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BIOLOGICAL MANAGEMENT OF SOUTH AMERICAN TOMATO MOTH (*TUTA ABSOLUTA* MEYRICK) IN ETHIOPIA

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Abstract: South American tomato moth (*Tuta absoluta* Meyrick) is one of the production constraints of Solanaceous crop of tomato (*Lycopersicon esculentum* Mill.). The trial was conducted using irrigation at Melkassa Agricultural Resarch Center (MARC) during 2014 off season to determine the optimum rate and frequency, and evaluate the efficacy of *Bacillus thuringiensis* var *kurstaki* against *T. absoluta*. The miya variety was used for this experiment. The experiment was laid out in RCBD with three replications. *Bacillus thuringiensis* was tested at 1 and 2 kg/ha in 7, days of foliage application in addition coragen as the standard check and the untreated check was included for comparison. The different doses of *Bacillus thuringiensis* were no variation on egg density and agronomic characters such as plant height, number of flower and fruit per cluster, and fruit set percentage. All treatments foliar application minimizing the leaf damaged score compared with untreated check. Coragen and 2kg/ha of B.t in weekly application were gave the maximum marketable yield, lowest fruit infestation percentage and fruit holes with *T.absoluta* and minimizing yield loss. *Bacillus thuringiensis* var *kurstaki* which are medium efficacy in controlling *T.absoluta* after the study compared with the standards check. It is an important component of integrated pest management so more extensive studies for integrating of *Bacillus thuringiensis* with botanicals and biological control methods including predator and parasitoids of control measures against *T.absoluta* would contribute to sustainable tomato production in Ethiopia.

Key words: Tomato, *Bacillus thuringiensis*, coragen, *Tuta absoluta*, miya

Introduction: Tomato (*Lycopersicon esculentum* Mill.) is one of the most important edible and nutritious vegetable crops in the world. It belongs to the Solanaceae family. It ranks third next to potato and sweet potato with respect to the volume of world vegetable production (FAO, 2006). It is one of the most economically important vegetable crops and is widely cultivated in tropical, sub-tropical and temperate climates in the world. It is the most frequently consumed vegetable in many

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countries, becoming the main supplier of several plant nutrients and providing an important nutritional value to the human diet (Willcox *et al*., 2003).

Agricultural pests can reduce yield, increase costs of control, and lead to the use of pesticides which ultimately lead to the disruption of existing integrated pest management systems (Thomas, 1999). Tomato crops are normally attacked by a great variety of insect pests including the tomato moth, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae), considered the most important tomato pest (Medeiros *et al.*, 2006). Productivity of tomato in Ethiopia is lower by half than the world average due to several biotic and abiotic stresses. However, with global agriculture and trade new pests are being introduced into the country frequently. A case in point is the South American tomato moth, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) occurrence of the pest in the country was detected following heavy infestation of tomato fields in February 2013 in the major tomato production belt of the central Rift Valley region (Gashawbeza and Abiy, 2013).

In its new regions, *T. absoluta* has spread extremely fast, becoming a potential threat to the world tomato production (Desneux *et al*., 2011). Unusually extensive leaf mining and fruit damage on tomato by a micro-lepidopteron moth was observed in some tomato growing areas of Ethiopia in January/February 2013. Heavy incidence of this moth was reported from Alamata area of Tigray and major tomato belt between Modjo and Zeway towns in the Central Rift Valley. Tomato growers in the affected areas of Ethiopia reacted to the pest damage by applying conventional insecticides locally available on the market. These include organophosphates, such as profenofos and pyrethroids, such as Lambda cyhalothrin with no success or reduction of infestation resulting huge financial loss. As it is a newly introduced pest in Ethiopia, no single insecticide was based on local efficacy data registered for the management of the pest in Ethiopia until the third quarter of 2013 (Gashawbeza and Abiy, 2013).The development of Biopesticides stimulates modernization of agriculture and will, undoubtedly, gradually replace chemical pesticides (Leng *et al*., 2011). Among the different entomopathogens *Bacillus thuringiensis* var. *kurstaki* (Btk) causes larval mortality at all instars and all commercial formulations can be successfully applied in the schemes for control of the pest in laboratory (Giustolin *et al*., 2001; Theoduloz *et al*., 2003; Niedmann and Meza-Basso, 2006). *Bacillus thuringiensis* exhibited a medium to low efficiency on all instars of *T. absoluta.* No information has been so far generated in Ethiopia on the efficacy of the microbial insecticide against *Tuta absoluta* including its optimum rate and application of frequency.

This study is proposed with the following objectives:

1. Evaluate the efficacy of *Bacillus thuringiensis* to manage the South American Tomato Moth (*Tuta absoluta*)

Materials and Methods:

Description of the Study Area: The present experiment was conducted during the off season in 2014 at Melkassa Agricultural Research Center (MARC). The Center is located 15 km south east of Adama in the semi-arid region of the Central Rift Valley of Ethiopia at 8^{o} 24’N latitude and 39^{o} 12’E longitude and at an elevation of 1550 meter above sea level (m.a.s.l.). The site receives 763 mm mean annual rainfall but with much variation in distribution and amount, 70% of which occurs between the months of May and September. Late onset of rains, intermittent periodic dry spells, and early cessation of rains are common causes of fluctuating annual production with occasional drastic reduction in crop yields and occurrence of pests (MARC, 1996). The maximum and minimum annual mean temperatures are 28 ^{o}C and 14 ^{o}C, respectively. Soil type of the site is Andosol cultivated for long period of time (MARC, 1996).The soils are mainly sandy with pH of 6.9-7.9 and mean temperature of 21°C

Table 1.Details of the treatment combinations and spray frequencies against South America tomato moth (*Tuta absoluta*)

Treatment	Description	Rate of Application
Untreated check	Control	
Btk 1.0 × 7 days	*Btk* 1.0 kg per ha 7 days	2.4 g/plot WP (0.5kg/ha) b/n 7 days interval
Btk 2.0 × 7 days	*Btk* 2.0 kg per ha 7 days	4.8 g/plot WP (0.5kg/ha) b/n 7 days interval
Coragen	250 ml per ha 14 days	0.6 ml/plot EC (250 ml/ha) b/n 14 days interval

Key: *Btk* *Bacillus thuringiensis* var. *kurstaki*
WP Wettable powder
EC Emucifable concentrate

Data to be collected: The central four rows of each plot were considered for collecting data. Four plants per plot were randomly selected to count egg density. Samples of three leaves each were collected from the bottom, middle and upper layer of the canopy and placed separately in plastic bags for transportation to the laboratory for counted the egg number under stereomicroscope.

South American tomato moth leaf damage score was taken based on scale of 1 to 5 (1= 1-10% no infestation; 2= 11- 25% slight infestation of; 3= 26-50% moderate infestation; 4= 51-75% heavy infestation of; 5= 76-100%.

Plant height (cm) was recorded by the average height of 10 plants of each plot measured from the ground level to the tip of the longest leaf at maturity.

Number of flowers per cluster: The total number of flowers per cluster was counted from 5 randomly selected plants and three flower clusters per plant at 50% flowering.

Number of fruits per cluster: The total number of fruits per cluster was counted from 5 randomly selected plants at red ripening stage of fruit using cluster used for flower count.

Fruit set percentage (%): Data on fruit set percentage was obtained by dividing the number of fruits per cluster by the number of flowers per cluster times 100.

Sorted the total fruit yield into marketable fruit yield and unmarketable fruit yield. Then the marketable fruit yield was recorded by counting and weighing from plots and expressed in results marketable fruit number and yield per hectare.

Unmarketable fruit yield partitioning based on the presence of damage symptoms by the *Tuta absoluta* or other problems was weighing in plots and expressed in to percentage of the unmarketable fruit. Percentage of unmarketable fruit was calculated as follows:

$$\text{Unmarketable fruit}(\%) = \frac{\text{weight of unmarketable fruit}}{\text{Total weight of harvested fruits}} \times 100$$

From the unmarketable fruit grouped the fruit damaged by the *Tuta absoluta* was weighing and expressed results in percentage of *Tuta absoluta*

$$Tutaabsoluta(\%) = \frac{\text{Weight of } Tutaabsoluta \text{ damaged fruit}}{\text{Total weight of harvested fruits}} \times 100$$

Ten samples fruit was taken from damaging fruits due to *Tuta absoluta* counting the holes number and take the average of the hole per fruit.

Total fruit yield (ton/ha) was recorded by sum up the weight of marketable and unmarketable fruit yields from plots and expressing it in hectare base. Total marketable and unmarketable fruit per number was recorded counting the fruits representing marketable and unmarketable one and dividing to the number of plants per plot.

Relative yield loss was calculated according to the following equation:

$$\text{Relative yield loss}(\%) - \frac{Yp - Yt}{Yp} \times 100$$

(Robert and James, 1991)

Where, Yp is the yield of maximum protected plot and Yt is yield from plots of other treatments.

Economic analysis: Total variable cost includes the cost of chemicals and chemical application costs. The price of Bt var. kurstaki, coragen and karate were 1050 birr/kg, 6600 birr/Liter and 450 birr/Liter, respectively. These costs were during the experiment time. Labor cost was 50 birr man-day for per application. A gross benefit was calculated by multiplying farm gate price that output sell of the product. Therefore, the price of output or tomato was 8 Birr/kg.Net benefit was calculated by subtracting the total variable costs from the gross benefit for each treatment. The cost of inputs and production practices were assumed to remain the same among all the treatments except the chemical costs and chemical application prices. On untreated plot there only inputs and production cost which was the same for all treatments.

Based on the data obtained from the field, cost-benefit analysis was performed using partial budget analysis. Partial budget analysis is a method of organizing data and information about the cost and benefit of various agricultural alternatives (CIMMYT, 1988).

Statistical Data Analysis: The data were analyzed using the General Linear Model (GLM) procedure of SAS statistical version 9.2 Software (SAS, 2009). Data were checked for satisfying ANOVA assumptions before subjecting them to ANOVA. To stabilize the variance the egg density count data were transformed to square root scale. Significance mean was separated using Student-Newmans-Keuls test.

Results and Discussion: Effect of Different Rate of Commercial *Bacillus thurinigensis* to Control *Tuta absoluta:*

Egg density: Mean number of *Tuta absoluta* egg in the leaf no significance difference ($p>0.05$) among treatments (Table 2). The number of *Tuta absoluta* egg in the leaf before and after application ranged from 1.56 to 2.45 and 1.17 to 2.41 respectively. Amongrates and frequencies of commercial Bacillus thurinigensis and chemical application on voiced activity was observed less effectivness.These results are concordant with Hafsi *et al.* (2012) who found that Bacillus thuringiensis Berliner var. kurstak low efficacy on egg mortality of *T.absoluta*.

Table 2. The effect of rate and frequency of *Bacillus thuringiensis* and synthetic chemicals on mean number of egg per plant

Treatments	Pre application	Post application	Leaf damage score
Bt @ 1 kg/ ha 7 days	2.45a	1.34a	2bc
Bt @ 2 kg/ha 7 days	2.16a	1.76a	2bc
Coragen250 ml/ha 14 days	2.03a	1.17a	1.83c
Untreated check	1.56a	2.41a	2.42a

The results of the study indicated that the main effect rate of *Bacillus thuringiensis* showed no significance difference on the egg density in the leaf.

Total fruit yield: The effects of microbial and synthetic insecticides treatments of *T.absoluta* on total fruit number and yield was compared. The results in Table 3 show no significant difference both in total fruit number and yield in response to *Btk* with different rate. Coragen and untreated check. The higher fruit number(726667) on tomato treated with Bt @ 2kg/ha 7 days, while lower fruit number (597083) recorded on untreated check. Evaluating the number of mines after application, when infestation was higher, there was no difference among the insecticides, however at lower infestation it might be observed that spin sad with Break-Thru at all rates were statistically the best treatment. It happened probably because at higher infestation the pest outbreak was too high to be controlled by the insecticide rate used what did not occurred at lower pest infestation (Santos *et al.*, 2011).

Table 3 The effects of rate and frequency of *Bacillus thuringiensis* and synthetic chemicals on total fruit and marketable fruit yield (ton/ha)

Treatments	TFN ha^{-1}	TY	MFN ha^{-1}	MY
Bt @ 1 kg/ ha 7 days	630625a	38.94a	148750cde	10.56bcd
Bt @ 2 kg/ha 7 days	726667a	45.71a	240000b	16.42b
Coragen 250 ml/ha 14 days	714792a	42.19a	451042a	28.39a
Untreated check	597083a	36.31a	58542e	3.89d

TFN ha^{-1}= Total fruit number per ha, TY=Total yield, MFN ha^{-1}= Marketable fruit number per ha, MY= Marketable yield

Marketable yield: Marketable fruit number and yield were significantly higher in coragen as compared to the untreated control (Table 4). Marketable fruit number 451042 and 240000and marketable yield 28.39 and 3.89 ton/ha were recorded in plots treated with the coragen and untreated check respectively in comparison to untreated plots marketable fruit number (58542) and marketable yield (3.89 ton/ha).Coragen was the most stable treatment affecting on T. absolute population (Ghanim and Ghani, 2014).

The different *Bacillus thuriniginesis* treatments had varying effects on marketable fruit number and yield. The lowest rates of *Bacillus thurinigiensis*, 1 kg/ha, did not significantly affect marketable fruit number and yield even in the spray interval of 7 days. Marketable fruit number and yield in plots treated with the higher rates 2 kg/ha of *Btk* were significantly higher in the 7 days. Moussa *et al*. (2013) reported that chlorantraniliprole and chlorfenapyr were able to overwhelm the pest population completely until the 7^{th} day after treatment. On the other hand, *Btk* showed provide satisfactory results on *T.absoluta* control with 75.9%.

In general, higher mean marketable fruit number and yield were recorded from plots that received relatively higher dosages of *Bt* microbial insecticides than that of plots sprayed with lower dosage. *Bacillus thuringiensis* frequency showed significant ($p < 0.0001$) difference in marketable fruit number and yield among the different spraying interval.

Percentage of total damaged fruits: Data presented in Table 5 indicated that the effect of coragen and untreated check was significant difference ($p<0.0001$) for the percentage of total damaged fruits from the total fruit yield. The treatments in combinations of Btk at 1kg/ha and 2 kg/ha with 7 days spraying interval were less fruit damaging compared to untreated check, however the standard check coragen more effective to reduce the damaging fruits. Baetan *et al.* (2013) showed that the most efficient product was the Coragen, which after it was used; it reduced the frequency of attacked plants with 94.4% in the greenhouse. In general, plots received Btk at 1kg/ha and 2kg/ha with weekly applications, appeared to be better in reducing the damaged fruits. Furthermore, management of T. absoluta based on treatments with Bt doesn't induce resistance inphytophagous populations that are a likely cause of field control failures (Silva *et al.*, 2011).

Increase the rate of *Btk* application from 1 kg/ha to 2 kg/ha inversely decrease the damaged fruits of tomato. In agreement with the present observation Khan *et al*. (2005) reported that in fields with high populations of *P. xylostella* larvae, *Bacillus thuringiensis* products were used every 5–7 days to provide control.

Table 5. The effects of *Bt* rate and frequency, coragen and karate on percentage of total and with *T.absoluta*damaged fruits

Treatments	% TDF	% DFTu
Bt @ 1 kg/ ha 7 days	72.7c-e	64.35ab
Bt @ 2 kg/ha 7 days	64.74e	54.82b
Coragen 250 ml/ha 14 days	33.08g	18.75d
Untreated check	89.03a	81.88a

% TDF= Percentage of total damage fruit, % DF Tu= Percentage of damage fruit with *T.absoluta*

Percentage of infested tomato fruits with T. absoluta: There were differences among treatments in their activity against T. absoluta. Among the tested insecticides effective control of T. absoluta coragen followed by those which received the highest concentration of 2 kg/ha with 7 days application interval, while others treatments were no significance difference with untreated check. Gonzales-Cabrera et al. (2011) obtained that the percentage of infested fruits with T. absoluta was significantly lower for all treatments with Bt compared to the control, however no differences among them.

The lowest percentage of infestation fruits with *T.absoluta* (18.75), recorded from plots treated with synthetic insecticides coragen, plots received the microbial insecticides *Btk* at the rate of2 kg/ha with 7 days spraying intervals was recorded lowest percentage (54.82). On the other hand, the highest percentage infestation of fruits with *T. absoluta* (81.88 %) was recorded from untreated check. The main damage is produced on the leaves and fruits. With respect to *T.absoluta*, the present results are in agreement with those obtained by Larrain *et al*. (2014) who reported that the percentage of damaged fruit (20 %) was significantly lower ($p < 0.05$) in the treatments with cyantraniliprole than in the untreated control where damage reached 88%..

Infestation of fruits due to *T. absoluta* showed a significant ($p<0.0001$) variation due to the effect of rate *Btk* (Table 6). *Bacillus thuringiensis* var *kurstaki* with rates of 2 kg/ha resulted in lowest infestation with *T. absoluta* (64.88%) (Table 7). However, this value was statically similar with infestation of fruits of tomatoes treated with *Btk* 1kg/ha.

Fruits holes number due to *T. absoluta:* In fruit, the tomatoes show necroses on the calyx and exit holes on the surface of the integument. Fruits hole number due to T.absoluta significantly affected by the different. The insecticides sprayed at different rates and schedules had varying effects on fruits holes number due to T.absoluta. With the exception of the treatments with Btk at a rate of 2kg/ha with 7 days schedules.

The highest fruit hole number 5.07 was recorded on untreated check, while the lowest fruit hole number 1.9, were observed on the treated with coragen. The second lower fruit hole number 2.86 was recorded when *Btk* was applied at the rate 2 kg/ha in weekly schedule. The caterpillars directly damage the leaves, the terminal buds, the flowers and the fruits (Moraes and Normanha, 1982; Haji *et al*., 1988; Lopes Filho, 1990; Castelo- branco, 1992; Souza and Reis, 1992), or decrease fruit quality indirectly by burning the skin of the fruit. The latter symptom has been frequently observed on fruits from caterpillar-defoliated plants. Also, potting *et al*. (2013) demonstrated that unacceptable levels of cosmetic fruit damage may occur in fresh market tomato production due to the mining habit of the organism. Without any control measure the potential damage may be 100%, especially at high population densities at the end of the growing season because the presence of the organism in a greenhouse may lead to unacceptable levels of cosmetic fruit damage.

Table 6. The effect of *Bt* rate and frequency, karate and coragen on FH, MFNo/p and UFNo/p

Treatments	FH	MFNo/p	UFNo/p
Bt @ 1 kg/ ha 7 days	4.09ab	4.96cde	16.12ab
Bt @ 2 kg/ha 7 days	2.86bc	8b	16.22ab
Coragen 250 ml/ha 14 days	1.9c	15.04a	8.79c
Untreated check	5.07a	1.95e	17.95a

Bt= *Bacillus thuringiensis*, FH= Fruit hole number, MFNo/p= Marketable fruit number per plant, UFNo/p= Unmarketable fruit number per plant

Marketable fruit number per plant:

Analysis of variance showed that there was significant ($p<0.05$) difference among treatments for marketable fruit number per plant (Table 7). *Bacillus thuringiensis* rate have different potentials of activity against. Weekly frequency in highest rates 2 kg/ha, the highest marketable fruit per number to reduce the

T.absoluta, but coragen was effective over all treatments.

Unmarketable fruit number per plant: The effect of Btk rate and frequency, the synthetic insecticides coragen treatments on tomato plants for unmarketable fruit number per plant was compared. The results in Table 7 show significance difference in unmarketable fruit number per plant in response to different treatments. Exception of synthetic insecticides no one treatments significance difference with the untreated check.

During crop cycle the infestation was higher in fruiting stage than initial stage of the crop due to increment of temperature in crop growing cycle (December to May) difficult to control the fruit damage by applying insecticide. An increase in temperature was detected at this time in the year. Their number became relatively high, as their attack became intense towards the end of crop cycle due to temperature rising. These results matched with those found by several authors (Miranda *et al.*, 1998; Lacordaire and Feuvrier, 2010). Leite *et al.* (2004) found that the attack of *T. absoluta* was severe at the end of growing season as the temperature increases.

Effect of Microbial insecticides on Some Agronomic Characteristics:

The agronomic characteristics of plant height, flower per clusters, fruit per cluster and fruit set percentage were non-significant difference among treatments (Table 8). In the leaf damaged scored showed that the infestation was less in these case no effect on the plant growth and development. This is coherent with the finding of Cely *et al*. (2010) who reported that in the vegetative variables there were no significant differences between the control and the lowest density of 2 up to 4 females per plant. However, there is an important reduction of the number of healthy fruit. The leaf infestation was lower due to lower population of pest during crop growing cycle so not affect the vegetative character significantly related to this there were not observed the treatment difference.

Table 8. Effect of microbial insecticides on Agronomic character of tomato

Treatments	PH	FlPC	FrPC	% FrS
Bt @ 1 kg/ ha 7 days	65a	3.93a	3.13a	79.73a
Bt @ 2 kg/ha 7 days	67.4a	4.27a	3.33a	81.9a
Coragen 250 ml/ha 14 days	65.4a	4.13a	3.13a	76.36a
Untreated check	66.2a	3.8a	2.93a	77.33a

PH= Plant height, FlPC= Flower per cluster, FrPC= Fruit per cluster, % FrS= Percentage of fruit set

Yield Loss:

Yield losses were computed relative to the average marketable yield of plots with the maximum protection against the insects (the highest marketable yield and lowest infestation), i.e. the plots treated with coragen. There were significant differences (P< 0.05) among treatments in reducing yield losses caused by *T. absoluta* in tomato (Table 10). The highest relative yield loss 86% recorded on untreated. *Tuta absoluta* attacks leaves and fruits and can cause up to100% crop loss if appropriate measures are not taken (Guenaoui, 2008).These results agree with Sabbour and soliman (2014) the percentage of yield loss in *B.t.* dipel were 36% as compared to 62% in the control. Sabbour and Shadia E-Abd-El-Aziz (2007) proved that applications with bioinsecticides increased the yield and decreased the infestation with insect pests.

Table 10. Gross and estimated net returns in birr and yield loss for tomato

Treatments	Gross return	Management Cost	Net return	Yield loss %
Bt @ 1 kg/ ha 7 days	76050	25650	50,400	61.85bc
Bt @ 2 kg/ha 7 days	118200	45600	72,600	43.82b
Coragen 250 ml/ha 14 days	204450	19500	184,950	23.56c
Untreated check	28050	0	28,050	86.02a

Economic analysis: Differences in net benefit were observed among the insecticides treatments. The net profit showed that the maximum benefit was recorded the plots treated with coragen (Table 10).

With increasing the concentrations of treatments and application schedules there was a decreasing trend in net return. In the dosages increases the insect control cost directly increases inversely the net befits decreases. Over all, the weekly application of microbial insecticides gave the best net befit compared with the fortnight and three weeks application.

Summary and Recommendation: Tomato (*Lycopersicon esculentum* Mill.) is one of the most important Solanaceous vegetable crops. The tomato plants are currently infested with many serious pests, recently the most destructive ones, *Tuta absoluta*. In the present study field trial was conducted to evaluate the efficacy *Bacillus thuringiensis* var *Kurstaki*on *T.absoluta* infestation under field conditions at MARC with natural infestation during 2013/2014off season. A contact insecticide, *Btk* was evaluated at 1and 2kg/ha rates whereas the frequency was applied at 7 days and the one standard check coragen and the untreated check. The treatments were tested for their effects on egg density, leaf damaged score and yield.

The plant infestation was initially lower then increases in the final crop growing cycle. The leaf infestations was lower but higher infestation was recorded in fruits due to the fruit are attacked as soon as they form, right up to maturity and one larva can damage several fruit on a single cluster. The maximum fruit infestation obtained the highest yield loss from untreated check. The synthetic insecticides coragen showed significantly affected marketable fruit number and yield. The main effects of *Btk* rate at 2kg/ha and frequency with 7 days interval give the better marketable fruit number and yield.

The lowest percentage of total damaged fruits was obtained from plots treated with coragen. The rate of *Btk* at 1 and 2kg/ha with 7 days frequency also reduced the percentage of total damaged fruits. The percentage of damaged fruit with *Tuta absoluta* lowest in treated with coragen, and 2 kg/ha *Btk* with weekly application. The main effect *Btk* rate at 2kg/ha best for reducing of infestation of *Tuta absoluta* in fruits and weekly frequency also good for control infestation. *Tuta absoluta* decrease the fruit quality by creating the holes and unattractive for the consumers. Coragen and *Btk* at 2 kg/ha with weekly application affect the hole number of fruits. Plots treated with *Btk* at 2 kg/ha and coragen score better marketable fruit per plant.

Cost-benefit analysis indicated that application of coragen pointed out maximum net benefit followed by Bt at 2kg/ha with weekly applications.

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