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ITK Based Pest Management Module for Sucking Peston Brinjal (*Solanummelongena* L.) Under Terai Agro-Ecological System of West Bengal

Sandeep Mandal, Saurabh Padamshali, Navneet Rana and Sonalika Kolhekar

Abstract
Brinjal, *Solanummelongena* L. (Eggplant) is one of the most important vegetable crops in Asia, where more than 90% of the world's eggplant production occurs. Among different biotic and abiotic stresses, insect pest is one of the most important limiting factors for successful cultivation of brinjal. Especially, sucking pests particularly, aphid, jassid, whitefly, etc. results in 10-15% reduction of yield depending on the intensity of infestation. To combat these pests, chemical control is generally most popular among farming community, but it has many drawbacks. This situation warranted environmentally friendly pest control strategies to mitigate the problems created by chemical control. The use of bio-rational products such as cow-urine and vermin-wash is one of the alternatives to chemical pesticides in suppressing the insect pests. Use of cow-urine (Sapre and Varma, 2006; Gupta and Yadav, 2006) and vermin-wash (Subsashri, 2004; Pareet 2006 and Meenatchi *et al*., 2010) have been evaluated against insect pests by few workers in past and found encouraging results. No sincere attempt has been made in the past by any worker in Gujarat to assess the impact of cow-urine and vermi-wash in suppressing insect pests of brinjal. Hence, a number of indigenous knowledge based pest management module for brinjal have been formulated and tested in the agro-ecosystem under consideration during rabi season of 2015 and 2016. Inspiring results obtained in field trial from two years of study. Insect pest population observed lowest in chemical based pest management module but natural enemy complex found drastically low. On the contrary in indigenous knowledge based pest management module moderate pest population were recorded with higher natural enemy population. Thus, production cost reduced, non-target arthropod faunal complex less hampered and reasonable harvest recorded in indigenous knowledge based management module where almost all the indigenous technology were accommodated including use of sieve ash, cow urine, cow dung slurry and cow urine+cow dung slurry (Karkar *et al*., 2014).

Keywords: pest management module, agro-ecological, shoot and fruit borer

Introduction
Brinjal, *Solanum melongena* L. (Eggplant) is one of the most important vegetables in Asia, where more than 90% of the world's eggplant production occurs. It has been cultivated in our country from about 4,000 years approximately. Although it is often thought as a Mediterranean or mid-Eastern vegetable. Among the Solanaceous vegetables, brinjalis the most common, popular and principal vegetable crop grown in many geographical regions in India. Asia accounts for about 94 percent of the world's Brinjal area with about 100 percent of world output. India and Indo-Chinaregion is considered as the centers of origin of eggplant (Vavilov, 1951). The area under Brinjal cultivation in India is estimated to be about 0.68 million ha with a total production of 12.706 million tonnes and productivity of 19.1 tonnes/ha. (Anon, 2014-15).

In India, West Bengal is one of the leading Brinjal producing state. The area under Brinjal cultivation in West Bengal is estimated to be about 0.140 million hectare witha total production of 2.388 million tonnes and productivity is 17.0 t/ha (Anon.2014-15).Brinjal plant is well adapted to high rainfall and high temperatures and is among the few vegetables capable of high yield in hot-wet environments (Hanson *et al*., 2006). Northern parts of West Bengal is suitable for providing this kind of agro-ecology for better production of Brinjal. Terai agro-climatic region of West Bengal experienced a typical sub-tropical per humid climate that favours the cultivation of a big group of vegetables. Thus, commercial cultivation of Brinjal is also a source of cash income for resource-poor farmers in agriculture dominated terai region of West Bengal.

There are several constraints in Brinjal production which are responsible both qualitative as well as quantitative deterioration in yield. Among several biotic and abiotic stresses one of the

most important limiting factors is the devastation caused by pest menace. Insect pest is one of the most important factors among them. It suffers intense insect-pest attack due to favourable conditions available for their reproduction and multiplication. Nayer *et al.* (1995) listed 53 insects attacking brinjal. Among the pests, shoot and fruit borer (*Leucinodes orbonalis* Guen.), whitefly (*Bemisia tabaci* Gennadius), leaf hopper (*Amrasca biguttula biguttula* Ishida) and epilachna beetle (*Henosepilachna viginctioctopunctata* (F.) cause severe damage. Infestation of leaf hopper, whitefly and shoot and fruit borer results in about 70- 92 per cent loss in yield of brinjal (Rosaiah, 2001). Of late, the intense attack of sucking pests particularly, aphid, jassid, whitefly, mealy bug and lace wing bug is found to play an important role in the reduction of yield. (Aslam *et al*., 2004; Swamina than *et al.*, 2010). The loss caused by sucking pests varies from 10-15 per cent depending on the intensity of infestation (Munde *et al*., 2011). Apart from the direct damage caused by sucking the cell sap and prohibiting the normal crop growth, several of the sucking pests also act as vectors of virus diseases.

For protecting the crops, farmers usually rely upon chemical pesticides those gradually hampering non-target organisms, increasing cost of production as well as leaving hazardous residues in the produce (Prempong *et al*., 1977). Among the non- chemical alternate technologies, indigenous technology may play important role in bringing sustainability in brinjal cultivation. From time immemorial, the farming communities of northern tract of West Bengal that comprises many aboriginal populations earlier used a number of indigenous techniques in managing pest menaces on brinjal. A good number of them are still in use on brinjal at different corners of the region. A number of indigenous knowledge based pest management module for brinjal have been formulated and tested in the agro-ecosystem under consideration during rabi season of 2015 and 2016. Inspiring results obtained in field trial from two years of study. Insect pest population observed lowest in chemical based pest management module but natural enemy complex found drastically low. On the contrary in indigenous knowledge based pest management module moderate pest population were recorded with higher natural enemy population. Thus, production cost reduced, non-target arthropod faunal complex less hampered and reasonable harvest recorded in indigenous knowledge based management module where almost all the indigenous technology were accommodated including use of sieve ash, cow urine, cow dung slurry and cow urine+cow dung slurry. (Karkar *et al.*, 2014). Hence, considering the ill effects of pesticidalapplication in agro-ecosystem and increasing cost of production, the indigenous technical knowledge based pest management technologies may be recommended to protect brinjal from pest menace. However, it may not be the only option but may be accommodated as one of the most viable as well as effective tools of IPM under northern parts of West Bengal.

Materials and methods

1. Technical Programmes to be undertaken

1.1. Experimental details

Variety	:	Local (Salta)
Season	:	Rabi
Year	:	2015-16 and 2016-17
Date of sowing	:	10.11.2015 and 10.11.2016
Design	:	RBD
Replications	:	5
Observation units	:	10 plants per replication
Plot size	:	5m X 5m
Spacing	:	60cm X 60cm
NPK	:	100:50:50
Plant Protection measures	:	One week interval
Number of treatments	:	6

1.2. Materials used in the indigenous technolog

a. Cow dung slurry
b. Cow urine
c. Fresh cow dung
d. Wood ash

In addition to those, Carbosulfan 25% EC (Manufactured by FMC India Pvt. Ltd.) was taken as an insecticide for chemical based pest management module of Brinjal. Other material required to conduct the study were measuring balance, knapsack sprayer, bamboo sticks, ropes etc.

1.3. Evaluation of different ITK based pest management module

Four ITK based pest management modules have been formulated. One chemical based management module and another one control was there. Thus, altogether the efficacies of six treatments wereevaluated in field condition. The Brinjal seedlings were transplanted during the second week of November for every two years i.e. during 2015-16 and 2016-17.

First top dressing was given after 30 days of transplanting @ 5g Urea per plant and second top dressing was given after 60 days of transplanting @ 10g Urea and 5g MOP as the source of nitrogen and potassium per plant respectively.Recording of observation was started immediately after first top dressing. All other agronomic practices for raising the crop were as per the recommendation of Brinjal for terai region of West Bengal.

Table 1: Treatment details of the study.

Treatments	Particulars	Remarks
T1	Application of wood ash	Sprinkling on leaves @ 50g/plant at 10 days interval.
T2	Application of Cow urine	Spraying of Cow urine and water (1:10) at 10 days interval.
T3	Application of Cow dung slurry	Spraying of Cow dung slurry and water (1:10) at 10 days interval.
T4	Application of Cow dung slurry + Cow urine	Spraying of Cow dung slurry and Cow urine (1:1) then the mixed with water (1:5) at 10 days interval.
T5	Application of *Carbosulfan 25% EC*	Spraying of Carbosulfan 25% EC@1ml/lit. At 10 days interval.
T6	Control (without adopting any pest management tactic).	Spraying only with tap water at 10 days interval.

1.4. Recording observation

No insect pest related observation was recorded in seed bed. Observation recording were started in the main field after first top dressing. For that purpose ten plants were selected randomly in each plot measuring 5x5 mt.by keeping at least five feet distance from the boundary. Plants marked by using jute sticks. Observations were recorded weekly and were continued till the last harvest.

Sucking Pest Complex (Aphid, Jassid, Whitefly etc.)

Observations on aphids (nymph and adult) were recorded on 10 randomly selected plants/plot by taking 2 leaves each from upper, middle and lower plant canopy.

Results and discussion

Brinjal is one of the most important vegetable crops grown commercially under northern tract of West Bengal and is infested by a number of insect pests during its growing season. Brinjal is cultivated round the year in the agro-ecological region under consideration and insects pests cause irrepairable crop losses all round the year. However, only a few cause havoc damage of the crop in field condition and affect production both from qualitative and quantitative aspects. Farmers apply conventional toxic chemical insecticides indiscriminately to protect their crops from pest menace. This practice not only causing faunal destabilisation in the agro-ecosystem but also leaving toxic residue in the produce.

Indigenous technical knowledge (ITK), which the aboriginal farming communities of northern West Bengal are using in agriculture since time immemorial may take pivotal role in minimising pesticidal load on brinjal. Considering this perspectives, in the present investigation four ITK based pest management modules have been formulated and evaluated against the pest complex of brinjal during rabi seasons of 2015-16 and 2016-17. One chemical based management module and another one control were also there with a view to compare the efficacy of ITK based management modules. Thus, altogether six treatments were evaluated in field condition in the present study. The crop i.e. brinjal were transplanted during second week of February every year during 2016 and 2017. First top dressing was applied at 21 days after transplanting. All other agronomic practices for raising the crop were as per recommendation of brinjal in terai region of West Bengal. Observation were recorded weekly and continued till harvest.

Data thus obtained from the study were stabilised and statistically analysed by Microsoft Excel and Indostat presented in tabular as well as graphical form as follows

4.1. Incidence of sucking pests on brinjal

A number of sucking pests are found to infest brinjal under terai region of West Bengal. They suck plant sap from tender parts of the crop. The infested plant become weak, devitalised and yield reduced drastically. In addition to cause direct damage to crop, they also some times cause indirect damage by transmitting several viral diseases from infected to healthy crops. Incidence of these sucking pests like aphids, jassids, white flies etc. in different pest management module of brinjal have been studied, data recorded, analysed statistically and presented as under.

4.1.1. Aphid, *Myzuspersicae* Sulz. (Hemiptera: Aphididae)

Incidence of aphid, *M. persicae* in different pest management module of brinjal during rabi season of 2015-16 and 2016-17 have been presented in table-2. It appeared from the presentation that the number of aphids detected in variousin pest management module varied significantly. During 2015-16, maximum population of aphid was recorded on T-6 i.e. control plot (11.61/3 leaves) and minimum was on T-5 i.e. in chemical based pest management module (4.66/3 leaves). Among ITK based pest management modules, the lowest population was recorded on T-4 followed by T-1, T-2 and T-3 (7.74, 8.37, 8.71 and 8.78/3 leaves respectively).During crop growing season 2016-17, maximum population of aphid was recorded on T-6 i.e. in control plot (8.53/3 leaves) and minimum was on T5 i.e. chemical based pest management module (3.05/3 leaves). Among ITK based pest management module lowest population was recorded on T-4 followed byT-1, T-2 and T-3 (5.33, 5.98, 6.22 and 6.30/3 leaves respectively).

Two years pooled analysis of the study revealed that least population of aphid was on chemical based management module (3.86/3 leaves). Among ITK based management module T4 appeared as the best treatment (6.53/3 leaves). On the contrary, highest population of aphid was noted on control plot (10.07/3 leaves) which is significantly higher than all the other treatments. However, T2, T3, T4 are statistically at par with each other.

Table 2: Incidence of Aphid, *Myzuspersicae* Sulz. (Hemiptera: Aphididae) in different ITK based pest management module of brinjal.

Treatments	Number of Aphid/3 leaves		
	2016	2017	Pooled over 2016-17
T-1	8.37^{c} (2.72)	5.98^{c} (1.84)	7.18^{c} (2.51)
T-2	8.71^{d} (2.78)	6.22^{d} (1.88)	7.46^{d} (2.57)
T-3	8.78^{d} (2.80)	6.30^{d} (1.90)	7.54^{d} (2.59)
T-4	7.74^{b} (2.62)	5.33^{b} (1.78)	6.53^{b} (2.40)
T-5	4.66^{a} (2.06)	3.05^{a} (1.35)	3.86^{a} (1.88)
T-6	11.61^{e} (3.25)	8.53^{e} (2.29)	10.07^{e} (3.01)
SEM (±)	0.089	0.059	0.074
CD at 0.05%	0.247	0.163	0.205

*Figures followed by same alphabet are not statistically different.

**Figures within parenthesis are square root transformed values.

[T1: Sprinkling of wood ash @ 50 gm/plant at 10 days interval, T2:Spraying of Cow urine and water (1:10) at 10 days interval, T3:Spraying of Cow dung slurry and water (1:10) at 10 days interval, T4:Spraying of cow dung slurry and Cow urine (1:1) then the mixed with water (1:5) at 10 days interval, T5:Spraying of Carbosulfan 25% EC@1ml/litre at 10 days interval, T6: Control (Spraying only with tap water at 10 days interval)].

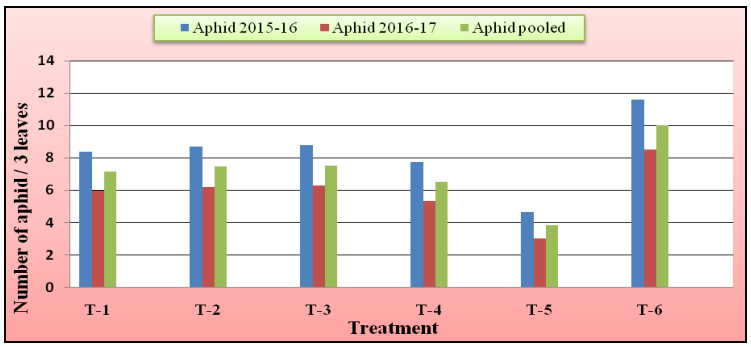

Fig 1: Incidence of aphid in different ITK based pest management module on brinjal.

4.1.2. Jassid, *Amrasca biguttula biguttula* Ishida (Homoptera: Cicadellidae)

Jassid, *A. Biguttula biguttula* is another important sucking pest of several solanaceous vegetable crops including brinjal. Both nymphs and adults cause damage to the crops by sucking plant sap from under surface of tender leaves as well as twigs. Incidence of jassids on brinjal under different pest management module have been detected in the present investigation during rabi season 2015-16 and 2016-17 and presented in table-3.

It appeared from the presentation that jassid population on brinjal was varied from 1.44 to 5.07/3 leaves during 2016 and 1.31 to 4.74 during 2017. During rabiseason of 2016, maximum population (5.07/3 leaves) of jassid was recorded on T-6 i.e. in control plot and minimum (1.44/3 leaves) was on chemical based pest management module (T-5). Among ITK based pest management module lowest population was recorded on T-4 followed by T-2, T-3 and T-1 (2.90, 3.28, 3.35 and 3.38/3 leaves respectively). During 2017, maximum population (4.74/3 leaves) of jassid was recorded on T-6 i.e. control plotand minimum (1.31/3 leaves) was on chemical based pest management module (T-5). Among ITK based pest management module lowest population was recorded on T-4 followed by T-2, T-3 and T-1 (2.60, 2.92, 3.02 and 2.91/3 leaves respectively).

Table 3: Incidence of Jassid, *Amrasca biguttula biguttula* Ishida (Homoptera: Cicadellidae), in different ITK based pest management module of brinjal.

Treatment	Number of Jassid/3 leaves		
	2016	2017	Pooled over 2016-17
T-1	3.38^{d} (2.31)	2.91^{c} (1.78)	3.14^{d} (1.70)
T-2	3.28^{c} (2.36)	2.92^{cd} (1.80)	3.10^{c} (1.72)
T-3	3.35^{d} (2.38)	3.02^{d} (1.81)	3.18^{d} (1.71)
T-4	2.90^{b} (2.18)	2.60^{b} (1.70)	2.75^{b} (1.67)
T-5	1.44^{a} (1.70)	1.31^{a} (1.30)	1.75^{a} (1.51)
T-6	5.07^{e} (2.78)	4.74^{e} (2.23)	4.90^{e} (1.84)
SEM (±)	0.012	0.009	0.003
CD at 0.05%	0.033	0.026	0.011

* Figures followed by same alphabet are not statistically different.
** Figures within parenthesis are square root transformed values.

[T1: Sprinkling of wood ash @ 50 gm/plant at 10 days interval, T2:Spraying of Cow urine and water (1:10) at 10 days interval, T3:Spraying of Cow dung slurry and water (1:10) at 10 days interval, T4:Spraying of cow dung slurry and Cow urine (1:1) then the mixed with water (1:5) at 10 days interval, T5:Spraying of Carbosulfan 25% EC@1ml/litre at 10 days interval, T6: Control (Spraying only with tap water at 10 days interval)].

When two years data were pooled together, significantly lowest jassid population (1.75/3 leaves) was recorded on T-5, i.e. in chemical based pest management module. Among the ITK based pest management module, minimum jassid population (2.75/3 leaves) was noted on T-4 which is also significantly differ from all other treatments at 5% level of significance. Again, T-1and T-3 have been found statistically at par with each other. However, T-2 showed intermediate in between T-1 and T-3. On the contrary, T-6, control treatment revealed significantly highest population of jassid (4.90/ 3 leaves) among all the treatments.

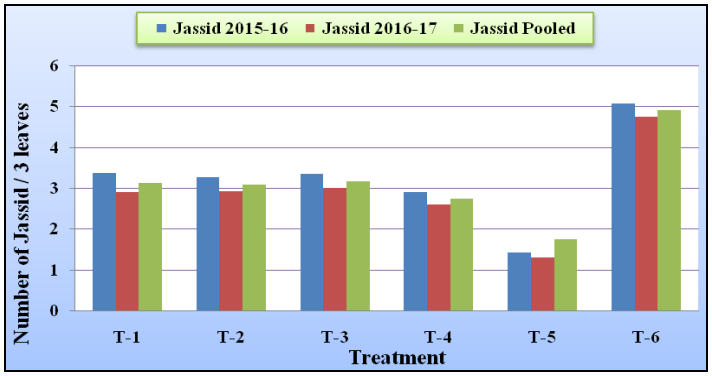

Fig 2: Incidence of Jassid in different ITK based pest management module on brinjal.

4.1.3. White fly, *Bemisiatabaci* Genn. (Hemiptera: Aleyrodidae)

White fly, *Bemisiatabaci* is one of the most important hemipteransucking pests of several vegetable crops. It also infest brinjal inflicting considerable crop losses. Like any other sucking pests, both nymphs and adults cause damage to the crops by sucking plant sap from tender plant parts. Incidence of white fly on brinjal under different pest management module have been detected in the present investigation during rabi season 2015-16 and 2016-17 and presented in table-4.

It appeared from the presentation that white fly population on brinjal has been varied from 1.75 to 5.68/3 leaves during 2015-16 and 1.89 to 6.08 during 2016-17. During crop season 2015-16, maximum population of whitefly (5.68/3leaves) was recorded on T-6, i.e. on control plot and minimum (1.78/3 leaves) was on chemical based pest management module (T-5). Among ITK based pest management modules, lowest population was recorded on T-4 followed by T-1, T-2 and T-3 (3.56, 3.71, 3.92 and 4.04/3 leaves respectively). During rabi season of 2016-17, maximum population (6.08/3 leaves) of white fly was recorded on control plot (T-6) and minimum (1.89/3 leaves) was on chemical based pest management module (T-5). Among ITK based pest management module lowest population was recorded on T-4 followed by T-2, T-3 and T-1 (3.12, 3.72, 3.74 and 4.31/3 leaves respectively).

Table 4: Incidence of white fly, *Bemisiatabaci* Genn. (Hemiptera: Aleyrodidae), in different ITK based pest management module of brinjal.

Treatment	Number of flies/3 leaves		
	2015-16	2016-17	Pooled mean
T-1	3.71^{c} (1.91)	3.72^{bc} (1.95)	3.72^{c} (1.93)
T-2	3.92^{d} (1.96)	3.74^{bc} (1.96)	3.83^{c} (1.96)
T-3	4.04^{d} (1.98)	4.31^{c} (2.05)	4.18^{d} (2.01)
T-4	3.56^{b} (1.87)	3.12^{b} (1.79)	3.34^{b} (1.83)
T-5	1.78^{a} (1.42)	1.89^{a} (1.44)	1.83^{a} (1.43)
T-6	5.68^{e} (2.35)	6.08^{d} (2.46)	5.88^{e} (2.40)
SEM (±)	0.011	0.035	0.026
CD at 0.05%	0.030	0.098	0.072

*Figures followed by same alphabet are not statistically different.

**Figures within parenthesis are square root transformed values.

[T1: Sprinkling of wood ash @ 50 gm/plant at 10 days interval, T2:Spraying of Cow urine and water (1:10) at 10 days interval, T3:Spraying of Cow dung slurry and water (1:10) at 10 days interval, T4:Spraying of cow dung slurry and Cow urine (1:1) then the mixed with water (1:5) at 10 days interval, T5:Spraying of Carbosulfan 25% EC@1ml/litre at 10 days interval, T6: Control (Spraying only with tap water at 10 days interval)]

Pooled mean data of two years study revealed that lowest population (1.83/ 3 leaves) of white flies found to observed on chemical based pest management module. On the contrary, highest population (5.88/ 3 leaves) of the pest was noted on control (T-6). Among the ITK based pest management module T-4 showed significantly lowest population. T-1 and T-2 remain statistically at par with each other.

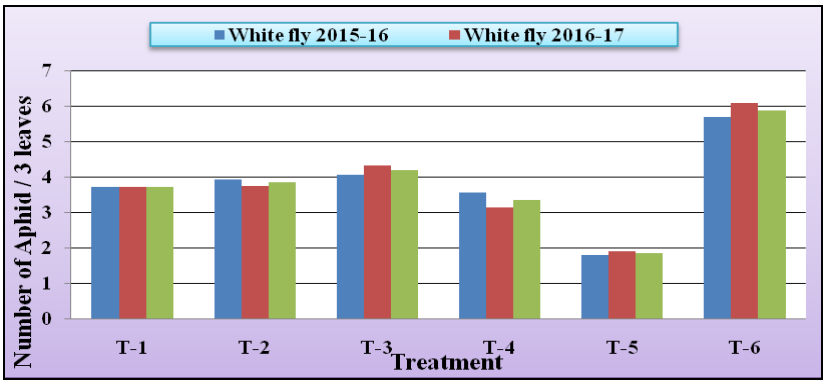

Fig 4: Incidence of white fly in different ITK based pest management module on brinjal.

Summary and Conclusion

In the agro-ecological situation under consideration, the crops have to pass through several biotic and abiotic stresses. Among the stresses insect pest is one of the most important limiting factors for realizing optimum yield potentiality of the crop. To protect the crop farmers are usually rely upon chemical pesticides that gradually hampering non-target organisms, developing resistance in the pest species. Resurgence of pest population also happening in addition to increasing cost of production.

With a view to lessen pesticidal load in brinjal agro-ecosystem, the alternate ways of crop protection may take important role. Among the alternate non-pesticidal technologies, indigenous technology may play pivotal role in bringing sustainability in agriculture. Indigenous technical knowledge (ITK) is the accumulated skill, technology of a locality or a community and has been passed from one generation to another generation. From time immemorial, the farming communities of northern tract of West Bengal that comprises many aboriginal populations used a number of indigenous techniques in managing pest menaces on brinjal. A good number of them are still in use on rabibrinjal at different corners of the region. Some of the indigenous technologies used in cultivation by the farmers have been documented through exhaustive snow ball survey methodology by Laskar *et al.* (2015). In the present study a number of indigenous knowledge based pest management module for rabibrinjal have been formulated and tested in the

agro-ecosystem under consideration during rabi season of 2015-16 and 2016-17. Inspiring results obtained in field trial from two years of study.

The salient findings of the study are stated as follows:

- Production cost reduced, non-target arthropod faunal complex less hampered and reasonable harvest recorded.
- Insect pest population was noted lowest in chemical based module (T-5). Recommended chemical module included Carbosulfan 25% EC@1ml/lit. at 10 days interval. In respect of benefit cost ratio T-5 have also been appeared as the best pest management module.
- Among the ITK based pest management module T-4, i.e. application of cow dung slurry and cow urine mixture at an interval appeared as the most effective treatment.
- Brinjal without pest management practice suffer intense arthropod stress and thereby give lower yield as observed in control plot (T-6) in the present investigation.

Thus, it may be inferred that application of indigenous techniques like cow dung slurry, wood ash and cow urine may be included in the present day IPM of brinjal under northern tract of West Bengal along with indigenous cultivars because these indigenous techniques show their best efficacy under the cultivation of local cultivars.

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