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Determining doses of application of fermented cattle urine and indigenous plant extracts against scale insects and mealybugs of sugarcane

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Abstract

An experiment was set up in 2013-14 cropping season at Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh to find out the efficacy of fermented cattle urine and three indigenous plant extracts i.e., neem, mahagoni and allamanda against scale insects and mealybugs of sugarcane. Cattle urine (10, 20, and 30%), plants extracts (5, 10, and 15%) and one recommended insecticides were applied at fortnight interval starting from the first initiation of the pest attack as foliar and stem spray. Germination percent, tiller number, millable cane, yield, incidence of scale insects and mealybugs and marginal benefit cost ratio (MBCR) were measured. Yield parameters were increased by 30% fermented cattle urine and 15% neem seed kernel and mahagoni seed extracts. Performance of 30% fermented cattle urine (T_3 treatment) resulted 48.66 – 62.37% control of scale insects and 52.40 – 67.15% suppression of mealybugs, T_6 treatment consisting of 15% neem seed kernel extracts reduced 38.27 – 53.62% scale insects and 40.12 – 57.07% mealybugs and T_9 treatment using mahagoni seed extracts decreased 35.32 – 46.47% scale insects and 37.35 – 49.37% mealybugs in different months of the cropping seasons were the best. MBCR of those treatments was 6.25, 6.00 and 5.02. Considering performance of pest control, yield and MBCR, the treatments T_3, T_6 and T_9 may be advocated for the management of scale insects and mealybugs as alternative to chemical insecticides in the sense of economic and safe environment.

Keywords: Cattle urine, doses, mealybugs, plant extracts, scale insects, sugarcane.

Introduction

The average yield of sugarcane in Bangladesh is low compared to other sugarcane growing countries of the world. Various factors are responsible for low yield of cane in Bangladesh (42.0 t ha^{-1}) (BBS, 2000) as against 56.0 t ha^{-1} in India (Yadava, 1991). Considerable yield losses which are estimated to be around 20% in yield and 15% in sugar recovery have also been reported (Avasthy, 1983). In Bangladesh, sugarcane is attacked by nearly about seventy species of insect pests (SRTI, 1973-78). Among 70 insect pests attacking sugarcane, scale insects and mealybugs are the destructive now a days. Among the factors causing low production of sugarcane, the insect pests constitute the major factor. To increase the crop productivity, management of insect pest is a great significance.

Conventional pesticides are generally synthetic materials that directly kill or inactivate the pest. The indiscriminate use of chemical pesticides has resulted in adverse effects like resistance (Saxena et al., 1992; Armes, et al., 1992), ecological imbalance, health hazards and resurgence of secondary pests. Today due to awareness about the harmful effects of the chemical insecticides and pesticides, most of the farmers are diverting towards the organic farming. Bio-insecticides are less toxic and also reduce the pollution caused by conventional pesticides. However, indigenous plant products are usually safe for beneficial organisms, such as bees, predators, parasitoids, mammals and environment (Ahmed and Grainge, 1986; Tang et al., 2002). In order to find out alternatives to chemical insecticides, cattle urine and indigenous plant parts may be used effectively because these are less expensive, biodegradable and safe for environment. Cattle urine is a strong repellant for insects which normally inhabit the common crops. Mansinghka (2007) revealed that mixing some plant extracts with it enhances the repellant activity. Neem, sitaphal (Annonaceae) are some common plants which enhance the insect repellant capability of cattle

urine. Neem derivatives have been reported to provide broad-spectrum control of more than 200 species of phytophagous insects (Ascher, 1993). Many synthetic chemicals have been recommended against pest, which are costly and sometimes not available. On the other hand, cattle urine and indigenous plant extracts are economic and easily available in Bangladesh. These products are environmentally safe, non-hazardous and no side effect. Considering the above facts, the present study was undertaken to find out the suitable dose s of fermented cattle urine and plant extracts against scale insects and mealybugs of sugarcane.

Results and Discussion

Percent germination of buds

All treatments gave significant result in germination over control (43.17%). The highest germination (59.65%) was recorded in T_{13} (recommended insecticide applied) treated plot followed by T_3 (57.19%), T_6 (55.29%) and T_9 (54.73), respectively which were statistically identical (Fig. 1). The lowest germination was found in T_{10} (44.88%), T_4 (46.01%), T_7 (47.34%) and T_1 (49.80%) treated plot. Akhter (2014) found that neem leaf powder 100 Kg ha^{-1} and fermented cattle urine suspension @ 50% gave 32.78 and 26.11% increase in germination as compared to untreated plot against sugarcane termite. Miah, et al., (2009) also found that 30% fermented cattle urine solution gave 42.81% germination as compared to untreated plot (34.06%) against major sugarcane pests.

Incidence of scale insects and mealybugs of sugarcane

The results showed that scale insects infestation was ranged from 3.05 to 6.45% in the treated plots whereas the untreated plots were 10.63% in June and they did vary significantly over control. The lowest scale insects infestation (3.05%) was observed in plots T_{13} sprayed with recommended insecticide over control followed by T_3 (30% fermented cattle urine applied) giving 62.37% effectiveness in June. In July, treatment T_3 was gave 57.92% effectiveness whereas 68.61% was T_{13} (recommended insecticide applied) over control. In August to November, significant difference was observed among the treatments. Scale insects infestation was lowest in plots T_{13} followed by T_3 and T_6 treatments at different months of the cropping seasons (Table 1).

In case of mealybugs, significant difference was observed among the treatments at different months of the cropping season (Table 2). Mealybugs infestation was low in May and June. Data collected in May showed that T_{13} treatments demonstrated 73.04% effectiveness to control followed by T_3 and T_6 treatments (67.15 and 57.07%). From June to July, there was a moderate increase in pest infestation from 11.16 to 15.94% in control plot (T_{14}) which continued to September (29.48%). In October to November, the treatment T_{13} was best, that gave 59.06 and 56.68% effectiveness over control followed by T_3 treatment (49.94% and 52.40%).

Effect on yield and yield contributing parameter

The tiller production was ranged from 114.33 to 155.33×10^3 ha^{-1} among the treatments. No significant effects on tiller production among the treatments were found (Table 3). The highest tiller production was recorded in T_{13} (155.33×10^3 ha^{-1}) followed by T_3 (147×10^3 ha^{-1}) and T_6 (143.67×10^3 ha^{-1}) which were statistically similar. The lowest tiller production was found in treatment T_{14} (untreated control). In case of millable cane production, the highest millable cane was found in treatments T_{13} and T_3 but the lowest in T_{14} and T_{10} treatments. Similar results were also reported by Miah, et al., (2009) in case of 30% fermented cattle urine application. All the tested treatments were showed positive effect on cane yield as compared to control plot. The yield was ranged from 68.76 to 102.36 ton ha^{-1} among treated plots whereas the control plot was 59.31 ton ha^{-1}. The cane yield of treated plots was increased over control from 15.93 to 72.58%. Sungor 40 EC @ 1ml 5 l^{-1} of water applied plot T_{13} had the highest yield 102.36 ton ha^{-1} showing 72.58% yield increase over control followed by fermented cattle urine @ 30% (T_3) and neem seed kernel extracts @ 15% (T_6) treated plot which gave 95.71 and 92.21 ton ha^{-1} showing 61.37 and 55.47% yield increase over control, respectively. The results of the present findings is comparable with those of Akhter (2014) who found that fermented cattle urine @ 50% performed better in respect of yield of sugarcane among different botanical and natural products.

Economic analysis on yield

The highest MBCR was obtained from T_{13} treatment (6.28) followed by T_3 (6.25) and T_6 (6.00) treatments while the lowest was found in mahagani seed extract @ 5% application (1.80) as shown in Table 4.

Materials and Methods

Plant materials

Plant materials were Ishurdi (Isd) 36 variety of sugarcane.

Experimental site

The experiment was conducted to evaluate the doses of cattle urine and three indigenous plant extracts against scale insects and mealybugs of sugarcane during 2013-14 cropping season at Bangabandhu Sheikh Mujibur Rahman Agricultural University farm, Gazipur under Madhupur Tract (AEZ 28) of Bangladesh. The site was situated at the 24.09° N latitude and 90.26° E longitude on the subtropical climatic zone, characterized by heavy rainfall during May to September and scanty rainfall during rest of the year (Rahman, 2001). Soil of the experimental field was silty clay loam in texture and acidic in nature with a pH of 5.9 and poor fertility status (Supplementary Table 1). It belongs to the 'Shallow red brown terrace' soil of Salna series under Madhupur Tract (Haider et al., 1991) of

Table 1. Effects of fermented cattle urine and indigenous plant extracts in controlling scale insects of sugarcane at BSMRAU farm, Gazipur in 2013-14 cropping season.

Treatments	Percent pest infestation (mean of 3 replications)					
	June	July	August	September	October	November
T_1	5.47 bc	7.26 bcde	9.13 cde	12.76 def	16.86 efg	17.75 fg
	(48.54)	(44.15)	(38.22)	(36.61)	(36.66)	(37.50)
T_2	5.11 bcd	7.25 bcde	8.54 ef	11.53 fg	15.85 gh	16.69 gh
	(51.92)	(44.23)	(42.21)	(42.72)	(40.45)	(41.23)
T_3	4.00 de	5.47 ef	6.94 fg	9.85 gh	13.49 hi	14.58 hi
	(62.37)	(57.92)	(53.04)	(51.06)	(49.32)	(48.66)
T_4	5.50 bc	7.47 bcd	9.43 bcde	12.89 def	18.40 cdef	19.89 cdef
	(48.25)	(42.53)	(36.19)	(35.96)	(30.87)	(29.96)
T_5	5.42 bcd	7.20 cde	8.98 de	12.95 cdef	17.87 defg	19.23 efg
	(49.01)	(44.61)	(39.24)	(35.66)	(32.87)	(32.28)
T_6	4.93 cd	6.47 de	8.39 ef	12.19 ef	16.39 fg	17.53 fg
	(53.62)	(50.23)	(43.23)	(39.44)	(38.42)	(38.27)
T_7	6.09 bc	9.14 b	11.15 b	14.73 bcd	20.30 bcd	21.82 bcd
	(42.70)	(29.69)	(24.56)	(26.82)	(23.74)	(23.16)
T_8	6.45 b	8.19 bcd	9.91 bcde	13.38 cdef	18.14 defg	19.43 def
	(39.32)	(37.00)	(32.94)	(33.53)	(31.85)	(31.58)
T_9	5.69 bc	7.72 bcd	9.35 bcde	13.02 cdef	17.13 efg	18.35 efg
	(46.47)	(40.61)	(36.73)	(35.32)	(35.64)	(35.38)
T_{10}	5.57 bc	8.62 bc	10.63 bcd	15.20 bc	20.79 bc	22.31 bc
	(47.60)	(33.69)	(28.07)	(24.49)	(21.90)	(21.44)
T_{11}	6.45 b	8.91 bc	10.88 bc	15.86 b	21.35 b	22.85 b
	(39.32)	(31.46)	(26.38)	(21.21)	(19.79)	(19.54)
T_{12}	5.93 bc	8.04 bcd	9.73 bcde	14.40 bcde	19.12 bcde	20.40 bcde
	(44.21)	(38.15)	(34.16)	(28.46)	(28.17)	(28.16)
T_{13}	3.05 e	4.08 f	5.79 g	8.17 h	11.59 i	12.28 i
	(71.30)	(68.61)	(60.82)	(59.41)	(54.46)	(56.76)
T_{14}	10.63 a	13.00 a	14.78 a	20.13 a	26.62 a	28.40 a
LSD (0.05)	1.42	1.92	1.87	2.27	2.48	2.56
CV%	14.80	14.75	11.73	10.15	8.17	7.88

- Figures followed by the same letter (s) are not significantly different at 5% level as per LSD test.
- Figures in parentheses are percent effectiveness over control.

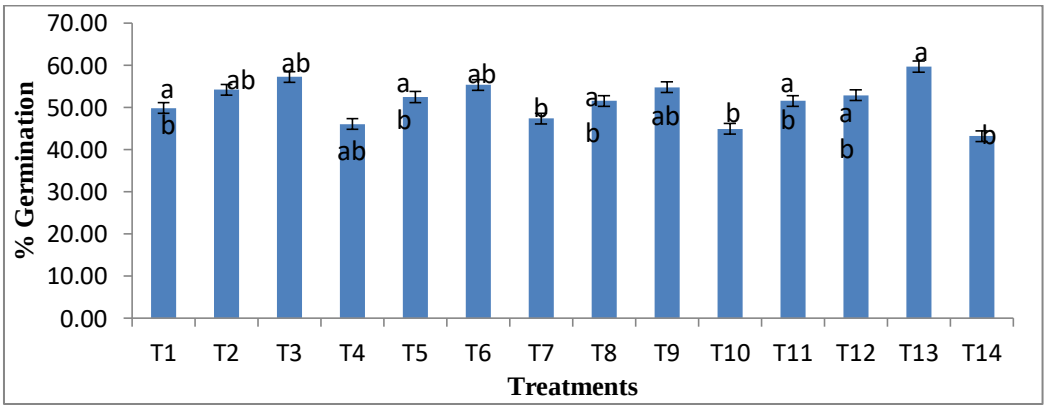

Fig 1. Effects of different treatments on germination percentage at BSMRAU research field during cropping season 2013-14. [Bars marked with same letter do not differed significantly (P= 0.05)] .

Table 2. Effects of different treatments in controlling mealybugs of sugarcane at BSMRAU farm, Gazipur in 2013-14 cropping season.

Treatments	Percent pest infestation (mean of 3 replications)						
	May	June	July	August	September	October	November
T_1	4.09 cd	6.35 cde	10.41 bcde	15.44 bcde	21.74 bc	20.36 bc	18.56 bcd
	(53.68)	(43.10)	(34.69)	(29.40)	(26.25)	(28.08)	(28.53)
T_2	3.82 cd	5.95 de	9.32 de	13.60 ef	20.56 bcd	19.68 bc	17.56 bcd
	(56.73)	(46.68)	(41.53)	(37.81)	(30.25)	(30.48)	(32.38)
T_3	2.90 de	5.09 ef	8.00 ef	11.64 fg	15.24 de	14.17 de	12.36 ef
	(67.15)	(54.39)	(49.81)	(46.77)	(48.30)	(19.94)	(52.40)
T_4	4.01 cd	7.47 bcd	11.86 bcd	17.37 bcd	24.03 abc	22.54 bc	20.10 bcd
	(54.58)	(33.06)	(25.59)	(20.57)	(18.48)	(20.38)	(22.60)
T_5	4.06 cd	7.20 bcd	11.17 bcd	16.09 bcde	23.75 abc	22.73 bc	20.77 bc
	(54.02)	(35.48)	(29.92)	(26.42)	(19.43)	(19.71)	(20.02)
T_6	3.79 cd	6.07 de	9.84 cde	14.01 def	18.58 cd	17.43 cd	15.55 def
	(57.07)	(45.60)	(38.26)	(35.93)	(36.97)	(38.43)	(40.12)
T_7	4.57 c	8.15 bc	12.21 bc	17.77 bc	24.94 ab	23.41 ab	21.37 ab
	(48.24)	(26.97)	(23.40)	(18.74)	(15.40)	(17.30)	(17.71)
T_8	6.02 b	9.20 b	12.91 b	18.08 bc	21.54 bc	20.25 bc	18.08 bcd
	(31.82)	(17.56)	(19.00)	(17.32)	(26.93)	(28.47)	(30.38)
T_9	4.47 c	7.32 bcd	10.57 bcde	14.65 cdef	19.52 bcd	17.89 cd	16.27 cde
	(49.37)	(34.40)	(33.68)	(33.01)	(33.78)	(36.80)	(37.35)
T_{10}	4.04 cd	7.61 bcd	12.16 bc	17.24 bcde	23.91 abc	22.39 bc	20.35 bcd
	(52.24)	(31.81)	(23.71)	(21.17)	(18.89)	(20.91)	(21.64)
T_{11}	4.96 bc	8.46 b	12.95 b	18.44 ab	23.93 abc	21.96 bc	19.93 bcd
	(43.82)	(24.19)	(18.75)	(15.68)	(18.82)	(22.43)	(23.25)
T_{12}	4.65 c	7.62 bcd	11.38 bcd	16.04 bcde	20.67 bcd	19.88 bc	17.78 bcd
	(47.33)	(31.72)	(28.60)	(26.65)	(29.88)	(29.77)	(31.53)
T_{13}	2.38 e	3.73 f	6.13 f	8.51 g	11.91 e	11.59 e	11.25 f
	(73.04)	(66.57)	(61.54)	(61.08)	(55.59)	(59.06)	(56.68)
T_{14}	8.83 a	11.16 a	15.94 a	21.87 a	29.48 a	28.31 a	25.97 a
LSD (0.05)	1.34	1.86	2.78	3.67	5.72	5.43	4.87
CV%	17.87	15.35	14.98	13.89	15.94	16.03	15.89

- Figures followed by the same letter (s) are not significantly different at 5% level as per LSD test.
- Figures in parentheses are percent effectiveness over control.

Table 3. Effects of different treatments on yield parameters during the cropping season 2013-14 at BSMRAU farm, Gazipur.

Treatments	Tiller ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Cane yield (t ha^{-1})	%Yield increase over control
T_1	123.67	73.13 efg	76.78 ef	29.45
T_2	131.33	77.82 de	81.71 cde	37.76
T_3	147.00	91.16 ab	95.71 b	61.37
T_4	125.33	67.49 fgh	70.86 fg	19.47
T_5	134.67	74.49 def	78.21 de	31.86
T_6	143.67	87.82 bc	92.21 b	55.47
T_7	123.33	65.52 h	68.76 g	15.93
T_8	135.67	77.16 de	81.01 cde	36.58
T_9	137.33	81.49 cd	85.56 c	44.25
T_{10}	131.33	65.49 h	68.76 g	15.93
T_{11}	131.00	66.82 gh	70.16 g	18.29
T_{12}	134.00	79.82 de	83.81 cd	41.30
T_{13}	155.33	97.49 a	102.36 a	72.58
T_{14}	114.33	56.49 i	59.31 h	-
LSD (0.05)	NS	7.13	6.06	-
CV%	18.39	5.61	4.54	-

- Figures followed by the same letter (s) are not significantly different at 5% level as per LSD test.

Table 4. Economic analysis of different treatment tested against scale insects and mealybugs during cropping season 2013-14.

Treatments	Yield (ton ha^{-1})	Gross Return (BDT ha^{-1}) *	Cost of Treatments (BDT ha^{-1})	Net Benefit (BDT ha^{-1})	Adjusted Return (BDT ha^{-1})	MBCR
T_1	76.78	224197.60	17000.00	34012.40	51012.40	3.00
T_2	81.71	238593.20	17000.00	48408.00	65408.00	3.84
T_3	95.71	279473.20	17000.00	89288.00	106288.00	6.25
T_4	70.86	206911.20	16000.00	17726.00	33726.00	2.10
T_5	78.21	228373.20	16000.00	39188.00	55188.00	3.44
T_6	92.21	269253.20	16000.00	80068.00	96068.00	6.00
T_7	68.76	200779.20	15250.00	12344.00	27594.00	1.80
T_8	81.01	236549.20	15250.00	48114.00	63364.00	4.15
T_9	85.56	249835.20	15250.00	61400.00	76650.00	5.02
T_{10}	68.76	200779.20	12000.00	15594.00	27594.00	2.29
T_{11}	70.16	204867.20	12000.00	19682.00	31682.00	2.64
T_{12}	83.81	244725.20	12000.00	59540.00	71540.00	5.96
T_{13}	102.36	298891.20	20000.00	105706.00	125706.00	6.28
T_{14}	59.31	173185.20	-	-	-	-

*Price of cane BDT 2.92 Kg^{-1} (BDT = Bangladeshi Currency i.e., Taka)

Bangladesh. The major weather factors of experimental site were recorded during January to November 2014 (Supplementary Table 2).

Design and layout of experiment

The experiment was laid out in randomized complete block (RCB) design with three replications. The plot size was 5 m × 3 m. Blocks were 2 m apart from each other while the plot border was 1m. Planting was done through conventional set placement in the trenches with sugarcane variety Isd 36 on December 9, 2013. Twenty two sets were (two eye budded) placed per line. So, eighty eight sets were placed per plot.

Preparation of fermented cattle urine

Cattle urine was collected from cattle farm of Salna, Gazipur. After collection, it was kept underground in earthen pots for 14 days for fermentation. Then 100, 200 and 300 ml of fermented cattle urine was diluted with 1 liter of water to make up the concentration to 10, 20 and 30%. Then lime was added to neutralize the released toxic phenols and acids (NRI, 2003).

Preparation of plant extracts

For the preparation of plant extracts 50, 100 and 150 grams of neem and mahagoni seeds were shade dried, crushed and then soaked overnight in 1 litre of water to get 5, 10 and 15% concentration. Then 50, 100 and 150 grams of pieces allamanda leaves were blended with 1 litre of water to get 5, 10 and 15% concentration. Later, all mixtures were squeezed through the muslin cloth.

Application of prepared solution

The prepared solutions were sprayed with a knap-sack sprayer at fortnight interval starting from the first initiation of the pest attack from May to November, 2014 as foliar and stem spray.

Treatment details

There were fourteen treatments including one untreated control, one natural product i.e., fermented cattle urine (3 doses), three indigenous plants extracts (each extracts are 3 doses) and one recommended insecticides.

The following treatments were included in the experiment:

T_1- Fermented Cattle Urine (FCU) @ 100 ml/litre of water spray at fortnight interval
T_2- FCU @ 200 ml/litre of water spray at fortnight interval
T_3- FCU @ 300 ml/litre of water spray at fortnight interval
T_4- Neem Seed Kernel Extract (NSKE) @ 50 gm/litre of water spray at fortnight interval

T_5- NSKE @ 100 gm/litre of water spray at fortnight interval

T_6- NSKE @ 150 gm/litre of water spray at fortnight interval

T_7-Mahagoni Seed Extract (MSE) @ 50 gm/litre of water spray at fortnight interval
T_8- MSE @ 100 gm/litre of water spray at fortnight interval
T_9- MSE @ 150 gm/litre of water spray at fortnight interval
T_{10}-Allamanda Leaves Extract (ALE) @ 50 gm/litre of water spray at fortnight interval
T_{11}- ALE @ 100 gm/litre of water spray at fortnight interval
T_{12}- ALE @ 150 gm/litre of water spray at fortnight interval
T_{13}- Standard insecticide [Sungor 40EC (Dimethoate)] @ 1 ml/5 liter of water spray at fortnight interval
T_{14}- Untreated

Data collection

Germination percentage, number of tiller and millable cane were recorded. Both the tiller population and millable cane stalks were recorded and expressed as 1000

ha^{-1}. Data on the incidence of scale insects and mealybugs were recorded in the month of May to November. The yield of sugarcane was also recorded at harvest.

Germination percentage

Germination percentage of sugarcane sets were determined by counting the number of total buds (one set consists of two buds) placed in each plot at the time of plantation and the number of setlings germinated after 60 days of planting on 07 February, 2014. The numbers of setlings were converted into germination percentage using the following formula:
% Germination (bud basis) = Number of setling/Total buds × 100

Number of tiller and millable cane

Number of tillers in each plot was counted at 20 weeks of planting. Total number of millable cane (healthy stalks) was recorded from each plot on 22 December, 2014 at harvesting period. The tiller number and total number of millable cane per plot were counted and expressed in thousand per hectare.

Infestation of scale insects and mealybugs

Data collection was done on fortnight basis for insect pest infestation by counting the total number of infested plants, leaves and stems. Percent pest infestation and effectiveness were calculated using the following formula:
% Infestation = Number of infested cane/ Total cane × 100

%Effectiveness = Infestation of untreated plot – Infestation of treated plot/Infestation of
untreated plot × 100

Yield of cane

For yield data, twenty selected sugarcane stalks were cut randomly at the ground level from each plot and green top as well as dried leaves removed. The weight of twenty clean stalks was recorded in kilogram. The cane yield was expressed in ton per hectare based on weight of 20 cane stalks per plot. Yield increase or decrease over untreated control was also calculated using following formula:
% Yield increase over control = Yield of treated plot – Yield of untreated plot/ Yield of untreated
plot × 100

Economic analysis

Cost of all treatments and other managements were recorded to compute the MBCR. The monetary return from the yield was calculated on the basis of mill gate price during December, 2014. Major parameters of economic analysis were computed according to following formula:
Gross return = Yield ×sale price
Net benefit = Adjusted return – Cost of treatment
Adjusted return = Gross return of treated plot – Gross return of untreated plot
MBCR = Adjusted return/Cost of treatment

Statistical analysis

The collected data were converted to percent infestation to measure the level of incidence and analyzed for comparison using LSD at 0.05 levels for interpretation by Statistix 10 software.

Conclusion

The treatment T_3 reduced 48.66 – 62.37% of scale insects and 46.77 – 67.15% of mealybugs. Treatment T_6 decreased 38.27 – 53.62% of scale insects and 35.93 – 57.07% of mealybugs Whereas T_9 treatment reduced 35.32 – 46.47% of scale insects and 33.01 – 49.37% of mealybugs. These three treatments were the best in different months of the cropping season. The MBCR of these treatments were 6.25, 6.00 and 5.02. This result was at par with that obtained by recommended chemical insecticides [Sungor 40EC (Dimethoate) @ 1ml 5 l^{-1} of water]. Considering the performance of pest control, yield and MBCR, treatments T_3, T_6 and T_9 may be included as a component of IPM packages reduces the use of chemical insecticides for the effective management of scale insects and mealybugs of sugarcane.

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