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Evaluation of new molecules against sucking pests and bollworms in cotton

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Abstract
Bio efficacy studies were carried out at All India Co-ordinated Research Project on cotton KVK, Chamarajanagar UAS, Bengaluru, during 2017-18 for sucking pests and bollworms with new insecticide molecules. Totally three sprays were taken at different intervals. The sucking pests population was observed at pre and seven days after every spray. The mean of three sprays indicated that, spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha recorded lower number of aphids (12.80 /3 leaves), leafhoppers (1.02/3 leaves), thrips (5.67/3 leaves) and whiteflies (1.00/3 leaves). Significantly less incidence of *Helicoverpa armigera* (1.20 larvae/plant) and *Pectinophora gossypiella* (1.92 larvae/10 bolls) were recorded in spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha with maximum seed cotton yield (17.60 q/ha).

Keywords: Cotton, insecticides, sucking pests, bollworms

Introduction
Cotton (*Gossypium hirsutum* L.), the "white gold" is an important commercial and industrial crop unanimously designated as 'king of fibre". The major factor responsible for the low productivity and quality deterioration of cotton is the severe attack of insects/pests from sowing to harvesting. Large area under rainfed situation and extensive replacement of conventional varieties with superior hybrids made the crop easily vulnerable to insect pests. In India cotton crop known to attacked by 162 species of insects pests from sowing to harvesting and which causes loss up to 50-60 per cent (Agarwal *et al.*, 1984) [1]. Cotton pests can primarily divided into bollworms and sucking pests. Among the sucking pests, aphids, *Aphis gossypii* (Glover), leafhoppers, *Amrasca biguttula biguttula* (Ishida), thrips, *Thrips tabaci* (Lind.) and whiteflies, *Bemisia tabaci* (Genn.) are of major importance. These sucking pests occurs at all the stages of crop growth and responsible for indirect yield losses. A reduction of 22.85 per cent in seed cotton yield due o sucking pests has been reported by Satpute *et al*., 1990). Sucking pests also referred to as "sap feeders", limit the realization of the potential productivity of cotton, they are deleterious to the cotton plant growth and development by being assimilated sappers, stand reducers and light stealers. The heavy infestation of nymphs and adults of sucking pests resulted in leaf yellowing, wrinkled leaves and leaf distortion. They also secrets the honey dew which leads to the growth and development of shooty mould fungus (*Capnodium sp*.) on leaves. The fungus inhibits the photosynthetic activity of the plants resulting into chlorosis that affect the seed cotton yield. Moreover, whitefly also act as a vector to transmit leaf curl dieses in cotton. Keeping these points in view it was tried to find out the effective chemicals for the management of sucking pests and bollworms

Material and Methods
Field experiment was conducted at All India Co-ordinated Research Project on cotton KVK, Chamarajanagar during *Kharief* 2017-18 in Randomized Block Design (RCBD) with 11 treatments which were replicated in thrice using Suraj cotton variety (non *Bt*) in a plot size of 4.5m x 3.6 m for each treatment. The crop was raised with a spacing of 90 x 60 cm by following all recommended package of practices of University of Agricultural Sciences, Bangalore except (Anonymous,2014) [3] plant protection measures. New molecules of insecticides were evaluated for bio-efficacy against sucking pests and bollworms in cotton. The sprays interventions were made on the ETL of sucking pests for three times at 45, 60 and 75 days after sowing by using manual hand operated knapsack spray. Five plants per

replication were selected randomly and tagged. The number of aphids, leafhoppers, thrips and whiteflies were counted on top growing (3, 5 and 7 leaf on the main stem from top) three leaves from each plant. Population count was made one day before spray and 7 days after 1st, 2nd and 3rd sprays respectively. The mean population per leaf per plant was estimated and subjected to statistical analysis The mean population per leaf per plant was estimated and subjected to statistical analysis, ANOVA test [6]. With respect to *Helicoverpa armigera* (Hubner) number of larvae were counted on five randomly selected plants and converted to larvae per plant. Whereas, observation on pink bollworm *Pectinophora gossypiella* (Saunders) was recorded by collecting ten bolls from each randomly selected plant and later converted to larvae per ten bolls.

Table 1: Treatment details

Sl. No.	Insecticide Treatments	Dosage (*g ai.*,/ha)	Formulation (ml or g/ha)
T1	Spinetoram 10% + Sulfoxaflor40% WG	120	300
T2	Spinetoram10% + Sulfoxaflor40% WG	140	350
T3	Spinetoram 12% SC	30	250
T4	Sulfoxaflor 24% SC	90	375
T5	Spinetoram 12% SC	35	291.60
T6	Sulfoxaflor 24% SC	105	437.5
T7	Pyriproxyfen 5% EC + Fenpropathrin 15% EC	37.5 +112.5	750
T8	Pyriproxyfen 5% EC	37.5	750
T9	Fenpropathrin 15% EC	112.5	750
T10	Control (unsprayed)	--	--
T11	Control (water spray)	--	--

Results

Aphid population a day before spray during the first treatment imposition ranged from 75.33 to 79.40 per three leaves and there was no significant difference among different treatments. Lowest population of aphids after seven days of spray was noticed in spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha (29.07 per three leaves) and found superior followed by its lower dosage treatment. Chemical treatments Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha, sulfoxaflor 24%SC @ 437.5 ml/ha, sulfoxaflor 24%SC @ 375 ml/ha recorded 40.33, 47.20, 47.27 aphids per three leaves respectively and were on par with each other. Similar trend was noticed in second and third spray. The mean of three sprays indicated that the lowest number of aphid population (12.80/3 leaves) was recorded in the spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha followed by its lower dosage treatment as compare to control. Per cent reduction of aphid population over control was also calculated and the results indicated that highest per cent reduction over control (79.83%) was recorded in the treatment where pest population was reduced significantly *ie.*, spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha spray (Table 2).

Leafhoppers population a day before spray at the time of first treatment imposition ranged from 6.00 to 7.00 leaf hoppers per three leaves and there was no significant difference between the treatments. Lowest leafhoppers population after seven days of spray was noticed in Spinetoram 10%+ Sulfoxaflor 40%WG @ 350 g/ha (1.43 per three leaves) followed by its next lower dose and Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha, Sulfoxaflor 24%SC @ 437.5 ml /ha, Sulfoxaflor 24%SC @ 375 ml/ha. Similar trend was noticed in second and third spray (Table 3). The mean of three sprays indicated that the lowest number of Leafhoppers population (1.02/3 leaves) was recorded in the spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha followed by its lower dosage treatment as compare to control. When Percent reduction of leafhoppers over control was considered, highest percent reduction over control (84.37%) was recorded in the treatment spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha spray.

Thrips population was non significant before imposition of first treatment. Significantly lesser population of thrips was recorded in treatment Spinetoram 10%+ Sulfoxaflor 40%WG @ 350 g/ha (12.20 per three leaves) followed by its next lower dose and Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha, Sulfoxaflor 24%SC @ 437.5 ml /ha, Sulfoxaflor 24%SC @ 375 ml/ha. Similar trend was noticed in second and third spray (Table 4). To know the trends in thrips reduction over three sprays, mean was calculated. The mean results indicated that spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha spray recorded lowest thrips population over all sprays (5.67/3 leaves) followed by its lower dosage treatment as compare to control. When Percent reduction of thrips over control was considered, highest percent reduction over control (73.99%) was recorded in the treatment spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha spray.

Similar trend was noticed with respective whitefly population also. Wherein, non significant population was recorded before imposition of first treatment and significantly lesser population of whitefly was recorded in treatment Spinetoram 10%+ Sulfoxaflor 40%WG @ 350 g/ha (1.80 per three leaves) followed by its next lower dose and Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha, Sulfoxaflor 24%SC @ 437.5 ml /ha, Sulfoxaflor 24%SC @ 375 ml/ha. Similar trend was noticed in second and third sprays also. The mean whitefly population of all three sprays indicated that minimum number (1.0/3 leaves) of whiteflies recorded in Spinetoram 10%+ Sulfoxaflor 40%WG @ 350 g/ha spray. Same treatment exhibited highest per cent reduction of whiteflies (79.16%) population (Table 5).

The population of bollworm a day before spray ranged from 1.97 to 2.06 larvae /plant in *H. armigera* and 3.65 to 3.80 larvae/10 bolls in *P. gossypiella* and there was no significant difference among the treatments. Seven days after spray, lowest population of *H. armigera* (1.20 larvae/plant) and pink boll worm (1.92 larvae/ 10 bolls) was observed in spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha and was on par with next lower dosage treatment of spinetoram 10%+ sulfoxaflor 40%WG @ 300 g/ha.

Seed Cotton Yield

The data on seed cotton yield revealed that all the chemical treatments were significantly superior over control. Among the treatments, maximum seed cotton yield of 17.60 q/ha was recorded in the treatment of spinetoram 10%+ sulfoxaflor

40%WG @ 350 g/ha followed by spinetoram 10%+ sulfoxaflor 40%WG @ 300 g/ha (16.53 q/ha).

Discussion

Sucking pests are the major threats in cotton production. For the management of sucking pests *viz.*, aphids, leafhoppers,thrips and whiteflies application of spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha found best which had recorded lower number of these pests.(12.80,1.02,5.67 and 1.00/3 leaves, respectively). The same combination insecticide also recorded lower number of *H.armigera* larvae (1.20 larvae/plant) and *P. gossypiella* (1.92 larvae/ 10 bolls).Hence the insecticide molecule of spinetoram 10%+ sulfoxaflor 40%WG @ 350 g/ha found promising for the management of sucking pests and bollworms in cotton than other insecticide molecules tested. Similar studies also shows that Sulfoxaflor, a group that has not previously been associated with crop protection chemistries. It exhibits a mode of action that is unique among all other insecticides as it kills target pests by interacting with the insects nicotinic acetylcholine receptors in a manner which is contrasted to that of neonicotinoid insecticides (Babcock *et al.,* 2011) [4]. The perusal of literature revealed that there is scanty of work on this aspect. However the present results are in accordance with the findings of Melissa *et al.,* 2012 [8] who reported that application of sulfoxaflor @ 50 g.ai/ha proved good in control of Tarnished plant bug (Hemiptera: Miridae) in cotton and got equal yield levels as that of acephate application. Jonathan *et al.,* 2011[7] reported that sulfoxaflor @ 50 g.ai/ha gave good control of sweet potato whitefly equivalent to that of acetameprid (75 g ai./ha) and imidaclopride (50 g ai/ha) and better than that of thiomethoxam (50 g ai/ha).Sulfoxaflor is the xylem mobile and is especially effective in controlling wide variety of sap feeding insects by contact and also by injection (Andre A.,2013) [2]. Bhanu *et al.*,2015 [5] reported that Sulfoxaflor 24 SC at both the dosages *viz.*, 75 and 90 g ai/ha reduced the build-up of rice plant hoppers in both the seasons and was superior to other insecticides with mean percent reduction of 88.0 and 85.7, respectively during *Kharief* 2011 and 74.3 and 84.4, respectively during Rabi 2011-12, over the untreated control(Melissa *et al.,* 2012) [8]

Table 2: Efficacy of different insecticides against Aphids on cotton.

Treatments	Formulation (ml or g/ha)	Aphids population per three leaves								% reduction of pest over control
		First spray		Second spray		Third spray		Mean		
		Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	
Spinetoram 10% + Sulfoxaflor40% WG	300	78.60 (8.92)	35.20 (6.01)	40.13 (6.41)	8.20 (2.93)	10.40 (3.37)	3.20 (2.04)	43.04	15.53	75.53
Spinetoram10% + Sulfoxaflor40% WG	350	78.47 (8.91)	29.07 (5.42)	25.27 (5.06)	6.93 (2.74)	8.40 (3.06)	2.40 (1.84)	37.38	12.80	79.83
Spinetoram 12% SC	250	78.33 (8.90)	59.80 (7.79)	60.20 (7.82)	34.13 (5.92)	36.00 (6.08)	10.80 (3.42)	58.18	34.91	45.01
Sulfoxaflor 24% SC	375	77.87 (8.88)	47.27 (6.94)	52.13 (7.28)	14.60 (3.94)	16.33 (4.15)	5.33 (2.51)	48.78	23.31	63.28
Spinetoram 12% SC	291.60	79.40 (8.96)	56.80 (7.59)	59.13 (7.75)	32.60 (5.79)	34.20 (5.93)	9.20 (3.18)	57.58	32.87	48.22
Sulfoxaflor 24% SC	437.5	78.93 (8.93)	47.20 (6.94)	45.20 (6.79)	14.20 (3.88)	17.20 (4.26)	5.20 (2.48)	47.11	22.22	65.00
Pyriproxyfen 5% EC + Fenpropathrin 15% EC	750	75.33 (8.72)	40.33 (6.37)	59.40 (7.77)	11.20 (3.47)	14.47 (3.91)	4.60 (2.37)	49.73	18.71	70.53
Pyriproxyfen 5% EC	750	78.87 (8.92)	50.00 (7.14)	50.27 (7.15)	33.27 (5.83)	34.93 (5.99)	7.40 (2.89)	54.69	29.29	53.87
Fenpropathrin 15% EC	750	75.67 (8.74)	52.13 (7.28)	55.27 (7.48)	34.27 (5.92)	37.20 (6.17)	8.07 (3.00)	56.05	31.49	50.40
Control (unsprayed)	--	78.33 (8.90)	71.80 (8.52)	70.20 (8.43)	66.47 (8.21)	56.00 (7.54)	52.20 (7.29)	68.18	63.49	-
Control (water spray)	--	79.13 (8.93)	77.53 (8.85)	75.33 (8.71)	66.73 (8.22)	58.20 (7.69)	54.13 (7.42)	70.89	66.13	-
S.EM		0.29	0.35	0.32	0.33	0.22	0.17			
CD (P=0.05)		NS	1.02	0.95	0.98	0.65	0.49			
CV%		5.66	8.35	7.61	11.09	7.18	8.25			

DAS: Days After Spray

Figures in the Parentheses indicates √x+0.5 transformed values

Table 3: Efficacy of different insecticides against Leaf hoppers on cotton

Treatments	Formulation (ml or g/ha)	Population of Leaf hoppers per three leaves								% reduction of pest over control
		First spray		Second spray		Third spray		Mean		
		Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	
Spinetoram 10% + Sulfoxaflor40% WG	300	6.27 (2.69)	1.57 (1.60)	3.13 (2.02)	1.20 (1.48)	2.60 (1.90)	0.76 (1.33)	4.00	1.18	81.92
Spinetoram10% + Sulfoxaflor40% WG	350	6.80 (2.79)	1.43 (1.56)	2.87 (1.96)	1.00 (1.41)	2.20 (1.78)	0.64 (1.28)	3.96	1.02	84.37
Spinetoram 12% SC	250	7.00 (2.82)	3.80 (2.19)	5.60 (2.56)	2.90 (1.97)	5.13 (2.47)	1.62 (1.62)	5.91	2.77	57.58
Sulfoxaflor 24% SC	375	6.50 (2.74)	2.08 (1.75)	4.60 (2.35)	2.20 (1.79)	4.10 (2.25)	1.30 (1.52)	5.07	1.86	71.51
Spinetoram 12% SC	291.60	6.60 (2.76)	3.20 (2.05)	5.20 (2.49)	2.80 (1.95)	4.80 (2.41)	1.50 (1.58)	5.53	2.50	61.71
Sulfoxaflor 24% SC	437.5	6.30 (2.70)	1.90 (1.69)	4.40 (2.31)	1.80 (1.67)	3.80 (2.19)	1.20 (1.48)	4.83	1.63	75.03
Pyriproxyfen 5% EC + Fenpropathrin 15% EC	750	6.20 (2.68)	1.62 (1.62)	4.20 (2.28)	1.60 (1.61)	3.70 (2.16)	0.98 (1.41)	4.70	1.40	78.56
Pyriproxyfen 5% EC	750	6.70 (2.77)	2.50 (1.87)	4.80 (2.40)	2.50 (1.85)	4.20 (2.27)	1.36 (1.53)	5.23	2.12	67.53
Fenpropathrin 15% EC	750	6.90 (2.81)	2.80 (1.95)	5.00 (2.44)	2.70 (1.92)	4.50 (2.34)	1.42 (1.55)	5.47	2.31	64.62
Control (unsprayed)	--	6.00 (2.64)	6.20 (2.68)	6.20 (2.68)	6.20 (2.68)	6.30 (2.70)	7.20 (2.86)	6.17	6.53	-
Control (water spray)	--	6.30 (2.70)	6.00 (2.64)	6.40 (2.72)	6.00 (2.64)	6.50 (2.73)	6.80 (2.79)	6.40	6.27	-
S.EM		0.08	0.08	0.13	0.11	0.11	0.07			
CD (P=0.05)		NS	0.24	0.38	0.32	0.33	0.22			
CV%		5.15	7.10	9.29	9.78	8.34	7.50			

DAS: Days After Spray
Figures in the Parentheses indicates √x+0.5 transformed values

Table 4: Efficacy of different insecticides against Thrips on cotton

Treatments	Formulation (ml or g/ha)	Population of Thrips per three leaves								% reduction of pest over control
		First spray		Second spray		Third spray		Mean		
		Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	
Spinetoram 10% + Sulfoxaflor40% WG	300	26.27 (5.22)	13.27 (3.77)	16.23 (4.13)	4.20 (2.27)	4.80 (2.41)	1.80 (1.67)	15.77	6.42	70.55
Spinetoram10% + Sulfoxaflor40% WG	350	26.00 (5.19)	12.20 (3.62)	14.40 (3.92)	3.40 (2.09)	4.20 (2.27)	1.40 (1.54)	14.87	5.67	73.99
Spinetoram 12% SC	250	28.40 (5.42)	18.33 (4.39)	22.20 (4.81)	8.27 (3.03)	8.50 (3.08)	4.50 (2.34)	19.70	10.37	52.43
Sulfoxaflor 24% SC	375	26.60 (5.25)	16.23 (4.15)	19.20 (4.49)	6.53 (2.73)	7.27 (2.87)	2.80 (1.95)	17.69	8.52	60.91
Spinetoram 12% SC	291.60	25.27 (5.12)	17.33 (4.26)	21.20 (4.71)	8.00 (2.99)	8.23 (3.03)	4.10 (2.25)	18.23	9.81	55.00
Sulfoxaflor 24% SC	437.5	24.73 (5.06)	15.20 (4.02)	18.10 (4.37)	6.23 (2.69)	6.60 (2.75)	2.40 (1.84)	16.48	7.94	63.57
Pyriproxyfen 5% EC + Fenpropathrin 15% EC	750	24.33 (5.03)	14.20 (3.89)	17.13 (4.25)	5.40 (2.53)	6.20 (2.68)	2.10 (1.75)	15.89	7.23	66.83
Pyriproxyfen 5% EC	750	27.07 (5.29)	17.20 (4.26)	20.00 (4.58)	7.13 (2.84)	7.30 (2.87)	3.30 (2.07)	18.12	9.21	57.75
Fenpropathrin 15% EC	750	26.87 (5.27)	17.40 (4.28)	20.60 (4.63)	7.80 (2.95)	7.80 (2.96)	3.80 (2.18)	18.42	9.67	55.64
Control (unsprayed)	--	26.60 (5.25)	24.20 (5.02)	25.07 (5.10)	25.87 (5.18)	22.40 (4.83)	15.33 (4.04)	24.69	21.80	-
Control (water spray)	--	25.73 (5.16)	23.67 (4.96)	24.27 (5.02)	24.33 (5.02)	21.60 (4.75)	14.73 (3.96)	23.87	20.91	-
S.EM		0.17	0.17	0.18	0.17	0.13	0.11			
CD (P=0.05)		NS	0.51	0.54	0.51	0.38	0.33			
CV%		5.74	7.12	7.03	9.62	7.08	8.33			

DAS: Days After Spray
Figures in the Parentheses indicates √x+0.5 transformed values

Table 5: Efficacy of different insecticides against Whiteflies on cotton

Treatments	Formulation (ml or g/ha)	Population of Whiteflies per three leaves								% reduction of pest over control
		First spray		Second spray		Third spray		Mean		
		Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	Pre treatment	Post (7DAS)	
Spinetoram 10% + Sulfoxaflor40% WG	300	5.27 (2.50)	2.10 (1.76)	2.50 (1.87)	0.90 (1.38)	1.20 (1.48)	0.48 (1.21)	2.99	1.16	75.83
Spinetoram10% + Sulfoxaflor40% WG	350	5.20 (2.49)	1.80 (1.67)	2.30 (1.81)	0.80 (1.34)	1.10 (1.45)	0.41 (1.19)	2.87	1.00	79.16
Spinetoram 12% SC	250	4.20 (2.27)	3.17 (2.04)	3.27 (2.06)	1.38 (1.54)	2.00 (1.73)	1.10 (1.44)	3.16	1.88	60.83
Sulfoxaflor 24% SC	375	4.60 (2.36)	2.60 (1.89)	2.77 (1.94)	1.31 (1.52)	1.62 (1.62)	0.62 (1.27)	3.00	1.51	68.54
Spinetoram 12% SC	291.60	4.80 (2.40)	3.07 (2.01)	3.47 (2.11)	1.60 (1.61)	1.98 (1.73)	0.90 (1.38)	3.42	1.86	61.25
Sulfoxaflor 24% SC	437.5	4.00 (2.23)	2.40 (1.84)	2.70 (1.92)	1.10 (1.45)	1.50 (1.58)	0.58 (1.26)	2.73	1.36	71.66
Pyriproxyfen 5% EC + Fenpropathrin 15% EC	750	3.93 (2.21)	2.20 (1.79)	2.60 (1.90)	1.04 (1.43)	1.42 (1.55)	0.53 (1.24)	2.65	1.26	73.75
Pyriproxyfen 5% EC	750	4.27 (2.29)	2.80 (1.95)	3.00 (1.99)	1.40 (1.55)	1.80 (1.67)	0.72 (1.31)	3.02	1.64	65.83
Fenpropathrin 15% EC	750	4.37 (2.31)	2.97 (1.98)	3.20 (2.05)	1.52 (1.59)	1.92 (1.71)	0.84 (1.36)	3.16	1.78	62.91
Control (unsprayed)	--	5.07 (2.46)	5.17 (2.48)	5.27 (2.50)	4.83 (2.41)	5.20 (2.49)	4.40 (2.32)	5.18	4.80	-
Control (water spray)	--	4.40 (2.32)	4.90 (2.43)	5.10 (2.47)	4.80 (2.40)	4.93 (2.43)	4.20 (2.27)	4.81	4.63	-
S.EM		0.10	0.09	0.09	0.06	0.07	0.06			
CD (P=0.05)		NS	0.25	0.25	0.17	0.22	0.17			
CV%		7.59	7.47	7.20	6.18	7.33	6.93			

DAS: Days After Spray
Figures in the Parentheses indicates √x+0.5 transformed values

Table 6: Efficacy of different insecticides against bollworms and yields of cotton

Treatments	Formulation (ml or g/ha)	*H.armigera* (Larva/plant)		*P. gossypiella* (larvae/10bolls)		Yield (q/ha)
		1 DBS	7 DAS	1 DBS	7 DAS	
Spinetoram 10% + Sulfoxaflor40% WG	300	2.01	1.23	3.75	2.02	16.53 (4.18)
Spinetora)m10% + Sulfoxaflor40% WG	350	1.99	1.20	3.72	1.92	17.60 (4.31)
Spinetoram 12% SC	250	2.04	1.36	3.65	2.27	13.00 (3.74)
Sulfoxaflor 24% SC	375	2.02	1.57	3.80	2.68	15.23 (4.02)
Spinetoram 12% SC	291.60	2.03	1.30	3.78	2.13	14.15 (3.88)
Sulfoxaflor 24% SC	437.5	1.98	1.55	3.76	2.53	15.50 (4.06)
Pyriproxyfen 5% EC + Fenpropathrin 15% EC	750	2.03	1.37	3.80	2.36	16.36 (4.17)
Pyriproxyfen 5% EC	750	2.02	1.52	3.72	2.48	15.03 (4.00)
Fenpropathrin 15% EC	750	2.06	1.50	3.80	2.40	14.77 (3.97)
Control (unsprayed)	--	1.97	1.97	3.73	3.85	12.03 (3.61)
Control (water spray)	--	2.01	2.00	3.78	3.80	12.20 (3.63)
S.EM		0.07	0.06	0.16	0.19	0.15
CD (P=0.05)		NS	0.18	NS	0.55	0.43
CV%		6.23	7.15	7.58	12.43	6.37

DBS - Days Before Spray; DAS - Days After Spray
Figures in the Parentheses indicates √x+0.5 transformed values

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