

Research Article



Effect of Different Control Methods on the Population of Sugarcane Whitefly (*Aleurolobus Barodensis* Mask.)

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Abstract | The sugarcane whitefly *Aleurolobus barodensis* Mask has become one of the serious threats to the sugarcane crop in Sindh province and other parts of the sugarcane growing areas. Experiment was conducted on integration of different control methods i.e. cultural, biological, yellow sticky traps and chemical against sugarcane whitefly during February 2016 at PARC-NSTHRI, Thatta, experimental field. The result revealed that lowest number of whitefly (0.38 nymphs + puparia per cm² per leaf) with highest % mortality (79.89) was recorded in T11 (cultural control + biological control + chemical control), followed by T10 (Cultural control + Biological control + Yellow sticky traps) in which recorded 0.48 nymphs + puparia with 74.60% mortality. The next best treatment was T7 (cultural control + chemical control) in which recorded 0.56 nymphs + puparia per cm² per leaf 70.37%, T5 (cultural control + Biological control) in which recorded 0.59 nymphs + puparia per cm² per leaf 63.49% and T6 (cultural control + Yellow sticky traps) in which recorded 0.71 nymphs + puparia per cm² per leaf 62.43%. The intermediate treatment was T9 (Biological control + Chemical control) in which recorded 0.78 nymphs + puparia with 58.73% mortality, followed by T4 (Chemical control) in which recorded 0.84 nymphs + puparia 55.56% mortality and T1 (Cultural control) in which recorded 0.93 nymphs + puparia with 50.79%. However, there is no significant difference between treatments i.e., T1 and T8, T2 and T3 and T6 and T9. The results indicated that, all control methods significantly reduce whitefly infestation and improve cane and sugar yield over control treatment.

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Introduction

Sugarcane (*Saccharum officinarum* L.) is one of the important crops due to its requirement not only for sugar but also as a raw material for several industries worldwide; in Pakistan sugarcane is cultivated under various agro ecological environments (Chohan et al., 2014). Sugarcane is a tropical crop and its maximum growth takes place under hot, humid and sunny

conditions (Junejo et al., 2009). It is ranked fourth in acreage after wheat, cotton and rice (Rasool et al., 2011). In Pakistan sugarcane is cultivated on about 1.341 million hectare; the sugarcane production is about 83.3 million tones and sugar produces 6580111tons from sugarcane and 40,922 tons from sugar beet. Our national average cane yield is 62.11 tones per hectares i.e., 64.10 tons per hectare in Punjab, 61.85 tons per hectare in Sindh and 51.23

tons per hectare in Khyber Pakhtunkhwa. The average recovery 9.79% is in Punjab, 10.55% in Sindh and 9.52% in Khyber Pakhtunkhwa and the national average is 10.02% (PSMA, 2018).

The sugarcane crop is invaded by several insect pests which cause major losses to the crop (Iqbal et al., 2012), and that may cause heavy loss in quality, these include; termites, borers, pyrilla, whitefly, bugs, mites etc., from these insects the whitefly is considered major threat on ratoon crops water logged soils, alkaline soils and soils with low manuring (Bhavani et al., 2013). Danialy, 1985 reported that the whitefly is a serious pest of sugarcane after borers and mite. Whitefly belongs to the family Aleyrodidae; presently 1556 species of whiteflies are published (Martin and Mound, 2007). Two species of whitefly are known to occur including *Aleurolobus barodensis* (Mask.) and *Neomaskellia bergii* (Sign.) (Masood, 2011). The losses due to heavy infestation reaches up to 86% and reduction in sugar recovery up to 1.4-1.8% are recorded. Traditionally for the control of whitefly several insecticidal recommendations have been reported in the past by various workers for the control of this pest at different places (Siddiqi and Saxena, 1960; Sandhu and Singh, 1964; Ananthanarayana et al., 1984).

The resistance among whitefly has been observed due to the extensive use of pesticides that ultimately causes imbalance of the environment and variety of unsolved health issues, also eradicate many of the natural enemies resulting in outbreak of secondary pests, interruption in eco-cycles and biodiversity which renders effective control even more difficult (Carruth and Moore, 1973; Sexena et al., 1992; Armes et al., 1992; Bellows, 2001). Human intervention for the goals of higher yields has created problems for biological control agents (Hodges and Evans, 2005).

Therefore, there is an essential need to develop alternate, economic and environmental friendly methods to suppress population of sugarcane insect pests alone or combination with different control measures including host plant resistance, mechanical, cultural and biological. (Rachappa et al., 2000). The biological control is one of the most successful insect pests control (Pedigo, 2004). Zia et al. (2008) reported that due to application of predator *Chrysoperlla carnea*, observed maximum reduction of whitefly population (57.3%) in August followed by September

(57.14%). Vidya and Balaji (2000) conducted studied on to evaluate performance of *Chrysoperlla carnea* (Stephens) on 6 insect pests of sugarcane and found very good predation on final instars of whitefly nymphs.

Due to high demands towards better control measures of sugarcane whitefly, present studies were designed to carry out in order to provide better strategies with minimum losses to the environment.

Materials and Methods

For the development of Integrated Pest Management strategies against whitefly, experiment was laid out during February 2016 in Randomized Complete Block Design, with three replications at PARC-National Sugar and Tropical Horticulture Research Institute, Thatta, experimental field. The plot size was 50 m² along with 5 row of each variety having 10 meter in length and 1-meter row to row distance. The experiment comprised of twelve treatments including check is as under.

Treatment	Methodology
T1= Cultural control	De-trash the infested leaves twice in the season i.e. August and October
T2= Biological control	Release of <i>Chrysoperlla carnea</i> cards at monthly interval starting from August to November
T3= Yellow sticky traps	Application of yellow sticky traps at monthly interval starting from August to November
T4= Chemical control	Application of pesticide (Fipronil 5SC) @ 1800 ml ha ⁻¹ through irrigation twice in season i.e., August and October
T5 = Cultural control + Biological control	
T6 = Cultural control + Yellow sticky traps	
T7 = Cultural control + Chemical control	
T8 = Biological control + Yellow sticky traps	
T9 = Biological control + Chemical control	
T10 = Cultural control + Biological control + Yellow sticky traps	
T11= Cultural control + Biological control + Chemical control	
T12 = Control (untreated)	

The data were recorded from June to December at fortnight interval. The observations were collected

from 10 plants of middle rows, from each plant fourth leaf was selected for the record of total number of nymphs and puparia, from the 4 cm² upper, middle and lower portion of each leaf and then converted into cm² per leaf. The data were analyzed statistically by using M-stat 8.1 software with the help of an IBM Compatible computer.

Cane yield

Cane Yield data tons ha⁻¹ was recorded from each plot at the time of harvest for comparison of treatments.

Analysis of juice qualities parameters

At maturity of crop, five canes were randomly selected from the bulk produce in each replication. The canes samples were crushed into a cutter grinder, (SCF-L4, Smith Crafts Fabricator, Pakistan) to obtain homogeneous mass for sub-sampling. A 1000 gram of sub sample is pressed for five minutes at 250 bars (3625 psig) with a hydraulic press (SCF-HP-06 Smith Crafts Fabricator, Pakistan). The press separates the sub-sample into the juice portion and bagase portion after juice extraction. The extracted juice and the bagase were used to analyze separately for different quality parameters i.e., Fiber%, Brix%, Pol% and also purity% and CCS%.

Results and Discussion

The study on different varietal characters as well as an effect of whitefly infestation in sugarcane crop categorically described as under.

Whitefly population

Result presented in the Table 1 showed that all the treatments significantly reduced the whitefly population over control. The lowest number of whitefly population (0.38 nymphs + puparia per cm² per leaf) with highest % mortality of whitefly (79.89%) was recorded in T11 where De-trash the infested leaves followed by Release of *Chrysoperlla carnea* and application of pesticide (Fipronil 5SC) @ 1800 ml ha⁻¹ through irrigation, followed by T10 in which recorded 0.48 nymphs + puparia per cm² per leaf with 74.60 % mortality in which de-trash the infested leaves followed by Release of *Chrysoperlla carnea* cards and applied yellow sticky traps was applied. Earlier researchers reported that detrashed of affected leaves help preventing spread of whitefly (Singh et al., 1956; Ananthanarayana et al., 1984).

The next best treatment was T7 (De-trash the infested leaves followed by application of pesticide (Fipronil 5SC) @ 1800 ml ha⁻¹ through irrigation.) in which recorded 0.56 nymphs + puparia per cm² per leaf with 70.37% mortality, followed by T5 (De-trash the infested leaves and Release of *Chrysoperlla carnea* cards) in which recorded 0.59 nymphs + puparia per cm² per leaf with 63.49% mortality and T6 (De-trash the infested leaves and Yellow sticky traps) in which recorded 0.71 nymphs + puparia per cm² per leaf with 62.43% mortality. Bhavani and Rao (2013) reported that removal of infested leaves + spray of imidachloprid gives higher percent mortality of whitefly over control (96.60%) and the removal of infested leaves + spray of dimethoate @ 2ml / lit. gives (80.86%) mortality. Siddiqui et al. (1961) observed the application of parathion at 0.05 percent against the third instars larvae and 0.1 percent against the pupae proved extremely effective with 91.1 and 84.1 % mortality.

The intermediate treatment was T9 (Release of *Chrysoperlla carnea* cards and Application of pesticide (Fipronil 5SC) @ 1800 ml ha⁻¹ through irrigation) which recorded 0.78 nymphs + puparia per cm² per leaf with 58.73% mortality followed by T4 (Application of pesticide (Fipronil 5SC) @ 1800 ml ha⁻¹ through irrigation) which recorded 0.84 nymphs + puparia per cm² per leaf with 55.56 and T1 (De-trash the infested leaves) which recorded 0.93 nymphs + puparia per cm² per leaf with 50.79% mortality.

Table 1: Effect of different treatments on reduction % of whitefly population.

Tr. No	Treatments	Mean±S.E	Reduction% over control
T1	Cultural control	0.93±0.23 c	50.79
T2	Biological control	1.21±0.27 b	35.98
T3	Yellow sticky traps	1.31±0.27 b	30.69
T4	Chemical control	0.84±0.23 cd	55.56
T5	T1 × T2	0.69±0.17 ef	63.49
T6	T1 × T3	0.71±0.15 de	62.43
T7	T1 × T4	0.56±0.14 fg	70.37
T8	T2 × T3	0.97±0.21 c	48.68
T9	T2 × T4	0.78±0.21 de	58.73
T10	T1×T2×T3	0.48±0.12 gh	74.60
T11	T1×T2 × T4	0.38±0.12 h	79.89
T12	Control	1.89±0.44 a	
SE	0.0687		
LSD	0.1351		

The satisfactory treatments were T2 (Release of *Chrysoperlla carnea* cards) which recorded 1.21 nymphs + puparia per cm² per leaf 35.98% mortality followed by T3 (Release of *Chrysoperlla carnea* cards) in which recorded 1.31 nymphs + puparia cm² per leaf with 30.69% mortality. Furthermore, the results indicated that the singly application of biological control and yellow sticky traps showed minimum reduction of whitefly population. However, combination of overall control methods proved significantly best control of whitefly population and increased cane yield.

Cane yield

The data regarding cane yield tons' ha⁻¹ in different treatments is presented in Table 2 indicated that the maximum yield % increase over control was 19.98% in T11 followed by T10 (17.92%), T7 (16.97%), T5 (15.45%), T6 (14.95%), T9 (13.86%), T3 (13.00%), T8 (11.00%), T1 (10.04%), T2 (7%) and T3 (5.11%). Butani (1965) observed that due to attack of sugarcane whitefly in India cause 15-20% reduction in tonnage. Furthermore, it was observed a clear fluctuation trend in increase in cane yield in various treatments. The treatments T2 and T3 when applied singly resulted in minimum increase in yield. Similarly, in T7 (De-trashing of leaves and application of pesticide were applied in combination) also showed a tremendous in percent increase in cane yield. It was further observed that increase in highest cane yield was observed in T11, where all the treatments were applied in combination.

Effect of different treatments on sugarcane juice quality

The data regarding brix%, pol%, purity% and sugar recovery% are given in Table 3 and also showed that the effect of different treatments on brix%, pol%, purity% and sugar recovery%. The detail of results is as under.

Effect on Brix %: The data regarding brix % in different treatments, the results presented (Table 3, Column A) revealed that the maximum brix (20.48%) was recorded from T11, followed by T10 (20.45%), T7 (19.92%), T9 (19.92%), T5 (19.78%), T6 (19.70%), T8 (19.23%), T4 (19.09%), T1 (18.86%), T2 (18.66%), T3 (18.49%) and T12 (17.76%). However, the data regarding the effect of treatments on brix % over control depicted in Table 3, Column-E revealed that maximum percentage increase (15.11%) of brix in T11, followed by T1,

T7, T9, T5, T6, T8, T4, T1, T2 and T3 with 15.11, 12.16, 11.93, 11.33, 10.92, 8.24, 7.45, 6.19, 5.07 and 4.09% increase, respectively.

Effect on pol %: The results regarding pol % in various treatments, the data showed in (Table 3, Column- B) that the treatment T11 exhibited maximum pol (16.01%) in sugarcane followed by T10, T9, T7, T5, T6, T8, T4, T1, T2, T3 and T12 with average 15.94, 15.48, 15.43, 15.29, 15.08, 14.97, 14.47, 14.23, 14.12, 13.96 and 12.97% pol, respectively.

However, the data regarding the effect of treatments on pol % over control treatment (Table 3, column-F) showed that the maximum percent increase (23.50%) of pol was observed in T11, followed by T10 (22.93%), T9 (19.38%), T7 (19.00%), T5 (17.89%), T8 (16.32%), T5 (15.42%), T4 (11.62%), T1 (9.77%), T2 (8.87%) and T3 (7.69%).

Effect on purity %: The data regarding purity percent in sugar samples of different treatments, the result (Table 3, Column-C) revealed that maximum purity (78.18%) was recorded from T11, followed by T10 (77.95%), T9 (77.84%), T8 (77.80%), T7 (77.44%), T5 (77.31%), T6 (77.57%), T4 (75.84%), T2 (75.64%), T3 (75.52%), T1 (75.45%) and T12 (73.00%).

The data regarding the effect of treatments on purity % over control, showed in Table 3, Column-G. The data revealed that the maximum percentage (7.11%) of purity increase in T11, followed by T10, T9, T8, T7, T5, T6, T4, T2, T3 and T1 with average increase 6.80, 6.65, 6.57, 6.09, 5.91, 4.89, 3.89, 3.62, 3.46 and 3.36% purity, respectively.

Effect on CCS %: The results pertaining to CCS (%) in the sugar samples of different treatments, the results is presented in Table 3, Column-D indicated that, maximum (11.20%) CCS of was recorded from T11, followed by T10, T9, T7, T5, T8, T6, T4, T1, T2, T3, and T12 with CCS of 11.11, 10.77, 10.65, 10.58%, 10.42, 10.38, 9.86, 9.64, 9.56, 9.42 and 8.45%, respectively.

The data regarding the effect of treatments on CCS % over control showed in Table 3, Column-H revealed that the maximum percentage of CCS% increase in T11 (32.55%), followed by T10 (31.53%), T9 (27.51%), T7 (26.06%), T5 (25.29%), T8 (23.29%), T6 (22.88%), T4 (16.74%), T1 (14.13%), T2 (13.18%) and T3 (11.52%).

Table 2: Means comparison of the data regarding cane yield (tons ha⁻¹) and increase % in yield over control in different treatments.

Tr. No	Control Methods	Mean Tons ha ⁻¹ (Mean±S.E)	Increase (%) in Yield over control
T1	Cultural control	96.39±0.97 f	10.04
T2	Biological control	93.73±0.95 g	7.01
T3	Yellow sticky traps	92.06±0.62 g	5.11
T4	Chemical control	98.97±0.60 de	13.00
T5	T1 X T2	101.13±0.80 bcd	15.46
T6	T1 X T3	100.69±0.79 cd	14.95
T7	T1 X T4	102.45±0.79 bc	16.97
T8	T2 X T3	97.22±1.13 ef	11.00
T9	T2 X T4	99.73±1.19 de	13.86
T10	T1XT2XT3	103.28±0.91 ab	17.92
T11	T1XT2 X T4	105.09±1.41 a	19.98
T12	Control	87.59±1.51 h	
SE	1.2241		
LSD	2.5387		

Table 3: Effect of different treatments on juice qualities parameters (Mean±S.E).

Tr. No	Brix%	Pol%	Purity%	CCS%	Increase (%) over control			
					Brix%	Pol%	Purity%	CCS%
	A	B	C	D	E	F	G	H
T1	18.86±0.09 d	14.23±0.14 e	75.45±0.36 d	9.64±0.14 e	6.19	9.77	3.36	14.13
T2	18.66±0.11d	14.12±0.06 e	75.64±0.29 d	9.56±0.07 e	5.07	8.87	3.62	13.18
T3	18.49±0.09 de	13.96±0.03 e	75.52±0.18 d	9.42±0.02 e	4.09	7.69	3.46	11.52
T4	19.09±0.24 cd	14.47±0.14 de	75.84±0.46 cd	9.86±0.11 de	7.45	11.62	3.89	16.74
T5	19.78±0.36 abc	15.29±0.19 bc	77.32±0.56 abc	10.58±0.10 bc	11.33	17.89	5.91	25.29
T6	19.70±0.24 abc	15.08±0.08 cd	76.57±0.59 bcd	10.38±0.04 cd	10.92	16.32	4.89	22.88
T7	19.92±0.21 ab	15.43±0.24 abc	77.44±0.36 ab	10.65±0.18 abc	12.16	19.00	6.09	26.05
T8	19.23±0.54 bcd	14.97±0.58 cd	77.80±0.84 ab	10.42±0.47 cd	8.24	15.42	6.57	23.29
T9	19.88±0.25 abc	15.48±0.33 abc	77.84±0.94 ab	10.77±0.31 abc	11.93	19.38	6.65	27.51
T10	20.45±0.27 a	15.94±0.22 ab	77.96±0.23 ab	11.11±0.18 ab	15.11	22.93	6.80	31.53
T11	20.48±0.28 a	16.01±0.18 a	78.18±0.29 a	11.20±0.12 a	15.31	23.50	7.11	32.55
T12	17.76±0.06 e	12.97±0.04 f	73.00±0.37 e	8.45±0.04 f				
SE	0.387	0.344	0.734	0.278				
LSD	0.804	0.713	1.521	0.576				

Conclusions and Recommendations

Based on result from this research, it was observed that application of cultural practices along with chemical followed by cultural with biological and cultural with yellow sticky traps is economically best for growers. Where, application of individual treatment of chemical and cultural gives satisfactory result as compare biological and yellow sticky traps. However, combination of overall control methods

cultural, biological, yellow sticky traps and chemical when applied in combination proved significantly best control of whitefly and increased cane yield. The biological control is environmentally safe, but it is effect on pest is slowly, for the adaptation of biological control it's applied continuously.

Author's Contribution

Illahi Bux Bhatti, conducted experiment; Imran Khatri, designed experiment and reviewed manuscript;

Maqsood Anwar Rustamani, analyzed data; Riffat Sultana: reviewed manuscript arranged data.

References

- Ananthanarayana, K., S. Shunmugasundaram and H. David. 1984. Studies on the insecticidal control of sugarcane whitefly, *Aleurolobus barodensis* mask. Pestol. 8: 9-21.
- Armes, N.J., D.R. Jathar., G.S. Bond and A.B.S. King. 1992. Insecticide resistance in the pod borer, *Helicoverpa armigera* in South India. Pestic. Sci. 34: 355-364. <https://doi.org/10.1002/ps.2780340409>
- Bellows, T.S. 2001. Restoring population balance through natural enemy introductions. Biol. Contr. 21: 199-205. <https://doi.org/10.1006/bcon.2001.0936>
- Bhavani, B. and V.N. Rao. 2013. Management of sugarcane white fly (*Aleurolobus barodensis* Mask.) in north coastal district of Andhra Pradesh, India. Int. J. Soc. Sci. Interdisciplin. Res. 2(9): Online available at www.indianresearchjournals.com
- Butani, D.K. 1965. Bionomics and control of sugarcane whitefly. J. Sci. Technol. 3: 159-167.
- Carruth, L.A. and L. Moore. 1973. Cotton scouting and pesticide use in Eastern Arizona. J. Econ. Entomol. 66: 187-190. <https://doi.org/10.1093/jee/66.1.187>
- Chohan. M., U.A. Talpur, S. Junejo, G.S. Unar, R.N. Pahnwar and I.B. Bhatti. 2014. Selection and evaluation of diverse sugarcane genotypes in 4th stage. J. Anim. Plant Sci. 24(1): 197-203.
- Danialy, M. 1985. Investigation of usage biological control, cultural and chemical methods against sugarcaneborer in Hafttapeh/ Khuzestan/Iran. MSc Thesis, Chamran Univ. Ahvaz, Iran. pp. 114.
- Hodges, G.S. and G.A. Evans. 2005. An identification guide to the whiteflies (Hemiptera: Aleyrodidae) of the Southeastern United States. Florida Entomol. 88(4): 518-534. [https://doi.org/10.1653/0015-4040\(2005\)88\[518:AIGTTW\]2.0.CO;2](https://doi.org/10.1653/0015-4040(2005)88[518:AIGTTW]2.0.CO;2)
- Iqbal, M., Z. Haq, Y. Jamil and M.R. Ahmad. 2012. Effect of pre-sowing magnetic treatment on properties of pea. Int. Agrophys. 26(1): 25-31. <https://doi.org/10.2478/v10247-012-0004-z>
- Junejo, S., M. Chohan, A.A. Junejo, G.M. Kaloi, R.N. Panhwar and M.Y. Arain. 2009. Comparative performance of elite sugarcane genotypes in 4 cycle for cane yield, yield components, quality and borer complex infestation. J. Anim. Plant Sci. 19(4): 1018-7081.
- Martin, J.H. and L.A. Mound. 2007. An annotated check list of the world's whiteflies (Insecta: Hemiptera: Aleyrodidae). Zootaxa. 1492: 1-84.
- Masood, N. 2011. Spatio-temporal trends and integrated management of sugarcane whitefly *Aleurolobus barodensis* (Mask.), (Aleyrodidae:Homoptera) Ph.D. thesis, Depart. Entomol. Univ. Agric. Faisalabad, Pak.
- Pedigo, L.P. 2004. Entomology and pest management. Prentice-hall of India PVT.LTD. New Dehli-1100.
- PSMA. 2018. Annual report, Pakistan sugar mills association, Islamabad, Pakistan, website: www.psmacentre.com
- Rachappa, V., L.K. Naik and J.V. Goud. 2000. Efficacy of different IPM modules against early shoot borer, *Chilo infuscatellus* (Snellon) in sugarcane. Karnataka J. Agric. Sci. 13 (4): 878-881.
- Rassol, A, M.A. Farooq, M. Zubair, M. Jamil, A. Saghir and A. Shahid. 2011. Prospects of intercropping rabi crops in autumn planted sugarcane. Pak. Sugar J. 26: 2.
- Sadhu, J.S. and S. Singh. 1966. Studies on the biology of sugarcane whitefly, *Aleurolobus barodensis* (Maskell). India. J. Sugar. Res. 7: 83-88.
- Sandhu, J.S. and S. Singh. 1964. Studies on the control of sugarcane whitefly, *Aleurolobus barodensis* Mask. in Punjab. India. J. Sugarcane Res. Dev. 8: 301-306.
- Sexena, J.D., S.K. Banerjee and S.R. Sinha. 1992. Pyrethroids resistance in field population of pink bollworm, *Pectinophora gossypiella* Saunders, in India. India. J. Entomol. 54(3): 347-350.
- Siddiqi, Z.A. and A.P. Saxena. 1960. Studies on the control of sugarcane whitefly and effect of its infestation on juice quality. Indian J. Entomol. 22: 99-104.
- Singh, H., A.N. Kalra and J.S. Sandhu. 1956. Sugarcane whitefly (*Aleurolobus barodensis* Mask.) and its control. Indian Sugar. 5: 689-696.
- Vidya, N.K. and S. Balaji. 2000. Preliminary evaluation studies on the feeding preference of *Chrysoperlla carnea* (Stephens) on sugarcane insect pests. Pak. J. Sci. and Indust. Res. 32(12): 820-822.
- Zia, K., F. Hafeez, R.R. Khan, M. Arshad and U.N. Ullah. 2008. Effectiveness of *Chrysoperlla carnea* (Stephens) (Neuroptera: Chrysopidae) on the population of *Bemisia tabaci* (genn.) (Homoptera: Aleyrodidae) in different cotton genotypes. J. Agric. Soc. Sci. 4: 112-6.