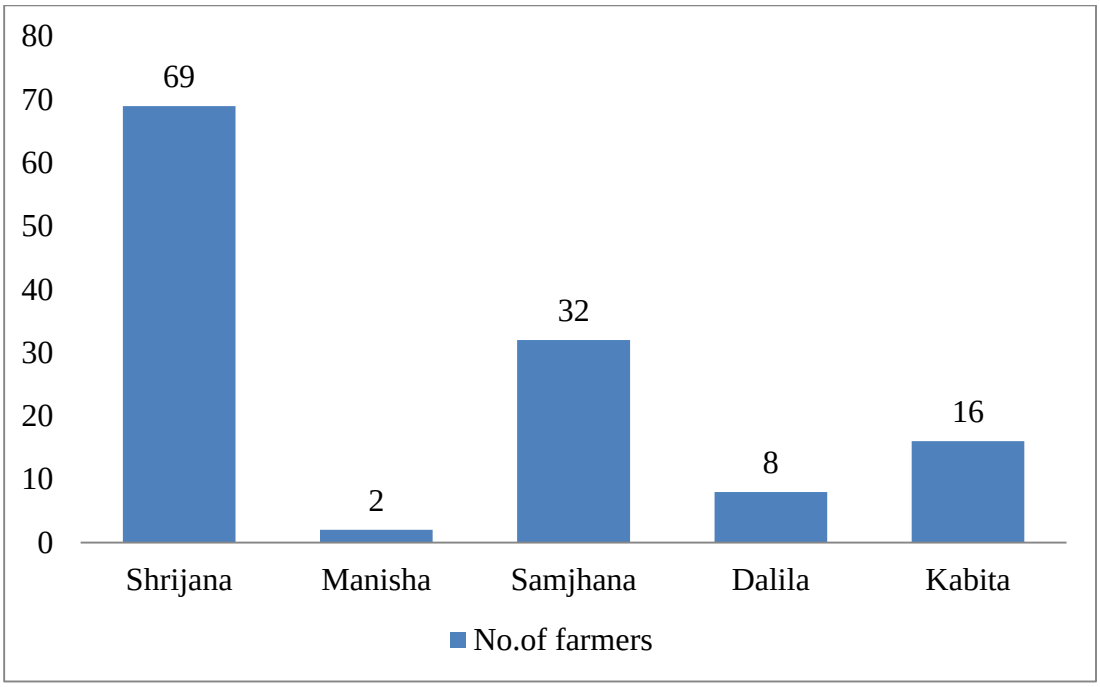

Figure 2: Different varieties cultivated in Farmers field

3.4 Major Problems seen in tomato cultivation

Farmers have more than one problem at a time. Major problems (including disease, insects) seen in tomato cultivation in the study area are ranked as follows:

Table 2: Major problems of tomato production

Problem	Index	Rank
Insects and diseases	0.99	I
Wild birds and animals	0.76	II
Lack of technical knowhow	0.49	III
Input unavailability	0.47	IV
Adverse weather	0.45	V

Table 3: Major diseases in tomato field

Diseases	Index	Rank
Blight	0.93	I
Viral disease	0.77	II
Wilt	0.55	III
Root knot Nematode	0.46	IV
Damping off	0.45	V

Table 4: Major insects in tomato

Insects of Tomato	Index	Rank
Tomato leaf miner	0.97	I
Tomato fruit borer	0.69	II
Whitefly	0.63	III
Cutworm	0.39	IV
Aphids	0.33	V

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Results illustrate that the major insect of tomato cultivation in the study area was Tomato leaf miner. As study had revealed 80-100% of yield loss occurred due to this pest and more than $50 million USD (Sah, 2017).

3.5 Tuta infestation in Nuwakot:

Tuta absoluta was seen in Shivapuri and Panchakanya Rural Municipalities from 2016 and playing major role in destruction of tomato. The study conducted by Bajracharya et al. (2016) reported that among all the major tomato growing areas (under survey) Kathmandu, Lalitpur, Bhaktapur and Kavrepalanchok showed the presence of Amercian TLM. However, in Dhading, *Tuta* was found only in one location – Sopyan Khola which lies near to Kathmandu. The study revealed that 97.1% of total respondent farms were found to be infested by *Tuta absoluta*. Following diagram shows the trend (from 2016) of Tuta infestation based on farmer's response.

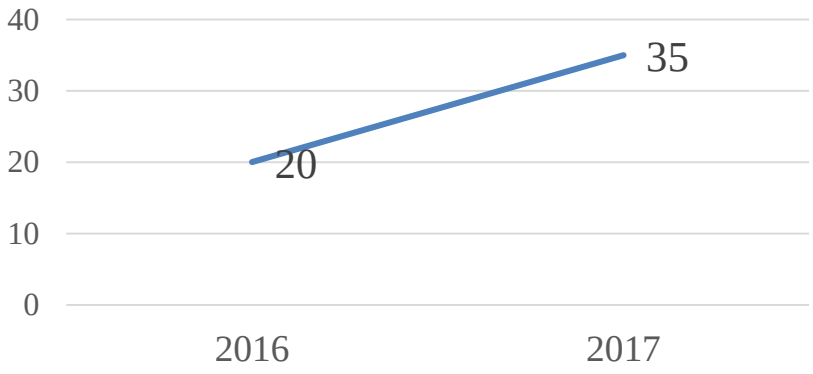

Figure 3: Responses of farmers on trend of infestation from 2016

Stage of plant at first infestation

This pest affects all the stages of plant. Sixty six of the respondents reported that seedling stage (early and late) was first infested by *Tuta* while only two responded that flowering was the first stage to be infested by this insect.

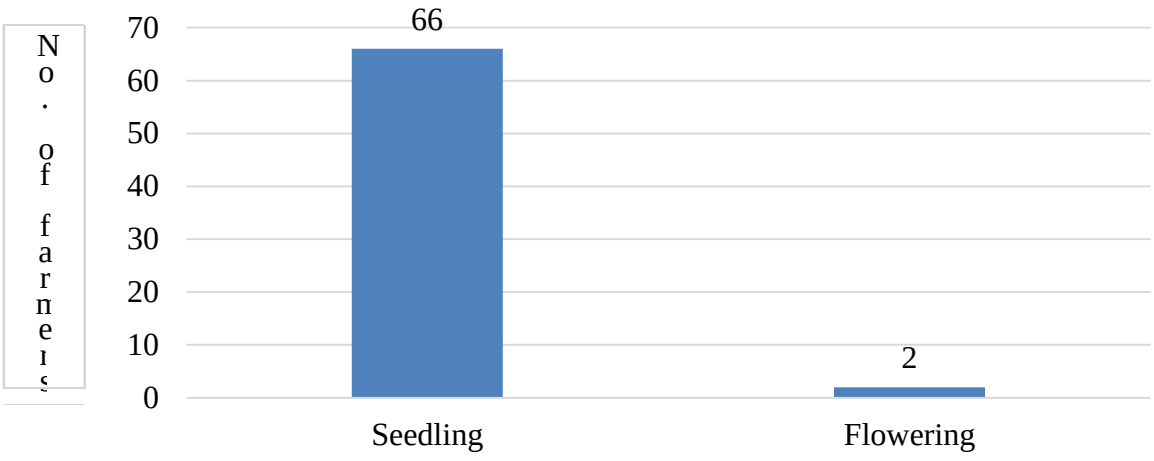

Figure 4: Stage of plant growth at first infestation

As shown in following diagram, 45 farmers responded that flowering stage was the most affected stage while 21 and 2 respondent reported that fruiting and seedling stage respectively were the most infested stage.

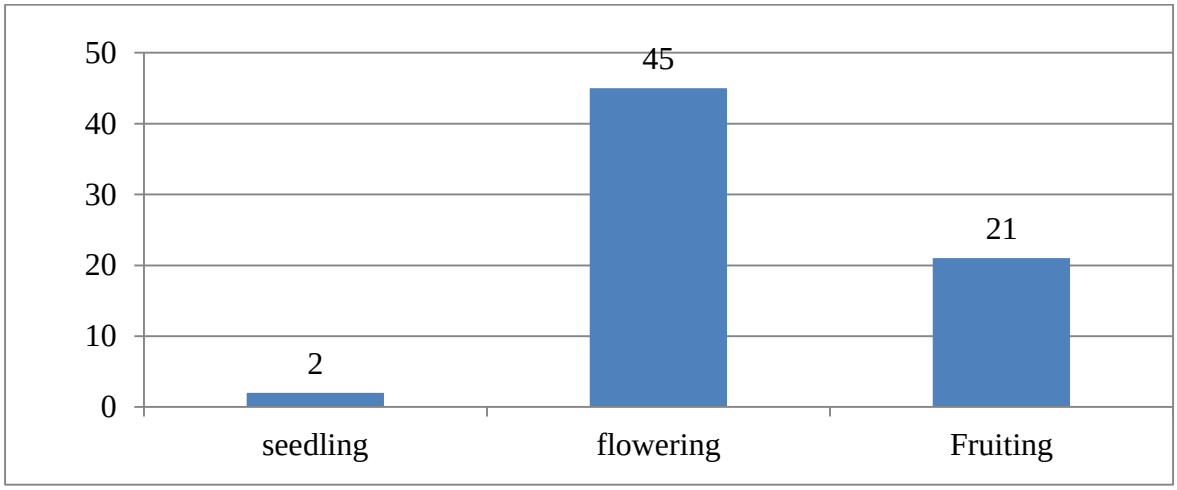

Figure 5: Most affected stage by *Tuta absoluta* (frequency)

3.6 Loss in production due to Tuta infestation:

Impact of *Tuta absoluta* in the study area was studied mainly on the basis of yield loss. The minimum yield loss due to *Tuta absoluta* was 10% and maximum loss was 80% with mean yield loss 45.8%. However, in severe case it is likely to cause 80-100% yield loss in tomato (Sah, 2017). The finding is relevant with the present study.

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High yield loss means high economic damage due to this pest; many farmers during the interview reported that they are losing faith in tomato cultivation as it has become a risky business. This ultimately effect on the price of tomato as crop protection price increases due to increase in application of expensive synthetic insecticides. This has increased the blind use of chemical pesticides which also causes disruption of IPM principles. Due to this highly destructive nature, many countries are banning trade of tomato including seedlings as seedling stage was found to be the first stage to be infested (Figure 4).

3.7 Control Measures adopted

3.7.1 Level of Awareness and Adoption of control measure

Out of 70 farmers, 25 had idea about control measures of this pest but only 23 farmers were found to be adopting these measures. Forty five farmers were unaware about control measures of TLM. The information is shown in the following figure.

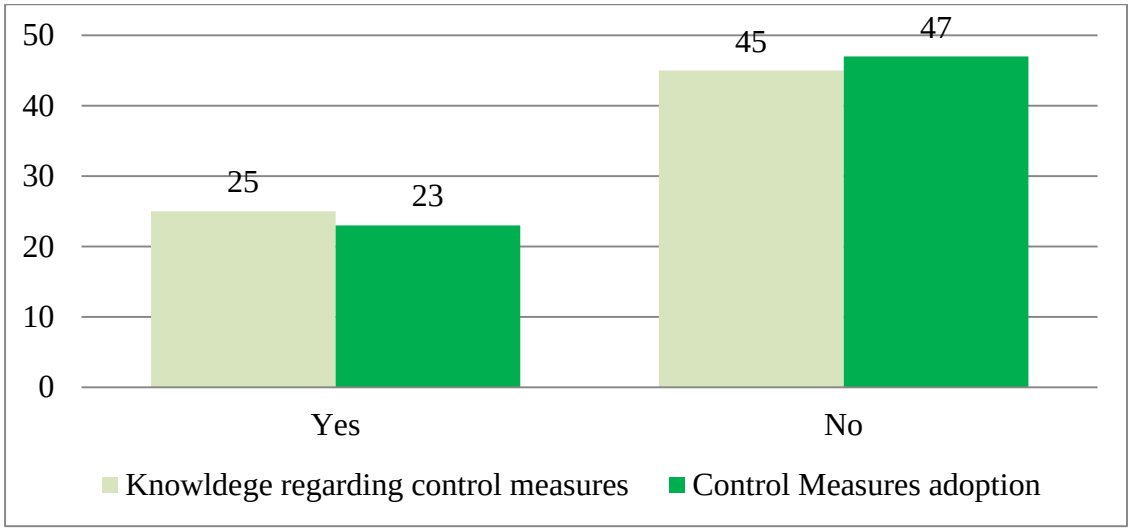

Figure 6: Knowledge regarding control measures and their adoption by farmers in the study area

Mainly, cultural, chemical and physical methods of control measures were adopted. Biological method of control measure was not used by anyone due to lack of availability.

3.7.2 Integrated Pest Management (IPM) Trainings

Survey regarding IPM awareness revealed that 47.2% of the farmers have not taken any kind of trainings on IPM practices whereas 52.9 % of the farmers had knowledge about IPM. The level of IPM knowledge was relatively better. Those who have taken IPM trainings were using some control measures. This signifies level of awareness and IPM plays vital role in technology and control measures adoption.

3.7.3 Various types of control measures

Table 5: Chemical, Mechanical, Cultural and Biological method in use

Method of control	Techniques/Materials/Chemicals
Chemical Control	Roger (Dimethoate) and Nuvan (Dichlorvos)- Common Alchlora and Tracer- Few of them use
Mechanical Control	TLM Lure, Netting, Hand picking
Cultural Control	Crop rotation, clean cultivation, pruning

Mechanical Control: Among 68 farmers infested with TLM, 43 were found to be using mechanical control methods. Effectiveness of the mechanical methods varied with farmers. 44% of the farmers found mechanical methods to be highly effective for TLM control.

Cultural control: Among 68 respondents, 47 adopted cultural control methods for *Tuta absoluta* which shows 51% of the farmers found cultural method to be less effective. Remaining 49% farmers found cultural methods to be moderately effective.

Chemical control: 100% of the infested farmers were found to be using chemical methods. 46% of the farmers found chemical methods to be less effective while 47% of the farmers found chemical methods to be moderately effective. Only 7% of the farmers found chemical methods to be highly effective.

Biological Control: No evidence regarding adoption of biological control measures was reported in the study area. For example: Neem plant contains a number of active metabolites such as alkaloids which can be

used control pests (Zekeya, Ndakidemi, Chacha, & Mbega, 2016).

3.7.4 Insect Net and TLM Lure use

Insect net use for *Tuta* control was found to be very low in the study area. Only 16% of the farmers used insect net for TLM management. Similarly, 29% of the farmers used TLM lure for *Tuta* control.

The level of crop damage of farmers using TLM lure and damage of farmers not using TLM lure was studied. The highest percentage of farmers using TLM lure suffered the loss in the range of 10 – 20 percent while the majority of farmers not using TLM lure suffered loss in the range of 40-60 percent. The *Chi square* test showed that loss suffered by farmers using TLM is significantly lower than loss suffered by farmers not using TLM lure. The level of significance was found to be 1%. In the article entitled "Update on *Tuta* Infestation in Nepal", the conclusion drawn was "pheromone traps may be quite effective in controlling this pest even in intense infestation" (IDE, 2017).

Table 6: Effect in level of crop damage due to TLM Lure use

Responses	**TLM Lure adopted**	**TLM Lure not adopted**
Low (1-10%)	6	1
Medium (10-20%)	10	5
High (20-40%)	3	11
Very High (40-60%)	1	24
Extreme (60-80%)	0	9

Chi-square value=**33.21 ***** (4 df and $p<0.01$)

Extreme level of loss was observed from the farmers not adopting TLM Lure for control. It illustrates that, TLM lure is one of the best solutions to avoid very high to extreme level of loss.

4. CONCLUSION

Wide host range and ecology of *Tuta absoluta* has made this pest vital in case of tomato around the globe. The pest infestation was found to be increasing from 2016 in Nuwakot. It's low to severe effect i.e. 10-80% loss faced by farmers under consideration, has been one of the major factors of discouragement in tomato

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cultivation. Most of them were even unaware that their field was infested by *Tuta*. Almost 97.1% of total farmers had problem of *Tuta absoluta* in their tomato field. 52.9% of the farmers had knowledge on IPM and have been reported using control measures. This signifies level of awareness and IPM plays vital role in technology and control measure adoption. The best mechanical method adopted in the study area to control *Tuta* was found to be TLM Lure. There was significant difference in damage level between the TLM lure users and non-users. No any evidence of using biological agents was reported in the study area due to lack of knowledge and unavailability; while chemical method was found discouraging for *Tuta* in some cases. Thus, IPM strategies in combined methods for the control of this pest could be effective.

RECOMMENDATION

Single management practice is not enough for the control of *Tuta*. So, further biological research should be carried out taking mechanical and chemical method in consideration to observe its combined effect in the study area.

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Conflict of Interest Statement:

We the authors of this research article declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We confirm that we have followed the regulations of our institutions concerning intellectual property. We further confirm that any aspect of the work covered in this manuscript has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript. We confirm that we have provided a current, correct email address which is accessible by the Corresponding Author.

-Authors

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