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Efficacy of systemic insecticides as stem application against sucking pests of cotton

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Abstract
A field experiment was conducted at Experimental Farm, Department of Agricultural Entomology, College of Agriculture, MAU, Parbhani, during the year 2009-2010 to study the effect of stem application of insecticides against sucking pests of cotton. Stem application of acephate at 3, 7, 14 days after insecticides application and on the basis of overall efficacy proved most effective against aphids (4.18/leaf), jassids (1.48/leaf), thrips (2.63/leaf) and whiteflies (2.63/leaf). The treatment with clothianidin @ 1:30 dilution proved most effective on aphid (4.91/leaf) and jassids (1.68/leaf). The treatment with dimethoate @ 1:6 dilution effective against aphid (6.03/leaf), jassids (2.10/leaf) and thrips (3.80/leaf).

Keywords: Acephate, clothianidin, fipronil, acetamiprid, thiamethoxam, stem application

Introduction
Cotton crop as commercial commodity plays an important role in industrial electivity of the nation and has a unique place in Indian economy and social affairs. India occupies 95.30 lakh ha area under cotton with a production of 310 lakh bales and productivity of 553 kg lint./ha. Maharashtra State occupies an area of about 31.90 lakh ha under cotton crop with production of 60 lakh bales and productivity of 320 kg lint/ha as against India's average of 553 kg lint/ha [1].
The pests of major significance are aphids, *Aphis gossypii* (Glover); jassids, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* (Gennadius); thrips, *Scirtothrips dorsalis* (Hood) and mealy bugs. *Phenacoccus* spp. and bollworms viz. spotted bollworms, *Earias vittella* (Feb), American bollworm, *Helicoverpa armigera* (Hubner) and Pink bollworm, *Pectinophora gossypiella* (Saunders).The farmers are mostly depending on insecticides for management of these insect pests. Nearly Rs. 12 billion worth of pesticides are used in India to control just the bollworm complex of cotton [2]. More than 10 per cent of the world insecticides are used in cotton farming [3].
The stem application of imidacloprid (200 SL) 1:20 dilution at 20, 40 and 60 DAS for the control of aphids, leaf hoppers and mealy bugs on cotton [2]. The management of sucking pests of cotton bystem application of imidacloprid 200 SL (1:20 dilution) using small brush at 20, 40 and 60 DAS keeps the crop free from sucking pests up to 75 days without harming natural enemies [4].
In the light of these facts the present investigations were carried out with the main objective of testing the efficacy of some selected systemic insecticides as stem application in comparison with other methods against the pests of cotton.

Materials and Methods
The field experiment was carried out at Experimental Farm, Department of Entomology, College of Agriculture, MAU, Parbhani (M.S.) during 2009-2010.

Treatment details: In the present investigation 7 insecticidal treatments and an untreated control were evaluated against sucking pests. The details of the treatments are as under.

Abbreviations		Treatment details
T_1	-	Stem application of dimethoate 30% EC @ 1:6 dilution at 30 and 45 days after sowing.
T_2	-	Stem application of acephate 75% WP @ 1:4 dilution at 30 and 45 days after sowing
T_3	-	Stem application of fipronil 5% SC @ 1:4 dilution at 30and 45 days after sowing
T_4	-	Stem application of acetamiprid 20% SP @ 1:30 dilution at 30 and 45 days after sowing.
T_5	-	Stem application of thiamethoxam 25% WG @ 1:30 dilution 30 and 45 days after sowing
T_6	-	Stem application of imidacloprid 17.8% SC @ 1:30 dilution at 30 and 45 days after sowing.
T_7	-	Stem application of clothianidine 50% WDG @ 1:30 dilution at 30 and 45 days after sowing.
T_8	-	Untreated control

Layout of experiment: The experiment was laid out in a Randomized Block Design with 8 treatments replicated thrice. The distance between two replications was 1.5m and it was 1 m between the treatments.

Application of insecticides: NCS-207 (Mallika Bt-2) cotton seed treated with imidacloprid was used for all the treatments including untreated control.

Stem application: The required quantity of insecticides was measured and added in the required quantity of water as per the treatment details and prepared the proper solutions in a small bucket. Insecticides were applied with the help of one centimeter painting brush on five centimeter of the middle portion of the upper half of plant height. The painting brush used for stem application was washed after each treatment.
No protection was required for bollworms as the incidence did not cross the ETL.

Recording of observations
The observations were recorded on five randomly selected plants in each net plot and were labeled with plastic tag. The observations were recorded at weekly intervals. The observations on the actual count of sucking pests viz. aphids, jassids, thrips and whiteflies were recorded from top, middle and bottom two leaves from the selected plants. The observations on number of mealy bugs were recorded from 5 cm length of growing stem from the selected plants. The observations on number of chrysopa and coccinellids were recorded on the whole plant from the selected plants.

Statistical analysis: The observations on the number of sucking pests and natural enemies were subjected to $\sqrt{x + 0.5}$ transformation before statistical analysis. The data were statistically analyzed as per the method given by Panse and Sukhatme (1967).

Results and Discussion
Effect of stem application of insecticides on sucking pests of cotton
Effect of different treatments on population sucking pests of cotton
The data on population of sucking pests of cotton before the application of treatments were presented in Table 1. The data revealed that the population of aphids, jassids, thrips and whiteflies in different treatments were non-significant. The aphids population aphids, jassids, thrips and whiteflies are ranged from 8.80 to 9.14 aphids per leaf, 2.98 to 3.20 jassids per leaf, 1.38 to 1.46 thrips per leaf and 0.46 to 0.54 whiteflies per leaf in various treatments.

Table 1: Population of sucking pests before application of insecticides**.**

Treatments	Conc./ Dilution (I:W)*	Sucking pests per leaf			
		Aphids	Jassids	Thrips	Whiteflies
T_1- Stem application of dimethoate 30 EC	1:6	8.80 (3.04)	3.20 (1.92)	1.46 (1.39)	0.46 (0.97)
T_2- Stem application of acephate 75% WP	1:4	8.98 (3.06)	3.18 (1.91)	1.38 (1.37)	0.48 (0.98)
T_3- Stem application of fipronil 5% SC	1:4	9.14 (3.10)	3.04 (1.87)	1.38 (1.37)	0.52 (1.00)
T_4- Stem application of acetamiprid 20% SP	1:30	9.04 (3.08)	3.02 (1.87)	1.42 (1.38)	0.48 (0.98)
T_5- Stem application of thiamethoxam 25% WG	1:30	9.00 (3.08)	2.98 (1.86)	1.46 (1.39)	0.50 (0.99)
T_6- Stem application of imidacloprid 17.8% SC	1:30	9.16 (3.10)	3.16 (1.91)	1.44 (1.38)	0.54 ()1.01
T_7- Stem application of clothianidin 50 WDG	1:30	9.08 (3.09)	3.14 (1.90)	1.42 (1.38)	0.46 (0.97)
T_8-Untreated control	-	9.06 (3.08)	3.10 (1.89)	1.38 (1.37)	0.48 (0.98)
SE±		0.098	0.065	0.061	0.040
CD at 5%		0.29	0.19	0.20	0.12

*I:W - Insecticide : Water
**Figures in parentheses are $\sqrt{x + 0.5}$ values

A) At 3 days after first application
The data in Table 2 reveal that the differences amongst various treatments were significant. The treatment with stem application of acephate @ 1:4 dilution proved superior over all other treatments, recording least population of aphids (1.06/leaf), jassids (0.59/leaf), thrips (0.20/leaf) and whiteflies (0.06/leaf). The next equally effective treatments were clothianidin @ 1:30 dilution for aphids (1.26/leaf), jassids (0.73/leaf), thrips (0.33) and whiteflies (0.10/leaf) imidacloprid @ 1:30 dilution for aphids (1.57/leaf), jassids

(0.92/leaf), thrips (0.66/leaf) and whiteflies (0.16/leaf). The population of aphids, jassids, thrips and whiteflies with treatment of dimethoate @ 1:4 dilution 1.93/leaf, 1.03/leaf, 0.53/leaf and 0.14/leaf respectively. The population of same pests with the treatment of fipronil @ 1:6 dilution 1.94 aphids/leaf, 1.16 jassids/leaf, 0.33 thrips/leaf and 0.15 whiteflies/leaf and the treatment with thiamethoxam @ 1:30 dilution the population of aphids, jassids, thrips and whiteflies are 2.10/leaf, 1.52/leaf, 0.86/leaf and 0.20/leaf respectively.
The untreated control recorded significantly higher number of aphids, jassids, thrips and whiteflies and it was at par with acetamiprid, thiamethoxam, fipronil and dimethoate.

B) At 7 days after first application

The data presented in Table 2 reveal that the differences amongst various treatments were significant. The population of aphids, jassids, thrips and whiteflies presented in sequence under different treatments. The treatment with acephate @1:4 dilution recorded the per leaf population of aphid 2.34, jassids 1.33, thrips 1.18 and whiteflies 1.88 proved significantly superior over all other treatments except clothianidin @1:30 dilution 2.6 per leaf, 1.53 per leaf, 1.26 per leaf and 1.93 per leaf aphids, jassids, thrips and whiteflies respectively. Similarly observe in imidacloprid @1: 30 dilution 2.93 aphids per leaf, 1.60 jassids per leaf, 1.53 thrips per leaf and 2.53 whiteflies per leaf. The treatment with dimethoate @ 1:6 dilution recorded the population of aphid 3.6/leaf, jassids 1.79/leaf, thrips 1.53/leaf and whiteflies 2.13/leaf.
The untreated control recorded significantly higher population of aphids (10.2/leaf), jassids (3.40/leaf), thrips (1.93/leaf) and whiteflies (3.40/leaf).

C) At 14 days after first application

The data presented in Table 2 reveal that the differences amongst various treatments were significant. The treatment with acephate @ 1:4 dilution proved superior over all other treatments recording least population of aphids (8.73/leaf), jassids (1.94/leaf), thrips (4.20/leaf) and whiteflies (3.73/leaf). These were followed by clothianidin @ 1:30 dilution which recorded 9.8 aphids/leaf, 1.92 jassids/leaf, 4.66 thrips/leaf and 3.93 whiteflies/leaf. Next effective treatment was imidacloprid @ 1:30 dilution which recorded 10.86 aphids per leaf, 2.26 jassids per leaf, 6.06 thrips per leaf and 4.86 whiteflies per leaf. The treatments with dimethoate @ 1:6 dilution recorded 12.73 aphids per leaf, 2.40jassids per leaf, 5.60 thrips per leaf and 4.13 whiteflies per leaf and fipronil @ 1:4 dilution recorded 13.73 aphids per leaf, 2.66 jassids per leaf, 5.86 thrips per leaf and 4.86 whiteflies per leaf. The treatments of thiamethoxam @ 1:30 dilution recorded highest population of aphids, jassids, thrips and whiteflies i.e. 16.00, 2.86, 6.06 and 4.93 per leaf respectively and did not differ significantly from untreated control.

Table 2: Population of sucking pests after first application of insecticide

Treatments	Conc./ Dilution (I:W)*	Aphids / leaf			Jassids / leaf			Thrips / leaf			Whiteflies / leaf		
		Days after Ist application			Days after Ist application			Days after Ist application			Days after Ist application		
		3	7	14	3	7	14	3	7	14	3	7	14
T_1- Stem application of dimethoate 30 EC	1:6	1.93 (1.55)	3.6 (2.01)	12.73 (3.61)	1.03 (1.23)	1.79 (1.51)	2.40 (1.70)	0.53 (1.01)	1.53 (1.42)	5.60 (2.46)	0.14 (0.79)	2.13 (1.62)	4.13 (2.15)
T_2- Stem application of acephate 75% WP	1:4	1.06 (1.25)	2.34 (1.68)	8.73 (3.03)	0.59 (1.04)	1.33 (1.34)	1.94 (1.56)	0.20 (0.83)	1.18 (1.29)	4.20 (2.16)	0.06 (0.75)	1.88 (1.54)	3.73 (2.05)
T_3- Stem application of fipronil 5% SC	1:4	1.94 (1.56)	4.4 (2.21)	13.73 (3.76)	1.16 (1.29)	1.89 (1.54)	2.53 (1.74)	0.33 (0.90)	1.24 (1.31)	4.46 (2.22)	0.15 (0.80)	2.26 (1.66)	4.06 (2.13)
T_4- Stem application of acetamiprid 20% SP	1:30	2.17 (1.63)	5.6 (2.46)	15.86 (4.04)	1.50 (1.41)	2.00 (1.46)	2.66 (1.74)	0.80 (1.13)	1.53 (1.42)	5.86 (2.52)	0.18 (0.82)	2.33 (1.68)	4.86 (2.31)
T_5- Stem application of thiamethoxam 25% WG	1:30	2.10 (1.61)	5.66 (2.48)	16.00 (4.02)	1.52 (1.42)	2.06 (1.60)	2.86 (1.81)	0.86 (1.16)	1.66 (1.47)	6.06 (2.56)	0.20 (0.83)	2.46 (1.71)	4.93 (2.33)
T_6- Stem application of imidacloprid 17.8% SC	1:30	1.75 (1.44)	2.93 (1.84)	10.86 (3.36)	0.92 (1.19)	1.60 (1.44)	2.26 (1.65)	0.66 (1.07)	1.53 (1.42)	6.06 (2.56)	0.16 (0.81)	2.53 (1.77)	4.86 (2.31)
T_7- Stem application of clothianidin 50 WDG	1:30	1.26 (1.32)	2.6 (1.75)	9.8 (3.20)	0.73 (1.10)	1.53 (1.42)	1.92 (1.55)	0.33 (0.90)	1.26 (1.32)	4.66 (2.27)	0.10 (0.77)	1.93 (1.55)	3.93 (2.10)
T_8- Untreated control	-	2.95 (1.85)	10.2 (3.27)	18.6 (4.37)	3.12 (1.90)	3.40 (1.97)	5.13 (2.37)	1.46 (1.39)	1.93 (1.55)	7.26 (2.78)	0.54 (1.01)	3.40 (1.97)	6.26 (2.60)
SE±		0.111	0.078	0.181	0.056	0.090	0.119	0.058	0.027	0.030	0.028	0.041	0.024
CD at 5%		0.37	0.23	0.55	0.17	0.27	0.36	0.17	0.08	0.09	0.08	0.12	0.07

*I:W - Insecticide : Water
**Figures in parentheses are $\sqrt{x + 0.5}$ values

D) At 3 days after second application

The data in Table 3 reveal that the differences amongst various treatments were significant. The treatment with acephate @ 1:4 dilution (2.66 aphids per leaf, 0.60 jassids per leaf, 1.06 thrips per leaf and 1.13 whiteflies per leaf) proved significantly superior over all other treatments except clothianidin @ 1:30 dilution (3.79 aphids per leaf, 0.86 jassids per leaf, 1.26 thrips per leaf and 1.33 whiteflies per leaf). After that imidacloprid @ 1:30 dilution recorded 3.84 aphids per leaf, 0.93 jassids per leaf, 1.86 thrips per leaf and 1.93 whiteflies per leaf. The treatment with dimithoate @ 1:6 dilution recorded 3.98 aphids per leaf, 1.00 jassids per leaf, 1.33 thrips per leaf and 1.60 whiteflies per leaf. The untreated control recorded significantly highest population of aphids (16.66/leaf), jassids (5.20/leaf), thrips (7.73/leaf) and whiteflies (7.6/leaf).

E) At 7 days after second application

The data in Table 3 indicate that the differences amongst various treatments were significant. The treatment with acephate @ 1:4 dilution (4.26/leaf) recorded lower population of aphids than all other treatments.
The treatments with clothianidin @ 1:30 dilution (5.13/leaf), imidacloprid @ 1:30 dilution (5.46/leaf) and dimethoate @ 1:6 dilution (6.33/leaf) and were significantly effective over rest of the treatments on population of aphid. The other treatments in order of their merits were fipronil @ 1:4 dilution (7.4 aphids per leaf), acetamiprid @ 1:30 dilution (8.39

aphids per leaf) and thiamethoxam @ 1:30 dilution (9.59 aphids per leaf).

The treatment with clothianidin @ 1:30 dilution and imidacloprid @1:30 dilution recorded less population of jassids (1.93/leaf) and (2.13/leaf) respectively. The next effective treatments were dimethoate @ 1:6 dilution, fipronil @ 1:4 dilution, acetamiprid @ 1:30 dilution and thiamethoxam @ 1:30 dilution which recorded the jassid population of 2.66, 2.86, 3.06 and 3.06 jassids respectively were on par with each other.

The treatment with acephate @ 1:4 dilution (3.06/leaf) and fipronil @ 1:4 dilution (3.26/leaf) were significantly superior over all other treatments and were on par with each other for the population of thrips. The next effective treatment was clothianidin @1:30 dilution (3.86 thrips per leaf). Differences between dimethoate @ 1:6 dilution (5.40 thrips per leaf) and acetamiprid @ 1:30 dilution (5.40 per leaf) were non-significant and these were significantly effective than thiamethoxam @ 1:30 dilution (5.86 thrips per leaf), imidacloprid @ 1:30 dilution (6.13 thrips per leaf).

The treatment with acephate @1:4 dilution (3.86 whiteflies per leaf) was significantly superior over all other treatments but, it did not differ significantly from clothianidin @1:30 dilution (4.06 whiteflies per leaf) and fipronil @1:4 dilution (4.13 whiteflies per leaf). The treatments with dimethoate @1:6 dilution (4.86 whiteflies per leaf), acetamiprid @1:30 dilution (5.26 whiteflies per leaf) and thiamethoxam @1:30 dilution (5.33 whiteflies per leaf) were statistically equal.

The untreated control recorded significantly highest population of aphids (17.92/leaf), jassids (7.06/leaf), thrips (9.60/leaf) and whiteflies (8.80/leaf).

F) At 14 days after second application

The data in Table 3 show that the differences amongst various treatments were significant. The treatment with acephate @ 1:4 dilution proved to be superior over all other treatments, recording least population of aphids (6.06/leaf). The next equally effective treatments were clothianidin @ 1:30 dilution, imidacloprid @ 1:30 dilution dimethoate @1:6 dilution and fipronil @ 1:4 dilution which recorded 6.91, 7.30, 7.66 and 8.6 aphids per leaf and were at par with each other. The differences between acetamiprid @ 1:30 dilution (10.6/leaf) and thiamethoxam @1:30 dilution (10.92/leaf) were non-significant.

The treatments with acephate @ 1:4 dilution (2.66 jassids per leaf) and clothianidin @ 1:30 dilution (3.13 jassids per leaf) were significantly effective over all other treatments except imidacloprid @ 1:30 dilution (3.33 jassids per leaf) and were at equal.

The next effective treatments on population of jassids were dimethoate @ 1:6 dilution (3.73 jassids per leaf) and fipronil @ 1:4 dilution (3.86 jassids per leaf) were statistically at par with each other. The treatments with acetamiprrid @ 1:30 dilution (5.80 jassids per leaf) and thiamethoxam @ 1:30 dilution (5.86 jassids per leaf) were statistically at par with each other.

The treatments with acephate @ 1:4 dilution (6.13/leaf), fipronil @ 1:4 dilution (6.33/leaf) and clothianidin @ 1:30 dilution (6.46/leaf) were significantly superior to all other treatments and were on par with each other for the population of thrips. The next effective treatments in order of their merits were dimethoate @ 1:6dilution (8.46 thrips per leaf), acetamiprid @ 1:30 dilution (9.4 thrips per leaf), thiamethoxam @ 1:30 dilution (10.2 thrips per leaf) and imidacloprid @ 1:30 dilution and differences between these treatments were significant.

The population of whiteflies treatment with acephate @1:4 dilution (5.13/leaf) was superior over all other treatments except clothianidin @1:30 dilution (5.46/leaf). The next effective treatments were fipronil @1:4 dilution (5.86 whiteflies per leaf) and dimethoate @1:6 dilution (6.80 whiteflies per leaf) were significantly superior over rest of treatments the treatment with acetamiprid @1:30 dilution (7.73 whiteflies per leaf), thiamethoxam @1:30 dilution (7.80 whiteflies per leaf), imidacloprid @1:30 dilution (7.86 whiteflies per leaf) were at par with each other.

The untreated control recorded significantly highest population of aphids (19.14/leaf), jassids (8.20/leaf), thrips (14.73/leaf) and whiteflies (10.2/leaf).

Table 3: Population of sucking pests after Second application of insecticide

Treatments	Conc./ Dilution (I:W)*	Aphids / leaf			Jassids / leaf			Thrips / leaf			Whiteflies / leaf		
		Days after IInd application			Days after IInd application			Days after IInd application			Days after IInd application		
		3	7	14	3	7	14	3	7	14	3	7	14
T_1- Stem application of dimethoate 30 EC	1:6	3.98 (2.11)	6.33 (2.60)	7.66 (2.85)	1.00 (1.22)	2.66 (1.77)	3.73 (2.05)	1.33 (1.35)	5.40 (2.42)	8.46 (2.99)	1.60 (1.44)	4.86 (2.31)	6.80 (2.70)
T_2- Stem application of acephate 75% WP	1:4	2.66 (1.77)	4.26 (2.18)	6.06 (2.54)	0.60 (1.04)	1.79 (1.51)	2.66 (1.77)	1.06 (1.24)	3.06 (1.88)	6.13 (2.57)	1.13 (1.27)	3.86 (2.08)	5.13 (2.37)
T_3- Stem application of fipronil 5% SC	1:4	4.75 (2.29)	7.40 (2.18)	8.60 (3.01)	1.20 (1.30)	2.86 (1.83)	3.86 (2.08)	1.14 (1.28)	3.26 (1.94)	6.33 (2.61)	1.53 (1.42)	4.13 (2.15)	5.86 (2.52)
T_4- Stem application of acetamiprid 20% SP	1:30	6.91 (2.72)	8.39 (2.98)	10.60 (3.33)	1.33 (1.35)	1.33 (1.35)	5.80 (2.50)	1.66 (1.47)	5.40 (2.42)	9.40 (3.14)	1.86 (1.53)	5.26 (2.45)	7.73 (2.86)
T_5- Stem application of thiamethoxam 25% WG	1:30	7.04 (2.74)	9.59 (3.17)	10.92 (3.37)	1.40 (1.37)	3.06 (1.88)	5.86 (2.52)	1.80 (1.51)	5.86 (2.52)	10.2 (3.27)	1.86 (1.53)	5.33 (2.41)	7.80 (2.88)
T_6- Stem application of imidacloprid 17.8% SC	1:30	3.84 (2.08)	5.46 (2.44)	7.30 (2.79)	0.93 (1.19)	2.13 (1.62)	3.33 (1.95)	1.86 (1.53)	6.13 (2.57)	11.2 (3.42)	1.93 (1.55)	5.60 (2.46)	7.86 (2.89)
T_7- Stem application of clothianidin 50 WDG	1:30	3.79 (2.07)	5.13 (2.37)	6.91 (2.72)	0.86 (1.16)	1.93 (1.55)	3.13 (1.90)	1.26 (1.32)	3.86 (2.08)	6.46 (2.63)	1.33 (1.35)	4.06 (2.13)	5.46 (2.44)
T_8- Untreated control	-	16.66 (4.14)	17.92 (4.29)	19.14 (4.43)	5.20 (2.38)	7.06 (2.75)	8.20 (2.94)	7.73 (2.86)	9.60 (3.17)	14.73 (3.90)	7.6 (2.84)	8.80 (3.04)	10.2 (3.27)
SE±		0.127	0.070	0.100	0.050	0.062	0.047	0.035	0.032	0.030	0.035	0.051	0.047
CD at 5%		0.38	0.21	0.30	0.15	0.18	0.14	0.10	0.09	0.09	0.10	0.15	0.14

*I:W - Insecticide : Water

**Figures in parentheses are $\sqrt{x + 0.5}$ values

G) Overall efficacy of different treatments against sucking pests of cotton

The data on overall efficacy of different treatments are presented in Table 4. All the insecticidal treatments were significantly effective than the untreated control (14.24 aphids per leaf, 5.35 jassids per leaf, 7.11 thrips and whiteflies per leaf). The results indicated that the treatment with acephate @ 1:4 dilution (4.18 aphids per leaf, 1.48 jassids per leaf, 2.63 thrips and whiteflies per leaf) was significantly superior to all other treatments.

The treatment with clothianidin @ 1:30 dilution (4.91 aphids per leaf) and imidacloprid @ 1:30 dilution (5.35 aphids per leaf) were statistically equal and significantly effective than rest of the treatments. The other treatments in order of their merits were dimethoate @ 1:6 dilution (6.03 aphids per leaf), fipronil @ 1:4 dilution (6.80 aphids per leaf), acetamiprid @ 1:30 dilution and thiamethoxam @ 1:30 dilution (8.55 aphids per leaf). Significantly highest population of aphid recorded in untreated control (14.24/leaf).

The treatment with imidacloprid @ 1:30 dilution (1.86 jassids per leaf) was significantly effective over rest of the treatments except dimethoate @ 1:6 dilution (2.10 jassids per leaf). No significant difference were observed between acetamiprid @ 1:30 dilution (2.72 jassids per leaf) and thiamethoxam @ 1:30 dilution (2.79 jassids per leaf).

The other effective treatment after acephate @ 1:4 dilution for population of thrips was fipronil @1:4 dilution (2.79/leaf) and clothianidin @1:30 dilution (2.97/leaf). The next effective treatments on population of thrips were dimethoate @1:6 dilution (3.80/leaf), acetamiprid @1:30 dilution (4.10/leaf), thiamithoxam @1:30 dilution (4.40/leaf) and imidacloprid @1:30 dilution (4.57/leaf) were statistically equal to each other on the population of thrips.

The other effective treatment after acephate @ 1:4 dilution for population of whiteflies was clothianidin @1:30 dilution (2.97/leaf) and fipronil @1:4 dilution (2.99/leaf) and were statistically at par with each other.

The application of Orthene 75 S^{TM} (acephate) in a 3:1 and 4:1 (V: V ratio) water slurry was painted on trunks of row planted, seedling crape mystle, *Lagerstroemia indica*, was effective for 4 weeks the control of aphid [5].

The effective control of aphid in cotton with stem application of imidacloprid (200 SL) 1:20 dilution at 20, 40 and 60 DAS. The present results are supported by the above workers [6].

The management of sucking pests of cotton by stem application of imidacloprid 200 SL (1:20) dilution using small brush at 20,40 and 60 DAS keep the crop free from sucking pests up to 75 days without harming natural enemies [4].

Similar results were found as effective treatment imidacloprid as stem smearing against sucking pests of cotton [7].

Effect of different treatments on yield of seed cotton

The data on yield of seed cotton are presented in Table 4. Results indicated that the difference among various treatments were significant. The treatment with acephate @ 1:4 dilution (1233.33 kg/ha) and clothianidin @ 1:30 dilution (1225 kg/ha) recorded significantly highest yield of seed cotton than all of the treatments and were on par with each other. These were followed by imidacloprid @ 1:30 dilution (1033.33 kg/ha), fipronil @ 1:4 dilution (1016.66 kg/ha) and dimethoate @ 1:6 dilution (1003.00 kg/ha) which were at par with each other. The treatments with acetamiprid @ 1:30 dilution (993.33 kg/ha) and thiamethoxam @ 1:30 dilution (975 kg/ha) recorded equal yield. Significantly lowest yield was recorded untreated control (666.67 kg/ha).

Table 4: Overall efficacy of different treatments against populations of sucking pests and yield of seed cotton.

Treatments	Conc./ Dilution (I:W)*	Sucking pests per leaf				Yield of seed cotton
		Aphids	Jassids	Thrips	Whiteflies	Kg/ha
T_1- Stem application of dimethoate 30 EC	1:6	6.03 (2.48)	2.10 (1.58)	3.80 (1.97)	3.27 (1.87)	1003.33
T_2- Stem application of acephate 75% WP	1:4	4.18 (2.09)	1.48 (1.38)	2.63 (1.68)	2.63 (1.70)	1233.33
T_3- Stem application of fipronil 5% SC	1:4	6.80 (2.63)	2.25 (1.63)	2.79 (1.73)	2.99 (1.80)	1016.66
T_4- Stem application of acetamiprid 20% SP	1:30	8.25 (2.89)	2.72 (1.76)	4.10 (2.05)	3.70 (1.97)	993.33
T_5- Stem application of thiamethoxam 25% WG	1:30	8.55 (2.94)	2.79 (1.78)	4.40 (2.11)	3.76 (1.98)	975.00
T_6- Stem application of imidacloprid 17.8% SC	1:30	5.32 (2.33)	1.86 (1.51)	4.57 (2.14)	4.57 (1.99)	1033.33
T_7- Stem application of clothianidin 50 WDG	1:30	4.91 (2.26)	1.68 (1.42)	2.97 (1.78)	2.97 (1.75)	1225.00
T_8-Untreated control	-	14.24 (3.80)	5.35 (2.40)	7.11 (2.71)	7.11 (2.55)	666.67
SE±		0.045	0.034	0.062	0.057	39
CD at 5%		0.13	0.10	0.19	0.17	120.31

*I:W - Insecticide : Water

**Figures in parentheses are $\sqrt{x + 0.5}$ values

The lowest population of fruit borer, *Earias vittella* (Fabricius),; leafminer, *Liriomyza trifolii* (Burgess) and lowest population of aphid, *Aphis gossypii* (Glover), leafhopper, *Amrasca biguttula biguttula* (Ishida) and predatory coccinellids beetles, *Menochilus sexmaculatus* (Fabricius) and *Verania vincta, (*Gorham) with stem application of imidacloprid (1:20) at 20, 40 and 60 DAS and highest marke Table fruit yield (25.83 q/ha) on Okra [8]. The higher yield of seed cotton were obtained in stem smearing technique of monocrotophos 36 per cent + Water (1:1) and monocrotophos 36 per cent + Water (1:3) [9].

The perusal of literature revealed that no pertains information is available with respect on effect of the stem application of various insecticidal treatments used in the present study.

Conclusion

The results of present studies can be concluded as

1) The stem application of insecticides was effective against

sucking pests of cotton.

2) Stem application of acephate @ 1:4 dilution, clothianidin @ 1:30 dilution and imidacloprid @ 1:30 dilution were effective against aphids and jassids.
3) Stem application of acephate @ 1:4 dilution, fipronil @ 1:4 dilution and clothianidin @ 1:30 dilution were effective against thrips.
4) Stem application of acephate @ 1:4 dilution, clothianidin @ 1:30 dilution and fipronil @ 1:4 dilution were effective on whiteflies.
5) Stem application of acephate @ 1:4 dilution recorded highest seed cotton yield followed by clothinidin @ 1:30 dilution, imidacloprid @ 1:30 dilution, fipronil @ 1:4 dilution and dimethoate @ 1:6 dilution.
6) Stem application of imidacloprid @ 1:30 dilution gave highest cost benefit ratio followed by acephate @ 1:4 dilution. However, stem application of clothianidin @ 1:30 dilution, thimethoxam 1:30 dilution and acetamiprid @ 1:30 dilution were uneconomical.

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