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Evaluation of safe insecticides against sucking pests, jassid (*Amrasca bigutula bigutula* Ishida) and aphid (*Aphis gossypii* Glov.) infesting chilli (*Capsicum annum* L.) crop

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Abstract
Chilli (*Capsicum annuam* L.) is an important spice crop as well as vegetable crop infested by different insect pests of which jassid (*Amrasca bigutula bigutula*.) and aphid (*Aphis gossypii* cause substantial damage to chilli plant. Highest reduction of jassid population was noticed from the treatments Imidacloprid 17.8% SL @ 50 a.i. g/ha. No statistical variation was observed on percent reduction of jassid at 1, 3, 7 and 14 days after spray for both the treatments of Imidacloprid 17.8% SL @ 50 a.i. g/ha and 37.5 a.i. g/ha and recorded maximum reduction of 83.70% and 82.21% respectively at 3 days after spray. Maximum reduction of aphid (88.89%) was recorded from Imidacloprid 17.8% SL @ 50 g a.i./ha which was statistically at par with Imidacloprid 17.8% SL @ 37.5 g a.i./ha (85.34%) at 3 day after spray. Maximum number of predator population was observed in the treatment imidacloprid @ 25 a.i. g/ha (1.63 per plant) as well as untreated plot (2.03 per plant). Imidacloprid 17.8% SL was found effective to control jassid and aphid on chilli crop with no phytotoxicity and no adverse effect on natural enemies.

Keywords: Imidacloprid, fipronil, phytotoxicity, persistency, coccinellid

1. Introduction
Chilli (*Capsicum annuam* L.) is an important spice crop as well as vegetable crop grown all over India. In India, chilli is cultivated in an area of 7.67 lakh hectares and the production is estimated at 12.34 lakh tones. India is the largest producer of dry chillies and peppers in the world (Priyadarshini *et al*., 2017) [20]. It is considered as one of the major remunerative cash crops to the farmers of West Bengal, India (Bala and Ghosh, 2016) [3]. Among the different insect pests of chilli, aphid (*Aphis gossypii* Glov.), whitefly (*Bemisia tabaci* Genn.), thrips *(Scirtothrips dorsalis* Hood*)* mite (*Polyphagotarsonemus latus Banks*) and jassid (*Amrasca bigutula bigutula*.) were most important to cause substantial damage to chilli plant. Ghosh and senapati (2003) [16] reported that jassid population (4.63/leaf) was very high during April-May and positively correlated with temperature gradient, relative humidity and rainfall. Ghosh *et al.* (2004) [13] reported that *Aphis gossypii* was found active throughout the year on with highest population in August and positively correlated with average temperature, relative humidity and rainfall. Ghosh *et al.* (2007) [12] reported that lady bird beetle / coccinellid beetle *Menochilus sexmaculatus* was an important predator of aphid and jassid and its feeding activity was found throughout the year. Coccinellid beetle *Coccinella septempunctata* as the generalized predatory agent have gained great scientific interest for biological control in West Bengal, India (Ghosh, 1999 [7]; Chakraborty and Ghosh, 2010) [5].

During the last two decades insecticidal control of chilli pests is characterized by high pesticide usage and hence has posed problems of residues in the fruits (Nandihalli, 1979) [18]. Ghosh (2017) [8] reported that Acetamiprid was found highly efficacious against aphid and found to suppress 85.11% aphids closely followed by *neem* + *Spilanthes* (73.29%). Subba *et al*. (2015) [23] reported that acetamiprid was very effective against jassid recording more than 80% control. Ghosh *et al*. (2009) [14] reported that Imidacloprid was found most effective (91.15% control) against aphid three days after treatment. Imidacloprid was the most effective in providing more than 80% aphid suppression followed by azadirachtin (Ghosh *et al.*, 2016) [9]. Acharya *et al*., (2002) [2] reported that the efficacy of new molecules like imidacloprid, abamectin were safer to lady bird beetles. Most of the Conventional chemicals viz. organochlorines and organophosphates are broad spectrum, persistent in nature and having

long residual action (Subba *et al*., 2017; Nayar, *et al*.. 1992) [24, 19]. The indiscriminate use of broad spectrum chemicals induced resurgence and contamination of food and eco-system (Singh, 2000) [22]. Ghosh and Chakraborty (2012) [15] reported that pest control by using bio-control agent is an important component of Integrated Pest Management (IPM) and organic farming. So, there is search for newer insecticides in proper dose in specific time that can break the resistance and are less persistent, non-toxic to non-target organisms, and have less residual action. Das *et al.* (2010) [6] and Ghosh *et al.* (2012) [11] reported that a rapid degradation of persistency was observed in Imidacloprid than monocrotophos which had a greater importance as fruits and vegetables are plucked at frequent interval and consumed after little cooking. The objective of the study was to formulate suitable control measure with the use of some new safe molecules to reduce the infestation of sucking pest of chilli and less harmful to beneficial insects and environment.

2. Materials and Methods

2.1. Location and study period

The experiment was conducted at the District Seed Farm of BCKV located at Kalyani, West Bengal, India during the year 2015-2016. The geographical details of the site are 23° N latitude, 89° E longitude and 9.75 meter above mean sea level (MSL) (Thakoor *et al*., 2020) [26]. The soil of the experimental field was typically gangetic alluvial soil (Entisol) having sandy clay loam texture with good drainage facility, neutral in reaction and moderate in fertility (Priyadarshini *et al*., 2019) [21]. The soil type of the experimental field was sandy loam with PH range 5.75 to 6.5 and climate of this zone is subtropical humid with a short winter spell during December –January (Bala *et al*., 2015; Karmakar *et al.*, 2017) [4, 17].

2.2. Treatment Details

The treatment details are as follows:

Sl. No	Treatments	Dose a.i. (g/ha)	Dosage Formulation (ml or g/ha)
1	T1= Imidacloprid (Confidor 17.8% SL)	25.00	125.00
2	T2= Imidacloprid (Confidor 17.8% SL)	37.50	187.50
3	T3= Imidacloprid (Confidor 17.8% SL)	50.00	250.00
4	T4= Fipronil (Regent 5% SC)	25.00	500.00
5	T5= Fipronil (Regent 5% SC)	37.50	750.00
6	T6= Fipronil (Regent 5% SC)	50.00	1000.00
7	T7= Untreated control	---	----
8	Imidacloprid (Confidor 17.8% SL) (For phytotoxicity Study**)**	100.00	500.00
9	Fipronil (Regent 5% SC) (For phytotoxicity Study**)**	100.00	2000.00

2.3 Lay out of the experiment

i. Design : RBD
ii. Treatment: Seven
iii. Replication: Three
iv. Crop / Variety: Chilli, Cultivar- Suryamukhi
v. Target pests: Jassid and Aphid
vi. Plot Size : 3.5 m x 3.0 m
vii. Dose of fertilizer: Fertilizer as recommended
viii. Date of transplanting: 19.11.2015 (one month old seedlings)
ix. Spacing: 30 cm x 30 cm
x. No. of insecticidal spray done: Three 2015-16: 1st spray - 14.01.2016; 2nd spray - 29.01.2016 and 3rd spray - 13.2.2016
xi. Spraying technique: Knapsack sprayer fitted with hollow cone nozzle with 500 lit water / ha.
xii. Number of observation: Observation for pest population after 1, 3, 7, 14 days of each spray was recorded.

2.4. Methodology adopted for recording observation on Bio-efficacy

The data of target pests were recorded from randomly selected five plants in each plot. Observations of total number of jassid and aphid were recorded from five top young leaves of each plant per plot. First count was taken one day before first spray and post treatment counts were recorded on 1, 3, 7 and 14 days after each spray. Different species of predatory coccinellid beetle were found and hence their pre-count and post count (10 DAS) population was recorded. The green chilli yield from each plot was recorded and analyzed statistically in t/ha. The data were subject to analysis after making necessary transformation and express on the basis of percent reduction of pest population by the following formula (Abbott, 1925) [1]:

$$Pt = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Pt = Corrected mortality, Po = Observed mortality and Pc = Control mortality.

Data were analyzed by using INDO-STAT- software for analysis of variance following randomized block design (RBD) treatment means were separated by applying CD Test (critical difference) at 5% level of significance.

2.5. Methodology adopted for recording observation on Phytotoxicity

Ten randomly selected plants were observed for phytotoxicity (Necrosis, Epinasty, Hyponasty, Leaf injury on tips/surface, Wilting and Vein clearing) at different date of intervals (1st, 3rd, 7th, 10th and 14th day) following 0 – 10 scale after 1st, 2nd and 3rd round of spray. The details Index for phytotoxicity evaluation of Imidacloprid and Fipronil are as follows:

Rating	Phytotoxicity
0	0% (No phytotoxicity)
1	1 – 10%
2	11 – 20%
3	21 – 30%
4	31 – 40%
5	41 – 50%
6	51 – 60%
7	61 – 70%
8	71 – 80%
9	81 – 90%
10	91 – 100%

3. Results and Discussion

Three doses each of imidacloprid 17.8 SL and Fipronil 5% SC @ 25, 37.50, and 50 a.i. g /ha were sprayed to work out their efficacy against jassid and aphid and to find out the phytotoxic effects on chilli with high dose of imidacloprid 17.8% SL @ 100 a.i. g/ha and Fipronil 5% SC @ 100 a.i. g/ha also. Three round spraying has been done where first round was initiated after first week of January observing natural infestation of target pests and subsequent spraying has been done at 15 days interval. The data on the result has been presented in the table 1 - 2 and the natural enemies population has been presented in the table-3 and yield in table 4.

3.1. Efficacy of pesticides against chilli jassid

Among the different pests attacked the chilli crop, jassid was one of the most dominating and damaging pests recorded during the period of investigation. One day before spray jassid population ranged from 4.99 to 6.00 per 3 leaves and it was statistically non significant showing equal distribution in all the treatments (Table-1). Highest reduction of jassid population was noticed from the treatments Imidacloprid 17.8% SL @ 50 a.i. g/ha. No statistical variation was observed on percent reduction of jassid at 1, 3, 7 and 14 days after spray for both the treatments of Imidacloprid 17.8% SL @ 50 a.i. g/ha and 37.5 a.i. g/ha and recorded maximum reduction of 83.70% and 82.21% respectively at 3 days after spray. There is no significant difference between these two treatments. The treatment Imidacloprid 17.8% SL @ 25 a.i. g/ha was rendering satisfactory result recording 70.99% control, but this treatment is significantly different from the two treatments of Imidacloprid 17.8% SL @ 50 a.i. g/ha and 37.5 a.i. g/ha. Similar trend of percent reduction of jassid was observed at 1, 7 and 14 days after spray. The lowest percent reduction was observed in the plots treated with Fipronil 5% SC @ 25 a.i. g/ha followed by Fipronil 5% SC @ 50 a.i. g/ha. From overall observation it was found that Imidacloprid 17.8% SL @ 50 a.i. g/ha recorded highest mortality of jassid population (71.85%) very closely followed by Imidacloprid 17.8% SL @ 37.5 a.i. g/ha (69.68%) mortality.

3.2. Efficacy of pesticides against chilli aphid

Chilli aphid is considered to be the most notorious pest causing extensive damage throughout the year. It is very difficult to manage due to its capacity of rapid multiplication. The pre-count population of aphid was ranging from 9.67 to 10.33 per leaf which was statistically non significant and observed a uniform distribution in all the treatments (Table-2). Efficacy of imidacloprid 17.8% SL was noticed after spraying at three different doses viz. 25 g, 37.5 g and 50 g a.i. /ha. Maximum reduction of aphid (87.68%) was recorded from Imidacloprid 17.8% SL @ 50 g a.i./ha which was statistically at par with Imidacloprid 17.8% SL @ 37.5 g a.i./ha 83.91% at 1 day after spray. Similarly, no statistical variation was observed on percent reduction of aphid at 3 days after spraying recording 88.89% and 85.34% control in the treatment from Imidacloprid 17.8% SL @ 50 g a.i./ha and Imidacloprid 17.8% SL @ 37.5 g a.i./ha respectively. Similarly, no statistical variation was observed on percent reduction of aphid at 7 and 14 days after spray for both the treatments of Imidacloprid 17.8% SL @ 50 a.i. g/ha and 37.5 a.i. g/ha. The treatment Imidacloprid 17.8% SL @ 25 a.i. g/ha was rendering satisfactory result. Fipronil 5% SC @ 25 a.i. g/ha, fipronil 5% SC @ 37.5 a.i. g/ha and fipronil 5% SC @ 50 a.i. g/ha are comparatively less effective against aphid recorded 64.14%, 72.14% and 69.05% reduction respectively at one day after spraying. Similar trend of result has been found at 3, 7 and 14 days after spraying. From overall observation it was found that Imidacloprid 17.8% SL @ 50 a.i. g/ha recorded highest mortality of aphid population (78.66%) very closely followed by Imidacloprid 17.8% SL @ 37.5 a.i. g/ha (76.10%) mortality.

Table 1: Efficacy of Insecticides against jassid in chilli during experiment 2015-16 (cumulative of three sprays)

Treatments	Dose *a.i.* g/ha	Per cent reduction of Jassid population (cumulative of three sprays)					
		Pre spray jassid population /3 leaves	1 DAS	3DAS	7 DAS	14 DAS	Mean
T1= Imidacloprid 17.8% SL	25.00	5.00	67.82 (55.62)	70.99 (57.60)	52.42 (46.53)	46.97 (43.24)	59.55 (50.75)
T2= Imidacloprid 17.8% SL	37.50	5.33	75.77 (60.90)	82.21 (65.41)	67.74 (55.72)	53.01 (46.79)	69.68 (57.21)
T3= Imidacloprid 17.8% SL	50.00	5.77	77.67 (62.13)	83.70 (66.52)	70.67 (57.50)	55.37 (48.37)	71.85 (58.63)
T4= Fipronil 5% SC	25.00	5.67	61.41 (51.82)	63.99 (52.86)	40.67 (39.60)	28.19 (31.90)	48.56 (44.04)
T5= Fipronil 5% SC	37.50	6.00	67.36 (55.23)	70.34 (57.29)	55.50 (48.20)	35.49 (36.59)	57.17 (49.33)
T6= Fipronil 5% SC	50.00	4.99	66.96 (55.08)	67.34 (55.37)	52.19 (46.28)	32.05 (34.66)	54.66 (47.85)
T7= Untreated control	--	5.33	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
S. Em. ± CD (0.05)			1.39 4.09	1.17 3.46	1.64 4.78	1.89 5.61	-- ---

Values in the parenthesis are angular transformed, DAS: Days after spray

Table 2: Efficacy of Insecticides against aphid in chilli during experiment 2015-16 (cumulative of three sprays)

Treatments	Dose *a.i.* g/ha	Per cent reduction of aphid population (cumulative of three sprays)					
		Pre spray aphid population/ leaf	1 DAS	3DAS	7 DAS	14 DAS	Mean
T1= Imidacloprid 17.8% SL	25.00	10.33	74.45 (59.91)	75.81 (60.01)	62.56 (52.44)	50.02 (45.13)	65.71 (54.37)
T2= Imidacloprid 17.8% SL	37.50	9.67	83.91 (66.62)	85.34 (67.71)	73.61 (59.04)	61.56 (51.75)	76.10 (61.28)
T3= Imidacloprid 17.8% SL	50.00	10.12	87.68 (69.92)	88.89 (70.87)	74.97 (60.18)	63.12 (52.70)	78.66 (63.42)
T4= Fipronil 5% SC	25.00	9.88	64.14 (53.15)	63.47 (52.98)	52.09 (46.32)	35.85 (36.71)	53.89 (47.29)
T5= Fipronil 5% SC	37.50	9.75	72.14 (58.06)	73.88 (59.60)	64.24 (53.59)	50.19 (45.13)	65.11 (54.09)
T6= Fipronil 5% SC	50.00	10.33	69.05 (56.53)	67.34 (52.01)	53.76 (47.06)	37.82 (37.92)	56.99 (48.38)
T7= Untreated control	--	10.25	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)
S. Em. ±	---	---	1.72	1.58	1.13	1.39	---
CD (0.05)	---	---	5.11	4.67	3.33	4.11	---

Values in the parenthesis are angular transformed, DAS: Days after spray

3.3 Effect of pesticides on natural enemies

The chilli crop was observed to harbor coccinellid beetle as natural enemies. Result shows that the population of natural enemies in treatments comprising of imidacloprid were more or less similar to that of untreated control plot. Before spray predatory population *viz.,* coccinellids were found to be uniform. The observations were recorded 10 days after each spray and mean population was worked out for overall comparison. After ten days of application, lowest numbers of coccinellids mean population (0.53 per plant) was recorded in the plot treated with Fipronil 5% SC @ 50 a.i. g/ha and maximum number of population was observed in the treatment imidacloprid @ 25 a.i. g/ha (1.63 per plant) as well as untreated plot (2.03 per plant) (Table-3).

3.4 Phytotoxicity effect of pesticides on chilli plant

No phytotoxicity symptom such as leaf injury on tips/ surface, wilting, vein clearing, necrosis, epinasty and hyponasty were observed on chilli due to application of the insecticides considered in this context. Hence the test products were non phytotoxic to chilli crop.

3.5 Green Chilli yield

The data on green chilli yield revealed that all the treatments were significantly superior over untreated control. Highest green chilli yield was harvested from Imidacloprid 17.8% SL @ 50 a.i. g/ha (5.62 t/ha), which was statistically at par with Imidacloprid 17.8% SL @ 37.5 a.i. g/ha (5.61 t/ha). The next best yield was obtained from Imidacloprid 17.8% SL @ 25 a.i. g/ha (4.55 t/ha) followed by Fipronil 5% SC @ 25 a.i. g/ha (4.07 t/ha). The treatments Fipronil 5% SC @ 50 a.i. g/ha (3.66t/ha), Fipronil 5% SC @ 37.5 a.i. g/ha (3.95 t/ha) along with untreated control (3.13 t/ha) recorded relatively lower yield (Table-4).

Table 3: Effect of insecticides on the population of natural enemies (Coccinellids)

Treatments	Dose a.i. g/ha	Coccinellids (Population no. per plant)				
		Pre spray population	10 days after first spray	10 days after second spray	10 days after third spray	Mean of three sprays
T1= Imidacloprid 17.8% SL	25.00	1.72 (1.49)	1.72	1.52	1.66	1.63^{b} (1.52)
T2= Imidacloprid 17.8% SL	37.50	1.60 (1.46)	1.59	1.42	1.55	1.52^{b} (1.49)
T3= Imidacloprid 17.8% SL	50.00	1.67 (1.47)*	1.50	1.35	1.40	1.42^{c} (1.38)
T4= Fipronil 5% SC	25.00	1.65 (1.47)	1.64	1.48	1.70	1.61^{b} (1.51)
T5= Fipronil 5% SC	37.50	1.73 (1.49)	1.04	0.85	1.02	0.97^{d} (1.19)
T6= Fipronil 5% SC	50.00	1.72 (1.49)	1.62	1.54	1.44	0.53^{cd} (0.41)
T7= Untreated control	--	1.70 (1.48)	2.05	2.15	1.88	2.03^{a} (1.65)

Similar alphabets represents the homogeneous means group due to Duncan's Multiple Test range
*Values in the parentheses are square root transformed

Table 4: Cumulative yield of green chilli in t/ha

Treatments	Dose *a.i.* g/ha	Dosage Formulation (ml/ha)	Yield of green chilli in t/ha
T1= Imidacloprid 17.8% SL	25.00	125.00	4.55^{b}
T2= Imidacloprid 17.8% SL	37.50	187.50	5.61^{a}
T3= Imidacloprid 17.8% SL	50.00	250.00	5.62^{a}
T4= Fipronil 5% SC	25.00	125.00	4.07^{c}
T5= Fipronil 5% SC	37.50	250.00	3.95^{cd}
T6= Fipronil 5% SC	50.00	1000.00	3.66^{d}
T7= Untreated control	--	----	3.13^{e}
S. Em. ±	--	--	0.13
CD (0.05)	--	--	0.37

Similar alphabets represents the homogeneous means group due to Duncan's Multiple Test range

From overall observation among the different pests attacked the chilli crop, jassid and aphid were found dominating and damaging pests recorded during the period of investigation. The chilli crop was observed to harbor coccinellid beetle as natural enemies of jassid and aphid. The product Imidacloprid 17.8% SL @ 25 to 50 a.i. g/ha was found effective to control jassid and aphid on chilli crop with no phytotoxicity and no adverse effect on natural enemies. Persistency of Imidacloprid 17.8% SL @ 25 to 50 a.i. g/ha is very lower and so safer to natural enemies and environment.

Ghosh (2013) [10] reported that Imidacloprid 17.8 SL resulted in the best suppression of sucking pest hopper/ jassid population (91.89%) over untreated control which supports the present investigation. Das *et al*. (2010) [6] reported that Imidacloprid was found to record best result (90.97% control) against jassid at three days after treatment and a rapid degradation of persistency was observed in Imidacloprid which also support the present investigation and indicate that persistency of Imidacloprid is lower. Thakoor *et al*. (2019) [26] reported that Maximum aphid population reduction were found in the insecticidal treatment Imidacloprid 30.5 SC @ 160ml/ha (88.73% control) and Flonicamid 50 WG @ 300g/ha (88.71% control) in tomato field which support the present investigation. Ghosh *et al.* (2012) [11] reported that a rapid degradation of persistency was observed in Imidacloprid than monocrotophos which had a greater importance as fruits and vegetables are plucked at frequent interval and consumed after little cooking and also indicate that this pesticide is safer to predators. Higher yield was obtained from Imidacloprid treated plots.

Farmers often use pesticides indiscriminately to control insect pest with an immediate effect and getting more benefit. Sometimes they use high doses of pesticides for controlling insect pests in vegetable crops like chilli field. In doing so high level of pesticide residues remain in vegetable crops which causes health hazards and environmental pollution. High level of lesticide uses kill the biocontrol agent. Not only that it increase the cost of cultivation and so reduce profit. So use of proper insecticide dose is very important. Ghosh and Chakraborty (2012) [15] reported that pest control by using bio-control agent is an important component of Integrated Pest Management (IPM) and organic farming. So, there is search for newer insecticides in proper dose in specific time that can break the resistance and are less persistent, non-toxic to non-target organisms, and have less residual action. In the present findings Imidacloprid is the best pesticide for controlling jassid and aphid in chilli field but dose is important. Maximum reduction of jassid and aphid was recorded from Imidacloprid 17.8% SL @ 50 g a.i./ha which was statistically at par with Imidacloprid 17.8% SL @ 37.5 g a.i./ha. So proper and recommended dose should be Imidacloprid 17.8% SL @ 37.5 g a.i./ha. Less persistent insecticides should be used for pest control in vegetable field like chilli. Ghosh *et al.* (2012) [11] reported that a rapid degradation of persistency was observed in Imidacloprid. So Imidacloprid is good pesticides for controlling jassid and aphid in chilli field.

4. Conclusion/recommendation

Imidacloprid 17.8% SL @ 50 a.i. g/ha and 37.5 a.i. g/ha recorded maximum reduction of 83.70% and 82.21% respectively at 3 days after spray and they are statistically similar. No statistical variation was observed on percent reduction of aphid at 3 days after spraying recording 88.89% and 85.34% control in the treatment from Imidacloprid 17.8% SL @ 50 g a.i./ha and Imidacloprid 17.8% SL @ 37.5 g a.i./ha respectively. Population of natural enemies in treatments comprising of imidacloprid were more or less similar to that of untreated control plot. Highest green chilli yield was harvested from Imidacloprid 17.8% SL @ 50 a.i. g/ha (5.62 t/ha), which was statistically at par with Imidacloprid 17.8% SL @ 37.5 a.i. g/ha (5.61 t/ha). Imidacloprid 17.8% SL @ 37.5 a.i. g/ha is very suitable for jassid and aphid control in chilli field and may be recommended for general farmers use.

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6. References

1. Abbott WS. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology. 1925; 18:265-267.
2. Acharya S, Mishra HP, Dash D. Efficacy of insecticides against okra jassid (*Amrasca biguttula biguttula* Ishida). Annals of Plant Protection Science. 2002; 10(2):230-232.
3. Bala SC, Ghosh SK. Host plant resistance-cum-chemical control approach for the sustainable management of yellow mite, *Polyphagotarsonemus latus* (Bank) Journal of Entomological Research. 2016; 40(4):373-377.
4. Bala SC, Karmakar K, Ghosh SK. Population dynamics of mite, *Aceria tulipae* Keif. on garlic (*Allium sativum* L.) and its management under Bengal basin. International Journal of Science, Environment and Technology. 2015; 4 (5):1365-1372.
5. Chakraborty K, Ghosh SK. Incidence of *Coccinella septempunctata* in brinjal with some pesticides. Current advances in Agricultural Sciences. 2010; 2(2):129-130. (Short Communication).
6. Das K, Biswas S, Chakraborty G, Ghosh SK. Efficacy of insecticides against Jassid (*Amrasca biguttula biguttuka* Ishida) on okra in terai agro-ecology of West Bengal. Journal of Applied Zoological Research. 2010; 21(1):33-35.
7. Ghosh SK. Studies on the pest constraints of brinjal/eggplant (*Solanum melongena* L.) and their management under terai region of West Bengal, India. Ph.D. Thesis awarded by BCKV-Agriculture University, West Bengal, India. 1999, 43-44.
8. Ghosh SK. Seasonal Incidence of aphid (*Aphis gossypii* Glove.) Infesting tomato (*Lycopersicon esculentum* L.) and their management by using botanical pesticides International Journal of Advances in Science Engineering and Technology. 2017; 5(3, 1):14-17.
9. Ghosh SK, Mandol T, Chakraborty K. Population fluctuation of aphid (*Aphis craccivora* Koch.) infesting Som plant leaves (*Machilus bombycina* King.) and its management. Journal of Entomological Research. 2016; 40(3):235-241.
10. Ghosh SK. Sustainable management of mango hopper (*Amritodas atkinsony* Leth. and *Idioscopus niveosparsus* Leth. Together) by using insect growth regulator (IGR), buprofezin 25 SC. Uttar Pradesh Journal of Zoology.

2013; 33(2):119-128.
11. Ghosh SK, Mandal T, Biswas S, Chakraborty K. Field evaluation of cultivars and bio-efficacy of insecticides against pest complex of ladysfinger (*Abelmoschus esculentus* L.). Journal of Applied Zoological Research. 2012; 23(2):121-128.
12. Ghosh SK, Laskar N, Senapati SK. Seasonal incidence of predator *Menochilus sexmaculatus* Berliner on brinjal and harmful effect of insecticides on the predator. Indian Journal of Agriculture. Research. 2007; 41(2):102-106.
13. Ghosh SK, Laskar N, Senapati SK. Seasonal fluctuation of *Aphis gossypii* Glov. on brinjal/eggplant and field evaluation of pesticides from different origin against *A. gossypii* under tcrai region. Indian Journal of Agriculture Research. 2004; 38(3):171-177.
14. Ghosh SK, Mahapatra GSS, Chakraborty G. Field efficacy of plant extracts and microbial insecticides against aphid (*Aphis gossypii*) infesting okra (*Abelmoschus esculentus*). Redia, Itali XC11. 2009; 249-252. (with sub-title Journal of Entomology).
15. Ghosh SK, Chakraborty K. Incidence and abundance of predatory beetle with special reference to *Coccinella septempunctata* in sub-Himalayan region of north-east India. International Journal of Plant, Animal and Environmental Sciences. 2012; 2(3):157-162.
16. Ghosh SK, Senapati SK. Biology and seasonal abundance of jassid infesting brinjal in terai region of West Bengal. Environment and Ecology. 2003; 21(3):716-719.
17. Karmakar K, Bala SC, Ghosh SK. Population dynamics of sheath mite (*Stenotarsonemus spinki*) Infesting rice cultivar IET-4786 and its management under Gangetic basin of West Bengal. Journal of Entomology and Zoology Studies. 2017; 5(4):663-666.
18. Nandihalli BS. Efficacy of different insecticides in control of chilli leaf curl and their residues. University of Agricultural Science, Bangalore, India, 1979.
19. Nayar KK, Ananthakrishnan TN, David BV. General and Applied Entomology, 1992, 430-431.
20. Priyadarshini S, Pal S, Ghosh SK. Field screening of chilli cultivars against thrips (*Scirtothrips dorsalis* Hood.) and its management under West Bengal condition. Journal of Entomology and Zoology Studies. 2017; 5(6):2106--2110.
21. Priyadarshini S, Ghosh SK, Nayak AK. Field screening of different chilli cultivars against important sucking pests of chilli in West Bengal. Bulletin of Environment, Pharmacology and Life Sciences. 2019; 8(7):134-140.
22. Singh SP. Bio Intensive approach Helpful. The Hindu Survey of Indian Agriculture. 2000, 159-163.
23. Subba B, Ghosh SK, Banerjee D, Jasudasu GS. Seasonal incidence of Jassid Infesting tomato (*Lycopersicon esculentum* L.) and their sustainable management .Annals of Plant and Soil Research. 2015; 17:19-22 Special Issue).
24. Subba B, Pal S, Mandal T, Ghosh SK. Population dynamics of white fly (*Bemisia tabaci* Genn.) Infesting tomato (*Lycopersicon esculentum* L.) and their sustainable management using bio-pesticides. Journal of Entomology and Zoology Studies. 2017; 5(3):879-883.
25. Thakoor P, Ghosh SK, Bala SC. Effect of abiotic factors on seasonal incidence and bio-efficacy of some newer insecticides against white fly (*Bemisia tabaci*) on tomato crop (*Solanum lycopersicon* L) in West Bengal. Journal of Entomology and Zoology Studies.2020; 8(3):267-271.
26. Thakoor P, Ghosh SK, Nihal R, Ramya Sri N. Effect of abiotic factors on seasonal incidence and bio-efficacy of some newer insecticides against aphid (*Aphis gossypii*) in tomato (*Abelmoschus esculentus*). Journal of Entomology and Zoology Studies. 2019; 7(3):513-516.