Bio-Efficacy of Agro Clean, A Bioproduct Against Sucking Insect Pests of *Bt* Cotton

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ABSTRACT

An experiment was conducted during two consecutive *kharif* seasons of 2013-14 and 2014-15 in order to evaluate the bio-efficacy of agro clean, a bioproduct @ 1, 2, 3 and 4% along with NSKS @ 5% and imidacloprid 17.8 SL @ 0.008% as standard check against sucking insect pests of *Bt* cotton. The results of the field efficacy experiment showed that the standard check, a synthetic insecticide imidacloprid 17.8 SL @ 0.008% was found highly effective in reducing the population of aphid, leaf hopper, thrips and whitefly in cotton followed by biopesticides, agro clean @ 3 and 4%. The seed cotton yield was also recorded significantly the highest in imidacloprid 17.8 SL @ 0.008 (31.05 q/ha) followed by agro clean @ 4% (28.32 q/ha) and agro clean @ 3% (26.90 q/ha). Considering the results of bio-efficacy and yield, agro clean, a bioproduct of M/s Shukla Ashar Impex Private Limited, Rajkot @ 3 and 4% was found effective against major sucking pests in *Bt* cotton.

Key words: Bio-efficacy, sucking insect pests, agro clean, *Bt* cotton, seed cotton yield

INTRODUCTION

Cotton is an important commercial crop, designated as ‘king of fibre crops’ and is prone to insect pests attack at various stages of crop growth. World total cotton production was 120.97 million bales from the 34.35 million hectares of total cultivated area and 767 kg/hectare productivity in 2012-13 (Anon., 2013). Among the variety of reasons of low yield, the magnitude of insect-pests, which damage (average 5-10 percent) the cotton crop from sowing to maturity, plays an important role. The severe attack of insect pests causes heavy qualitative and quantitative yield losses varying from 40-50 per cent (Naqvi, 1976). India is the third largest consumer of pesticides in the world and highest among the South Asian countries. Insecticides account for 60% of total pesticides consumed in India, out of which natural pesticides (including botanicals) consumption is a meagre 2% (Agnihotri, 2000). Botanicals are now emerging as a viable component of integrated pest management (IPM) strategies for all crops due to their efficacy to managing pests, environmental and public health safety, eco-friendly nature and cost effectiveness. Botanical pest control is a distinct possibility in subtropical countries which are endowed with the biodiversity of such plants. Introduction of synthetic pyrethroids resulted in resurgence of sucking pests in cotton

especially the whitefly, *Bemisia tabaci* Gennadius (Ajri *et al*., 1986 and Patil *et al*., 1986). Introduction of *Bt* cotton, resulted in the suppression of major bollworms like *Helicoverpa*. However, year after year, the infestation of sucking pests is in increasing trend. A wide range of insecticides have proved as effective weapons in reducing the pest population. However, negligence of the principles in the crop protection, indiscriminate and extensive use of synthetic pesticides led to problems like insecticidal resistance, pest resurgence and destruction of natural enemies. Therefore, to overcome the above problems, discovery of new bioproduct is essential which are effective and have least exposure in the environment. Some plant products have pesticide properties against sucking pests (Parmar, 1995; Schmutterer and Singh, 1995; Haris, 2001). Chemical pest control agents are extensively used in all countries of the world but they are regarded as ecologically unacceptable. Therefore, there is an increased social pressure to replace them gradually with biopesticides which are safe to humans and non-target organisms. The harmful environmental implications of the synthetic chemicals have compelled to search for some alternative methods. This leads to increased development of compounds based on the models of naturally occurring toxins of biological origin, having various biological activities. Biopesticides include a broad array of microbial pesticides, biochemical derived from micro-organisms and other natural sources and processes involving the genetic modification of plants to express genes encoding insecticidal toxins. In view of this, an attempt was made to determine the bio-efficacy of agro clean, a bioproduct at various doses against sucking insect pests of *Bt* cotton.

Agro Clean, a product of M/s. Shukla Ashar Impex Private Limited, Rajkot is fundamentally an augmented bio-remediation technology derived from a relatively new field of advanced materials science known as organic colloidal chemistry. Using proprietary manufacturing process, renewable, sustainable plant and vegetable oils are blended to create a truly eco-friendly particle that is too small and able to penetrate and emulsify complex organic molecules quickly and easily. Agro Clean makes impacts on the pest by disrupting the molecular structure of chitin and other protein substances those protect insect. This action triggers the rapid deterioration of the insect spiracles and tracheal system resulting in suffocation. Agro clean has a favourable mammalian toxicity coupled with a low toxicity to beneficial insects and predatory mites. As such, it is considered an important addition in pest management programmes in various agricultural systems for controlling the diversity of sucking pests.

MATERIALS AND METHODS

Field experiment was conducted at Agronomy farm, B. A. College of Agriculture, AAU, Anand during two consecutive *kharif* seasons of 2013-14 and 2014-15 in Randomized Block Design with seven treatments and three replications to determine the bio-efficacy of agro clean, a bioproduct at various doses against sucking insect pests infesting *Bt* cotton (RCH- 2 BG-II). The treatments are agro clean (agro clean @ 1, 2, 3 and 4%) and two standard checks *viz*., Neem Seed Kernel Suspension (NSKS) @ 5% and imidacloprid 17.8 SL @ 0.008%. The respective chemical treatments were sprayed on cotton as and when sucking insect pest population reached to ETL using knapsack sprayer with high volume fitted hollow cone nozzle. Altogether, four applications were made at 15 days intervals during both the seasons. The observations on population of sucking pests (*Aphis gossypii* Glover, *Amrasca biguttula biguttula* Ishida, *B. tabaci* and *Thrips tabaci* Lindeman) were recorded on five plants selected randomly in each plot. On each plant, three leaves were selected randomly from top, middle and bottom canopy and population counts were made before the first spray

as well as on 5, 10 and 15 days after each spray. Seed cotton yield was also recorded plot-wise and converted in to q/ha. The data on populations of the sucking pests were subjected to square root transformation before statistical analysis following Gomez and Gomez (1984) to test the significance of treatment effects.

RESULTS AND DISCUSSION

Effect on aphid, *A. gossypii*

The pooled mean data on aphid population during 2013-14 and 2014-15 was uniform in all the treatments before first spray as treatment difference was non-significant ranging from 12.24 to 12.53/ leaf (Table 1). Among the treatments, imidacloprid 17.8 SL @ 0.008% significantly reduced the aphid population and recorded 3.91 per leaf at five days after spray (DAS). Next best treatment was agro clean @ 4% (6.31 aphids/ leaf) and was at par with agro clean @ 3% (7.12 aphids/ leaf) and found equally effective in reducing aphid population followed by NSKS @ 5% (9.36 aphids/ leaf). Among the treatments, the highest aphid population was recorded in agro clean @ 1% (11.40 aphids/ leaf) at 5th day after spray. More or less same trend of effectiveness was noticed after 10 DAS as observed after 5 DAS. After 10 days of spray, the aphid population slightly increased in all the treatments during both the years. The pooled data revealed that all the insecticidal treatments were significantly superior to untreated control. Imidacloprid 17.8 SL @ 0.008% was found most effective in reducing aphid population (3.66/ leaf) was at par with Agro clean at 4% (5.90/ leaf). The highest (11.33/ leaf) aphid population was noticed in treatment with Agro clean at 1% followed by Agro clean at 2% and proved inferior treatments.

Effect on leaf hopper, *A. biguttula biguttula*

The pooled data (2013-14 and 2014-15) showed that the population of leaf hopper before initiation of spray was uniform with the range of 13.34 to 13.49 per leaf (Table 2). After the 5th, 10th and 15th day of spray, imidacloprid 17.8 SL @ 0.008% was found significantly more effective in controlling the leaf hoppers. Agro clean @ 4% recorded 6.21 leaf hoppers per leaf at five days after application and 4.70 leaf hoppers per leaf at 10 days after application. After 15 days of spray, the leaf hopper population slightly increased in all treatments during both years. Agro clean @ 3% and NSKS @ 5% were the next effective treatments against *A. biguttula biguttula*. Among the evaluated treatments, the highest leaf hopper population was recorded in the plots treated with Agro clean @ 1% (11.96 leaf hoppers/ leaf) and followed by Agro clean @ 2% (Table 2). The pooled data revealed that all the insecticidal treatments were significantly superior to control (Table 2). In all, leaf hopper population was effectively managed with the application of imidacloprid 17.8 SL @ 0.008% followed by Agro clean @ 4%, Agro clean @ 3% and NSKS @ 5%. Agro clean @ 1% and Agro clean @ 2% treated plots registered higher population of leaf hopper and were less effective treatments.

Effect on whitefly, *B. tabaci*

The whitefly population was uniform in all the treatments before first spray as treatment difference was non-significant and the population ranged between 10.86 to 11.13 / leaf (Table 3). After one day, imidacloprid 17.8 SL @ 0.008% was found significantly more effective (3.54 whiteflies/ leaf). Agro clean @ 4% recorded lower population of whitefly *i.e.* 6.26 per leaf after 5th day and 4.47 per leaf after 10th day of spray. In case of agro clean @ 3%, it recorded 7.01 per leaf after 3rd day of spray and 5.16 per leaf after 10th day of spray. After 15 days of spray, the aphid population slightly increased in all treatments during both years. The highest pest population was observed in plots treated with agro clean @ 1% during

both the years. The pooled data over years (Table 3) showed that all the insecticidal treatments were significantly superior to control. Imidacloprid 17.8 SL at 0.008% (3.34 whiteflies/ leaf) and agro clean @ 4% (5.80 whiteflies/ leaf) were found more effective than the rest of the treatments followed by agro clean @ 4%. The lower dose, agro clean @ 4% was found least effective by recording higher whitefly population and proved inferior treatment.

Effect on thrips, *T. tabaci*

The pooled data clearly indicated that the population of thrips before initiation of spray was uniform with a range of 9.23 to 9.42 per leaf (Table 4). After five days of spray, imidacloprid 17.8 SL @ 0.008% found significantly more effective in controlling thrips (3.26 thrips/ leaf). Agro clean @ 4% recorded 5.65 thrips per leaf at 5^{th} day after application; 4.08 thrips per leaf at 10^{th} day after application. Agro clean @ 3% and NSKS @ 5% were found equally effective in reducing thrips population in cotton. Lower doses of agro clean *i.e.* 2% and 1% were less effective as these treatments registered higher (10.00 and 10.46/ leaf, respectively) number of thrips after 10^{th} days of spray (Table 4). The pooled data revealed that all the treatments were significantly superior to control (Table 4). Thrips population (3.15 /leaf) was effectively managed with the application of imidacloprid 17.8 SL @ 0.008%. Agro clean at 4% recorded lower (5.40/leaf) thrips population which was at par with succeeding dose *i.e.* 3% (5.95 thrips/ leaf) and NSKS at 5% (7.06 thrips/ leaf). Agro clean @ 1% and Agro clean @ 2% treated plots registered higher population of thrips and were proved less effective.

The results of present investigation are in close conformity with the findings of Kranthi *et al.,* (2004) reported that the imidacloprid was more effective on the sucking pests of cotton as compared to conventional insecticides. Preetha *et al.,* (2012) who mentioned that imidacloprid 17.8 SL at the recommended dose of 25 g a.i./ ha was quite promising in reducing the population of aphids. Yazdani *et al.,* (2000) who reported the higher efficacy of imidacloprid against leaf hoppers in cotton. Mustafa (2000) reported that imidacloprid exert almost 72.60% mortality of whitefly. Asi *et al.,* (2008) proved that imidacloprid showed better results against cotton thrips with the mortality of 96.12% at 72 hrs after spray. The scanty of information is available as far as the bioefficacy of agro clean against sucking pests of cotton is concerned. Biopesticides are plant substances to control insect pests (Nzanza and Mashela, 2012) and these naturally occurring substances control pests by non-toxic mechanisms (Bardin *et al*., 2008) while toxic effects of synthetic pesticides cannot be tolerated hence safer insect pest control may be possible by biopesticides application (Adalbert *et al.* 2013). The biopesticides have been used for almost all field crops and vegetables against bollworms, fruit borers, aphids, jassids, thrips, whitefly, diamond back moth etc. by acting act as repellant, anti-feedant and its seeds contain certain chemicals, which inhibits the population of insect pests (Ursani *et al*., 2014). Some plant products have pesticide properties against sucking pests (Sharma, 2007; Anon., 2014). Ghelani (2014) reported that biopesticides were effective in reducing the thrips population in cotton. Singh *et al*. (2011) reported that biopesticides treated plots are superior to control treatment in thrips reduction in onion. Biopesticides coupled with insecticides were effective for the management of thrips in tomato (Bharani *et al*., 2015). Vekaria and Patel (2000) reported significant results with biopesticides for the control of aphids in mustard. The biopesticides are effective in suppressing the larval population of jassids in cabbage (Prasad and Devappa, 2006) and many other insect pests infesting vegetables (Jeyarani and Kennedy, 2004).

Effect on seed cotton yield

Data on seed cotton yield over years (2013-14 and 2014-15) revealed that there was significant impact of biopesticidal treatments on seed cotton yield (Table 5). Imidacloprid 17.8 SL at 0.008%, synthetic insecticide produced significantly the highest (31.05 q/ha) seed cotton yield and it was at par with Agro clean at 4% (28.32 q/ha) followed by Agro clean at 3% (26.90 q/ha). Mandal *et al.* (2008) reported 16.91% to 27.07% increase in yield of cotton over control due to the use of biopesticides.

In nutshell, Agro clean at 3 and 4% was found effective apart from imidacloprid 17.8 SL @ 0.008% for the management of sucking pests infesting *Bt* cotton and also realized the higher yield of seed cotton. The spraying of the biopesticides for sucking pest of cotton can reduce the population of soft bodied insect as well as save the natural enemies in cotton eco-system. This schedule will also benefit in reducing the egg and early instar larval damage of bollworm in proceeding days.

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Table 1. Effect of Agro clean against aphid, *A. gossypii* in *Bt* cotton (Pooled data of 2013-14 and 2014-15)

Treatments	Dose (%)	No. of aphids/ leaf				
		Before spray	5 DAS	10 DAS	15 DAS	Pooled
Agro clean	1	3.59 (12.39)	3.45 (11.40)	3.34 (10.66)	3.52 (11.89)	3.44 (11.33)
Agro clean	2	3.57 (12.24)	3.32 (10.52)	3.19 (9.68)	3.41 (11.13)	3.31 (10.46)
Agro clean	3	3.57 (12.24)	2.76 (7.12)	2.45 (5.50)	2.95 (8.20)	2.72 (6.90)
Agro clean	4	3.58 (12.32)	2.61 (6.31)	2.24 (4.52)	2.74 (7.01)	2.53 (5.90)
NSKS	5	3.57 (12.24)	3.14 (9.36)	2.92 (8.03)	3.22 (9.87)	3.09 (9.05)
Imidacloprid 17.8 SL	0.008%	3.61 (12.53)	2.10 (3.91)	1.74 (2.53)	2.28 (4.70)	2.04 (3.66)
Control	-	3.61 (12.53)	3.78 (13.79)	3.77 (13.71)	3.76 (13.64)	3.77 (13.71)
S. Em. ±	-	0.12	0.17	0.17	0.16	0.17
CD (5%)	-	NS	0.52	0.51	0.51	0.51
CV (%)	-	9.45	11.69	12.07	10.50	11.40

Note: Figures in parentheses are retransformed values; $\sqrt{X+0.5}$ those outside are transformed values; Treatment mean with letter(s) in common are not significant at 5 % level of significance within a column; DAS = Days after spray.

Table 2. Effect of Agro clean against leaf hopper, *A. biguttula biguttula* in *Bt* cotton (Pooled data of 2013-14 and 2014-15)

Treatments	Dose (%)	No. of leaf hoppers/ leaf				
		Before spray	5 DAS	10 DAS	15 DAS	Pooled
Agro clean	1	3.72 (13.34)	3.52 (11.89)	3.40 (11.06)	3.53 (11.96)	3.48 (11.61)
Agro clean	2	3.72 (13.34)	3.37 (10.86)	3.22 (9.87)	3.39 (10.99)	3.34 (10.66)
Agro clean	3	3.71 (13.26)	2.75 (7.06)	2.45 (5.50)	2.93 (8.08)	2.71 (6.84)
Agro clean	4	3.73 (13.41)	2.59 (6.21)	2.28 (4.70)	2.78 (7.23)	2.55 (6.00)
NSKS	5	3.72 (13.34)	3.01 (8.56)	2.90 (7.91)	3.10 (9.11)	3.00 (8.50)
Imidacloprid 17.8 SL	0.008%	3.74 (13.49)	2.08 (3.83)	1.79 (2.70)	2.34 (4.98)	2.07 (3.78)
Control	-	3.72 (13.34)	3.83 (14.17)	3.82 (14.09)	3.85 (14.32)	3.84 (14.25)
S. Em. ±	-	0.12	0.15	0.15	0.13	0.14

CD (5%)	-	NS	0.47	0.45	0.41	0.44
CV (%)	-	9.19	10.65	10.77	9.72	10.37

Note: Figures in parentheses are retransformed values; $\sqrt{X+0.5}$ those outside are transformed values; Treatment mean with letter(s) in common are not significant at 5 % level of significance within a column; DAS = Daya after spray.

Table 3. Effect of Agro clean against whitefly, *B. tabaci* in *Bt* cotton (Pooled data of 2013-14 and 2014-15)

Treatments	Dose (%)	No. of whitefly/ leaf				
		Before spray	5 DAS	10 DAS	15 DAS	Pooled
Agro clean	1	3.37 (10.86)	3.40 (11.06)	3.26 (10.13)	3.47 (11.54)	3.38 (10.92)
Agro clean	2	3.37 (10.86)	3.32 (10.52)	3.20 (9.74)	3.39 (10.99)	3.30 (10.39)
Agro clean	3	3.39 (10.99)	2.74 (7.01)	2.38 (5.16)	2.83 (7.51)	2.65 (6.52)
Agro clean	4	3.41 (11.13)	2.60 (6.26)	2.23 (4.47)	2.70 (6.79)	2.51 (5.80)
NSKS	5	3.40 (11.06)	2.92 (8.03)	2.80 (7.34)	3.03 (8.68)	2.92 (8.03)
Imidacloprid 17.8 SL	0.008%	3.41 (11.13)	2.01 (3.54)	1.66 (2.26)	2.20 (4.34)	1.96 (3.34)
Control	-	3.41 (11.13)	3.62 (12.60)	3.62 (12.60)	3.67 (12.97)	3.63 (12.68)
S. Em. ±	-	0.12	0.16	0.16	0.15	0.16
CD (5%)	-	NS	0.50	0.49	0.47	0.49
CV (%)	-	9.81	11.20	12.02	10.59	11.25

Note: Figures in parentheses are retransformed values; $\sqrt{X+0.5}$ those outside are transformed values; Treatment mean with letter(s) in common are not significant at 5 % level of significance within a column; DAS = Days after spray.

Table 4. Effect of Agro clean against thrips, *T. tabaci* in *Bt* cotton (Pooled data of 2013-14 and 2014-15)

Treatments	Dose (%)	No. of whitefly/ leaf				
		Before spray	5 DAS	10 DAS	15 DAS	Pooled
Agro clean	1	3.13 (9.30)	3.21 (9.80)	3.13 (9.30)	3.31 (10.46)	3.22 (9.87)
Agro clean	2	3.13 (9.30)	3.15 (9.42)	3.05 (8.80)	3.24 (10.00)	3.14 (9.36)
Agro clean	3	3.15 (9.42)	2.60 (6.26)	2.25 (4.56)	2.77 (7.17)	2.54 (5.95)
Agro clean	4	3.14 (9.36)	2.48 (5.65)	2.14 (4.08)	2.66 (6.58)	2.43 (5.40)
NSKS	5	3.12 (9.23)	2.73 (6.95)	2.61 (6.31)	2.90 (7.91)	2.75 (7.06)
Imidacloprid 17.8 SL	0.008%	3.14 (9.36)	1.94 (3.26)	1.58 (2.00)	2.19 (4.30)	1.91 (3.15)
Control	-	3.13 (9.30)	3.48 (11.61)	3.49 (11.68)	3.52 (11.89)	3.50 (11.75)
S. Em. ±	-	0.11	0.13	0.12	0.13	0.13
CD (5%)	-	NS	0.40	0.37	0.41	0.39
CV (%)	-	9.36	10.02	10.37	9.62	9.99

Note: Figures in parentheses are retransformed values; $\sqrt{X+0.5}$ those outside are transformed values; Treatment mean with letter(s) in common are not significant at 5 % level of significance within a column; DAS = Days after spray.

Table 5. Effect of Agro clean applied at different doses on seed cotton yield

Treatments	Yield (q/ha)		
	2011-12	2012-13	Mean
Agro clean @ 1%	21.23	20.23	20.73
Agro clean @ 2%	23.47	21.40	22.43
Agro clean @ 3%	27.33	26.47	26.90
Agro clean @ 4%	29.10	27.53	28.32
NSKS @ 5 %	24.00	23.13	23.57
Imidacloprid 17.8 SL @ 0.008%	32.25	29.85	31.05
Control	19.27	18.47	18.87
S. Em±	1.45	1.83	1.05
CD (5%)	4.46	5.64	3.04
CV (%)	9.94	13.28	11.64