The Pharma Innovation Journal 2022; SP-11(12): 446-451

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(12): 446-451

www.thepharmajournal.com
Received: 27-10-2022
Accepted: 29-11-2022

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Preparation and evaluation of cow-based insecticides against *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae)

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Abstract
Luxurious consumption of chemical and synthetic insecticides used for the management of noctuid pests like *Spodoptera litura* (Fab.) led to the development of resistance to a wide variety of insecticide classes. The present investigation employing cow-based organic products *viz*., Cow urine, Panchagavya, Darekastra, Agneystra, and Dashaparni were evaluated for their bio efficacy at different concentrations against *S. litura* under both laboratory and protected conditions. Maximum larval mortality of 76.67 percent was recorded by Darekastra (at 100%), followed by Darekastra (70.00% at 100.00% conc.) against 3rd instar larvae. Cow-based organic products also caused significant reduction in larval population after sprayed with cent percent concentration under screen-house conditions. Under screen-house, Darekastra and Panchagavya recorded 59.00 and 54.00 percent population reduction, respectively after 3 days of spraying. The research clearly indicates that all the cow-based test products have significant larvicidal properties and could be used as an alternative to traditional pest management.

Keywords: *Spodoptera litura*, cow urine, panchagavya, darekastra, agneystra, and dashaparni

1. Introduction
The tobacco cutworm, *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) is one of the major polyphagous and notorious pests that originated from India, China, and Japan and found to feeding on nearly 300 plant species belonging to 99 families (Kandagal and Khetagoudar, 2013: Wu *et al*., 2004) [10, 20]. These pests are found to be consuming and causing economical damage to more than 40 crop species in the Indian subcontinent, including crucifers, pulses, sweet peppers, tomatoes, potatoes, etc. The genus Spodoptera consists of more than 30 species and is primarily found in warm and humid climates. 15 species of Spodoptera are regarded as economically exhaustive, damaging significant agricultural crop families in the Indian subcontinent (Zenker *et al*., 2007) [21].
This cosmopolitan pest is reported from all over India causing considerable economic damage to a large number of agriculturally significant crops including pulses (Dhir *et al*., 1992) [8], cereals (Sitaramaiah *et al*., 2001) [17], cash crops (80-100%) (Chari *et al*., 1986) [6], vegetables (12-23%) (Patnaik, 1998) [12], and oilseeds (48.7%) (Bhattacharjee and Ghude, 1985) [4]. In Himachal Pradesh alone, the pest has caused heavy losses to crops under both non-protected and protected cultivation. The epidemic of *S. litur*a on oilseeds (majorly soybean) in Kota (Rajasthan) had an economic loss of 300 crores (Dhaliwal *et al*., 2010) [7]. The pest also devastated the Vidarbha region (Maharashtra) in August 2008 and caused losses of 30-100 percent in soybean. Another outbreak of *S. litura* resulted in central and southern India on sunflower caused 90-100 percent defoliation (Sujatha and Lakshminarayana, 2007) [18].
Traditionally, chemical pesticides have been widely used for the management of agricultural pests including *Spodoptera litura*. The luxurious consumption of pesticides by the crops has caused tremendous concerns for the environment including the presence of large concentrations of pesticide residue, a decline in the beneficial microbial population, and the destruction of non-targeted beneficial species. Therefore, the identification of potential new and alternative non-chemical, green-labeled and safer insecticides is the last resort method to minimize the ill effects of chemical insecticides. The luxurious and non-judicial application of chemical and synthetic pesticides has resulted in physiological resistance development and numerous other adverse environmental effects, apart from the high input cost (Udaiyan *et al*., 2017) [19]. Currently, populations of numerous polyphagous noctuid pests including *S. litura* have developed physiological resistance to many commonly available pesticides (Abbas *et al*.,

2014, Rabari *et al*., 2016) [1, 15]. *S. litura* has manifested resistance and was found to be enormously tolerant to major conventional insecticides in crops like soybean, potato, tomato, etc. which is quite alarming to the insecticide groups like organophosphates (Chlorpyriphos and Quinalphos) (Udaiyan *et al*., 2017) [19].

Currently, in India, there is an increasing public awareness regarding the demerits and consequences of unscientific chemical pest management and the need for insecticide-free and organic food. In order to reduce the harmful effects of traditional insecticides, the most economically plausible alternative is biocontrol or GMO or organic insecticides, or a combination of these non-chemical tools of pest management. Considering these relevant points, the present investigation was planned with a prime focus on determining all the toxic effects of cow-based organic products against *S. litura* (3rd instar)

2. Materials and experimental procedure

2.1 Raising of crops

Non-*Bt* tomato seedlings were raised in pots in the screen house. Healthy seedlings of tomato were raised in plug trays filled with cocco-peat, perlite, and vermiculite mixture (3:1:1). 3-4 weeks old healthy seedlings were transplanted in the earthen pots in the screen house and leaves collected from these seedlings were used as the feed for maintaining the *S. litura* culture

2.2 Culturing of *Spodoptera litura* (Fab)

The pioneer culture (4th / 5th instar larvae) of *S. litura* was collected from a tomato polyhouse in the CSKHPKV, Himachal Pradesh. These larvae were carefully reared on tomato leaves in plastic jars of 18 x 15 cm till the adult emergence. The emerged adults were then sexed and mated inside glass chimneys on the basis of wing patterns. One pair of opposite-sexed moths was released and the mouth was covered tightly with a clean muslin cloth. A clean cotton swab dipped in honey solution (10%) was provided in each chimney as the feed for the moths in a Petri plate (60mm x 15mm). The eggs laid by the moths after (mating) on muslin cloth and or crumpled paper were collected. The eggs laid occasionally on the chimney walls were moistened with distilled water and separated carefully with the help of a camel hair brush. The crumpled paper and muslin cloth containing egg masses were then carefully transferred to plastic jars were monitored for hatching.

Leaves collected from tomato seedlings were provided as food when the incubation period is over and eggs were about to hatch. The neonate larvae were kept separately in individual jars (7.0 x 4.5 cm) and provided with fresh feed. The larvae reared in masses during the early instars (first and second instar) and later on, 10-15 larvae were transferred in each jar of 18 x 15 cm. The fully-fed larvae were then carefully transferred to plastic jars containing a thick layer (10 cm) of the moist soil-sand mixture. The larvae pupate in the soil and 3-4 days old pupae were sexed and kept in another jar for adult emergence. The mass rearing of the test insect was carried out under optimum and controlled conditions (25±1 °C and 70-80% RH).

2.3 Synthesis of cow-based organic products

2.3.1 Synthesis of Agneystra

Constituents: Ipomea leaves (1 kg), Melia leaves (5 kg), red chili (500 g), Garlic (500 g), cow urine (10 L) and water (10 L).

To a thoroughly cleaned plastic pot of 25 liters, 10 liters of freshly procured cow urine was added. To the cow urine, 1 kg of Ipomea leaves, 1 kg of Melia leaves, 500 grams of red chili and 500 grams of garlic were added by crushing in it in the same order. This solution is well mixed and allowed to ferment by keeping overnight. This solution was used as 100.00 percent standard stock and various concentrations ranging from 2.5 to 80.00 percent were prepared by serial dilution.

2.3.2 Synthesis of Darekastra

Constituents: Melia leaves (1 kg), cow urine (5 L), and cow dung (2 kg)

Fresh cow dung (2 kg) collected from Department of Organic Farming, CSKHPKV, Palampur, Himachal Pradesh was taken in an earthen pot of 10 liters capacity and vigorously mixed. To the cow dung, 1 kg of dried and crushed Melia leaves, 5 liters of fresh cow urine and water were added, mixed and kept overnight before the larval treatment.

2.3.3 Synthesis of Panchagavya

Constituents: Fresh cow dung (5 kg), cow urine (3 L), cow milk (2L), curd (1L) and desi ghee (1 kg).

One day one, a mixture of cow dung (5 kg) and desi ghee (1 kg) were prepared and stored in a mud pot for 3 days with at least 2 stirring per each day. To this mixture, cow urine (3 L) and water (3 L) were added and mixed thoroughly, and stored again for 10 days with 2 stirring per day. To this solution, fresh cow milk (2 L) and curd (1 L) were added stored for a month (3 stirring per day) before using.

2.3.4 Synthesis of Dashaparni

Constituents: Melia leaves (400 g), garlic (250 g), Ipomea leaves (100 g), Walnut leaves (100 g), stinging nettle leaves (100 g), lantana Leaves (100 g), eupatorium leaves (100 g), wild marigold (100 g), red chili (100 g), cow urine (2 L) and water (12 L).

Twelve liters of water was taken in a large plastic container and add the ingredients, Melia leaves (400 g), garlic (250 g), Ipomea leaves (100 g), Walnut leaves (100 g), stinging nettle leaves (100 g), lantana Leaves (100 g), eupatorium leaves (100 g), wild marigold (100 g) and red chili (100 g) after crushing. Store the mixture for a day with intermittent stirring in each 3 hours. To this mixture, 2 liters of water was added and stored at least 10 days before usage.

The products synthesized were filtered through what man no. 41 filter paper and collected in a plastic jar. This filtrate of each was considered as a 100 percent stock solution from which the desired dosages (2.5 to 80.00 percent) were prepared. The evaluation was done against 3rd instar larvae of *S. litura* in the laboratory and screen house by leaf dip method bioassay using different concentrations of organics.

2.4 Evaluation of cow-based organic treatments under laboratory

Larvae were taken in clean and dry plastic jars (18 x 15 cm) and starved for 4 hours before the initiation of treatment. Fresh tomato leaves were dipped in the treatment for 45 seconds, dried under shade and kept in sterilized plastic jars for the larval feeding. For each organic treatment, a total of 30 larvae (10 larvae per replication) were taken. Water-soaked clean cotton plugs were wrapped tightly around the petioles of the leaves to keep them from spoiling. A control was

maintained where the leaves were dipped in double-distilled water instead of any other cow-based organics. The observations on the larval mortality were recorded at an interval of 24 hours up to 72 hours after the treatment. The corrected percent larval mortality was calculated as per Abbotts formula (1925).

$$\text{Corrected mortality (\%)} = \frac{\text{\% mortality in treatment-\% mortality in control}}{\text{100-\%mortality in control}} \text{ X } 100$$

2.5 Evaluation of cow-based organic treatments under screen house

The investigation was conducted in a screen house of the Department of Entomology, CSKHPKV, Palampur, Himachal Pradesh. Tomato seedlings of variety 7711 F_1 hybrid was used for the screen-house study. When the seedlings reached a growth period of 40 days old, twenty 3rd instar larva per seedling were placed gently on the plant leaves. After one day, the number of larvae established on the plants were counted and sprayed with different concentrations of each treatment. The data 1 day after spray (DAS), 2 DAS and 3 DAS were taken and reduction in population over control calculated.

We counted number of larvae were kept the formula used for the calculation of percentage reduction of pest population over control was a modified Abbott's formula (Fleming and Ratnakaran, 1985) which is given below:

$$P = 100 \text{ x } 1\text{-} \left\{ \frac{Ta \text{ x } Cb}{Tb \text{ x } Ca} \right\}$$

P = percent population reduction over control Ta = population in treatment after spray

Ca = population in control after spray Tb = population in treatment before spray

Cb = population in control before spray

2.6 Statistical analysis of data

The heterogeneity, regression equation, relative toxicity, LC_{50} and LC_{90} values with their fiducial limits were calculated by using probit analysis. The data for experiment on the evaluation of organics against *S. litura* on tomato under screen house conditions were subjected to analysis for critical variance or difference through CPCS-1 software as per the procedure suggested by Gomez and Gomez (1984).

3. Experimental results

3.1 Laboratory evaluation of organics against different instars of *S. litura*

Five different concentrations (6.125%, 12.50%, 25.00%, 50.00% and 100.00%) of five cow-based organic products including cow urine, panchagavya, darekastra, agneystra and dashaparni, evaluated against 3rd instar larvae under laboratory and screen house on tomato seedlings

3.1.1 Cow urine

Variable concentrations i.e., 6.125 to 100 percent were tested and data on their mortality at 24, 48 and 72 hours are given in the table no.1 With the increase of either concentration or data recording intervals, mortality of the larvae increased at all the concentrations. Larval mortality of 10.00 percent to 66.67 percent was recorded by the variable concentrations after 72 hours of treatment.

Table 1: Evaluation of toxicity of cow urine against *Spodoptera litura* (3rd instar)

Concentration (%)	Cumulative corrected mortality (%) at indicated hours			Mean
	24	48	72	
6.125	3.33(10.51)	6.67(14.96)	10.00(18.42)	6.67(14.96)
12.5	6.67(14.96)	13.33(21.40)	20.00(26.55)	13.33(21.40)
25	10.00(18.42)	23.33(28.87)	40.00(39.21)	24.44(29.61)
50	13.33(21.40)	30.00(33.19)	50.00(44.98)	31.11(33.88)
100	16.67(24.08)	40.00(39.21)	66.67(54.71)	41.11(39.86)
Mean	10.00(18.42)	22.67(29.61)	37.33(37.64)	

CD (P = 0.05) Concentration (A) = 1.57 Days (B) = 2.24 A x B = 3.85

Values in the parentheses are sine transformed

3.1.2 Panchagavya

Third instar larvae recorded a mean larval mortality of 12.22 percent to 42.22 percent by different concentrations of panchagavya after 72 hours of treatment. Maximum larval mortality of 70.00 percent was recorded by 100.00 percent panchagavya, followed by 50.00 percent with 60.00 percent larval mortality. The very least larval mortality of 23.33 was recorded by panchagavya at 6.125 percent concentration. The interaction effects of A x B were found to be significant for the 3rd instar larvae (Table 2)

Table 2: Evaluation of toxicity of panchagavya against *S. litura* (3rd instar)

Concentration (%)	Cumulative corrected mortality (%) at indicated hours			Mean
	24	48	72	
6.125	3.33(10.51)	10.00(18.42)	23.33(28.87)	12.22(20.45)
12.5	6.67(14.96)	20.00(26.55)	36.67(37.25)	21.11(27.34)
25	10.00(18.42)	26.67(31.08)	46.67(43.07)	27.78(31.79)
50	13.33(21.40)	33.33(35.24)	60.00(50.74)	35.55(36.58)
100	16.67(24.08)	40.00(39.21)	70.00(56.77)	42.22(40.50)
Mean	10.00(18.42)	26.00(30.64)	47.33(43.45)	

CD (P = 0.05) Concentration (A) = 1.94 Days (B) = 2.75 A x B = 3.76 Values in the parentheses are sine transformed

3.1.3 Darkstar

Larval mortality recorded by the concentrations from 6.125 percent to 100 percent when evaluated for their bioefficacy against the 3rd instar larvae is recorded in the table no.4. At 24 HAT, 3.33 percent to 16.67 percent larval mortality by 6.125 percent to 100.00 percent of panchagavya. Similarly, larval mortality of 13.33 percent to 43.33 and 26.67 percent to 76.67 percent was recorded at 48 HAT and 72 HAT, respectively. Mortality differences amongst the treatments either for concentrations (A) or data recording intervals (B) were found to vary significantly. Interaction effect (A x B) was also found to be significant

Table 3: Evaluation of toxicity of darekastra against *S. litura* (3rd instar)

Concentration (%)	Cumulative corrected mortality (%) at indicated hours			Mean
	24	48	72	
6.125	3.33(10.51)	13.33(21.40)	26.67(31.08)	14.44(22.32)
12.5	6.67(14.96)	23.33(28.87)	43.33(41.15)	24.44(29.61)
25	10.00(18.42)	30.00(33.19)	56.67(48.81)	32.22(34.57)
50	13.33(21.40)	40.00(39.21)	70.00(56.77)	41.11(39.86)
100	16.67(24.8)	43.33(41.15)	76.67(61.11)	45.55(42.43)
Mean	10.00(18.42)	30.00(33.19)	43.11(41.02)	

CD (P = 0.05) Concentration (A) = 1.71 Days (B) = 2.42 A x B = 4.20

Values in the parentheses are sine transformed

3.1.4 Agneystra

From the perusal of the data in the table no 4, it can be seen that when different concentrations of Agneystra ranging from 6.125 to 100 percent evaluated against 3rd instar larvae of *S. litura*, a pattern of increase in larval mortality with the increase of data recording intervals and concentrations was observed. After 72 hours of treatment, the mean larval mortality of different concentrations ranged from 11.11 percent (at 6.125%) to 42.22 percent (at 100.00 percent).The interaction effects of A x B was found to be significant in the 3rd instar larva of test insect (Table 4)

Table 4: Evaluation of toxicity of agneystra against of *S. litura* (3rd instar)

Concentration (%)	Cumulative corrected mortality (%) at indicated hours			Mean
	24	48	72	
6.125	3.33(10.51)	10.00(18.42)	20.00(26.55)	11.11(19.46)
12.5	6.67(14.96)	16.67(24.08)	33.33(35.24)	18.89(25.75)
25	10.00(18.42)	26.67(31.08)	46.67(43.07)	27.78(31.79)
50	13.33(21.40)	33.33(35.24)	60.00(50.74)	35.55(36.58)
100	16.67(24.08)	40.00(39.21)	70.00(56.77)	42.20(40.50)
Mean	10.00(18.42)	25.33(30.20)	43.11(41.02)	

CD (P = 0.05) Concentration (A) = 1.68 Days (B) = 2.38 A x B = 4.12
Values in the parentheses are sine transformed

3.1.5 Dashaparni

Similar to the other cow-based organic products, larval mortality of the test insect was found to be linearly related to the concentration. Minimum larval mortality of 3.33 percent to 20.00 percent with mean larval mortality of 11.11 percent was recorded by Dashaparni at 6.125 percent. Similar pattern in the larval mortality was recorded by the remaining concentrations with the highest larval mortality of 13.33, 40.00 and 70.00 percent recorded at 24, 48 and 72 HAT, respectively by cent percent Dashaparni (Table 5).

Table 5: Evaluation of toxicity of dashaparni against *S. litura* (3rd instar)

Concentration (%)	Cumulative corrected mortality (%) at indicated hours			Mean
	24	48	72	
6.125	3.33(10.51)	10.00(18.42)	20.00(26.55)	11.11(19.46)
12.5	3.33(10.51)	16.66(24.08)	33.33(35.24)	17.78(24.92)
25	6.67(14.96)	23.33(28.87)	53.33(46.89)	27.78(31.79)
50	10.00(18.42)	30.00(33.19)	56.67(48.81)	32.22(34.57)
100	13.33(21.40)	40.00(39.21)	70.00(56.77)	41.11(39.86)
Mean	7.33(15.70)	23.99(29.32)	43.11(41.02)	

CD (P = 0.05) Concentration (A) = 1.49 Days (B) = 2.11 A x B = 3.67
Values in the parentheses are sine transformed

3.2 Relative toxicity of cow-based organics against larva of *S. litura* (3rd instar)

The LC_{50} values along with relative toxicities, slope of the regression lines depicted with log concentration and probit kill of different organics against 3rd instar larvae of *S. litura* (Fig 1 and 2) presented in the table no 6. Darekastra caused maximum mortality with least LC_{50} value of 18.27 percent, followed by Panchagavya and Agneystra with 29.34 and 31.48 percent, respectively. Among the treatments, cow urine caused least mortality with highest LC_{50} value of 42.57 percent, followed by Dashaparni with 34.20 percent. Relative toxicity data shows that Darekastra and Panchagavya were 2.33 and 1.45 times more toxic than cow urine against the rest insect.

Table 6: Relative toxicity of cow-based organics against larvae of *S. litura* (3rd instar)

Organics	LC_{50}	Regression equation	Slope (b)	Heterogeneity (χ^2)	Relative toxicity
Cow urine	42.57	3.32+1.02X	1.02	0.17	1.00
Panchagavya	29.34	3.49+1.02X	1.02	0.09	1.45
Darekastra	18.27	3.39+1.27X	1.27	0.04	2.33
Agneystra	31.48	3.30+1.13X	1.13	0.10	1.35
Dashaparni	34.20	3.29+1.10X	1.10	0.05	1.24

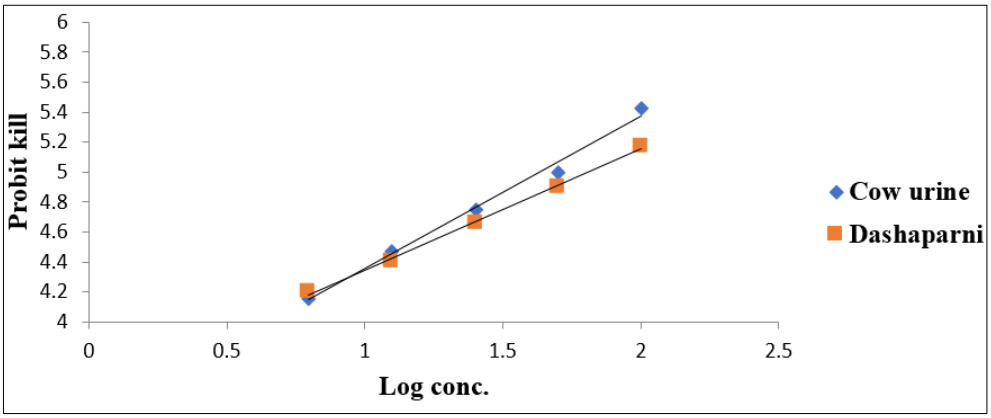

Fig 1: Dosage mortality response of cow urine and Dashaparni against larvae of *S. litura*

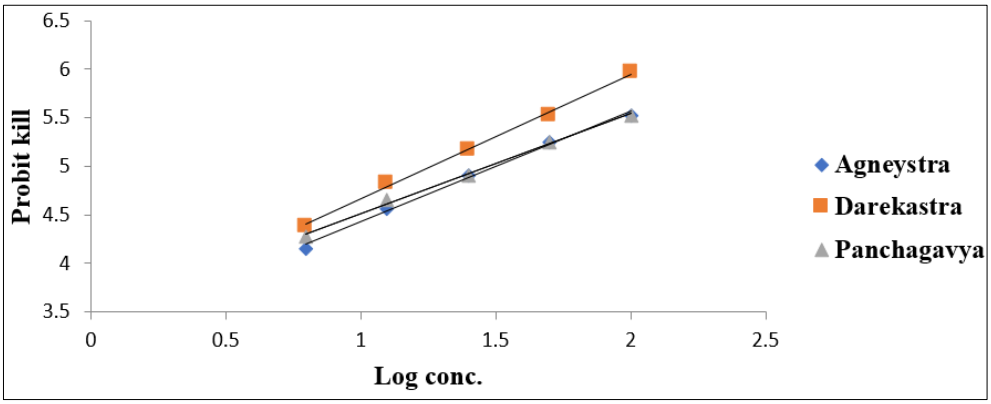

Fig 2: Dosage mortality response of Agneystra, Darekastra and Panchagavya against larvae of *S. litura* (3rd instar)

Table 7: Efficacy of cow-based organics against 3rd instar larvae of *S. litura* in screen house

Organics	Conc (%)	Larval population/plant				Mean	Reduction in population (%)
		Before spray	1 DAS	2 DAS	3 DAS		
Cow urine	100	20.50	18.00* (4.30)	15.75* (4.03)	13.00 * (3.67)	16.81 *	34.00
Panchagavya	100	20.00	16.75 (4.15)	13.00 (3.67)	8.75 (3.04)	14.62	55.00
Darekastra	100	19.25	16.00 (4.06)	12.75 (3.64)	7.75 (2.87)	13.93	59.00
Agneystra	100	20.00	17.00 (4.18)	14.25 (3.84)	10.00 (3.24)	15.31	48.00
Dashaparni	100	19.75	18.75 (4.38)	15.00 (3.93)	12.25 (3.57)	12.18	36.00
Untreated Check	-	21.00	20.50 (4.58)	20.00 (4.58)	20.00 (4.58)	20.16	

CD (P = 0.05) Treatment (A) = 1.11 Days (B) = 1.71 A x B = 3.44
*Values in parentheses are square root transformed DAS-Days after Spray

3.3 Screen house evaluation of cow-based organics against *S. litura* (3rd instar)

Various cow-based organic products which are generally recommended at the dosages for the control of insect pests were tested against 3rd instar larvae of *S. litura* under screen house on tomato (var F_1 hubrid 7711) in pots. The products were sprayed with the help of an automizer. In control plots, only water was sprayed. Data on the number of larvae, before spray, I day after spray (1 DAS), 2 DAS and 3 DAS were recorded and percent reduction in different treatments over control was calculated and are being presented in the table no. 7.

A perusal of the data presented in the table no. 7 revealed that at 1 DAS the larval population was found to decrease compared to the population (per plant) before spray and ranged from 16.00 (in Darekastra) to 20.00 (in cow urine), compared to 21.00 in control. The population decreased in all the treatments after spray. At 3 DAS, the population (per plant) ranged from 12.75 (in Darekastra) to 15.75 (in cow urine). When decrease in population over control was calculated, it was found be maximum Darekastra caused maximum reduction of 59.00 percent in population control, followed by Panchagavya (55.00%), Agneystra (48.00%), Dashaparni (36.00%) and cow urine (34.00%). The results indicate that natural cow-based organics have considerably significant potential to control *S. litura* under screen-house conditions.

4. Discussion

Among different cow-based organic treatments, cow urine is found to be least toxic with highest LC_{50} value, followed by dashaparni. The order of toxicity according to LC_{50} in decreasing order was cow urine > dashaparni > agneystra > panchagavya > darekastra

For screen house evaluation, crop (tomato var F_1 hybrid 7711) was sprayed with cow urine, panchagavya, darekastra, agneystra and dashaparni @ 10 percent, and the data were recorded on larval reduction of *S. litura* before spray, 1, 2 and 3 days after spray. After 3 days of spray, Darekastra caused highest population reduction (19.05%), followed by Panchagavya (14.10%), Agneystra (12.90%), Dashaparni (10.30%) and cow urine (10.00%).

Literature scanning revealed that information pertaining to the present investigation is scanty. In the present investigation, cow urine or natural cow-based preparations (panchagavya, darekastra, agneystra and dashaparni) containing by products of cow showed considerable toxicity against 3rd instar larval stages of *S. litura* variably under laboratory. However, the effectiveness of these products was considerably reduced under screen house. The information on majority of products under estimation is not available. Low effectiveness of cow urine and cow dung has been reported by Purwar and Yadav (2003) [14]. Bhoomiraj *et al.* (2004) reported that panchavaya was found to minimize the economic loss caused by *Amrasca biguttula* and *Bemisia tabaci*

Various workers have evaluated the efficacy of cow products in combination either with neem or the plant products for their efficacy against *S. litura* or other insect pests and have reported variable extent of control. (Bharathi 2005; Sapre *et al.*, 2006; Boomathi *et al.*, 2006; Mudigora *et al.*, 2009; Poonam and Shriram 2010) [3, 16, 5, 11, 13].

5. References

1. Abbas N, Sarfraz AS, Razaq M, Waheed A, Aslam M. Resistance of *Spodoptera litura* (Lepidoptera: Noctuidae) to Profenofos: Relative fitness and cross resistance. Crop Protection. 2014;58:49-54
2. Abbott WS. A method for computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925;18:265-267
3. Bharathi SM. Role of organics and indigenous technologies against *Spodoptera litura* in groundnut and soyabean ecosystem. M.Sc. (Agri.) Thesis, UAS Dharwad; c2005. p. 70-75.

4. Bhattacharjee NS, Ghude DB. Effect of artificial and natural defoliation on the yield of soyabean. Indian Journal of Agricultural Sciences. 1985;55(6):427-429.
5. Boomathi N, Sivasubramanian P, Raguraman S. Biological activities of cow excreta with neem seed kernel extract against Helicoverpa armigera (Hübner). Annals of Plant Protection Sciences. 2006;14(1):11-16.
6. Chari MS, Bharpoda TM, Patel AR. Bio efficacy of fluvalinate against *Spodoptera litura* in tobacco nursery. Pestology. 1986;35:60-66.
7. Dhaliwal GS, Koul O. Quest for pest management: From green revolution to gene gevolution. Kalyani Publishers, New Delhi; c2010. p. 249.
8. Dhir BC, Mohapatra HK, Senapati B. Assessment of crop loss in groundnut due to leaf eating caterpillar, *Spodoptera litura Fabricius* with insecticide baits in NLS. Pestology. 1992;10:21-24.
9. Flemming R, Ratnakaran A. Evaluating single treatment data using Abbot's formula with reference to insecticides. Journal of Economic Entomology. 1985;78:1179-1181.
10. Kandagal AS, Khetagoudar MC. Study on larvicidal activity of weed extract against *Spodoptera litura*. Journal of Environmental Biology. 2013;34:253-257.
11. Mudigora S, Shekarappa, Balikai RA. Evaluation of plant products in combination with cow urine and panchagavya against against sorghum shoot fly, *Atherigona soccata* Rondani. Karnataka Journal of Agricultural Sciences. 2009;22(3):618-620.
12. Patnaik HP. Pheromone trap catches of *Spodoptera litura* F. and extent of damage on hybrid tomato in Orissa. In: Proceedings of the First National Symposium on Pest management in Horticultural Crops: environmental implications and thrusts, Banglore, India; c1998. p. 68-72.
13. Poonam C, Shriram. The bio efficacy of cow urine and its decoctions against *Spodoptera litura*. Annuals of Plant Protection Sciences. 2010;18(2)515-516.
14. Purwar JP, Yadav SR. Field efficacy of pest controlling agents from different origins against tobacco caterepillar, *Spodoptera litura* on soyabean. Indian Journal of Entomology. 2003;24:30-32.
15. Rabari PH, Dodia DA, Davada AY, Patel PS. Field efficacy of new erzinsecticidal molecules against *Spodoptera litura* on cabbage. The bio scan. 2016;11:173-175.
16. Sapre JK, Varma RK. Influence of cow urine and buttermilk on the activity of lytic enzymes secreted by three soil borne pathogens of soyabean. Journal of Mycopathological Research. 2006;44(2):277-288.
17. Sitaramaiah S, Sreedhar U, Ramaprasad G, Satyanarayana SV. Management of tobacco caterpillar, *Spodoptera litura* (F.). Indian journal of Plant Protection. 2001;20:215-217.
18. Sujatha M, Lakshminarayana M. Resistance to *Spodoptera litura* Fabr in Helianthus species and backcross derived inbred lines from crosses involving diploid species. Euphytica. 2007;155:205-213.
19. Udaiyan S, Murugan K, Panneerselvam C, Rajaganesh R, Roni M, Al-AohNHM, *et al*. Suaeda maritime Based herbal coils and green nanoparticles against the dengue vector Aedes aegypti and tobacco cutworm *Spodoptera litura*. Physiology and Molecular Plant Pathology. 2017;101:225-235.
20. Wu CJ, Fan SY, Jiang YH, Zhang AB. Inducing gathering effect of taro on *Spodoptera litura* Fabricius. Chinese Journal of Ecology. 2004;23:172-174.
21. Zenker MM, Specht A, Corseuil E. Immature stages of *Spodoptera cosmioides* (Lepidoptera, Noctuidae). Revistra Brasiliera de Zoologia. 2007;24(1):99-107.