



EFFICACY OF PLANT PRODUCTS AGAINST LEAFHOPPER *AMRASCA BIGUTTULA BIGUTTULA* (ISHIDA) IN BT COTTON

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ABSTRACT

Field experiments were conducted on Bt cotton at the RRS Abohar and PAU, Ludhiana to evaluate various plant products viz. castor oil, pongamia oil, crude neem oil, sesame oil, linseed oil, garlic extract along with commercial neem-based biopesticides, Nimbecidine (azadirachtin 1500 ppm) and Ecotin (azadirachtin 5000 ppm) against leafhopper, *Amrasca biguttula biguttula* (Ishida) in Bt cotton. Three days after application, maximum mortality was in garlic extract @ 30 ml/l (54.00 and 52.68%) followed by neem oil @ 10 ml/l (49.17 and 47.83%), Ecotin (azadirachtin 5000 ppm) @ 1.5 ml/l (45.39 and 44.17%) at Abohar and Ludhiana, respectively. After five and seven days of second application, it was significantly more with Ecotin @ 1.5 ml/l (44.56, 44.06 and 28.83, 28.17%) followed by neem oil @ 10 ml/l (40.34, 39.95 and 28.28 and 27.67%) and Nimbecidine @ 10 ml/l (37.33, 36.83 and 21.56, 21.17%) at both the locations, respectively. Among various plant products, maximum predator counts were obtained with in garlic extract @ 30 ml/l. Seed cotton yield was also significantly higher in Ecotin @ 1.5 ml/l treated plots.

Key words: *Amrasca biguttula biguttula*, Bt cotton, efficacy, azadirachtin, oils, plant products, garlic extract, Ecotin, Nimbecidine, neem oil, seed cotton yield, predators, mortality

Cotton *Gossypium hirsutum* (L.) is the most important commercial crop, and it is attacked by large number of insect pests. Adoption of genetically modified cotton led to reduction in bollworms incidence but sucking pests namely mealybug, whitefly, thrips and leafhopper emerged as serious pests (Vennila, 2008). Among these, leafhopper, *Amrasca biguttula biguttula* (Ishida) (Hemiptera: Cicadellidae) is a serious pest of cotton in North India. Cotton and okra are most preferred hosts of leafhopper (Hussain and Lal, 1940; Afzal and Ghani, 1946). It has become one of the limiting factors in cotton productivity (Balakrishnan et al., 2007). Among the various measures adopted by farmers to manage leafhopper in cotton, insecticides are the major ones. Many insecticides are recommended, even then control failures had been reported. Among the various factors, development of resistance and resurgence are the major ones (Jeya Pradeepa and Regupathy, 2002; Rohini et al., 2012). To manage these problems, utilization of the natural products may prove to be the best. The information related to the management of the leafhopper with such ecofriendly approaches is very scanty. The present study is carried out to test the efficacy of different plant generated oils against leafhopper in Bt cotton.

MATERIALS AND METHODS

The study on the efficacy of various plants products

against *A. biguttula biguttula* on Bt cotton hybrid, RCH 776 was carried out at two locations namely Abohar and Ludhiana during 2019. The experiment comprised of various treatments namely castor oil @ 20 and 30 ml/l; pongamia oil @ 10 and 20 ml/l; neem oil @ 5 and 10 ml/l; sesame oil @ 6 and 12 ml/l; garlic extract @ 15 and 30 ml/l; linseed oil @ 20 and 30 ml/l; Nimbecidine (azadirachtin 1500 ppm) @ 10 ml/l; Ecotin (azadirachtin 5000 ppm) @ 1.5 ml/l; surf detergent and untreated control. The crop was sown in randomized block design (RBD) having three replications with a plot size of 50 m² each. The crop was raised as per PAU recommended agronomic practices (Anonymous, 2019). The commercially available oils were dissolved in surf detergent powder @ 10g/l of water before the spray. The mixture was stirred properly so that no lumps of surf were seen and then after obtaining a homogenized solution, it was filtered using a white muslin cloth to avoid clogging of the nozzles. The commercial formulations namely Nimbecidine and Ecotin were mixed directly in water without adding any surfactant. The various plant products were sprayed on clear sunny day with manually operated knap sack sprayer, when the population of leafhopper reached ETL (second injury grade). The nymphal counts/ three leaves were taken a day before spray and one, three, five, seven and ten days after spray. The counts of predators namely spiders, coccinellids and chrysopa were also observed

on per plant basis, and the seed cotton yield (kg/ ha) on whole plot basis. The corrected mortality was worked out by using Henderson and Tilton (1955), and the data subjected to ANOVA after appropriate transformation.

RESULTS AND DISCUSSION

Effect of plant products/ oils on *Amrasca biguttula biguttula* when analysed with data obtained from Abohar revealed that during kharif 2019, the nymphs/ three leaves did not differ significantly among treatments before first application. One days after first application, efficacy was superior in Ecotin (azadirachtin 5000 ppm) @ 1.5 ml/ l (33.89%) followed by garlic extract @ 30 ml/ l (29.95%). After three days after spray, garlic extract @ 30 ml/ l (52.40%) was superior followed by neem oil @ 10 ml/ l (47.50%) and others. After five days, Ecotin @ 1.5 ml/ l (43.89%) was superior followed by neem oil @ 10 ml/ l (39.72%) and others, results were similar after seven days and ten days. With second application, after three days, garlic extract @ 30 ml/ l (54.00%) was the best followed by neem oil @ 10 ml/ l (49.17%). After five days, Ecotin @ 1.5 ml/ l (44.56%) followed by neem oil @ 10 ml/ l (40.43%) were superior; after seven- and ten-days similar trend was observed. The data obtained from Ludhiana again revealed the superiority of garlic extract @ 30 ml/ l (51.51%) followed by neem oil @ 10 ml/ l (46.67%), after three days of first spray. After five days, Ecotin @ 1.5 ml/ l (42.83%) followed by neem oil @ 10 ml/ l (38.67%) were the best, and similar trend was observed after ten days of spray. With second application, after three days garlic extract @ 30 ml/ l (52.68%) proved the best, and after five days, it was Ecotin (44.06%) followed by neem oil @ 10 ml/ l (39.95%). After seven and ten days, almost similar results were obtained. Seed cotton yield was significantly more with Ecotin @ 1.5 ml/ l (24.63 q/ ha), neem oil @ 10 ml/ l (24.47 q/ ha) and garlic extract @ 30 ml/ l (24.43 q/ ha) (Table 1).

From the above results, it can be concluded that Ecotin (azadirachtin 5000 ppm) @ 1.5 ml/ l, neem oil @ 10 ml/ l, nimbecidine @ 10 ml/ l and pongamia oil @ 20 ml/ l were more effective up to seven days of its application. However, garlic extract @ 30 ml/ l proved superior up to five days of spray. These observations corroborates with the earlier ones of Verma et al. (1989), Natarajan and Sundaramurthy (1990), Raju et al. (1992), Uthamasamy and Gajendran (1992) on the effect of neem oil 0.5% containing 0.1% Teepol as surfactant and NSKE (neem seed kernel extract) @ 5%. Natarajan et al. (2000) also revealed that NSKE and garlic extract

were effective against leafhopper. Azadirachtin 1500 ppm @ 1000 ml/ ha, neem oil and garlic extract were found effective (Prathibhan and Ananthan, 1998; Iqbal et al., 2015). Rajput et al. (2017) showed that neem oil, linseed oil showed efficacy. Khanzada and Khanzada (2018) and Ullah et al. (2015) revealed that garlic extract was effective.

Pooled data on the effect of plant products on predators (chrysopa, coccinellid beetle and spiders) in Bt cotton at Abohar during kharif 2019 revealed that counts of predators/ plant after three days of spray was significantly higher in garlic extract @ 15 ml/ l (6.11), sesame oil @ 6 ml/ l (6.06), linseed oil @ 20 ml/ l (5.78), garlic extract @ 30 ml/ l (5.55), castor oil @ 20 ml/ l (5.50), pongamia oil @ 10 ml/ l and sesame oil @ 12 ml/ l (5.44) as compared to all other treatments (Table 2); after seven days of spray, significantly higher predator population was recorded in garlic extract @ 30 ml/ l (6.06) and other oils, and similar trend was observed after 10 days of spray. The pooled data obtained from Ludhiana after three days revealed significantly higher counts of predators/ plant again with garlic extract @ 15 ml/ l (6.78), followed by other oils; after seven days and ten days also almost similar results were obtained. Thus, it can be concluded that garlic extract, sesame oil, castor oil and pongamia oil are safe to the predators. Abdullah et al. (2017) reported that neem seed extracts @ 4 and 6% against leafhopper in Bt and non Bt cotton had least effect on natural enemies like Chrysopa, coccinellids and spiders. Among the plant products Ecotin @ 1.5 ml/ l up to seven days and garlic extract @ 30 ml/ l up to five days of sprays are effective against cotton leafhopper. Also, garlic extract, sesame oil, castor oil and pongamia oil are safe to the predators in Bt cotton.

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Table 1. Efficacy of plant products and oils against *A. biguttula biguttula* on Bt cotton

Treatment	Dose/l	No. of nymphs/3 leaves	Mortality of nymphs (%)						No. of leafhopper/3 leaves	Mortality of nymphs (%)						Seed cotton yield (q/ha)
			First application			Second application				First application			Second application			
			Before spray	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS		Before spray	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
Abohar																
Castor oil	20 ml	5.89	15.06 (22.82)	26.72 (31.1)	23.45 (28.95)	14.06 (22.00)	10.83 (19.21)	5.00 (2.45)	15.83 (23.44)	27.67 (31.72)	24.61 (29.73)	14.89 (22.69)	11.83 (20.8)	23.33		
Castor oil	30 ml	5.75	17.89 (25.01)	35.72 (36.64)	29.56 (32.91)	17.50 (24.71)	12.06 (20.30)	4.73 (2.39)	18.89 (25.75)	37.00 (37.14)	30.06 (33.22)	18.56 (25.51)	13.11 (21.22)	23.73		
Pongamia oil	10 ml	5.95	18.78 (25.67)	32.28 (34.60)	26.00 (30.64)	15.6 (23.26)	11.50 (19.81)	4.89 (2.43)	19.55 (26.23)	33.56 (35.39)	26.61 (31.04)	16.56 (24.00)	12.67 (20.79)	24.27		
Pongamia oil	20 ml	6.17	21.83 (27.84)	40.50 (39.51)	34.94 (36.22)	18.83 (25.71)	13.50 (21.54)	4.50 (2.34)	22.78 (28.49)	40.94 (39.77)	35.83 (36.76)	19.61 (26.27)	14.44 (22.33)	24.40		
Neem oil	5 ml	5.84	20.44 (26.87)	38.78 (38.50)	32.56 (34.78)	21.17 (27.37)	17.22 (24.50)	4.39 (2.32)	21.11 (27.34)	40.72 (39.64)	32.61 (34.81)	22.06 (28.00)	17.89 (24.99)	24.43		
Neem oil	10 ml	6.27	24.22 (29.47)	47.50 (43.55)	39.72 (39.05)	27.34 (31.51)	17.78 (24.92)	4.11 (2.26)	25.06 (30.02)	49.17 (44.50)	40.34 (39.41)	28.28 (32.11)	18.61 (25.55)	24.90		
Sesame oil	6 ml	5.89	17.83 (24.07)	28.80 (32.50)	23.22 (28.80)	13.83 (21.82)	10.78 (19.13)	5.11 (2.47)	16.06 (23.61)	30.33 (33.41)	24.22 (29.47)	15.22 (22.94)	11.67 (19.96)	23.60		
Sesame oil	12 ml	5.89	19.89 (26.47)	36.89 (37.38)	32.17 (34.54)	17.61 (24.80)	12.39 (20.89)	5.00 (2.45)	17.28 (24.55)	36.22 (36.99)	32.45 (34.71)	17.78 (24.93)	13.39 (21.44)	23.97		
Nimbecidine (azadirachtin 1500 ppm)	10 ml	6.56	23.67 (30.00)	44.11 (41.60)	36.55 (37.18)	20.95 (27.22)	14.11 (22.05)	4.60 (2.37)	24.45 (29.62)	45.78 (42.56)	37.33 (34.65)	21.56 (27.65)	13.78 (21.78)	24.63		
Linseed oil	20 ml	5.89	16.89 (24.25)	26.22 (30.78)	21.94 (27.92)	13.17 (21.26)	9.94 (18.37)	5.28 (2.50)	17.72 (24.88)	27.67 (31.72)	22.17 (28.06)	14.06 (22.01)	10.50 (18.82)	22.77		
Linseed oil	30 ml	5.83	17.83 (24.97)	34.22 (35.79)	30.50 (33.51)	16.17 (23.70)	11.22 (19.55)	5.00 (2.45)	19.05 (25.86)	33.11 (35.12)	27.78 (31.78)	16.17 (23.70)	12.33 (20.55)	23.17		
Garlic extract	15 ml	6.28	21.61 (27.69)	41.89 (40.03)	27.55 (31.65)	17.17 (24.46)	8.78 (17.22)	4.61 (2.37)	22.44 (28.27)	42.61 (40.74)	28.17 (32.04)	17.61 (24.80)	7.89 (16.30)	24.17		
Garlic extract	30 ml	5.72	29.95 (33.16)	52.40 (46.36)	31.94 (34.40)	21.61 (27.69)	12.67 (20.83)	4.28 (2.30)	29.39 (32.81)	54.00 (47.28)	32.39 (34.67)	22.22 (28.11)	14.28 (22.19)	24.83		
Ecotin (azadirachtin 5000 ppm)	1.5 ml	6.50	33.89 (35.59)	45.11 (42.18)	43.89 (41.47)	27.95 (31.90)	19.89 (26.47)	4.22 (2.28)	36.34 (37.06)	45.39 (42.34)	44.56 (41.86)	28.83 (32.43)	21.17 (27.38)	24.97		
Surf	10g	6.50	14.28 (22.19)	6.89 (15.20)	3.83 (11.27)	1.78 (7.61)	1.00 (5.74)	7.44 (2.91)	13.39 (21.45)	7.45 (15.83)	4.11 (11.68)	2.56 (9.10)	2.17 (8.45)	20.73		
Untreated control	--	5.89	6.17 (0.81)	6.67 (0.89)	6.89 (0.86)	7.28 (1.03)	7.89 (1.31)	7.89 (0.09)	8.17 (0.87)	8.67 (0.93)	9.00 (1.19)	9.33 (1.57)	10.11 (1.47)	20.43		
LSD (p=0.05)	--	NS												0.48		
Ludhiana																
Castor oil	20 ml	5.22	14.00 (21.96)	25.83 (30.53)	22.50 (28.30)	13.56 (21.59)	10.06 (18.48)	5.11 (2.47)	15.00 (22.77)	26.83 (31.18)	23.84 (29.21)	14.22 (22.13)	11.06 (19.41)	22.90		

(Table 1 contd.)

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Castor oil	30 ml	5.09	16.95 (24.30)	35.00 (36.25)	27.95 (31.89)	16.89 (24.25)	11.28 (19.60)	4.85 (2.42)	17.95 (25.05)	36.17 (36.95)	29.28 (32.74)	17.89 (25.00)	12.28 (20.49)	23.30
Pongamia oil	10 ml	5.33	17.67 (24.84)	31.33 (34.02)	24.50 (29.65)	14.89 (22.69)	10.78 (19.156)	5.00 (2.45)	18.67 (25.59)	32.50 (34.74)	25.83 (30.53)	15.89 (23.48)	11.78 (20.06)	23.83
Pongamia oil	20 ml	5.50	20.83 (27.14)	39.22 (38.76)	33.83 (35.55)	18.17 (25.21)	12.67 (20.84)	4.72 (2.39)	21.78 (27.81)	40.05 (39.25)	35.17 (36.36)	19.11 (25.91)	13.61 (21.63)	23.97
Neem oil	5 ml	5.13	19.33 (26.07)	37.89 (37.98)	31.56 (34.16)	20.44 (26.87)	16.11 (23.65)	4.61 (2.37)	20.33 (26.79)	39.06 (38.66)	31.56 (34.15)	21.39 (27.53)	17.05 (24.37)	24.07
Neem oil	10 ml	5.53	23.17 (28.75)	46.67 (43.07)	38.67 (38.44)	26.67 (31.08)	17.00 (24.34)	4.31 (2.30)	24.22 (29.47)	47.83 (43.74)	39.95 (39.18)	27.67 (31.72)	17.94 (25.05)	24.47
Sesame oil	6 ml	5.18	17.39 (24.63)	27.94 (31.90)	22.17 (28.07)	13.05 (21.17)	9.89 (18.31)	5.33 (2.52)	14.88 (22.67)	28.83 (32.46)	23.17 (28.76)	14.56 (22.41)	10.95 (19.31)	23.17
Sesame oil	12 ml	5.17	18.83 (25.71)	35.94 (36.82)	31.17 (33.92)	16.78 (24.17)	11.61 (19.91)	5.18 (2.49)	16.28 (23.78)	35.06 (36.29)	31.78 (34.30)	17.11 (24.43)	12.61 (20.79)	23.53
Nimbecidine (azadirachtin 1500 ppm)	10 ml	5.82	22.61 (28.38)	43.17 (41.06)	35.56 (36.59)	20.22 (26.71)	13.33 (21.40)	4.77 (2.40)	23.61 (29.06)	44.39 (41.76)	36.83 (37.35)	21.17 (27.38)	13.33 (21.40)	24.20
Linseed oil	20 ml	5.11	15.67 (23.30)	25.28 (30.17)	20.83 (27.14)	12.33 (20.54)	9.17 (17.62)	5.50 (2.55)	16.67 (24.08)	25.89 (30.57)	21.39 (27.53)	13.45 (21.50)	9.67 (18.10)	22.33
Linseed oil	30 ml	5.14	16.78 (24.15)	33.22 (35.18)	29.39 (32.81)	18.50 (23.18)	10.44 (18.84)	5.22 (2.49)	17.94 (25.05)	32.06 (34.47)	30.50 (33.45)	15.56 (23.22)	11.89 (20.16)	22.77
Garlic extract	15 ml	5.55	20.50 (26.91)	40.50 (39.51)	26.83 (31.18)	16.50 (23.95)	7.61 (15.99)	4.83 (2.41)	21.50 (27.61)	41.50 (40.09)	27.50 (31.61)	17.44 (24.68)	8.89 (17.31)	23.70
Garlic extract	30 ml	5.06	28.95 (32.54)	51.51 (45.85)	30.50 (33.50)	20.89 (27.18)	11.56 (19.85)	4.50 (2.35)	28.61 (32.33)	52.68 (46.52)	31.67 (34.23)	21.89 (27.88)	12.72 (20.88)	24.43
Ecofin (azadirachtin 5000 ppm)	1.5 ml	5.83	36.28 (37.02)	43.17 (41.05)	42.83 (40.86)	26.50 (30.97)	19.28 (26.03)	4.33 (2.31)	35.67 (36.66)	44.17 (41.63)	44.06 (41.47)	28.17 (32.03)	20.44 (26.87)	24.63
Surf	10g	5.80	12.95 (21.08)	6.11 (14.29)	3.11 (10.13)	1.44 (6.89)	0.83 (5.18)	7.17 (2.86)	12.72 (20.88)	6.95 (15.27)	3.72 (11.12)	1.89 (7.84)	1.89 (7.89)	19.83
Untreated control	--	5.06	5.17	5.67	6.11	6.83	7.28	7.28	7.44	7.83	8.11	8.39	9.17	19.93
LSD (p=0.05)	--	NS	(1.00)	(1.30)	(1.26)	(0.94)	(1.06)	(0.09)	(1.07)	(0.83)	(1.80)	(1.21)	(1.20)	0.66

Mean of three replications; DAS: Days after spray; Figures in parentheses are sine transformed values

Table 2. Effect of plant products and oils on predators in Bt cotton

Treatment	Dose/ l	*No. of predators/ plant RRS Abohar					*No. predators/ plant PAU, Ludhiana						
		Before spray	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	Before spray	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS
Castor oil	20 ml	6.94	4.83	5.50	4.61	5.83	6.22	7.78	5.50	6.17	5.28	6.50	6.89
Castor oil	30 ml	6.00	4.50	5.17	4.83	5.28	5.39	6.83	6.17	5.83	5.50	5.94	6.06
Pongamia oil	10 ml	6.72	4.78	5.44	5.55	5.61	5.78	7.56	5.44	6.11	6.22	6.28	6.44
Pongamia oil	20 ml	6.50	4.67	5.33	5.17	5.28	6.17	7.33	5.33	6.00	5.83	5.95	6.83
Neem oil	5 ml	5.94	3.83	4.50	4.50	4.44	5.50	6.78	4.50	5.17	5.17	5.11	6.17
Neem oil	10 ml	6.06	3.83	4.22	4.28	4.17	5.44	6.89	4.50	4.89	4.94	4.83	6.11
Sesame oil	6 ml	7.00	5.39	6.06	5.83	5.11	6.22	7.89	6.05	6.72	6.50	6.11	6.89
Sesame oil	12 ml	6.00	4.78	5.44	5.28	5.33	5.39	6.89	5.44	6.11	6.28	6.00	6.06
Nimbecidine (azadirachtin 1500 ppm)	10 ml	6.83	3.50	4.17	4.11	4.17	5.94	7.67	4.17	4.83	4.78	4.83	6.61
Linseed oil	20 ml	7.11	4.78	5.78	5.50	5.78	5.33	7.94	5.44	6.44	6.17	6.44	6.00
Linseed oil	30 ml	6.83	4.44	5.11	4.94	4.67	6.17	7.67	5.11	5.78	5.61	5.33	6.83
Garlic extract	15 ml	6.05	5.44	6.11	6.05	5.78	6.00	6.89	6.11	6.78	6.72	6.44	6.67
Garlic extract	30 ml	6.89	4.89	5.55	5.44	6.06	6.39	7.78	5.55	6.22	6.10	5.72	7.06
Ecotin (azadirachtin 5000 ppm)	1.5 ml	6.28	4.44	5.11	5.17	5.11	5.44	6.89	5.11	5.78	5.83	5.78	6.11
Surf	10g	7.50	4.00	4.55	4.72	5.22	5.22	8.33	4.67	5.22	5.39	5.89	5.89
Untreated control	--	6.50	6.78	7.11	7.67	8.22	8.44	7.33	7.44	7.78	8.33	8.89	9.11
LSD (p=0.05)	--	NS	0.63	0.68	0.88	0.75	0.72	0.79	0.72	0.58	0.70	0.67	0.64

Mean of three replications; DAS: Days after spray; *Predators include Chrysopa, coccinellids and spiders

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