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Effect of Different Colored Polythene Mulches and Net House on Insect Incidence and Yield of Brinjal in Rampur, Chitwan

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ABSTRACT

Field experiment was conducted in single factor randomized complete block designed to evaluate effect of different color polythene mulch and net house on insect pest incidence of brinjal in chitwan, nepal during october 2016 to may 2017. Five different treatment were selected with four replications, included net house with black polythene mulch, black polythene mulch only, reflective polythene mulch only and black polythene mulch with emamectin benzoate 5%sg spray and control (no mulch+ no net + no pesticide spray) . The result revealed that the net house totally restricts the brinjal shoot and fruit borer whereas black polythene mulch with emamectin benzoate spray plot reduced brinjal shoot and fruit borer larvae upto 70.58%. Total marketable yield was found highest in the black polythene mulch with emamectin benzoate spray plot (49.17 mt /ha) followed by black polythene mulch only (38.59 mt/ha) and lowest in control plot (28.53 mt/ha). Damaged fruit percentage by brinjal fruit and shoot borer was highest in the control (35.68%) followed by black polythene mulch (28.10%), reflective polythene mulch (19.02%) and lowest in net house with black polythene mulch (0%). The damaged weight inside the net house with black polythene mulch and black mulch with pesticide were significantly different whereas the damaged weight in other treatments similar which proved that there was no effect of mulch on brinjal shoot and fruit borer. The B:C ratio was the highest (3.34:1) in the black polythene mulch with emamectin benzoate spray plot while the lowest in net with black polythene mulch (1.68:1). Although the B:C ratio was lower in the net with black polythene mulch due to the low yield in the winter season. Creation of suitable soil environment by black polythene mulch and being biologically originated, having minimum residual effect and short half-life of emamectin benzoate, black polythene mulch with emamectin benzoate can be used for the eco-friendly management of brinjal shoot and fruit borer.

Keywords- Brinjal shoot and fruit borer, Emamectin benzoate, mulching, net house

I. INTRODUCTION

Brinjal is grown almost in all parts of Nepal except higher altitude all-round the year. In Nepal, its production is 1, 24, 216 tons in an area of 8,362 ha with the productivity of 14.85 ton/ha (MoAD, 2017). Due to the higher yield and longer fruiting and harvesting period, many farmers are cultivating the brinjal in their fields (Ghimire & Khatiwada, 2001). Because of the high cost of production on the management of insect pest complex there is a threat in brinjal cultivation in recent years.

The key pest, *L. orbonalis* Guenee is threatening the brinjal cultivation (Mainali, Thapa, Tiwari, Pokhrel, & Ansari, 2014). Because of its higher productive potential, rapid turnover of generations and intensive cultivation of brinjal both in wet and dry seasons of the year. During winter months particularly in December–January the activity of the borer becomes less due to low temperature. It reduces the quality of fruit production and attacks eggplant irrespective to growth stages of the plant unlike other pests. The yield loss caused by this pest has been estimated up to 70% -92% (Chakraborti & Sarkar, 2011). In Nepal, brinjal shoot and fruit borer may cause about 45% crop loss (Joshi, 2003). Larvae bore into tender shoots and wither it, makes zig-zag feeding tunnels in fruits filled with excreta which makes fruits unfit for marketing and consumption. The pest infestation mostly starts with the vegetative growth affecting the tender shoots and appeared peak during fruiting (Mainali et al., 2014). The abiotic factor plays an important role in the activities of brinjal shoot and fruit borer. Temperature, rainfall, relative humidity of morning respond positively in increasing infestation and intensity on shoot and fruits whereas relative humidity in the evening negatively (Sahu, Kumar, Khan, Habil, Dhaked, & Naz, 2018).

Insecticides are commonly used for controlling the insect pest of brinjal. Farmers excessively use insecticide to control the borer and apply insecticides 10-12 times in winter and 25 to 30 times or even more in summer and rainy season crop in higher dose during fruiting and harvesting (Ghimire, 2001), which is costly and often leads to resistance build up, and has negative effects on non-target organisms as well as it hampers the health and environments. Thus, alternative and effective methods of managing these pests are in continuous demand (Kiptoo, Kasina, Wanjala, Kipyab, Wasilwa, Ngouajio, & Martin, 2015). Farmers are still unaware about the pest exclusion net, which is an effective pest management tool (Singh et al., 2018), improve quality, and yield (Scarascia-Mugnozza, Sica, & Russo, 2012). Such nets facilitate in the moderation of microclimate, which improves the crop performance (Briassoulis, Mistriotis, & Eleftherakis, 2007). According to Kaur, Bal, Singh, Sidhu, and Dhillon (2004) fruit damage in a net house was nearly 50% lower than the fruit damage recorded under field condition. Majumdar and Powell (2011) observed netting offered 90% reduction of tomato fruit infestation in the field condition. 50-mesh insect netting significantly protects the tomato fruit worm (*Heliothis zea*) infestation, beet armyworm (Spodoptera exigua) compared to ex situ condition, and effectiveness was 82%-100%. Further, it is possible to lower pesticide use and enhance the quality and quantity of the product. It also provides the protection from natural enemies and from hailstone, strong sunlight, rain, snow by the use of pest exclusion net. The main objective of the research was to develop ecofriendly method of insect pest management in brinjal for increasing its production.

II. MATERIALS AND METHODS

The experiment was conducted at horticultural research field of AFU, Chitwan. Shamli variety was selected. The experiment was laid out in Randomized Complete Block Design (RCBD) consisting of five treatments with four replications. Each plot size was 4.2m*2.4m (10.08m^2) consists of 28 plants planted at a distance of 60 cm row to row and 60cm plant to plant. The treatment is as net house with black polythene mulch only, black polythene mulch only, reflective polythene mulch only, black polythene mulch with emamectin benzoate spray and control where no mulch no application of insecticides. Different parameters were recorded during the study of insect's pests in brinjal as monitoring of brinjal shoot and fruit borer using leucin lure in funnel traps, brinjal shoot and fruit borer population before and after the spray, horticulture parameters total yield, marketable yield, unmarketable yield damaged by brinjal shoot and fruit borer, fruit diameter and fruit height, economic analysis as cost of cultivation, gross return, net return, benefit cost ratio. The collected data were compiled using the Ms-Excel program. Analysis of variance for all parameters was carried out as per the procedures given in R-STATC statistical computer package for the single factor randomized block design. Duncan's Multiple Range Test (DMRT) for mean separations was done from the reference of Gomez and Gomez (1984). Modified Abbots formula given by (Fleming and Retnakaran 1985) was used to calculate the percentage of the population reduction over control in heterogeneous or non-uniform population of insects. Statistical analysis of data was done by converting them into $^2\sqrt{(x+0.5)}$ as suggested by (Gomez and Gomez 1984). Yield comparison between different treatments was done by using the increase in yield over control.

III. RESULTS AND DISCUSSION

Monitoring of brinjal shoot and fruit borer

The adult of brinjal shoot and fruit borer was observed first time on 14th Feb 2017. The number of adult was increased slowly and reached maximum on 7th March when the temperature was 30.25ºC and minimum temperature 12.5ºC. The maximum catch reached up to 8 and then declined reaching 0 at 23rd May as shown in (Figure 1). Similarly, Prasannakumar, Chakravarthy, Kumar, and Gangappa (2013) also found the peak activity of moth at 28ºC during November to October. Maximum temperature and evaporation influence moth catch at an extent of 34%.

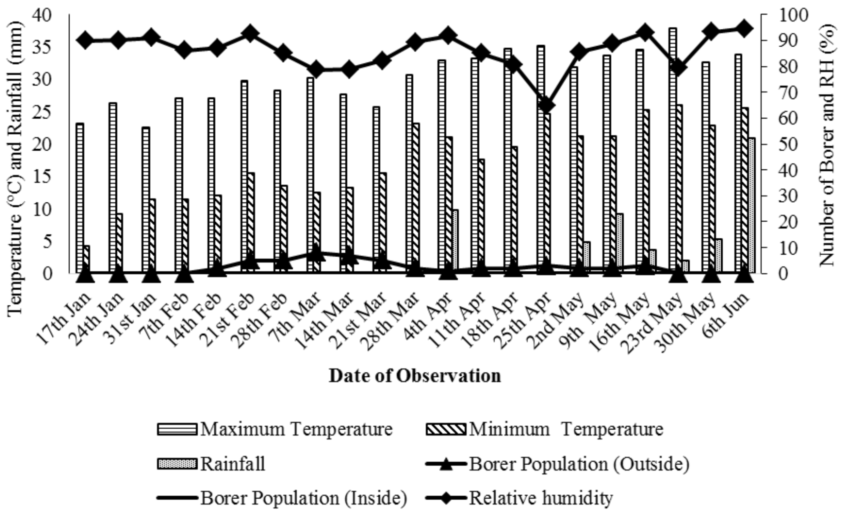

Figure 1: Graphical diagram showing number of brinjal shoot and borer population in pheromone traps different dates of monitoring

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Effect on population of brinjal shoot and fruit borer (Leucinodes orbonalis Guenee)

Initial population of *Leucinodes orbonalis* was observed higher in the control (1.75) comparative to the black polythene mulch only (1.25), reflective polythene mulch only (1.25), where net house totally restrict the population of brinjal shoot and fruit borer.

The population reduction over control (PROC) after sixth and twelfth days of the first spray in emamectin benzoate spray plot is 68.18%, 70.83% shown in (Table 1).

Table1: Effect of treatments against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on brinjal after first spray at AFU, Rampur, Chitwan, 2016/2017.

Treatments	Initial number (Larva)	6 DAS	PROC%	12DAS	PROC %
Control	1.75 [a] ± 0.25 (1.49)	2.75 [a] ± 0.478 (1.78)		1.5 [a] ± 0.288 (1.40)	
Black polythene mulch with emamectin benzoate spray	1.0 [a]± 0.408 (1.18)	0.5 [bc] ± 0.288 (0.96)	68.18	0.25 [bc] ± 0.25 (0.83)	70.83
Reflective polythene mulch only	1.25 [a]± 0.25 (1.31)	1.25 [b] ± 0.25 (1.31)	36.36	1[ab]± 0.408 (1.18)	6.66
Black polythene mulch only	1.25 [a]± 0.25 (1.31)	1.25 [b]± 0.25 (1.31)	36.36	1.5 [a]± 0.288 (1.40)	- 40
Net house with black polythene mulch	0 [b]± 0.0 (0.70) [b]	0.00 [c] ±0.00 (0.70)	100	0.0 [c]±0.0 (0.70)	100
F test	** (**)	*** (***)		** (**)	
LSD(0.05)	0.807 (0.32)	0.96 (0.35)		0.86 (0.35)	
CV (%)	49.94 (17.33)	54.42 (18.72)		66.23 (20.92)	

DAS: Days after spraying, CV: Coefficient of variation LSD: Least significant difference, *: significant value with the same letters in a column is not significantly different at 5% by DMRT and figures after ±indicate standard error. The figures in parentheses are square root transformation

Similarly, black polythene mulch with emamectin benzoate spray plot population reduction over control is 52%, - 6.6% after 6 DAS and 12 DAS shown in (Table 2).

Table 2: Effect of treatments against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) on brinjal after the second spray at AFU, Rampur, Chitwan, 2016/2017.

Treatments	Initial number (Larva)	6DAS	PROC %	12 DAS	PROC %
Control	4.00 [a] ± 0.404 (2.11)	2.5 [a]± 0.288 (1.72)		0.75[a]± 0.25 (1.09)	
Black polythene mulch with Emamectin benzoate spray	2.50 [b] ± 0.288 (1.72)	0.75 [c] ± 0.25 (1.09)	52	0.5 [ab] ± 0.288 (0.96)	- 6.6
Reflective polythene mulch only	3.75 [a] ± 0.478 (2.05)	2.00[ab]± 0.408(1.56)	14.6	0.75 [a] ± 0.288 (1.09) [a]	- 6.6
Black polythene mulch only	2.25 [b] ± 0.25 (1.65)	1.5 [b]± 0.228 (1.40)	- 6.6	0.5[ab]± 0.288 (0.96)	-18.5
Net house with black polythene mulch	0.0 [c] ± 0.0 (0.70)	0.0 [d] ±0.0 (0.70)		0.0 [b] ± 0.0 (0.70) [b]	
F test	***(***)	***(***)		.(.)	

LSD(0.05)	1.16 0.27	0.77 (0.28)	0.570 (0.30)
CV (%)	28.98 (11.00)	37.03 (14.07)	75.27 (20.17)

DAS: Days after spraying, CV: Coefficient of Variance, LSD: Least significant difference, PROC: Population Reduction over Control, Value with the same letters in a column is not significantly different 5% by DMRT and figures after ±indicate standard error. The figures in parenthesis are square root transformation.

As the efficacy of emamectin benzoate observed higher 4 to 8 days after spray. Reason behind it may be as emamectin benzoate penetrates leaf tissues by trans-laminar movement, following its treatment; larvae stop feeding within hours and die after 2-4 days (Hanafy and Sayed, 2013). Deore, Borikar, Chavan and Bhute (2009) found that emamectin benzoate 5 SC @ 6.75 g a.i /ha significantly controlled the bollworms in cotton. Similar results of low fruit damage and high marketable yield by the use of emamectin benzoate was also found by Sharma (2010) in his work in bio-efficacy of insecticides against *Leucinodes orbonalis* Guenee on brinjal.

Yield attributing characters:

Maximum marketable yield was obtained from the black polythene mulch with emamectin benzoate spray plot (49.17 mt/ha) than that of control plot (28.53 mt/ha) (Table 3). 72.34 % of increased marketable yield was obtained in black polythene mulch with emamectin benzoate spray plot compare to the control (no net + no spray+ no mulching) shown in Table 2. It may be due to the higher percentage of early fruit harvesting and higher yield of eggplant, which is similar to the finding of (Brown, Goff, Dangler, Hogue & West, 1992) who found higher yield by plants grown in black polythene mulch as compared to plants without mulching. Increased yield under black polythene mulch might be due to higher magnitude of yield attributing characters as influenced by higher soil temperature and moisture, which are in agreement with the work of (Gudugi, Odofin, Adeboye & Oladiran, 2012; Almasoum, 1998). Chandrasekaran and Regupathy (2007) who found that use Emamectin @ 8.75 g ai/ha had the highest reduction of fruit damage along with the highest marketable yield and benefit-cost ratio in brinjal, which is similar with the finding of Shobanadevi (2003) in cotton bollworm. Similarly, Kumar and Devappa (2006) also observed that application of proclaim (emamectin benzoate) 5 SG @ 200 g/ha were effective in reducing the fruit damage in brinjal with higher total yield.

Table 3: Increase in marketable yield over control in different treatments plots at AFU, Rampur, Chitwan.

Treatments	Marketable yield (mt/ha)	Increase in marketable yield over control (%)
Control	28.53	
Black polythene mulch with Emamectin benzoate spray	49.17	72.34
Reflective polythene mulch only	36.67	28.53
Black polythene mulch only	38.59	40.51
Net house with black polythene mulch	33.76	18.33

The total yield was lower in the net with black polythene mulch than other treatments. It may be due to the climatic conditions and pollination. Pollinators were completely restricted inside the net with black polythene mulching which may also be the reason for low yield. Pollination is one of the condition for achieving good quality yields and seeds (Mc Gregor, 1976; Polverente, Fontes, & Cardoso, 2005). Amoako and Yeboah-Gyan (1990) also reported that the plant is partially self-inconsistent and requires cross-pollination for better fruit setting. Pollination by the bumblebees increases the yield by 23% in brinjal and 17% in tomato (Abak et al., 1995).

Economic analysis

The total cost of cultivation was higher in the net with black polythene mulch plot (Rs. 3,99,685) followed by control plot (Rs. 2,48,935). Total marketable yield was highest in the black polythene mulch with emamectin benzoate spray plot (49.17 mt/ha) and lowest in control plot (28.53 mt/ha). The net profit was observed highest in black polythene mulch with emamectin benzoate spray plot (Rs. 5,17,285) followed by black polythene mulching (Rs. 3,70,185) and lowest was observed in control plot (Rs. 1,79,015). The highest benefit-cost ratio was obtained from black polythene mulch with emamectin benzoate spray plot (3.34:1) and lowest was observed in net with black polythene mulching (1.68) which is shown in Table 4.

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Table 4: Economic analysis of different treatments on brinjal at AFU, Rampur, Chitwan, 2016/2017.

Treatments	Total cost of cultivation (Rs/ha)	Total yield (Ton/ha)	Farm gate price (Rs/kg)	Gross income (Rs/ha)	Net profit (Rs/ha)	B:C Ratio
Control	2,48,935.00	28.53	15.00	4,27,950.00	1,79,015.00	1.71
Black polythene mulch with Emamectin benzoate	2,20,265.00	49.17	15.00	7,37,550.00	5,17,285.00	3.34
Reflective polythene mulch only	2,16,457.00	36.67	15.00	5,50,050.00	3,33,593.00	2.54
Black polythene mulch only	2,08,665.00	38.59	15.00	5,78,850.00	3,70,185.00	2.77
Net house with black polythene mulch	3,99,685.00	33.76	20.00	6,75,200.00	2,80,515.00	1.68

IV. CONCLUSION

Brinjal shoot and fruit borer (*Leucinoides orbonalis* Guenee) being an economic pest of brinjal causes damage to both shoots and fruits. The use of the net completely restricted the infestation caused by *L. orbonalis* which eliminated the use of insecticides. Fruit production of brinjal inside the net was less due to low temperature and low light intensity and restriction of pollinators resulting low B: C ratio. While in the black polythene with emamectin benzoate the yield was higher due to the favourable environment created by the plastic mulch inside the soil as well as the plants were in access with pollinators. The B: C ratio for the use of net house was lower for single season compared to other practices. The damage caused by larva was effectively controlled by the use of emamectin benzoate (short half-life) of 0.625 gm/l leaving minimum residues. Hence, the use of black polythene mulch and emamectin benzoate is towards the eco- friendly management of brinjal shoot and fruit borer.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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