EFFECT OF VARIOUS BIOPESTICIDES ON SUCKING INSECT PESTS OF TOMATO (SOLANUM *LYCOPERSICUM* L.) GROWN UNDER NORTH BANK PLAIN ZONE OF ASSAM

ABSTRACT

Aims: To evaluate the effectiveness of various bio-pesticides *viz*, Azadirachtin 1500ppm @ 5ml/lit, garlic extract @ 5ml/lit, biogreen-L @ 5ml/lit, Azadirachtin 1500ppm @ 5ml/lit + garlic extract @ 5ml/lit, Azadirachtin 1500ppm @ 5ml/lit + biogreen-L @ 5ml/lit, garlic extract @ 5ml/lit + biogreen-L @ 5ml/lit, Azadirachtin 1500ppm @ 5ml/lit + garlic extract @ 5ml/lit + biogreen-L @ 5ml/lit against sucking pests of tomato like aphid, whitefly and jassid.

Study design: Field experimentation, Randomized Block Design

Place and duration of study: The study was conducted at the experimental farm for PG research, Biswanath College of Agriculture, Sonitpur during *Rabi*, 2022-23.

Methodology: The population of aphid, *Aphis craccivora* Koch; whitefly, *Bemisia tabaci* (Genn) and jassid, *Amrasca biguttula biguttula* (Ishida) were recorded on five plants selected randomly in each plot, considering three leaves upper, middle and lower. The population of coccinellid and spider were recorded by counting their numbers on five plants selected randomly in each plot. For the study of effectiveness of various bio pesticides, the pest infestation was recorded one day ahead of each application (pre-treatment record) and third, seventh and fifteenth days after the application of bio pesticides (post treatment record).

Results: The results reveals that among different treatments, *Aphis craccivora* population found to be significantly lower in Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l treated plot followed by Azadirachtin 1500ppm @ 5ml/l + garlic extract @ 5ml/l, biogreen-L @ 5ml/l after first spray and second spray. After both first and second spray *Bemisia tabaci* population was recorded lowest in Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l treated plot followed by Azadirachtin 1500ppm @ 5ml/l + garlic extract @ 5ml/l and Azadirachtin 1500ppm @ 5ml/l treated plot, respectively. Among different treatments, *Amrasca biguttula biguttula* population was recorded to be lowest in Azadirachtin 1500ppm @ 5ml/l + garlic extracts @ 5ml/l treated plot followed by Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l treated plot after first and second spray. Garlic extracts @ 5ml/ l + Biogreen-L @ 5ml/ l was found least effective against all the insect pests. The population of natural enemy (coccinellid) was more in Azadirachtin 1500ppm @ 5ml/l treated plots after first and second spray. However, no significant different was observed among the treatments in maintaining spider population. From the present investigation, it was found that all the bio-pesticides were congenial for population build-up of natural enemy.

Conclusion: To confront various environment and health hazards caused by these persistent and non-biodegradable insecticides it is indispensable to use bio-pesticides as these are biodegradable in nature and also proved to be safe for the population build-up of natural enemies.

Keywords: Tomato, Aphis craccivora, Bemisia tabaci, Amrasca biguttula biguttula, Coccinellid, spider, biogreen, Azadirachtin 1500ppm, garlic extract

1. INTRODUCTION

Tomato, *Solanum lycopersicum* L. is one of the most widely grown commercial vegetable crop in the world after potato. It is said to be a native of tropical America. In India, Assam has the highest production of tomato in North East India which produces 396.24 MT with an area of 18.28 Ha (Saxena *et al*., 2018). Tomato production has been intensified over the years; however, yields continue to be low due to

several production constraints such as pests, diseases and environmental factors. The incidence of insect pests may vary from season to season and different growth stages of the crop. Sucking insect pests including aphid, whitefly and jassids, pose a threat to tomato plants on a global scale. These insect extract leaf sap by feeding on the plants phloem tissue and secret saliva containing enzyme at feeding site. The enzymatic action contribute to the breakdown of host cells, facilitating insect infestation. Moreover, these sap sucking insect act as a primary vectors for viral diseases and their feeding activities manifest in symptoms like leaf curling, withering, leaf drooping, stunting and premature fruit drop (Deore *et al.,* 2024). Among the various methods of pest management use of chemical insecticides is most popular. The increasing concern for environment awareness of pesticides hazard has evoked a worldwide interest in the development of biopesticides or biological pesticides based on plants or pathogenic microorganisms and specific to the target pest, offer an ecologically sound and effective solution to the pest problem (Kunbhar *et al.,* 2018). Keeping in view the above facts on importance of the crop, tremendous losses caused by various insect pests and to reduce the pesticide hazards, the study was undertaken to assess the effectiveness of various bio pesticides and to evolve a technically feasible environmentally sound and economically viable pest management practice.

2. MATERIAL AND METHODS: The Field experiment was conducted at the experimental farm for PG Research, Biswanath College of Agriculture, Sonitpur (latitude and longitude coordinates are 26º 30'N and 27º 01'N, respectively) during *Rabi* season of 2022-23 using tomato variety *Swaraksha* (Seed rate 100-150 g/ ha). The seeds are sown on October 12, 2022. The experiment was conducted in Randomized block design (RBD) with eight treatments, replicated thrice. There were 24 numbers of plots with individual size 3.0 m × 3.0 m and spacing was 60cm x 45 cm. All recommended agronomic practices were followed except the plant protection measures. The crop was regularly inspected from the transplanting till the harvesting of the crop for the population dynamics of the insect pests, and these were collected and brought to the laboratory for identification. Observations on their incidence were recorded at weekly intervals from randomly selected five plants/ plot; the populations of aphid, whitefly and leaf hopper were recorded on five plants selected randomly in each plot, considering three leaves upper, middle and lower. The population of coccinellid and spider were recorded by counting their numbers on five plants selected randomly in each plot.

For the study of effectiveness of various bio pesticides, the pest infestation was recorded one day ahead of each application (pre-treatment record) and third, seventh and fifteenth days after the application of bio pesticides (post treatment record) from five randomly selected plants of each plot.

The details of the bio pesticides used in the experiment are given below.

T_1	Azadirachtin 1500 ppm @ 5ml/l
T_2	Garlic Extracts @ 5ml/ l
T_3	Biogreen-L @ 5ml/ l
T_4	Azadirachtin 1500ppm @ 5ml/ l + Garlic extracts 5ml/l
T_5	Azadirachtin 1500ppm @ 5ml/ l + Biogreen-L @ 5ml/ l
T_6	Garlic extracts @ 5ml/ l + Biogreen-L @ 5ml/ l
T_7	Azadirachtin 1500ppm @ 5ml/ l + Garlic extracts @ 5ml/ l + Biogreen-L @ 5ml/ l
T_8	Control

The experimental data were converted into mean values which were further transformed into square root. The transformed data were statistically analysed. Significance of difference due to treatment effects in field were estimated by calculating the respective 'F' values (Gomez and Gomez, 1984) and by comparing the treatment means with appropriate CD values.

3. RESULT AND DISCUSSIONS

In the field experiment, 11 insect pests from four orders and eight families were recorded as pests of tomato (Bora, *et al*., 2024). Out of these pest the important sucking pests were *Bemisia tabaci*, *Aphis craccivora* and *Amrasca biguttula biguttula* which were found to be the dominant species throughout the investigation (Bora, *et al*., 2024).The bio pesticides when applied against these insect

pests revealed that there are significant reductions of sucking pests incidence at three, seven and fifteen days after first as well as second spray.

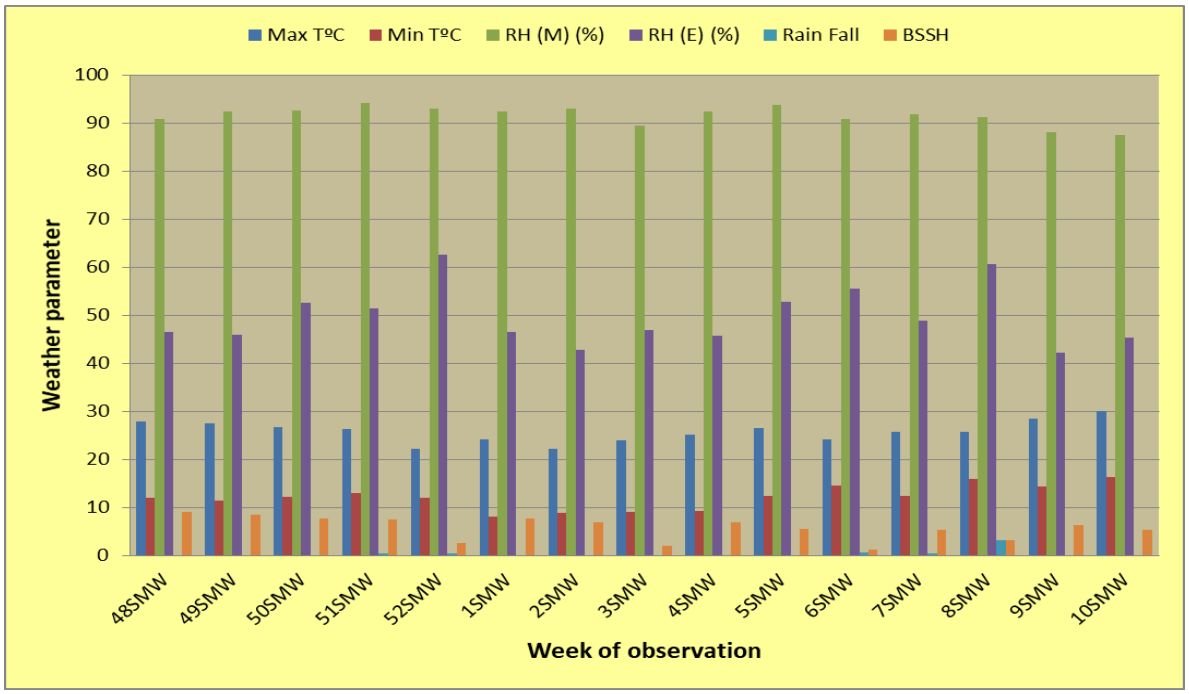

Fig: Different meteorological parameter

Table 1: Effect of different bio-pesticides on *A. craccivora* population after first and second spray during *Rabi* 2022-23

Treatments	*A. craccivora* population per leaf							
	1st spray				2nd spray			
	1 DBT	3 DAT	7 DAT	15 DAT	1DBT	3 DAT	7 DAT	15 DAT
T_1= Azadirachtin 1500ppm @ 5ml/l	12.76 (3.64)	8.98 (3.08)	8.13 (2.94)	8.98 (3.08)	11.82 (3.51)	8.11 (2.93)	6.31 (2.61)	7.04 (2.75)
T_2= Garlic extract @ 5ml/l	13.04 (3.68)	9.88 (3.22)	8.98 (3.08)	9.77 (3.20)	12.32 (3.58)	8.77 (3.04)	7.38 (2.81)	8.11 (2.93)
T_3= Biogreen-L @ 5ml/l	12.54 (3.61)	8.33 (2.97)	7.36 (2.80)	7.96 (2.91)	11.91 (3.52)	6.52 (2.65)	4.96 (2.34)	6.68 (2.68)
T_4= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l	12.38 (3.58)	6.92 (2.72)	5.71 (2.49)	6.18 (2.58)	11.72 (3.49)	5.11 (2.37)	3.48 (1.99)	4.13 (2.15)
T_5= Azadirachtin 1500ppm @ 5ml/l + Biogreen-L @ 5ml/l	12.11 (3.55)	6.18 (2.58)	4.61 (2.26)	5.08 (2.36)	11.56 (3.47)	3.13 (1.91)	2.78 (1.81)	3.27 (1.94)
T_6= Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	14.83 (3.92)	14.64 (3.89)	12.83 (3.65)	13.32 (3.72)	12.00 (3.54)	10.33 (3.29)	9.04 (3.09)	9.82 (3.21)
T_7= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	12.88 (3.66)	11.73 (3.50)	10.11 (3.26)	10.98 (3.39)	13.86 (3.79)	9.43 (3.15)	8.48 (2.99)	8.98 (3.08)
T_8= Control	14.16 (3.83)	17.88 (4.28)	17.28 (4.22)	16.92 (4.17)	12.88 (3.66)	14.46 (3.87)	13.88 (3.80)	12.80 (3.65)

S. Ed. (±)	0.10	0.14	0.12	0.16	0.08	0.11	0.15	0.14
$CD_{p \leq 0.05}$	NS	0.38	0.33	0.44	NS	0.30	0.41	0.39

DBT = Days before treatment, DAT = Days after treatment, NS = Non-significant

Data based on mean of 3 replication (3 leaves/plant and 5 plants/plot)

Figure within the parenthesis indicated square root transformed values

Aphid (*Aphis craccivora*): All the treatments were found to be effective in reducing *A. craccivora* population over control (Table 1). After first spray the lowest population of (6.18, 4.61 and 5.08) *A. craccivora* per leaf were recorded from the plot treated with Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l at three, seven and fifteen days after treatment. Similar trend of result was also obtained after second spray with 3.13, 2.78 and 3.27 population of *A. craccivora* per leaf from Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l treated plot at three, seven and fifteen days after treatment These findings were in conformity with Bhamat et al. (2022), who reported that NSKE5%, Azadirachtin 1500ppm 0.5% and *L. lecanii* 1% WP were most effective in reducing *Aphis craccivora* population in Indian bean. Wade et al. (2020) also reported that *L. lecanii* was found to be best treatment in reducing *A. craccivora* population which was at par with azadirachtin, *B. bassiana*, *M. anisopliae* and *B. thuringiensis*. The effectiveness of azadirachtin 0.0006%, Azadirachtin 1500ppm 0.3% and garlic extract 3% were also reported by Sarvaiya et al. (2018) which corroborates with the present investigation. Since, *B. bassiana, M. anisopliae* and *B. thuringiensis* were the components of the treatment Biogreen-L @5ml/l therefore, Biogreen-L might also be effective against aphid. Moreover, Halder et al. (2021) reported the compatibility of Azadirachtin 1500ppm with entomopathogenic fungi like *B. bassiana, M. anisopliae, B. thuringiensis* and *P. fluroscence* against major sucking insect pests of vegetable. Hence, the combination of Azadirachtin 1500ppm @5ml/l and biogreen-L @ 5ml/l might be performed best in lowering *A. craccivora* population.

Adult of *Aphis craccivora*

Table 2: Effect of different bio-pesticides on *B. tabaci*, population after first and second spray *Rabi* 2022-23

Treatments	*B. tabaci* population per leaf							
	1st spray				2nd spray			
	1 DBT	3 DAT	7 DAT	15DAT	1DBT	3 DAT	7 DAT	15 DAT

T_1= Azadirachtin 1500ppm @ 5ml/l	9.63 (3.18)	6.70 (2.68)	5.91 (2.53)	3.96 (2.11)	7.91 (2.90)	2.67 (1.78)	2.15 (1.63)	1.66 (1.44)
T_2= Garlic extract @ 5ml/l	10.05 (3.25)	7.92 (2.90)	7.38 (2.81)	5.71 (2.49)	8.12 (2.94)	4.16 (2.16)	3.72 (2.05)	3.08 (1.90)
T_3= Biogreen-L @ 5ml/l	11.21 (3.42)	7.28 (2.79)	6.73 (2.69)	4.52 (2.24)	8.18 (2.95)	3.38 (1.97)	2.78 (1.81)	2.28 (1.67)
T_4= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l	9.44 (3.15)	6.08 (2.56)	4.91 (2.33)	3.38 (1.97)	7.62 (2.85)	2.08 (1.61)	1.62 (1.46)	1.18 (1.29)
T_5= Azadirachtin 1500ppm @ 5ml/l + Biogreen-L @ 5ml/l	10.62 (3.33)	5.46 (2.44)	4.28 (2.18)	2.73 (1.80)	7.38 (2.81)	1.59 (1.45)	1.13 (1.27)	0.72 (1.10)
T_6= Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	11.46 (3.46)	9.63 (3.18)	8.93 (3.07)	8.28 (2.96)	8.56 (3.01)	6.57 (2.66)	5.39 (2.43)	4.72 (2.28)
T_7= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	10.92 (3.38)	8.77 (3.04)	8.41 (2.98)	6.92 (2.72)	8.33 (2.97)	4.96 (2.34)	4.35 (2.20)	3.78 (2.07)
T_8= Control	11.88 (3.52)	11.06 (3.40)	11.10 (3.41)	10.66 (3.34)	10.27 (3.28)	10.18 (3.27)	10.08 (3.25)	9.38 (3.14)
S. Ed. (±)	0.07	0.06	0.03	0.04	0.07	0.05	0.03	0.06
$CD_{p \leq 0.05}$	NS	0.16	0.08	0.11	NS	0.14	0.08	0.16

DBT = Days before treatment, DAT = Days after treatment, NS = Non-significant

Data based on mean of 3 replication (3 leaves/plant and 5 plants/plot)

Figure within the parenthesis indicated square root transformed values

Whitefly (*Bemisia tabaci*): Almost similar trend in efficacies of different treatments against *B. tabaci* were observed during the investigation (Table 2). The lowest *B. tabaci* population of 5.46, 4.28 and 2.73 whiteflies per leaf recorded in the plot treated with Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l at three, seven and fifteen days after first spray. Similarly, after second spray the lowest number of 1.59, 1.13 and 0.72 *B. tabaci* per leaf was observed in the plot treated with Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l at three, seven and fifteen days after second spray which was closely followed by Azadirachtin 1500ppm @ 5ml/l + garlic extract @ 5ml/l with 2.02, 1.62 and 1.18 *B. tabaci* per leaf. The findings are in close relation with Wade et al. (2020) who reported that *B. bassiana* was found to be best in reducing *B. tabaci* population which was at par with azadirachtin 1% EC and *M. anisopliae* which corroborates with the present findings. Our findings are in accordance with Nanza and Mashela (2012), according to whom Azadirachtin 1500ppm and garlic mixture was most effective in reducing *B. tabaci* population in tomato. Iqbal et al. (2015) previously said that garlic contains lectins that bind with the proteins of an insect's midgut and disrupt the detection of food, leading to physiological issues and ultimately death. . It was reported that garlic has an antifungal compound allicin therefore it might reduce the effect of Biogreen-L. Therefore, garlic extract @ 5ml/l + Biogreen-L @ 5ml/l was found to be the least effective in reducing *B. tabaci* and other pests' population.

Adult of *Bemisia tabaci*

Table 3: Effect of different bio-pesticides on *A. biguttula biguttula* population after first and second spray during *Rabi* 2022-23

Treatments	*A. biguttula biguttula* population per leaf							
	1st spray				2nd spray			
	1 DBT	3 DAT	7 DAT	15 DAT	1DBT	3 DAT	7 DAT	15 DAT
T_1= Azadirachtin 1500ppm @ 5ml/l	3.46 (1.99)	2.76 (1.81)	2.16 (1.63)	2.43 (1.71)	3.28 (1.94)	1.94 (1.56)	1.47 (1.40)	1.70 (1.48)
T_2= Garlic extract @ 5ml/l	3.70 (2.05)	3.25 (1.94)	2.66 (1.78)	3.05 (1.88)	3.17 (1.91)	2.70 (1.79)	2.09 (1.61)	2.36 (1.69)
T_3= Biogreen-L @ 5ml/l	3.41 (1.98)	3.12 (1.90)	2.44 (1.71)	2.73 (1.80)	3.07 (1.89)	2.44 (1.71)	1.87 (1.54)	2.11 (1.62)
T_4= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l	3.54 (2.01)	2.30 (1.67)	1.79 (1.51)	1.93 (1.56)	3.06 (1.88)	1.39 (1.37)	1.08 (1.26)	1.26 (1.33)
T_5= Azadirachtin 1500ppm @ 5ml/l + Biogreen-L @ 5ml/l	3.17 (1.91)	2.58 (1.75)	1.92 (1.56)	2.16 (1.63)	2.98 (1.86)	1.66 (1.47)	1.29 (1.34)	1.43 (1.39)
T_6= Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	3.73 (2.06)	3.46 (1.99)	2.90 (1.84)	3.18 (1.92)	3.33 (1.96)	2.87 (1.84)	2.20 (1.64)	2.57 (1.75)
T_7= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	3.21 (1.92)	2.91 (1.85)	2.32 (1.68)	2.59 (1.76)	2.86 (1.83)	2.23 (1.65)	1.61 (1.45)	1.93 (1.56)
T_8= Control	3.96 (2.11)	3.92 (2.10)	3.30 (1.95)	3.54 (2.01)	3.92 (2.10)	3.28 (1.94)	2.54 (1.74)	2.84 (1.83)
S. Ed. (±)	0.30	0.14	0.11	0.07	0.07	0.08	0.05	0.08
CD $_{p \leq 0.05}$	NS	0.38	0.30	0.19	NS	0.22	0.14	0.22

DBT = Days before treatment, DAT = Days after treatment, NS = Non-significant

Data based on mean of 3 replication (3 leaves/plant and 5 plants/plot)

Figure within the parenthesis indicated square root transformed values

Jassid (*Amasca biguttula biguttula*): All the treatments exhibited significant effect on the population reduction of *A. biguttula biguttula* after both first and second spray (Table 3). The lowest *A. biguttula biguttula* population, 2.70, 1.79 and 1.93 per leaf was recorded from the plot treated with

Azadirachtin 1500ppm @ 5ml/l + garlic extract @ 5ml/l at three, seven and fifteen days after first spray. After second spray also lowest *A. biguttula biguttula* population of 1.39, 1.08 and 1.26 per leaf was recorded in the plot treated with Azadirachtin 1500ppm @ 5ml/l + garlic extract @ 5ml/l at three, seven and fifteen days after treatment. The present findings were in conformity with Solangi et al. (2013), according to them Azadirachtin 1500ppm + beneficial microorganism found effective against *A. biguttula biguttula* population followed by Azadirachtin 1500ppm. The present findings are in accordance with that of Iqbal et al. (2017), who reported that after second spray bio-pesticides like Azadirachtin 1500ppm, neem extracts, tobacco, garlic and ginger performed best against reducing *A. biguttula biguttula* population in okra. The results of the present study are in accordance with Halder et al. (2021), according to whom combination of Azadirachtin 1500ppm + *L. lecanii* was found to be best in reducing *A. biguttula biguttula* population followed by Azadirachtin 1500ppm+ *B. bassiana* and Azadirachtin 1500ppm+ *M. anisopliae*. Since, the bio-pesticides were individually effective in reducing pest population; therefore the effectiveness of their combinations might be more in reducing the infestation of *A. biguttula biguttula*.

Table 4: Number of Coccinellid predators under different biopesticides after first and second spray during *Rabi* 2022-23

Treatments	No. of Coccinellids per plant					
	1st spray			2nd spray		
	3 DAT	7 DAT	15 DAT	3 DAT	7 DAT	15 DAT
T_1= Azadirachtin 1500ppm @ 5ml/l	2.40	2.27	2.40	2.20	2.07	2.20
T_2= Garlic extract @ 5ml/l	2.17	2.07	2.17	2.07	1.93	2.13
T_3= Biogreen-L @ 5ml/l	2.06	1.93	2.57	1.93	1.73	2.40
T_4= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l	1.67	1.53	1.87	1.57	1.33	1.73
T_5= Azadirachtin 1500ppm @ 5ml/l + Biogreen-L @ 5ml/l	1.27	1.13	1.43	1.17	1.06	1.27
T_6= Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	1.43	1.33	1.67	1.40	1.20	1.47
T_7= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	1.93	1.73	2.06	1.73	1.57	1.87
T_8= Control	2.73	2.53	2.73	2.53	2.40	2.63
S. Ed. (±)	0.10	0.07	0.08	0.07	0.06	0.05
$CD_{p \leq 0.05}$	0.27	0.19	0.22	0.19	0.16	0.14

DAT = Days after treatment

Data based on mean of 3 replication (5 plants per plot)

Table 5: Number of spiders under different bio-pesticides after first and second spray during *Rabi* 2022-23

Treatments	No. of spiders per plant					
	1st spray			2nd spray		
	3 DAT	7 DAT	15 DAT	3 DAT	7 DAT	15 DAT
T_1= Azadirachtin 1500ppm @ 5ml/l	0.87	0.86	0.90	0.93	0.89	0.85
T_2= Garlic extract @ 5ml/l	0.91	0.87	0.89	0.91	0.91	0.88
T_3= Biogreen-L @ 5ml/l	0.80	0.82	0.82	0.82	0.83	0.83

T_4= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l	0.82	0.84	0.87	0.84	0.8	0.82
T_5= Azadirachtin 1500ppm @ 5ml/l + Biogreen-L @ 5ml/l	0.78	0.75	0.78	0.79	0.76	0.77
T_6= Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	0.77	0.78	0.8	0.82	0.78	0.8
T_7= Azadirachtin 1500ppm @ 5ml/l + Garlic extract @ 5ml/l + Biogreen-L @ 5ml/l	0.84	0.88	0.85	0.87	0.85	0.86
T_8= Control	0.94	0.92	0.91	0.98	0.93	0.93
S. Ed. (±)	0.12	0.05	0.04	0.1	0.04	0.04
$CD_{p \leq 0.05}$	NS	NS	NS	NS	NS	NS

DAT = Days after treatment

NS = Non-significant

Data based on mean of 3 replication (5 plants per plot)

Natural enemies: Two coccinellid predators *viz*., Discolored lady beetle, *Micraspis discolor* (Fabricius) and Six spotted zigzag ladybird beetle, *Cheilomenes sexmaculata* (Febricius) and two spider species Grassland lycosid spider, *Lycosa tista* Tikader and Buzzing spider, *Anyphaena accentuata* (Walckenaer) were recorded as natural enemies, previously reported by Bora *et al.* (2024).The population of natural enemy (coccinellid) was more in Azadirachtin 1500ppm @ 5ml/l treated plots after both first (2.40, 2.27 and 2.40 predators per plant at three, seven and fifteen days after treatment, respectively) and second spray (2.20, 2.07 and 2.20 predators per plant at three, seven and fifteen days after treatment, respectively) (Table 4). Since all the bio-pesticides safe to the population build-up of natural enemy therefore, the reduction in predators population might be due to the reduction in aphid population in Azadirachtin 1500ppm @ 5ml/l + biogreen-L @ 5ml/l treated plot. This findings were in conformity with *Borah et al*. (2017), according to them highest population of coccinellid recorded from Azadirachtin 1500ppm @ 3ml/l treated plot after first application. Previously, Gaikwad *et al.* (2020) also reported that *B. bassiana* 0.4%, Azadirachtin 1500ppm 0.4% and *M. anisopliae* + *B. bassiana* 0.4% found to be beneficial in the population build-up of coccinellid on okra. However, no significant difference was observed among the treatments in maintaining spider population (Table 5). The present findings were in conformity with Ghosh (2020), according to him none of the treatments significantly reduce the population of spider and coccinellids. From the present investigation, it was found that all the bio-pesticides were congenial for population build-up of natural enemy.

Adult of *Micraspis dicolor*

Adult of *Cheilomenes sexmaculata*

Spider, *Anyphaena accentuata*

4. CONCLUSION

The tomato crop has been ravaged by a variety of insect pests at different stages of the crop, which needs serious attention of researchers. With the reference of the above results of bio pesticidal management of sucking pests of tomato it can be concluded that among the seven treatments tested, Azadirachtin 1500ppm @ 5ml/lit + biogreen-L @ 5ml/lit was found to be the best treatment in reducing *A. craccivora* and *B. tabaci* population which was closely followed by Azadirachtin 1500ppm @ 5ml/lit + garlic extracts @ 5ml/lit. In case of *A. biguttula biguttula* Azadirachtin 1500ppm @ 5ml/lit + garlic extracts @ 5ml/lit showed best result in reducing the population build-up of the pest species followed by Azadirachtin 1500ppm @ 5ml/lit + biogreen-L @ 5ml/lit. The population of natural enemy (coccinellid) was more in Azadirachtin 1500ppm @ 5ml/l treated plots. However, no significant different was observed among the treatments in maintaining spider population. These bio-pesticides are safer for the environment and also proved to be safe for the population build-up of natural enemies which is very helpful to regulate the pest population. Therefore, we should emphasize more on the use of bio-control agents or bio pesticides to overcome the excessive use and misuse of chemical pesticides as well as to increase the quality yield of tomato. Even though the potential demand for bio-pesticides is very high, the real demand from the farming community is very low due to the lack of awareness among the farmers about the benefit of this low cost product. We should trained farmers about the use of bio-pesticide, their benefit and influenced the farmers to adopt the sustainable management practices to manage the pest problem in their respective farm fields.

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COMPETING INTERESTS

The work has been done on sucking insect pests of tomato and to evaluate effectiveness of bio-pesticides to minimize the population build-up of pest species. The results in this manuscript are on the basis of original research conducted at Biswanath College of Agriculture, Assam Agricultural University, Assam, India. No conflict of interest is involved during experimentation.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

AUTHORS' CONTRIBUTIONS

NB designed the experiment. MB conducted the experiment, performed the statistical analysis and wrote the first draft of the manuscript with the help of NB, BKB and PR. BKB helped in identification of insect pests and supervised the findings of this experiment. All authors discussed the results and contributed to the final manuscript.

Disclaimer (Artificial intelligence)

Option 1:

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Details of the AI usage are given below:

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