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# MANAGEMENT OF INSECT AND MITE PEST ON BELL PEPPER USING NET BARRIER

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## Abstract

The study was conducted at the Research Field of Entomology Department, Sylhet Agricultural University (SAU) campus and farmer's field at Sreemangal, Moulvibazar during October 2017 to April 2018 to find out the effectiveness of net barrier in protecting major insect and mite pests of bell pepper. Four treatments viz., plot with coarse net (40-mesh mosquito net) + polyethylene ($T_1$), plot with fine net (120-mesh nylon net) + polyethylene ($T_2$), plot with polyethylene ($T_3$) and control plot ($T_4$) were used. The experiments were laid out in a Randomized Complete Block Design with five replications. In two sites, chili aphid (*Aphis gossypii* Glov.), jassid (*Amrasca biguttula* Ishida), common cutworm (*Spodoptera litura* Fab.) and white mite (*Tetranychus* sp.) were found as the major pests. Irrespective study sites, coarse net and fine net reduced 73 to 80% chili aphid, 51 to 74% jassid and 71 to 81% white mite. The treatments had no impact on reducing common cutworm. In both sites, highest fruit yields were obtained from fine net and polyethylene plot in SAU (12.74 t ha$^{-1}$) and also in Sreemangal (10.48 t ha$^{-1}$). The fine net plot gave higher Marginal Benefit Cost Ratio (MBCR) in SAU campus (MBCR = 7.56 : 1) and Sreemangal (MBCR = 4.9 : 1). The results indicated that fine net use in bell pepper plot is effective in controlling insect and mite pests, producing higher fruit yield and profits.

***Keywords*: *Capsicum*, sweet pepper, insect, mite, poly-tunnel.**

## Introduction

Bell pepper (*Capsicum annuum* L.) belonging to the family Solanaceae is an important vegetable or spice crop widely cultivated in almost all countries of the world (Channabasavanna and Setty, 2000). It is one of the most important vegetables cultivated in many parts of sub-humid and semi-arid tropics (Aliyu, 2000). It may be consumed as cooked or raw condition as well as sliced form of salad. One medium size green bell pepper can provide up to 8% of the recommended daily requirement of Vitamin A, 18% of Vitamin C, 2% of calcium and 2% of iron (Kelley and Boyhan, 2009). Furthermore, it is a good source of other vitamins viz., E, B1, B2, and D (Muhamman and Auwalu, 2009). Bell pepper is the most important summer crop of temperate regions, but now-a-days efforts are being given to grow bell pepper in Bangladesh (Paul, 2009). Although it is a high-value crop with high export potentiality, it is still not well-known to the most growers and consumers in Bangladesh (Saha, 2001).Chain supermarkets like Agora, Shwapno, etc. are purchasing bell pepper only from contract growers of sub-urban areas.Thus common people of the country have very limited access to bell pepper consumption due to its high price and low availability in the rural markets(Paul, 2009). The farmers of Sylhet region have very limited knowledge about the nutritional importance and production technologies of vegetables including bell pepper. It is thus essential to take necessary steps to increase and popularize bell pepper production in this region. According to Sinnadurai (1992), bell pepper requires milder climate for good production unlike hot pepper. The optimum temperature for the growth of bell pepper ranges from 20 to 25°C. In Bangladesh, from December to January during vegetative and fruiting stage of the crop, night temperature is gradually decreased below 10°C or less. In this situation, vegetative and reproductive growth stage of bell pepper becomes stunted, fruit and flower dropping may occur. Sonet barrier with polythene covering may be effective for proper growth and yield at low temperature at night time as it protects the plants from pest attack and cold injury. Significant yield loss in bell pepper was occurred due to infestation caused by major pests (Nandini, 2010). Chilli thrips (*Scirtothrips dorsalis* Hood), cotton aphid (*Aphis gossypii*), cotton leafhopper (*Amrasca devastans*), silverleaf whitefly (*Bemisia tabaci*), bean spider mite (*Tetranychus ludeni*), two-spotted spider mite (*T. urticae*) and broad mite (*Polyphagotarsonemus latus*) have been reported as major pests in Australia and Cambodia (ACIAR, 2013). Although thrips (*S. dorsalis* Hood) and broad mite (*P. latus*) have not been recorded as serious pests in temperate countries,they could be devastating in the tropical climate of India (Moorthy and Reddy, 2004). Based upon the above pest attack scenarios, environment friendly pest management techniques need to be developed for successful production of bell pepper that offers higher yield with lower pest infestation. Singh *et al*. (2010) showed that using poly-houses, poly-

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tunnels and plastic-mulching are most suitable production methods to increase yield of bell pepper. Protected structures act as physical barrier and play a vital role in integrated pest management by preventing spreading of insect pests and viral diseases in crop field. Some researchers of the Entomology Division at Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur have developed chemical management approach against some sucking pests such as thrips and mite on chili (BARI, 2015), but little works have been done in relation to net barrier application in reducing insect and mite pests on bell pepper. Considering the facts above, the present study was undertaken to find out the effectiveness of net barrier on pest management and yield improvement of bell pepper in Sylhet region. The specific objectives of the present study were to document the major insect and mite pests of bell pepper and develop non-chemical pest management techniques.

## Materials and Methods

The experiment was conducted at the Entomology Research Field of Sylhet Agricultural University, Sylhet and farmer's field located at Tikriya village of Sreemangal upazila, Moulvibazar. The soil of SAU campus and Sreemangal are sandy loam with pH of 5.47 (SRDI, 2018) and deep brown hilly soil with pH ranges from 4.3 to 4.5 (Saha *et al*., 2014). The climate of both the experimental sites falls under the sub-tropical climate which is characterized by high temperature, high humidity, and heavy rainfall with occasional gusty wind in the kharif season (May-September) and less rainfall associates with moderately low temperature in the rabi season (October-March). The hybrid variety 'Omaxe' was used in the study. Four treatments were used in bell pepper plots, viz. $T_1$ = Coarse net + polyethylene (40-mesh mosquito coarse net, white polyethylene), $T_2$ = Fine net + polyethylene (120-mesh fine nylon net,white polyethylene), $T_3$ = Polyethylene and $T_4$ = Untreated control plot. The treatments were used to manage the insect and mite pests. In order to use coarse net and fine net over the plots of $T_1$ and $T_2$ treatments, 1.2 m high bamboo made poly-tunnel structures were prepared and fixed up over the plots. When the seedlings of bell pepper became established in the research field, coarse net and fine net were used. Polyethylene sheet was used over the plots of $T_1$, $T_2$ and $T_3$ treatments only at night time during January-February when air temperature became low. The objective of polyethylene sheet over the plots was to protect bell pepper plants from cold injury.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with five replications. The experiment had twenty plots in each location. Four treatments were randomly allotted to each block. Block to block and plot to plot distance was 80 cm. The unit plot was 2.4 m × 1.2 m. Two rows of the plant were grown in each unit plot. Row to row distance was 60 cm and plant to plant distance was 40 cm. A total of twelve plants were grown in each unit plot. Data recording on the population of insect and mite pest species of bell pepper was started from transplanting to harvesting of the crop at 7-day intervals in the Entomology Research Field at Sylhet Agricultural University and 15-day intervals at the farmer's field in Sreemangal. The numbers of insect and mite pests were counted from five randomly selected plants of each plot and number per plant was calculated. Pest counting was done at early hours of the day when they were found less mobile. The population of aphid and jassidwere recorded through visual counting of both nymphs and adults on five leaves representing upper, middle and bottom portion of each plant and the number was recorded as aphids and jassids per five leaves. Fruit infestation caused by caterpillars of common cutworm (*Spodopteral itura* Fab.) were recorded at fruiting stage through counting total fruits and infested fruits from five randomly selected plants per plot and then fruit infestation was calculated in percentage. The population of white mite was recorded through counting both nymphs and adults from five leaves representing top, middle and bottom portion of each tagged plant. Leaves were plucked at random and kept in separate polythene bags, which were properly labeled and brought to the Laboratory of Entomology, Faculty of Agriculture, SAU, Sylhet for observing in binocular microscope. Fruit yields from all harvests from all treatment plots were recorded separately. Separately harvested all yield data were pulled and expressed in t ha$^{-1}$ at the end of the cropping season. Marginal Benefit Cost Ratios (MBCRs) of different treatments were calculated using the following formula.

$$\text{Marginal Benefit Cost Ratio (MBCR)} = \frac{\text{Adjusted net return (Tk)}}{\text{Total cost of treatment (Tk)}}$$

The recorded data on different parameters were statistically analyzed using R version 3.3.1 (R Core Team, 2016).

## Results and Discussion

### *Chili aphid*

The number of chili aphid on five leaves per plant was significantly influenced by different treatments (Table 1). In SAU campus, the lowest number of chili aphid was recorded in fine net + polyethyleneused plot (29.33) followed by coarse net + polyethylene used plot (33.12). The highest number of chili aphid was found in untreated control plot

(122.81) followed by polyethylene used plot (121.31). In Sreemangal site, the lowest number of chili aphid was recorded in coarse net + polyethylene used plot (22.43) followed by fine net + polyethylene (27.30). The highest number of aphid was found in polyethylene used plot (119.26) followed by untreated control plot (112.36). Regardless of the two study sites the use of coarse net and fine net reduced 73 to 80% chili aphid on bell pepper leaf.

**Table 1. Effect of net barrier on the reduction of chili aphid on bell pepper leaf in SAU campus and Sreemangal during October 2017 to April 2018**

| Treatment | No. of chili aphid on 5 leaves per plant | | Chili aphid reduction over untreated control (%) | |
|---|---|---|---|---|
| | SAU campus | Sreemangal | SAU campus | Sreemangal |
| Coarse net + polyethylene plot ($T_1$) | 33.12 b | 22.43 b | 73.0 | 80.0 |
| Fine net + polyethylene plot ($T_2$) | 29.33 b | 27.30 b | 76.1 | 75.7 |
| Polyethylene plot ($T_3$) | 121.31 a | 119.26 a | 1.2 | - |
| Untreated control | 122.81 a | 112.36 a | - | - |
| LSD | 14.87 | 10.50 | | |
| CV (%) | 14.08 | 10.84 | | |

Means in a column having the same letter did not differ significantly (*P*>0.01) according to Tukey's honestly significant difference (THSD) test

***Jassid***

The number of jassid on five leaves per plant was significantly influenced by different treatments (Table 2). In SAU campus, the lowest number of jassid was recorded in coarse net + polyethylene used plot (12.14) followed by fine net + polyethylene used plot (16.65) (Table 2). The highest number of jassidwas found in untreated control plot (39.48) followed by polyethylene used plot (33.02). In Sreemangal site, the lowest number of jassid was recorded in fine net + polyethylene (8.25) followed by coarse net + polyethylene used plot (15.52). The highest number of jassid was found in untreated control plot (31.51) followed by polyethylene used plot (27.73). Regardless of the two study sites the use of coarse net and fine net reduced 12.0 to 73.8% jassid on bell pepper leaf.

**Table 2. Effect of net barrier on the reduction of jassid on bell pepper leaf in SAU campus and Sreemangal during October 2017 to April 2018**

| Treatment | No. of jassid on 5 leaves per plant | | Jassid reduction over control (%) | |
|---|---|---|---|---|
| | SAU campus | Sreemangal | SAU campus | Sreemangal |
| Coarse net + polyethylene used plot | 12.14 b | 15.52 b | 69.3 | 50.7 |
| Fine net + polyethylene used plot | 16.65 b | 8.25 c | 57.8 | 73.8 |
| Polyethylene used plot | 33.02 a | 27.73 a | 16.4 | 12.0 |
| Untreated control | 39.48 a | 31.51 a | - | - |
| LSD | 8.46 | 4.24 | | |
| CV (%) | 24.24 | 14.84 | | |

Means in a column having the same letter did not differ significantly (*P*>0.01) according to Tukey's honestly significant difference (THSD) test.

***White mite***

The number of white mite on five leaves per plant was significantly influenced by different treatments. In SAU campus, the lowest number of white mite was recorded in fine net + polyethylene used plot (7.64) followed by coarse net + polyethylene used plot (11.41) (Table 3). The highest number of white mite was found in polyethylene used plot (41.07) followed by untreated control plot (39.27). In Sreemangal site, the lowest number of white mite was recorded in fine net + polyethylene used plot (7.72) followed by coarse net + polyethylene used plot (11.86). The highest number of white mite was found in untreated control plot (40.96) followed by polyethylene used plot (38.39). Regardless of the two study sites the use of coarse net and fine net reduced 6.3 to 81.2% white mite on bell pepper leaf.

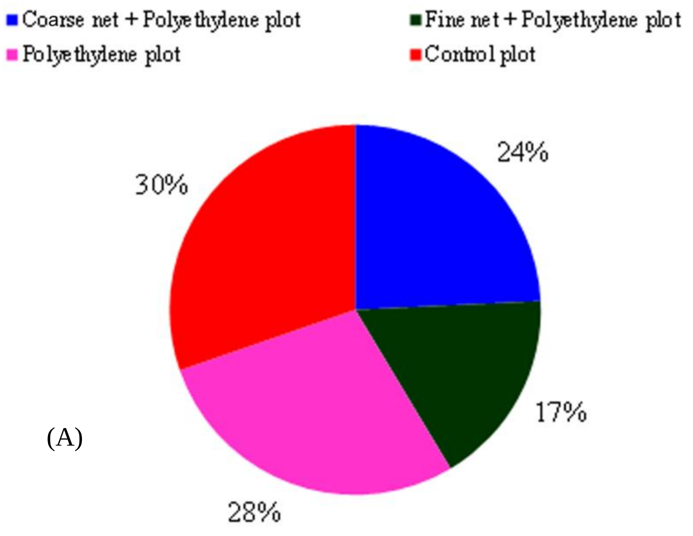
**Table 3. Effect of net barrier on the reduction of white mite on bell pepper leaf in SAU campus and Sreemangal during October 2017 to April 2018**

| Treatment | No. of white mite on 5 leaves per plant | | White mite reduction over control (%) | |
|---|---|---|---|---|
| | SAU campus | Sreemangal | SAU campus | Sreemangal |
| Coarse net + polyethylene plot ($T_1$) | 11.41 b | 11.86 b | 70.9 | 71.0 |
| Fine net + polyethylene plot ($T_2$) | 7.64 b | 7.72 b | 80.5 | 81.2 |
| Polyethylene plot ($T_3$) | 41.07 a | 38.39 a | - | 6.3 |
| Untreated control (without net, without polyethylene) | 39.27 a | 40.96 a | - | - |
| LSD | 14.28 | 9.89 | | |
| CV (%) | 41.72 | 29.02 | | |

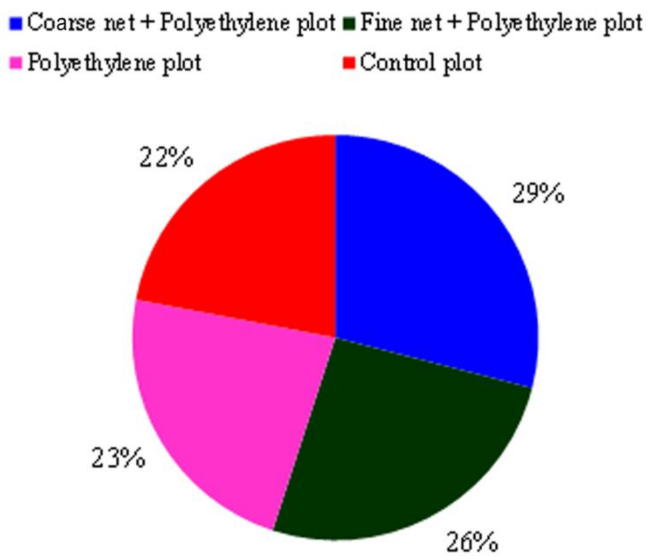
Means in a column having the same letter did not differ significantly (*P*>0.01) according to Tukey's honestly significant difference (THSD) test.

***Common cutworm***

The fruit infestation by common cutworm (%) was not significantly influenced by different treatments in SAU campus and Sreemangal (Fig. 1). The fruit infestation varied from 17 to 30% in SAU campus and from 22 to 29% in Sreemangal.




(A)




(B)

**Fig. 1. Relative abundance of common cutworm on bell pepper at different plots in SAU campus (A) and Sreemangal site (B) during October 2017 to April 2018**

***Fruit yield increase by net barrier***

The fruit yield was significantly influenced by different treatments (Table 4). In SAU campus, the highest fruit yield (12.74 t $ha^{-1}$) was obtained in fine net + polyethylene used plot. The lowest fruit yield (5.84 t $ha^{-1}$) was recorded in polyethylene used plot. Intermediate level of fruit yield was found in course net + polyethylene plot (9.24 t $ha^{-1}$) and untreated control plot (7.99 t $ha^{-1}$). In Sreemangal site, the highest fruit yield (10.48 t $ha^{-1}$) was recorded in fine net + polyethylene plot used plot. The lowest fruit yield was recorded in polyethylene used plot (6.35 t $ha^{-1}$) followed by untreated control plot (6.73 t $ha^{-1}$). Intermediate level of fruit yield (8.38 t $ha^{-1}$) was found in course net + polyethylene used plot. Regardless of the two study sites the use of coarse net and fine net increased 15.6 to 59.4% of fruit yield of bell pepper.

**Table 4. Effect of net barriers on the increase in total fruit yield of bell pepper in SAU campus and Sreemangal during October 2017 to April 2018**

| Treatment | Total fruit yield (t $ha^{-1}$) | | Total fruit yield increase over control (%) | |
|---|---|---|---|---|
| | SAU campus | Sreemangal | SAU campus | Sreemangal |
| Coarse net + polyethylene plot ($T_1$) | 9.24 b | 8.38 b | 15.6 | 24.5 |
| Fine net + polyethylene plot ($T_2$) | 12.74 a | 10.48 a | 59.4 | 55.7 |
| Polyethylene plot ($T_3$) | 5.84 c | 6.35 c | 26.9 | - |
| Untreated control (without net, without polyethylene) | 7.99 bc | 6.73 c | - | - |
| LSD | 2.185 | 1.3116 | | |
| CV (%) | 17.71 | 14.46 | | |

Means in a column having the same letter did not differ significantly ($P$>0.01) according to Tukey's honestly significant difference (THSD) test.

***Economic analysis***

Gross return, net return, adjusted net return and Marginal Benefit Cost Ratios (MBCRs) of different treatments are presented in Table 5.

In SAU campus, the highest MBCR (7.56 : 1) was obtained from fine net + polyethylene treated plot ($T_2$), which was followed by coarse net + polyethylene treated plot (4.65 : 1). The lowest MBCR (-2.61 : 1) was recorded in polyethylene treated plot ($T_3$). In Sreemangal, the highest MBCR (4.90: 1) was obtained from fine net + polyethylene treated plot ($T_2$), which was followed by coarse net + polyethylene treated plot (3.43:1). The lowest MBCR (-1.20 : 1) was recorded in polyethylene used plot ($T_3$). Regardless of the two study sites the use of fine net gave higher economic returns in terms of higher BCR values compared to that of coarse net treated plot.

In two sites of the present study, the use of coarse net and fine net significantly and identically reduced the incidence of aphid, jassid and white mite. These results are more or less in agreement with the very recent findings of Wang *et al*. (2018) who have found that 60-mesh, 80-mesh and 100-mesh insect-proof netting provided 57.2%, 98.4% and 100.0% protection against whitefly (*Bemisia tabaci*) in tomato. Sethi *et al.* (2009) observed that the major entry points for aphid, whitefly, thrips, and mites were through 40-mesh nylon net. The above results indicate that mesh size of the net is an important factor of protecting insect entry into crop. Palada and Wu (2009) suggested that the most promising way to prevent the entry of small-sized insects (thrips, whitefly, and aphids) and mites in net houses is to use finer net excluding 50-mesh or 60-mesh coarse nets. However, the reports of Martin *et al.* (2006) are not in compliance with the present results, as because larval fruit infestation by common cutworm (*Spodoptera litura* Fab.) was not protected in the present experiment using either coarse net or fine net. The failure of protecting common cutworm infestation on bell pepper fruits might have caused due to occurrence of heavy storms during some night times in Sylhet region at fruiting stage of Bell Pepper. At several night times, plots of the coarse net and fine net became uncovered due to gusty winds. It is assumed that the nocturnal moths of common cutworm were able to enter into the plots when nets became open at night time due to heavy storms. As a result, plots became unprotected and thus moths laid eggs which caused fruit infestation by cutworm larva. On the other hand, aphids, jassids and white mite are small in size and weak in flying long distance like cutworm moth. As such, their infestation might have not much affected by night time storms in the study sites. So, joint efficacy of netting and bagging methods may be evaluated to develop an effective management approach against common cutworm of bell pepper.

**Table 5. Economic analysis of various treatments in SAU campus and Sreemangal**

| Treat-ment | Cost of treatment (Tk ha$^{-1}$) | Yield (t ha$^{-1}$) | Price ( Tk kg$^{1}$) | Gross return (Tk) | Net return (Tk) | Adjusted net return (Tk) | Marginal Benefit Cost Ratio (MBCR) |
|---|---|---|---|---|---|---|---|
| **SAU Campus** | | | | | | | |
| $T_1$ | 453000 | 9.24 | 450 | 4158000 | 3705000 | 2107000 | 4.65 |
| $T_2$ | 483000 | 12.74 | 450 | 5733000 | 5250000 | 3652000 | 7.56 |
| $T_3$ | 268000 | 5.84 | 200 | 1168000 | 900000 | -6988000 | -2.61 |
| $T_4$ | --- | 7.99 | 200 | 1598000 | 1598000 | -- | -- |
| **Sreemangal** | | | | | | | |
| $T_1$ | 453000 | 8.38 | 400 | 3352000 | 2899000 | 1553000 | 3.43 |
| $T_2$ | 483000 | 10.48 | 400 | 4192000 | 3709000 | 2363000 | 4.90 |
| $T_3$ | 268000 | 6.35 | 200 | 1270000 | 1002000 | -344000 | -1.20 |
| $T_4$ | -- | 6.73 | 200 | 1346000 | 1009500 | -- | -- |

Costs of treatment: Bamboo = 117000 Tk ha$^{-1}$; Polyethylene = 131000 Tk ha$^{-1}$; Coarse net = 185000 Tk ha$^{-1}$; Fine net = 215000 Tk ha$^{-1}$; Labourer = 400 Tk ha$^{-1}$day$^{-1}$ labourer$^{-1}$ for 50 (fifty) days in total

It may be noted that the farmers of Bangladesh often apply several groups of toxic insecticides (e.g., cypermethrin, lambda cyhalothrin, dimethoate, chlorpyrifos, mixture of thiamethoxam & chlorantraniliprole (Voliam Flexi ® 300SC)) for the management of common cutworm in vegetable crops, but the pest has developed resistance against all these groups of insecticides (Rahman *et al*., 2013). Even though in the present results, use of fine net and polyethylene had little effects in controlling common cutworm, use of fine net and polyethylene sheet in bell pepper plot significantly protected insect and mite pests, produced maximum fruit yield and gave higher economic benefits, indicating that use of fine net is effective in managing sucking pests of bell pepper in Sylhet region and other regions of the country where bell pepper is grown.

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