RESEARCH ARTICLE

Management of sucking pests in rabi/summer groundnut using newer molecule insecticides

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ABSTRACT

The field experiments were conducted at Regional Research Station, Vriddhachalam, during *rabi*/summer season for three consecutive years from 2012 to 2015 to test the efficacy of newer molecules insecticides against sucking insect pests thrips and leafhopper in groundnut. Among the seven newer molecule insecticides tested, imidacloprid 200SL @ 200 ml ha^{-1} was found to be effective in reducing thrips damage (16%) followed by thiamethoxam 25WG @ 200gm ha^{-1} (18%) as against 33% in control. Imidacloprid 200SL and acetamiprid 20%SP@ 100 gm ha^{-1} registered less incidence of leafhopper (15%) compared to control (32%). Therefore, acetamiprid 20%SP @ 100 gm ha^{-1}, thiamethoxam 25WG @100 gm.ha^{-1} gm/ha and imidacloprid 200SL @ 200 ml. ha^{-1} were found to be effective against thrips, leafhopper population and its damage. These three molecules realized more dry pod (2274 kg/ha^{-1}, 2013 kg ha^{-1}, 2100 kg ha^{-1}) and haulm yield (8.2 t ha^{-1}, 7.6 t ha^{-1}, 7.8 t ha^{-1}) and ultimately the benefit cost ratio of 1:2.8; 1:2.4 and 1:2.5 respectively. However, imidacloprid 200SL and thiamethoxam 25WG 200 ml ha^{-1} recorded more number of predatory coccinellids (0.51 and 0.40 plant^{-1}), spider (0.27 and 0.24 plant^{-1}), spider egg mass (0.10 and 0.12 plant^{-1}). Thus, the use of imdiacloprid 200SL or thiamethoxam 25WG individually or incorporation of these chemicals in an integrated pest management programme for sucking pests on groundnut may prove as economically viable with less effect on natural enemies in groundnut eco-system during *rabi*/summer seasons.

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the major oilseed crops cultivated in about eight million hectares, with an annual production of over nine million tonnes of pods, contributing 45% of oilseed production in India. In India, which is mainly grown in the southern and north–western states, Gujrat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharastra, and Madhya Pradesh, together occupying about 90 percent of the groundnut area in the country. Insect pest menace is one of the few essential biotic stresses contributing towards lower yield. Sucking pests are the major biotic constraints in groundnut production. The major sucking insect pests of groundnut comprise of thrips (*Frankliniella hultzeri* Trybom, *Thrips palmi* Karny and *Scirtothrips dorsalis* Hood), leafhopper (*Empoasca kerri* Pruthi) (David and Ramamurthy, 2011). Thrips are the important sucking pests that live in the flowers and folded leaflets of groundnut known to cause yield loss and also responsible for spreading bud necrosis, a viral disease in groundnut. Leafhoppers suck the sap from the leaves and petioles and mainly prefer the first three-terminal leaves and feeding symptoms induce the yellowing of foliage that begins at the tip, known as hopper burn (Khan and Hussain, 1965). A heavy infestation of sucking pests on young plants results in considerable damage both by direct injury and by the transmission of diseases such as bud necrosis and rosette. Thrips and jassids are considered as important destructive pests on this crop during *rabi*/summer season. Keeping this in view, a study was undertaken to test the effectiveness of some newer molecule insecticides against these pests in groundnut.

MATERIAL AND METHODS

The field experiments were carried out during *rabi*/summer seasons of 2012-13, 2013-14, 2014-15 at Regional Research Station, Vriddhachalam (11°30' 0.00" N; 79° 19'48.00" E) using the popular groundnut variety VRI 2. The crop was sown at the spacing of 30 cm x 10 cm. All the recommended package of practices was followed

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except the plant protection measures. Treatments are acephate 75% SP @ 1.30 kg ha^{-1}, acetamiprid 20%SP 100 gm ha^{-1}, fipronyl 5%SC 100 gm ha^{-1}, imidacloprid 200SL @ 200 ml ha^{-1}, thiamethoxam 25WG @ 200 gm ha^{-1}, thiochloprid 480SC @ 200 ml ha^{-1}, triazophos 25EC @ 2 lit ha^{-1}, and control. The treatments were tested in a randomized Block Design with three replications. The treatments were imposed whenever the population of thrips and leafhopper appeared or on 30 day after sowing (DAS), whichever is earlier. Spraying was applied with the help of a manually operated knapsack sprayer. Thrips and leafhopper population was recorded before 24 hours and 7 and 15 days after spraying (DAS). Observations on the number of thrips/3 terminal leaves/plant and a number of hoppers/leaves/plant were made on top, middle and bottom leaves of 10 randomly selected plants from each replication. Natural enemies like coccinellids, spiders population and its egg mass were also recorded. While harvesting, pod and haulm yield were recorded to work out the cost-benefit ratio. Data were statistically analyzed using OPSTAT (Sheoran *et al.*, 1998).

RESULTS AND DISCUSSION

The reduction of sucking pests such as thrips and leafhopper population and their damage percent by the different newer molecule insecticides imposed on groundnut is given in Tables 1 and 2.

Table 1.Effect of newer molecules against thrips in groundnut during rabi/Summer seasons (2012-2015)

Treatment	Doseha^{-1}	No. of thrips/3 terminal leaves/plant									Thrips damage (%)								
		2012-2013			2013-2014			2014-2015			2012-2013			2013-2014			2014-2015		
		PTC	7DAS	15DAS	PTC	7DAS	15DAS	PTC	7DAS	15DAS	PTC	7DAS	15DAS	PTC	7DAS	15DAS	PTC	7DAS	15DAS
T1-Acephate 75SP	1.30 kg	5.7 (2.4)	4.2 (2.0)	4.3 (2.1)	3.5 (2.1)	2.2 (1.7)	2.5 (1.8)	8.2 (3.03)	4.5 (2.3)	4.5 (2.3)	30.0 (35.2)	27.0 (31.3)	29.0 (32.5)	22.0 (27.3)	12.0 (20.2)	10.0 (17.8)	18.0 (25.1)	10.0 (18.4)	11.0 (19.3)
T2-Acetamiprid 20%SP	100 gm	5.7 (2.4)	4.5 (2.1)	4.5 (2.1)	3.7 (2.1)	2.8 (1.9)	3.0 (1.9)	7.5 (2.9)	4.0 (2.2)	5.8 (2.6)	30.0 (35.2)	28.0 (31.9)	29.0 (32.5)	22.0 (27.9)	15.0 (22.7)	13.0 (21.1)	15.0 (22.7)	12.0 (20.2)	12.0 (20.2)
T3-Fipronyl5% SC	100 gm	5.7 (2.4)	4.5 (2.1)	4.6 (2.1)	4.8 (2.4)	3.2 (2.0)	3.5 (2.0)	8.0 (3.0)	5.2 (2.5)	6.5 (2.7)	32.0 (35.9)	30.0l (33.2)	31.0 (33.8)	26.0 (30.6)	18.0 (25.0)	14.0 (21.9)	18.0 (25.1)	16.0 (23.5)	18.0 (25.1)
T4-Imidacloprid 200SL	200 ml	5.7 (2.4)	4.3 (2.1)	4.3 (2.1)	4.6 (2.4)	2.5 (1.8)	3.2 (2.0)	7.5 (2.8)	3.2 (2.0)	3.8 (2.2)	34.0 (36.6)	27.0 (31.3)	29.0 (32.5)	22.0 (27.9)	12.0 (20.2)	12.0 (20.2)	15.0 (22.7)	8.0 (16.4)	8.0 (16.4)
T5-Thiamethoxam 25WG	200gm	5.7 (2.4)	4.3 (2.1)	4.4 (2.1)	5.2 (2.4)	3.0 (1.9)	3.0 (1.9)	8.0 (3.0)	3.8 (2.2)	4.2 (2.2)	34.0 (36.6)	31.0 (33.8)	30.0 (33.2)	20.0 (26.5)	12.0 (20.2)	12.0 (20.2)	16.0 (23.5)	12.0 (20.2)	13.0 (21.1)
T6-Thiochloprid 480SC	200 ml	5.6 (2.4)	4.5 (2.1)	4.5 (2.1)	5.0 (2.4)	3.2 (2.0)	3.2 (2.0)	8.2 (3.0)	4.0 (2.2)	5.2 (2.4)	32.0 (35.9)	30.0 (33.2)	31.0 (33.8)	20.0 (26.5)	14.0 (21.9)	14.0 (21.9)	16.0 (23.5)	12.0 (20.2)	13.0 (21.1)
T7-Triazophos 25EC	2.0 lit	5.6 (2.4)	4.5 (2.1)	4.4 (2.1)	5.5 (2.5)	4.0 (2.2)	4.2 (2.2)	8.5 (3.0)	4.8 (2.4)	5.0 (2.4)	31.0 (35.5)	29.0 (32.6)	33.0 (35.1)	20.0 (26.5)	14.0 (21.9)	15.0 (22.7)	15.0 (22.7)	13.0 (21.1)	20.0 (25.8)
T8-Control	-	5.7 (2.4)	6.8 (2.6)	7.1 (2.6)	5.8 (2.5)	9.0 (3.1)	12.5 (3.6)	8.2 (3.0)	12.0 (3.6)	16.5 (4.2)	36.0 (37.4)	38.0 (38.0)	40.0 (39.2)	28.0 (31.9)	32.0 (34.3)	35.0 (36.2)	18.0 (24.7)	22.0 (27.9)	25.0 (29.9)
CV	-	5.41	2.62	3.43	N/A	0.13	0.13	0.001	0.108	0.17	4.85	6.11	5.19	3.97	3.60	2.43	N/A	0.95	3.89
SE(m)	-	-	-	-	0.14	0.04	0.04	0.001	0.036	0.05	-	-	-	1.33	1.20	0.81	0.83	0.32	1.30
SEd	-	0.25	0.04	0.06	0.20	0.06	0.06	0.001	0.051	0.08	1.27	1.5	1.34	1.87	1.70	1.15	1.18	0.45	1.84
CD(0.05)	-	0.52	0.09	0.12	10.5	3.68	3.56	0.03	2.55	3.73	2.68	3.16	2.82	8.00	8.80	6.13	6.02	2.56	9.7

Values are mean of three replication of each treatment. Values in the paranthesis are square root transformed values for population and arcsine transformed values for percent damage. PTC- Pre treatment count, DAS-Days after spraying

The reduction in sucking pest population took place after imposing different newer molecule insecticides.

Thrips

Three years data indicated that significantly lower thrips population was recorded in all the treatments than in control (Table 1). However, significant reduction in thrips population (4.2/3 terminal leaves/plant) was noticed in acephate 75% SP @ 1.3 kg ha^{-1}a and it was at par with all other newer molecules when compared to control (6.8/3 terminal leaves/plant) on 7th DAS. The effect of the newer molecules insecticides on the thrips population was stable till 15th DAS during *rabi*/summer 2012-13. A similar trend was observed for *rabi*/summer 2013-14, where the thrips population (2.2 and 2.5/3 terminal leaves/plant) observed in acephate treated plots on 7th and 15th DAS respectively, was significant than in other treatments. Whereas during *rabi*/summer 2014-15 imidacloprid recorded significantly less thrips population 3.2 and 3.8/3 terminal leaves/plant on 7th and 15th DAS followed by thiomethoxam (3.8 and 4.2/3 terminal leaves/plant) and acephate (4.5 and 4.5/3 terminal leaves/plant). Zadda *et al.*,(2015) reported that imidacloprid was effective in reducing the thrips population in rainfed groundnut crop.

With respect to thrips damage percent, significantly less damage was recorded in acephate, acetamiprid, imidacloprid (29%) followed by thiomehoxam (30%) during *rabi*/summer 2012-13 (Table 1). During 2013-14 also acephate recorded significantly less damage (10%) followed by imdacloprid and thiomethoxam (12%). When compared to previous two years *rabi*/summer season over all thrips damage was less during 2014-15, yet imidacloprid recorded significantly low damage (8%), followed by acephate (11%), acetamiprid (12%), thiamethoxam and thiocloprid (13%) on 15th DAS (Table 1).

Results of the present study were in agreement with the earlier findings of Nataraja *et al.*, 2013;

Table 2.Effect of newer molecules against jassids in groundnut during rabi/Summer seasons (2012-2015)

Treatment	Dose ha^{-1}	No. of jassids/3 terminal leaves /plant									Leafhopper damage (%)								
		2012-2013			2013-14			2014-2015			2012-2013			2013-14			2014-2015		
		PTC	7 DAS	15 DAS	PTC	7 DAS	15 DAS	PTC	7 DAS	15 DAS	PTC	7 DAS	15 DAS	PTC	7 DAS	15 DAS	PTC	7 DAS	15 DAS
T1-Acephate 75%SP	1.30 kg	7.0 (2.6)	5.6 (2.4)	5.6 (2.4)	6.5 (2.7)	3.5 (10.4)	3.5 (10.4)	6.5 (14.6)	3.2 (9.9)	3.5 (10.4)	28.0 (31.9)	25.0 (31.3)	25.0 (30.0)	22.0 (27.3)	16.0 (23.3)	18.0 (24.9)	15.0 (22.5)	10.0 (18.3)	10.5 (18.8)
T2-Acetamiprid 20%SP	100 gm	7.2 (2.6)	4.8 (2.2)	5.3 (2.3)	6.5 (2.7)	3.2 (9.9)	2.8 (9.13)	4.5 (12.0)	2.5 (8.4)	3.5 (10.4)	28.0 (31.9)	26.0 (28.6)	25.0 (30.0)	28.0 (31.8)	12.0 (19.9)	14.3 (21.9)	18.0 (25.1)	8.0 (16.3)	8.5 (16.8)
T3-Fipronyl 5% SC	100 gm	7.4 (2.7)	5.6 (2.4)	5.6 (2.4)	6.2 (2.6)	3.8 (10.9)	4.0 (11.2)	5.0 (12.7)	3.5 (10.4)	5.5 (13.4)	25.0 (30.0)	26.0 (28.6)	26.0 (30.6)	22.0 (27.8)	18.0 (24.9)	20.0 (26.4)	15.0 (22.7)	12.0 (20.2)	12.0 (20.2)
T4-Imidacloprid 200SL	200 ml	7.0 (2.6)	4.5 (2.1)	5.4 (2.3)	6.8 (2.7)	3.2 (9.9)	2.2 (7.6)	5.0 (12.7)	2.0 (6.5)	2.5 (8.4)	28.0 (31.9)	25.0 (30.0)	24.0 (29.3)	26.0 (30.5)	13.3 (21.3)	16.0 (23.3)	18.0 (25.1)	8.0 (16.3)	8.0 (16.3)
T5-Thiamethoxam 25WG	200gm	6.8 (2.6)	5.4 (2.3)	5.5 (2.3)	7.5 (2.9)	3.5 (10.4)	3.2 (9.9)	5.0 (12.7)	3.0 (9.5)	3.5 (10.4)	30.0 (33.2)	24.0 (29.3)	26.0 (31.9)	25.7 (30.1)	18.0 (24.9)	16.0 (23.3)	16.0 (23.5)	11.0 (19.3)	12.0 (20.2)
T6-Thiochlopríd 480SC	200 ml	6.7 (2.6)	5.7 (2.4)	5.6 (2.4)	7.0 (2.8)	4.0 (10.8)	3.2 (9.9)	5.0 (12.7)	3.5 (10.4)	3.8 (10.9)	28.0 (31.9)	27.0 (31.3)	28.0 (31.9)	26.0 (29.9)	20.0 (26.4)	18.0 (24.9)	18.0 (25.1)	12.0 (20.2)	12.0 (20.2)
T7-Triazophos 25EC	2.0 lit	7.0 (2.6)	5.9 (2.4)	5.8 (2.4)	7.2 (2.8)	4.0 (10.8)	3.8 (10.9)	5.0 (12.7)	4.0 (11.2)	4.5 (12.0)	27.0 (31.3)	26.0 (30.6)	27.0 (31.7)	28.0 (31.8)	22.0 (27.8)	22.0 (27.8)	16.0 (23.5)	15.0 (22.7)	16.0 (23.5)
T8-Control	-	7.2 (2.7)	8.2 (2.8)	10.3 (3.)	7.0 (2.7)	10.0 (18.2)	12.0 (20.2)	6.5 (14.6)	8.5 (16.8)	12.0 (20.2)	28.0 (31.9)	32.0 (34.4)	38.0 (38.0)	28.0 (31.3)	32.0 (34.4)	34.0 (35.6)	18.0 (25.1)	20.0 (26.5)	23.0 (28.6)
C.D.	-	0.11	0.09	0.12	N/A	1.28	1.27	0.31	1.84	1.11	2.99	2.37	2.51	N/A	1.73	4.38	1.39	0.39	0.52
SE(m)	-	-	-	-	0.08	0.43	0.43	0.10	0.62	0.37	-	-	-	1.86	0.57	1.46	0.46	0.13	0.17
SE(d)	-	0.05	0.04	0.05	0.12	0.60	0.60	0.15	0.87	0.53	1.42	1.12	1.19	2.63	0.81	2.07	0.65	0.18	0.25
C.V	-	2.62	2.35	3.15	5.14	6.40	6.60	1.35	9.84	5.25	6.29	5.36	5.3	10.81	3.95	9.73	3.32	1.11	1.44

Values are mean of three replication of each treatment. Values in the paranthesis are square root transformed values for population and arcsine transformed values for percent damage. PTC- Pre treatment count, DAS-Days after spraying

Zadda *et al*., 2015; Nigude *et al*., 2018. Nataraja *et al*., (2013) found that thiamethoxam 25WG was effective in reducing thrips population in groundnut. Khanpara and his co-workers (2016) reported that spray of imidacloprid 200 SL @ 125 ml/ha or thiamethoxam 25 WG @ 200 gm ha^{-1} or acephate 75 % SP @ 500 gm ha^{-1} at 15 days interval after initiation of pests were the most effective against thrips in groundnut. The effect of acephate 75% SP @ 1000 gm ha^{-1} on thrips population reduction was reported by Nigude *et al*., (2018).

Table 3. Natural enemies (Coccinellids; spider and its egg mass) population in newer molecules treated groundnut crop during rabi/summer 2012-15

Treatment	Doseha-1	Mean Coccinellids (no $plant^{-1}$)			Mean	Mean Spider (no $plant^{-1}$)			Mean	Mean Spider egg mass (no $plant^{-1}$)			Mean
		2012-13	2013-14	2014-15		2012-13	2013-14	2014-15		2012-13	2013-14	2014-15	
T1-Acephate 75%SP	1.30 kg	0.66	0.20	0.03	0.30 (1.13)	0.30	0.03	0.05	0.13 (1.06)	0.25	0.02	0.02	0.10 (1.05)
T2-Acetamiprid 20%SP	100 gm	0.46	0.27	0.04	0.26 (1.12)	0.50	0.03	0.03	0.19 (1.08)	0.21	0.03	0.03	0.09 (1.04)
T3-Fipronyl 5% SC	100 gm	0.61	0.33	0.03	0.32 (1.15)	0.36	0.03	0.05	0.15 (1.07)	0.21	0.01	0.04	0.09 (1.04)
T4-Imidacloprid 200SL	200 ml	0.95	0.53	0.06	0.51 (1.22	0.68	0.07	0.07	0.27 (1.12)	0.25	0.02	0.04	0.10 (1.05)
T5-Thiamethoxam 25WG	200gm	0.86	0.27	0.06	0.40 (1.17)	0.66	0.03	0.03	0.24 (1.11)	0.32	0.01	0.04	0.12 (1.06)
T6-Thiochloprid 480SC	200 ml	0.66	0.20	0.04	0.30 (1.13)	0.53	0.05	0.05	0.21 (1.09)	0.21	0.01	0.03	0.08 (1.04)
T7-Triazophos 25EC	2.0 lit	0.43	0.20	0.06	0.23 (1.11)	0.46	0.03	0.05	0.18 (1.08)	0.21	0.02	0.03	0.09 (1.04)
T8-Control	-	1.16	0.80	0.11	0.30 (1.28)	0.73	0.07	0.09	0.30 (1.13)	0.523	0.04	0.05	0.20 (1.09)
C.D.	-	0.02	0.02	0.01	0.08	0.020	0.00	0.05	N/A	0.018	0.00	0.09	N/A
SE(m)	-	0.01	0.01	0.00	0.03	0.007	0.00	0.02	0.017	0.006	0.00	0.03	0.013
SE(d)	-	0.01	0.01	0.00	0.04	0.010	0.00	0.03	0.025	0.009	0.00	0.04	0.018
C.V.	-	0.89	1.21	0.33	4.12	0.962	0.00	2.31	2.768	0.958	0.00	4.45	2.138

Values are mean of three replications of each treatment and mean of three time observation.

Leafhopper

Three years of data indicated that a significantly lesser population of leafhopper was recorded in all the treatments than in control after 7th and 15th DAS. However, the significantly low population of leafhopper 4.5, 3.2 and 2.0/ 3 terminal leaves/plant on 7th DAS and 5.4,2.2 and 2.5/ 3 terminal leaves/ plant on 15th DAS were recorded in imidacloprid 200SL @ 200 ml ha^{-1} treatment for all the three years, respectively. Next to imidacloprid, acetamiprid

20SP@100 gm ha^{-1} recorded a low population of leafhopper 4.8, 3.2 and 2.5/ 3 terminal leaves/plant on 7th DAS and 5.3,2.8 and 3.5/ 3 terminal leaves /plant on 7th and 15th DAS during *rabi*/summer 2012-13, 2013-14 and 2014-2015 respectively (Table 2). With reference to leafhopper damage percent imidacloprid recorded a minimum of 24% followed by acetamiprid (25%) and acephate (25%) during 2012-13. During the successive *rabi*/ summer season, acetamiprid 20% SP, recorded 12% and 14.3%, which was significantly different from the next treatment, imidacloprid 200 SL, which recorded 13.3% and 16.0% damage on 7th and 15th DAS. During 2014-15, imidacloprid and acetamiprid reduced the leafhopper damage to the tune of 8.0% to 8.5%, which were significantly very low when compared to control (20-23%). Thiamethoxam stood third in reducing the leafhopper incidence by about 16% and 12% during *rabi*/summer 2013-14 and 2014-15, respectively (Table 2).

Table 4. Effect of newer insecticide molecules on groundnut pod and haulm yield during rabi/summer seasons (2012-2015)

Treatment	Dose ha^{-1}	Dry pod yield (kg ha^{-1}) 2012-13	2013-14	2014-15	Pooled mean (kg ha^{-1})	Haulm yield (t ha^{-1})* 2012-13	2013-14	2014-15	Pooled mean (t ha^{-1})	BCR
T1-Acephate 75%SP	1.30 kg	2000	1808	1983	1930	8.8	7.4	6.8	7.6	1:2.3
T2-Acetamiprid 20%SP	100 gm	2216	2450	2158	2274	9.1	8.1	7.3	8.2	1:2.8
T3-Fipronyl 5% SC	100 gm	2133	1948	1983	2021	8.9	7.9	7.2	8.0	1:2.5
T4-Imidacloprid 200SL	200 ml	2166	1890	1983	2013	8.8	7.6	6.6	7.6	1:2.4
T5-Thiamethoxam 25WG	200gm	2100	2217	1983	2100	8.4	7.7	7.3	7.8	1:2.5
T6-Thiochloprid 480SC	200 ml	1916	2018	2158	2030	8.4	7.3	6.3	7.3	1:2.4
T7-Triazophos 25EC	2.0 lit	2133	1983	2158	2091	8.6	7.4	6.4	7.5	1:2.5
T8-Control	-	1383	1692	1925	1666	7.5	7.2	7.0	7.2	1:2.2
C.D.	-	200.4	218.7	N/A	246.3	126.2	463.5	189.3	461.1	-
SE(m)	-	66.94	73.03	91.3	82.2	42.2	154.8	63.2	154.0	-
SE(d)	-	94.7	103.3	129.1	116.3	59.6	218.9	89.4	217.8	-
C.V.	-	5.70	6.3	7.75	7.03	0.84	3.50	1.58	3.45	-

*Values are converted into tones from kg ha^{-1}

The present findings were in confirmation with the results of Saradava (2004), Venkanna *et al.* (2010) and Karena (2012), who reported that imidacloprid 0.005 per cent or thiamethoxam 0.05 per cent proved the most effective against leafhopper in groundnut. Nigude *et al*., (2018) indicated that imidacloprid 17.8 SL @ 0.75 ml/lit was consistently most effective as compared to other treatments in reducing the survival population of leafhopper in groundnut. Similar positive effect of imidacloprid on leafhopper was reported in cotton. Imidacloprid and thiamethoxam proved significantly superior in controlling leafhopper in okra (Misra, 2002) and groundnut (Karuppuchamy, 2016).

Natural enemies

Pooled mean of the three years data indicated that significantly more no.of predatory coccinellids (0.51 plant^{-1}), spiders (0.27 plant^{-1}), spider egg mass (0.10 plant^{-1}) were recorded in imidacloprid 200SL followed by thiamethoxam 25WG, which recorded coccinellids 0.40 plant^{-1}, spider 0.24 plant^{-1}and spider egg mass (0.12 plant^{-1}) (Table 3). The reports of earlier research on the effect of newer molecules on coccinellids on different crops under field conditions were in conformity with the present study. Amirzade *et al*., (2014) reported that thiamethoxam toxicity to predatory coccinellids was lower than imidacloprid and acetamiprid. Munir ahmed *et al*., (2011) showed the least toxic effect of imidacloprid to the coccinellids. In contrast, Jadhav *et al*., (2018) reported that acetamiprid, thiamethoxam and imidacloprid were most toxic to the coccinellids in brinjal eco-system.

Yield

The pooled mean of pod and haulm yield for the three years data indicated that all the treatments gave the highest pod yield (>2000 kg ha^{-1}) significantly. However, the maximum of pod yield (2216 kg ha^{-1}) and haulm yield (8.1 t ha^{-1}) were recorded in acetamiprid 20%SP followed by thiamethoxam (2100 kg ha^{-1} and 7.8 t ha^{-1}) and imidacloprid 200SL (2013 kg ha^{-1} and 7.6 t ha^{-1}) (Table 4). The highest BCR 1:2.8 was realized in acetamiprid 20%SP followed by thiamethoxam, triazophos (1:2.5) and imidacloprid, thiochloprid, novaluran (1:2.4) as against 1:2.2 in control. These findings were in accordance with the one made by Hanamant *et al*. (2014), which revealed that a reduction in the number of thrips caused enhanced pod and haulm yield of groundnut. Khanpara et al., (2016) also reported that thiamethoxam 25WG and acetamirprid 20SP were the economically viable treatment against thrips and jassids in groundnut.

CONCLUSION

Considering the effectiveness and economics of insecticides, spraying of imidacloprid 200SL @ 200 ml ha^{-1} or thiamethoxam 25 @WG 200 gm ha^{-1} or acephate 75 % SP @ 500 gm ha^{-1} or acetamiprid 20%SP @ 100 gm ha^{-1} at the time of initiation of pests were found to be the most effective against thrips and leafhoppers in groundnut. However, the natural enemies population was more in imidacloprid 200SL @ 200 ml ha^{-1} and thiamethoxam 25WG 200 gm ha^{-1} gm/ha. Thus, incorporation of newer chemistry molecules like imdiacloprid 200 SL and thiamethoxam 25WG in integrated pest management programme for managing pests on groundnut may prove as economically viable with less interfering for the natural enemies in groundnut eco-system during *rabi*/summer seasons.

REFERENCES

Amirzade N, Izadi H, Jalali MA, H. Zohdi. 2014. Evaluation of three neonicotinoid insecticides against the common pistachio psylla, *Agonoscena pistaciae*, and its natural enemies. *Journal of Insect Science* **14:** 35. http://www.insectscience.org/14.35

David B.V. and V. V. Ramamurthy. 2011. Elements of Economic Entomology. Namrutha publications, Chennai, Tamil Nadu. P: 385.

Hanamant, G., H Mahabaleshwar, H and R.A. Balikai. 2014. Yield loss and economic injury level (EIL) estimation for Thrips in groundnut crop. *J. Exp. Zool. India* **17(2):** 683-686

Jadhav, R.D., Kadam, D.R., Jadhao P.B. and G.K. Kangale. 2018. Bioefficacy of newer insecticides against brinjal whitefly and their natural enemies. *J. of Entomol. and Zool. Stud.* **6(6)**: 1187-1191

Khanpara ,D.V. , Parmar, G.M., Chelani, M.K., and K.L. Dobariya.2016. Management of sucking pests in groundnut by foliar application with new insecticidal molecules. *J. Farm Sci.,* **29(2):** (280-282)

Karena, R.M., 2012. Seasonal incidence and bio-efficacy of bio-pesticides alone and in combination with insecticides against major insect-pests of groundnut. Thesis Submitted to Junagadh Agricultural University, Junagadh, 81 pp.

Karuppuchamy, P. 2016. Ecologically Sustainable Pest Management for Thrips and Aphids in Groundnut. *Madras Agric. J.,* **103 (4-6)**: 141-145

Misra H.P. 2002. Field evaluation of some newer insecticides against aphids (*Aphis gossypii*) and jassids (*Amrasca biguttula*) on okra. *Indian J. Entomol.* **64 (1):** 80–84.

Munir Ahmad, Muhammad Rafiq, Arif M.I, A.H. Sayyed. 2011. Toxicity of some commonly used insecticides against *Coccinella undecimpunctata* (Coleoptera: Coccinellidae). *Pakistan J. of Zoo*. **43(6):**1161-1165.

Nigude, V.K., S.P. Patil, S.A. Patil and A.S. Bagade. 2018. Management of Sucking Pest of Groundnut with Newer Molecules of Insecticides (*Arachis hypogaea* L.). *Int.J.Curr.Microbiol.App.Sci.* **7(01):** 566-569. doi: https://doi.org/10.20546/ijcmas.2018.701.068

Nataraj, M.V., Harish. G., Jasrotia. P., Holajjer. P., Savaliya. S.D. and M. Gajera. 2014. Neo-nicotinoids: A biorational approach for managing sucking insect-pests of groundnut. *Ann. Pl. protec. Sci.,* **22(1):** 42-48.

Sheoran, O.P; Tonk, D.S; Kaushik, L.S; Hasija, R.C and R.S. Pannu. 1998. Statistical Software Package for Agricultural Research Workers. Recent Advances in information theory, Statistics & Computer Applications by D.S. Hooda & R.C. Hasija Department of Mathematics Statistics, CCS HAU, Hisar (139-143)

Venkanna, Y., Ranga, G. V. and D. Reddy. 2010. Bioefficacy of neonicotinoid insecticides against thrips, *Scirtothrips dorsalis* and leafhoppers, *Empoasca kerri* in groundnut. *Indian J. Pl.Prot.,* **38:** 68-72.

Zadda, K. and C. Vijayraghavan. 2015. Evaluation of newer insecticides against sucking insects infesting rainfed groundnut. *Pestology* **9:** 45-48.