A PRELIMINARY STUDY ON VINEGAR-BASED BAIT AND ARTIFICIAL LURE ATTRACTANTS FOR TRAPPING AND MANAGEMENT OF *DROSOPHILA SUZUKII* (MATSUMURA) (DIPTERA: DROSOPHILIDAE) AT CHERRY FRUIT ORCHARDS AT KALAM SWAT PAKISTAN

Sajid Ali khan [1], Muhammad Wahid Khan*[1], Zahid Hussain [1] , Fazal Maula[2], Irshad Ghafoor [3] , and Junaid khan [4]

[1]Department of Plant Protection, University of Agriculture Peshawar, Pakistan

[2] Senior Research Officer, ARI Swat, Pakistan

[3]Department of Rural Development, University of Agriculture Peshawar, Pakistan

[4]Department of Zoology, Hazara University Mansehra , Pakistan

Abstract

The research work on cherry fruit fly management was carried out at kalam Swat, Pakistan. The first experiments performed comprised Artificial fly attractants Methyl eugenol (ME), Cue lure (CL), and Nu-lure (NL) (85:10:5) lure, sugar, and insecticide Diptrax were used in a cherry orchard. while in the second experiment the three different types of vinegar, Apple cider vinegar T1, Red vinegar T2, and White vinegar T3 (95:5) ratio Insecticide baited trap hung with three replications in cherry orchard Kalam. Swat Pakistan. In the case of fly attractants, the ME Baited traps were more efficient (28.58), in contrast to the NL and vinegar base bait, The maximum *Drosophila Suzukii* (Matsumura) (Diptera: Drosophilidae) *(*34.08) from apple cider vinegar were counted in the four weeks duration while Red and White vinegar captured, 25.00 and 17.66 respectively. We conclude that the remarkably high attractiveness and low cost of agricultural-grade Apple cider vinegar make it a useful tool for monitoring two spotted- wing *Suzukii* populations in cherry fruits.

Keywords; vinegar Baited traps, Cherry fruits orchard.

Introduction

Drosophila suzukii is an invasive pest worldwide. its family *Drosophilidae* (Diptera) consists of approximately 4,200 species (Dos Santos *et al.*, 2017). it is native to Asia and currently distributed in the whole world (Garcia, 2020).The two spotted wing *drosophila* has expanded its host range of plants from various types of berries, strawberries to cherries due to its polyphagous nature (Wollmann *et al.*, 2020). The yield losses were reported at 50% in raspberry, black and blueberries 40%, and 33 % in cherries Orchards annually (Bolda, Goodhue, & Zalom, 2010; Walsh *et al.*, 2011).

The females of *Drosophila Suzukii* lay eggs under the soft skin of healthy, ripening fruits by using their sharp and serrated ovipositor, which wounds the host physically and leaves it vulnerable to secondary contagion by pathogens (Cini, Ioriatti, & Anfora, 2012; Sasaki & Sato, 1995).In a study reported in efficacy of wing *Drosophila* that 11-different types of chemical tested bioassay results indicates that Malathion was the most effective insecticide against fly females, whereas malathion, spinetoram, spinosad and lambda-cyhalothrin had similar activity against fly males only but Systemic insecticides are not effective to adult Spotted wing fly and are not recommended for use in a control programme (Smirle, Zurowski, Ayyanath, Scott, & MacKenzie, 2017). As an earlier various methods to be adopted including metallic plastic mulches reduced two spotted wing drosophila populations to 42-51% while larval 52-72% reduction recorded in raspberries orchrds(McIntosh, Atucha, Townsend, Hills, & Guédot, 2022). The *Drosophila Suzukii* was monitored by a researcher on traps baited techniques with a various commercial attractants available at different regions of the world. (Iglesias, Nyoike, & Liburd, 2014; Knight & Hilton, 2012). The earlier research on attractants to wing *drosophila* indicated that the Fermentation products was used research workers to attract *Drosophila* species viz ethanol, acetic acid, and methanol (Becher, Bengtsson, Hansson, & Witzgall, 2010; Lee *et al.*, 2012; Reed, 1938).

An Initial studies conducted in Japan Results that spotted wing *drosophila* was attracted to different types of vine , rice wine, red grape wine (Lee *et al.*, 2012) and as well as home-brewed red grape wine mixed with , cherry fruit juice, table sugar water, and a variety of botanical oils (Gowton, Reut, & Carrillo, 2020) and found the yellow sticky traps were effective to western cherry fruit fly (Wee L Yee, 2018).

The spotted-wing *drosophila* was first reported in Islamabad Pakistan and growers used trapping method, to manage its population from peak. In Khyber Pakhtunkhwa it was early reported in kalam swat Pakistan. The research workers were used different food essence to monitored its population, the bait having strawberry base food essence were found effective in this locality (Khan *et al*., 2019).Therefore there is more need to develop a more efficient and more specific bait to attract *Drosophila Suzukii* on socially acceptable and economically feasible method of baited attractants used in cherry fruit orchards. Keeping in mind the above observations, the cherry fruit fly traps were hung in cherry orchards and investigate the infestation level of fruit fly's species and best cherries fruit fly attractant at Kalam summer station in Swat Pakistan.

Materials and Methods

The research work was conducted on the efficacy of the cherry fruit fly baited traps technique at Kalam Summer station Distract Swat Pakistan. The Kalam summer station has cherry Varieties, The new star, Sasha, Lapins, Stella, Vega, Marchant, and Sylvia were found in an orchard about 15 Years of age. While other varieties Hedle finger, Duron I, Duron II, Duron III, Anila Duron, and Magda are of 23 Years and 33 plants are new germ plasm and are of four years were grown in these summer research stations.

Trapping methodology

In both experiments were used the cone shape plastic traps having 11 cm in size and four holes for entry of fly. The traps were hung at about 6- meter height was maintained to kept traps safe from human intervention. Two experiments were conducted at the same time When the season of the fruits of cherry at full swing at summer station Kalam. The T1(Methyl eugenol) , T2(Cue lure) and T3(Nu-Lure) comprised (85: 10:5) Lure ,sugar and (Diptrax80-SP) Trichlorfon Insecticide ratio selected in first research trials while in the second experiment different vinegars of different brand such as Vinegars of Mitchell's fruit farm limited Lahore brands easily available at Pakistani markets selected .Three Treatments, T1

(Apple cider vinegar), T2 (Red vinegar) and T3 (white vinegar) containing five percent insecticide Route 57-EC ® (Malathion) were used.

Statistical analysis

All the treatments were replicated three times and data were collected on a weekly interval. The two factorial CRD design were used in both experiment, and data analyzed by Statistix.8.1 software.

Results and Discussion

Results of the first experiment show that the three lure baited traps used in the canopy of cherry fruits trees resulted that the Maximum mean numbers (28.58) of fly species *Bactrocera zonata* were counted in Methyl eugenol (ME) while *Bactrocera cucurbitae* (16.41) in Cue lure (CL) and *Bactrocera cucurbitae* ,*Bactrocera tau* .*Bactrocera diversa* and *Drosophila Suzuki* (6.50) were counted in Nu-lure baited traps as shown in Table 1 .In case of Nu-lure or protein bait used in trap to *Drosophila Suzukii* ,our results show similarity to the previous findings (Yousef, Aranda-Valera, & Quesada-Moraga, 2018).The study proved that attractiveness of phagostimulant baits, and Protein bait commercially available in different farm resulting improved insecticidal control, is specific to different groups of dipterans. The product GF-120, Nu-lure Naturalyte (Dow) based on sugars and plant proteins extracts and containing spinosad was effective in reducing infestations of certain Tephritid fruit fly pests (Adandonon, Vayssieres, Sinzogan, & Van Mele, 2009; Wee L Yee & Chapman, 2005).

In the second experiment maximum mean number 34.08 of *drosophila Suzukii* were counted from apple cider vinegar during weekly interval. These were followed by red vinegar and White vinegar with 25.00, 17.66 mean flies recorded in cherry orchard. Our research show similarity to the previous results of different researchers vine and vinegars used as attractants to two spotted wing drosophila (Landolt, Adams, Davis, & Rogg, 2012; Lasa, Aguas-Lanzagorta, & Williams, 2020) .The trap shape and bait color are key factor that is involved in the attractiveness of the two spotted drosophila ,as in earlier study its was reported that dark color e.g. Red color cap trap were more efficient (Basoalto, Hilton, & Knight, 2013). In overall experiment the female ratio of *Drosophila* was maximum as compared male sexes as shown in the Table 2.and Fig1

Table 1.

Means Fruit flies captured by three attractants in summer station at Kalam Swat

Treatment	May-June				Means
	Week1	Week2	Week3	Week4	
Methyl eugenol	30.66 a	25.66 a	28.00 a	30.00 a	28.58 a
Cue lure	24.66 ab	14.33 cd	8.66 de	18.00 bc	16.41 b
Nu-lure®	5.33 e	6.00 e	5.66 e	9.00 de	6.50 c
Mean	20.22 a	15.33bc	14.11 c	19.00 ab	17.167

$LSD_{0.05}$ value for Treatment = 3.79
$LSD_{0.05}$ value for weeks =4.38
$LSD_{0.05}$ value for Treatment*weeks interaction =7.58

Table 2.

Fruit fly's species Drosophila Suzukii captured by three attractants in Kalam Swat

Treatment	No of *Drosophila Suzukii* catch for four weeks duration				
Types of vinegar	Week1	Week2	Week3	Week4	Means
Apple cider vinegar	48.66	33.00	33.33	21.33	34.08 a
Red vinegar	30.33	20.66	29.66	19.33	25.00 b
White vinegar	22.66	13.66	22.33	12.00	17.66 c
Mean	33.88 a	28.44 b	22.44 c	17.55d	25.58

LSD value for treatment = 3.56 at Alpha level. 0.05 LSD value for weeks = 4.11

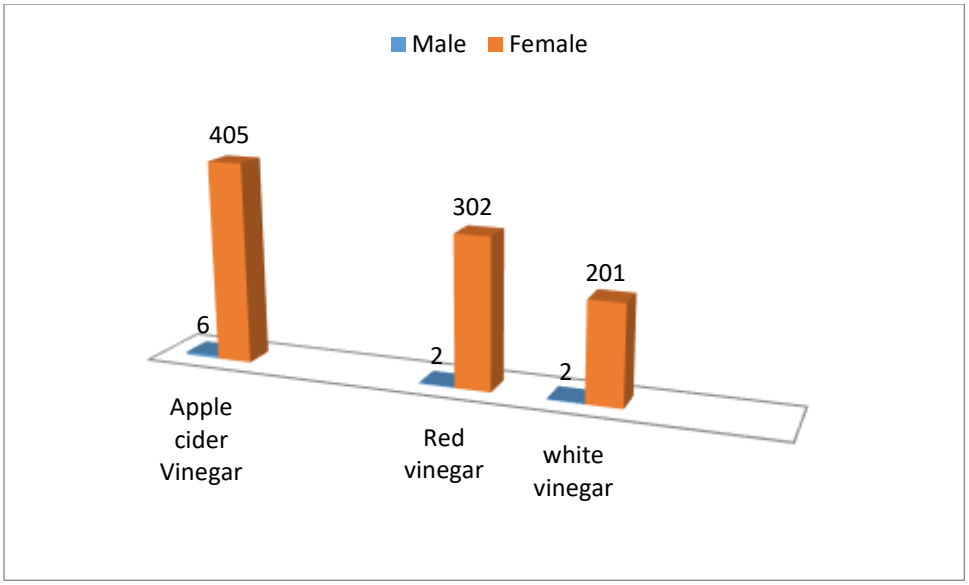

Fig.1 Male and Female ratio of *Drosophila suzukii* captured in vinegar baited traps

Conclusion and Recommendation

The research observations its prove that Para pheromones is not to be used in traps against two *spotted wing drosophila* and in bait applications, Apple cider vinegar is highly effective compared to other attractants. It has been recommended that for extension workers and researchers compulsory to aware the farmers about The *Drosophila Suzukii* were new pest in Kalam in cheery fruits therefore all those methods should be applied in cherry fruits orchards that *drosophila Suzuki* not become serious pest in Kalam. Swat Pakistan.

Declarations

Conflict of interest. The author declares that they have no conflict of interest.

Consent for publication: all the authors have approved that the submission and publication of this paper.

Acknowledgement

The first author thanked Mr. Fazal Maula Senior Research Officer Agriculture Research Institute Swat Pakistan whose suggestion helped prepare the manuscript.

References

Adandonon, A., Vayssieres, J.-F., Sinzogan, A., & Van Mele, P. (2009). Density of pheromone sources of the weaver ant Oecophylla longinoda affects oviposition behaviour and damage by mango fruit flies (Diptera: Tephritidae). Int.J. Pest Manag 55(4), 285-292.

B asoalto, E., Hilton, R., & Knight, A. (2013). Factors affecting the efficacy of a vinegar trap for Drosophila suzikii (Diptera; Drosophilidae). J. Appl. Entomol.137(8), 561-570.

Becher, P. G., Bengtsson, M., Hansson, B. S., & Witzgall, P. J. J. o. c. e. (2010). Flying the fly: long-range flight behavior of Drosophila melanogaster to attractive odors. 36(6), 599-607.

Bolda, M. P., Goodhue, R. E., & Zalom, F. G. (2010). Spotted wing drosophila: potential economic impact of a newly established pest. Agric. Resour. Econ .Update, 13(3), 5-8.

Cini, A., Ioriatti, C., & Anfora, G. (2012). A review of the invasion of Drosophila suzukii in Europe and a draft research agenda for Integrated Pest Management. Bulletin of Insectology 65 (1):149-160.

Dos Santos, L. A., Mendes, M. F., Krüger, A. P., Blauth, M. L., Gottschalk, M. S., & Garcia, F. R. J. P. o. (2017). Global potential distribution of Drosophila suzukii (Diptera, Drosophilidae). 12(3), e0174318.

Garcia, F. R. M. (2020). Introduction to Drosophila suzukii management. In Drosophila suzukii management (pp. 1-9): Springer.

Gowton, C. M., Reut, M., & Carrillo, J. (2020). Peppermint essential oil inhibits Drosophila suzukii emergence but reduces Pachycrepoideus vindemmiae parasitism rates. Scientific reports 10(1), 1-10.

Iglesias, L. E., Nyoike, T. W., & Liburd, O. E. J. J. o. e. e. (2014). Effect of trap design, bait type, and age on captures of Drosophila suzukii (Diptera: Drosophilidae) in berry crops. 107(4), 1508-1518.

Khan, M. S., Ullah, F., Badshah, H., Ahmad, B., Shahjehan, I. A., & Calatayud, P.-A. (2019). Bait attractants based on artificial fruit-essence for trapping and monitoring Drosophila suzukii (Diptera: Drosophilidae) females in Peshawar-Pakistan. Phytoparasitica 47(2), 179-184.

Knight, A., & Hilton, R. (2012). Developing a new bait for spotted-wing Drosophila in organic cherry production. Paper presented at the II International Organic Fruit Symposium 1001.

Landolt, P. J., Adams, T., Davis, T. S., & Rogg, H. (2012). Spotted wing drosophila, Drosophila suzukii (Diptera: Drosophilidae), trapped with combinations of wines and vinegars. Fla. Entomol. 95(2), 326-332.

Lasa, R., Aguas-Lanzagorta, S., & Williams, T. (2020). Agricultural-grade apple cider vinegar is remarkably attractive to Drosophila suzukii (Diptera: Drosophiliadae) in Mexico. Insects, 11(7), 448.

Lee, J. C., Burrack, H. J., Barrantes, L. D., Beers, E. H., Dreves, A. J., Hamby, K. A., . . . Shearer, P. W. J. J. o. e. e. (2012). Evaluation of monitoring traps for Drosophila suzukii (Diptera: Drosophilidae) in North America. 105(4), 1350-1357.

McIntosh, H., Atucha, A., Townsend, P. A., Hills, W. B., & Guédot, C. (2022). Plastic mulches reduce adult and larval populations of Drosophila suzukii in fall-bearing raspberry. J. Pest. Sci 95(1), 525-536.

Reed, M. R. J. P. Z. (1938). The olfactory reactions of Drosophila melanogaster Meigen to the products of fermenting banana. Physiol Zool 11: 317–325.

Sasaki, M., & Sato, R. (1995). Bionomics of the cherry drosophila, Drosophila suzukii Matsumura (Diptera: Drosophilidae) in Fukushima prefecture [Japan], 2: Overwintering and number of generations. *Annual Report of the Society of Plant Protection of North Japan (Japan)*.

Smirle, M. J., Zurowski, C. L., Ayyanath, M. M., Scott, I. M., & MacKenzie, K. E. J. P. m. s. (2017). Laboratory studies of insecticide efficacy and resistance in Drosophila suzukii (Matsumura)(Diptera: Drosophilidae) populations from British Columbia, Canada. 73(1), 130-137.

Walsh, D. B., Bolda, M. P., Goodhue, R. E., Dreves, A. J., Lee, J., Bruck, D. J., . . . Zalom, F. G. (2011). Drosophila suzukii (Diptera: Drosophilidae): invasive pest of ripening soft fruit expanding its geographic range and damage potential. J. Integr. Pest Manag. 2(1), G1-G7.

Wollmann, J., Schlesener, D. C. H., Mendes, S. R., Krüger, A. P., Martins, L. N., Bernardi, D., Garcia, F. R. M. (2020). Infestation index of Drosophila suzukii (Diptera: Drosophilidae) in small fruit in southern Brazil. Arquivos do Instituto Biológico .87.

Yee, W. L. (2018). Efficacies of Rhagoletis cerasi (Diptera: Tephritidae) traps and ammonium lures for western cherry fruit fly. J. Insect Sci .18(3), 14.

Yee, W. L., & Chapman, P. (2005). Effects of GF-120 Fruit Fly Bait concentrations on attraction, feeding, mortality, and control of Rhagoletis indifferens (Diptera: Tephritidae). J. Econ. Entomol.98(5), 1654-1663.

Yousef, M., Aranda-Valera, E., & Quesada-Moraga, E. (2018). Lure-and-infect and lure-and-kill devices based on Metarhizium brunneum for spotted wing Drosophila control. J .Pest Sci 91(1), 227-235.