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Effect of Various Colored Sticky Traps on Pest Population in Different Mango Varieties

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Abstract: *The experiment was carried out on Effect of Various Colored Sticky Traps on Pest Population in Different Mango Varieties at Horticulture Garden, Sindh Agriculture University, Tando Jam from November 2018 to March 2019. The orchard comprises of four mango varieties such as Sindhri, Neelum, Chausa and Saroli. The sticky traps of different colors i.e. yellow; brown and orange were installed on mango trees at 7-8 feet above the ground. The results of the experiment on the monitoring and effect of color traps on attraction of insect pests and predators on different mango varieties revealed that black ants, spiders, Brumus beetle, Zigzag beetle, Damsel fly and three mango pests namely mite, mango mealy bug and mango hoppers were attracted to the color traps. The appearance of adults on traps was recorded from 10-04-2019 to 01-05-2019. However, maximum catches were recorded on 24-04-2019. The total catches of all three traps indicated that the traps installed on Sindhri variety had maximum catches 142,100 adult mango hoppers and mealy bugs followed by Neelum 94, 53, Chaunsa 74, 31, and Saroli 100, 71. Further it was observed that traps installed before 10-04-2019 did not show any catches of hoppers and mealy bug. In the present experiment overall total 260 predators and 674 pests were trapped through three colored stick traps on four mango varieties. Three mango pests namely mango hoppers, mango mealy bug and mite were attracted to the color traps. The maximum 200 mango hoppers and 155 mango mealy bug orange 160, 75 and brown 50, 25, respectively. Further it was observed that traps installed before 10-04-2019 did not show any catches of male hoppers. The 1st appearance of adults was recorded on 10-04-2019 and continued till 01-05-2019. However, maximum catches were recorded on 24-04-2019. Analysis of variance showed that yellow sticky traps attracted significantly more insects ($F = 11.83$, $df = 2$, $P < 0.01$). LSD showed non- significant difference ($P< 0.05$) between insect catches on brown and orange sticky traps. The adult females of both mango hopper and mealy bug collected from the branches of mango plant having sticky traps installed showed significant difference in oviposition. Only 60% female laid their eggs, which were collected from the braches having blue sticky traps installed. Among them 20% laid.>100 eggs while reaming 40% females laid <100 eggs. Similarly, 60% of the females laid their eggs, which were collected from the branches having orange sticky traps, however, 30% of them laid <100 eggs. Only 30% of the females colleted from the branches having yellow color sticky traps laid their eggs. Out of 30%, females 20% laid <100 eggs. It was concluded from the results that the females laid less than 100 or no eggs were considered as unmated females; however, the eggs laid by them could be the result of parthenogenesis reproduction. Since yellow sticky traps effectively captured the adult males as a result majority of females went down the tree without mating.*

Keywords: Pest population; colors sticky traps; mango varieties; Sindhri; Neelum; Chausa; Saroli; mango hopper; .mealy bug.

1. INTRODUCTION

The king of fruits in Pakistan, an edible Mango *Mangifera indica* L. is an evergreen tree belongs to the family Anacardiaceae believed to originate from India or Burma (Myanmar), spread early on to Malaya, eastern Asia and eastern Africa. Mangos were introduced to California (Santa Barbara) in 1880 [3] and second most important fruit crop and also, one of the most important fruits in the world, as well as in Pakistan. In 2017, global production of mangoes led by India with 39% (19.5 million tonnes) of the world total, China and Thailand were the next largest producers [39]. Third largest and fifth exporting country of Pakistan, mango producer in the world [30]. Mango is grown in just under ninety tropical, and subtropical countries of the world. India, China, Mexico, Thailand, the Philippines, Pakistan, Nigeria, Indonesia, Brazil and Egypt are, in that order, the ten most important mango producing countries in the world. Asia, the original home of the fruit, provides approximately 3/4 of the world's mangoes [28]. Mango trees can grow to a height of 45 meters (147.64 feet) and can live for in excess of 100 years. Mango is a delicious fruit that is an excellent source of vitamins B and C, and contains water, protein, sugar, fat, fiber and iron, etc., which are also processed into preserves, juices, jams, jellies, nectars, mangoes crunchy, french fries, sandwiches, young and immature fruits such as pickles, relatives, and murabas, etc. [28], [32]. Pakistan is standing at 5th place by contributing 916.4 MT mangos, which is 3.9 % in the total world production [12], [22]. The mango is grown in Balochistan and KPK, the fruit is grown mainly in Sindh and southern Punjab. Mirpur Khas and Multan are known for their huge mango orchard. Hyderabad, Nawabshah, N.feroz, Khairpur Mirs, R.Y.K., Bhawalpur, Muzzafargarh, Sheikhupura are important areas of mango cultivation in Pakistan. Production of mango in Khanewal, Sahiwal, Vehari, Okara, Faisalabad, Jhang, Toba Tek Singh and Sargodha etc is also considerable [38]. There are many varieties of mango which are being grown and famous in Pakistan, but some are very common i.e, Sindhri, Langra, Chaunsa, Fajri, Samar bahisht, Anwar ratole, Doshehri, Saroli, Tutapari, Neelam, Maldah, Collector, and Began Palli etc. [18]. Pakistani mangoes are mostly yellow when fully ripe, have a strong aroma and a sweet taste, no mango of any origin can compete in taste with the Pakistani mango [5] but production has been threatened by insect and disease problems. Mango hopper *Amritodus atkinsoni* Leth. and mealy bug, *Drosicha mangiferae* Green among the insect-pests are most destructive of mango fruit may lead to complete failure of the crop and causes heavy damage to mango crop. Mango hopper, *Amritodus atkinsoni* Leth. and mealy bug, *Drosicha mangiferae* Green more than 300 insect pests have been recorded to attack mango crop globally as well as serious pests of mango in Pakistan. Mango hoppers damage is mainly caused by both the nymphs and adults of the hoppers puncture and suck the sap due to the sucking of sap from tender shoots, leaves and inflorescence which ultimately affects the fruit setting and dropping of immature fruits, thereby reducing the yield. On heavily infested trees, crop losses of 50% or more have been recorded [23], [1] and [20]. Mango hoppers remain active throughout the year, but the incidence is severe from Feb. to Apr. [24] which are difficult to control by insecticides. Testing several treatments developed IPM strategy. Pheromone sticky traps can effectively attract males from a distance of approximately 91. 44 meters [27], [37],[35], traps are cheap to prepare and easy to install on tree stem. The yellow sticky traps are effective in capturing the adult insects that other color sticky trap [34] and can be used for the controlling and monitoring the population of many pests [21]. The sticky bands along with burning and burying treatments significantly reduced the incidence about 0.00-15.79% infestation by *Drosicha mangiferae*. It is a harmful pest that seriously infests mango trees and could not be controlled by the exclusive use of insecticides, which led to the development of IPM strategies when developing different treatments including the use of sticky bands along with sticky traps that significantly reduced the mealy infestation to 16% [15]. The judicious use of all possible methods to pest control which do not result in the disturbance of environment and no harmful side effects are produced. Therefore preservation and encouragement of the natural enemies is the central feature of the Integrated Pest Management [8]. The present study is planned to evaluate the effect on the mating of the female in the hopper and mealy bug of the mango by using the several colored sticky traps in different mango varieties. The *Dorsicha stebbingi* is the most familiar dimor phic insect pest of mango trees [5]. The results of the experiments will be utilized in planning IPM strategies against mango hopper and mealy bug.

2. MATERIALS AND METHODS

The experiment was carried out in mango orchard infested with mango hoppers and mango mealy bug at Horticulture Garden, Sindh Agriculture University, Tando Jam from November 2018- March 2019. The orchard consists of four mango varieties such as Chaunsa, Saroli, Sindhri and Neelum, total five mango trees from each variety were randomly selected, one from center and four from different sides (North, South, West, and East) of the particular area of the varieties planted in mango orchards. The sticky traps of different colors, i.e., blue, green and yellow were installed on different sides of each tree. East, west and south of the mango trees at 1.5 – 2.15 meters above ground level. The traps were made of clean plastic sheets with a five millimeter grade. The size of each trap was 12” x12”. Grease as adhesive material was applied to the trap for attracting mango hoppers and flying male of mango mealy bugs and the associated predators and parasitoids. The adhesive material was replaced with the fresh one at weekly intervals. The adult female of mango mealy bugs were collected separately while down ward movement from those mango

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branches having color traps installed. The collected females were then released into separate buckets (1.5' high and 1.2' dia) having soil clods to facilitate them to lay eggs. There were ten replications (10 buckets for each color trap) and one female was released in each bucket. After release of the females, the clods were gently taken out from each bucket twice a week to examine any fecundity by the female. The impact of male catches was determined through egg lying of the females. The females who laid greater than 100 eggs were considered as mated females. The eggs laid less than 100 by the female might be the result of parthenogenesis reproduction, and those did not lay their eggs were considered virgin. Finally, the data was statistically analyzed through analysis of variance using Statistix 0.8.

3. RESULTS

The data in figure-01 shows that the five different predators i.e black ants, spiders, *Brumus* beetle, Zigzag beetle, damsel fly and three mango pests namely mite, mango mealy bug and mango hoppers were attracted to the color traps. The maximum catches predators and pests were recorded 480 on yellow sticky traps followed by orange 311 and brown sticky traps 143.

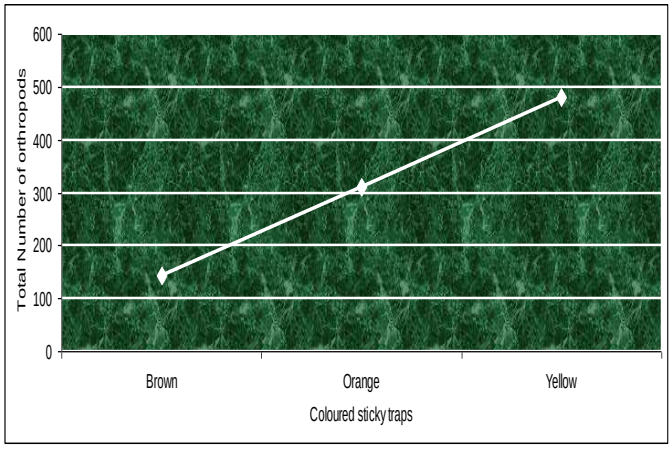

Fig.-01: Total predators and pests were caught through colored sticky traps.

The data in figure-02 shows that three mango pests namely mango hoppers, mango mealy bug and mite were attracted to the color traps. The maximum 200 male mango hoppers were attracted on yellow sticky traps compared with orange 160 and brown 50 and the maximum 155 male mango mealy bug were attracted on yellow and brown orange sticky traps compared with orange 75 and brown 25. Similarly, the maximum 4 mite pest recorded on yellow sticky traps compared with orange 1 and brown 4. Further it was observed that traps installed before 10-04-2019 did not show any catches of male hoppers. The 1st appearance of adults was recorded on 10-04-2019 and continued till 01-05-2019. However, maximum catches were recorded on 24-04-2019. Analysis of variance showed that yellow sticky traps attracted significantly more insects ($F = 11.83$, $df = 2$, $P < 0.01$). LSD showed non- significant difference ($P < 0.05$) between insect catches on brown and orange sticky traps.

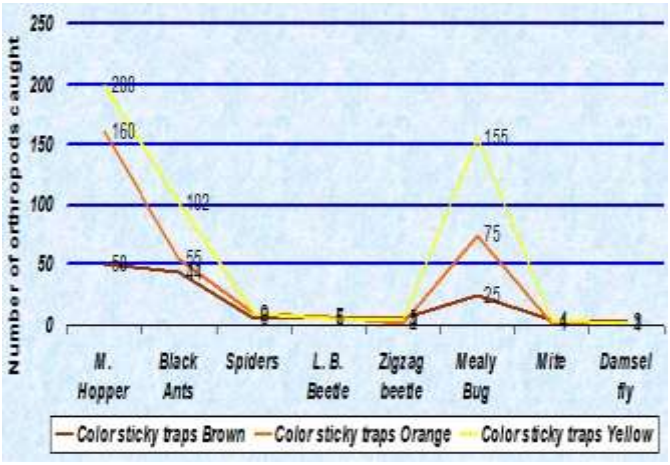

Fig. 02: Population of Mango hoppers, Mealy bug and other arthropods attracted through different coloured sticky traps on different Mango varieties

The data in figure- 03 reveals that maximum catches of males mango hoppers were recorded on Sindhri variety. 12, 50 and 80 on brown, orange and yellow sticky traps, respectively were installed on the branches of Sindhri variety tree. While traps installed on Neelum variety had 16, 48 and 30 on brown, orange and yellow sticky traps, respectively. The traps installed on Chaunsa had 18, 21 and 35 on brown, orange and yellow sticky traps, respectively. Similar on Saroli variety 4, 41 and 55 on brown, orange and yellow sticky traps were installed, respectively. The total catches of all three traps indicated that the traps installed on Sindhri variety had maximum catches 80 male Mango hoppers followed by Neelum 30, Chaunsa 35 and Saroli 55. Similarly, maximum catches of males mealy bug were recorded on Sindhri variety 5, 25 and 70 on brown, orange and yellow sticky traps, respectively were installed on the branches of Sindhri variety tree. While traps installed on Neelum variety had 3, 20 and 30 on brown, orange and yellow sticky traps, respectively. The traps installed on Chaunsa had 6, 10 and 15 on brown, orange and yellow sticky traps, respectively. Similar on Saroli variety 11, 20 and 40 on brown, orange and yellow sticky traps were installed, respectively. The total catches of all three traps indicated that the traps installed on Sindhri variety had maximum catches 142 and 100 male Mango hoppers mango mealy bug followed by Neelum 94 and 53, Chaunsa 74 and 31 and Saroli 100 and 71. While, maximum catches of predators black ants were recorded on Sindhri variety 5, 17 and 35 on brown, orange and yellow sticky traps, respectively were installed on the branches of Sindhri variety tree. While traps installed on Neelum variety had 6, 8 and 22 on brown, orange and yellow sticky traps, respectively. The traps installed on Chaunsa had 8, 22 and 26 on brown, orange and yellow sticky traps, respectively. Similar on Saroli variety 25, 8 and 19 on brown, orange and yellow

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sticky traps were installed, respectively. The total catches of all three traps indicated that the traps installed on Sindhri variety had maximum catches 57 black ants followed by Neelum 36, Chaunsa 56 and Saroli 52. This result was showed minimum damselfly (predator) was recorded 6 on all three traps and mango varieties.

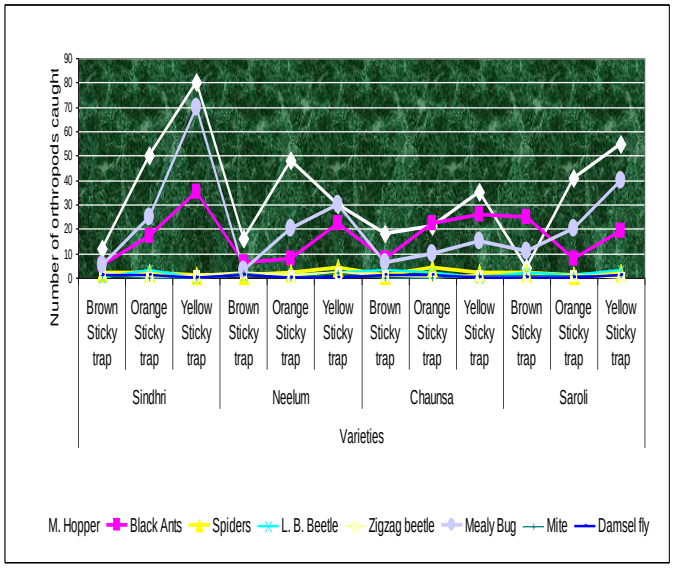

Fig.03: Population of Mango hoppers, Mango mealy bug and other arthropods on different mango varieties in 10th April – 1st May 2019

To determine the impact of male trapping on population development of Mango hopper and mealy bug, the selected adult females of mango hopper and mealy bug were taken from the branches of mango plants haring color sticky traps installed to the laboratory for oviposition. Data in Figure-04 reveals that only 60% females laid less eggs which were collected from the branches having blue sticky traps. Among them 20% females laid.>100 egg while reaming 40% laid <100 eggs. Similarly, 60% of the females laid their eggs that were collected from the branches having green sticky trap. Only 30% of female laid >100eggs. Thirty percent of female laid their eggs, which were collected from the branches having yellow sticky traps. 20% of them laid <100 eggs. It was concluded from the results that the females laid less than 100 or no egg were considered as unmated females; however, less than 100 eggs could be due to the parthenogenesis reproduction. Since the sticky traps especially yellow color effectively captured the male mealy bug that reduced the chance of mating to females, consequently majority of females went down the tree with out mating. Hence, reduced the eggs production in mango hopper and mealy bug.

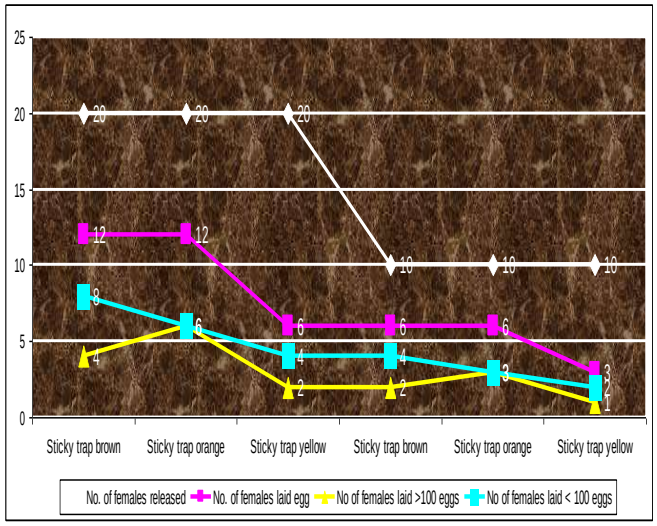

Fig. 04: Fecundity of females of Mango hopper and mealy bug collected from the branches having different color traps installed for male adult caches

The data in figure- 05 shows that the total 674 insect pest i.e., Mango hoppers, mango mealy bug, and mites were attracted to the color traps on four different mango varieties such as Chaunsa, Saroli, Sindhri and Neelum. While, the total 260 predator i.e., black ants, spiders, *Brumus* beetle, Zigzag beetle, and damsel fly were attracted to the color traps on four different mango varieties such as Chaunsa, Saroli, Sindhri and Neelum.

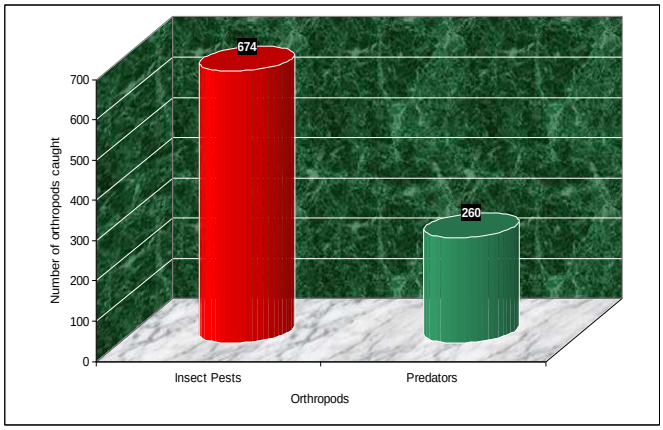

Figure- 05: Population of predators and insect pests on four different mango varieties

4. DISCUSSION

The experiment was carried out on Effect of Various Colored Sticky Traps on Pest Population in Different Mango Varieties at Horticulture Garden, Sindh Agriculture University, Tando Jam from November 2018 to March 2019.

In the present study the arthropods and non arthropods i.e., black ants, spiders, Lady Bird beetle, Zigzag beetle, damsel fly and three mango pests namely mite, mango mealy bug and mango hoppers were attracted to the color traps. The

yellow sticky traps attracted maximum predators and male mango hopper and mealy bug as compared to Organ and followed by brown sticky traps.

Our study agrees with [31] an experiment conducted the attraction of mango hopper *Idioscopus clypealis* to sticky traps of different colors. The number of adults *I. Clypealis* captured in sticky traps of different colors. The yellow color was more attractive with a capture of the largest number of adults of I. *clypealis* (11.53 adults / trap). While the pink and purple colors were less attractive. It was found that yellow sticky traps were more effective in trapping a considerably larger number of hoppers. Our study is related with [2]who studied that yellow trap was consistently the most attractive trap amongst the other trap colors tested with an overall average of 62.6 adults per trap. The traps set up at 25 and 50 cm above the ground captured. The present study partially agrees with those [7] investigated whether commercially available coloured sticky traps can be used as tool to monitor population densities of a pest–predator system and many adults captured by a sticky board [19]. Yellow traps should be used for combined monitoring of pests and predators. The monitoring of the presence of pests and the development of the population in the crop during the season is essential for integrated pest management. Although many tools, for instance coloured sticky traps were developed. This study also partially agrees with [17] evaluated that the preference of nine mango varieties, mango hopper, Idioscopus clypealis (Lethierry) (Hemiptera: Cicadellidae) is considered one of the serious pests of the mango that reproduces in the newly emerged flowers and creates an interruption in the setting of the fruits and the photosynthetic activity of the plant. Therefore, the choice of I. clypealis for mango varieties during the full flowering phase is crucial. Nine different mango varieties: 'Retaul-12', 'Sobey De Ting', 'Black Chaunsa', 'Chaunsa', 'White Chaunsa', 'Dusehri', 'Langra', 'Anwar Retaul' and 'Fajri Klan' were evaluated for their suitability for mango hoppers. [38] studied amongst the eight types of color traps, orange colored traps captured the highest number (145.6±19.7/trap) of P. mangicola adults while white-colored traps captured the lowest numbers (23.7±3.4/trap). The peak adult and larval population was observed on February 11, 2010 and March 2, 2010, respectively. The highest numbers of galls were recorded on different varieties Sufaid Chaunsa, Dusehri, Ratol and Kala Chaunsa (1.74±0.2/leaf). This study also agrees with those [10] described that the preference of insects towards specific colour is a much known phenomenon. Study was conducted using different coloured traps. Most often yellow coloured sticky traps can be used for monitoring and mass trapping as a component of IPM program. The present study is related with [6] Trials were conducted to evaluate the attractiveness of various colors. Colored plates were hung at about 1.70 m from ground level of the exterior canopy of the selected trees positioned toward the 4 cardinal directions. 7 insect species were frequently captured. Sticky colored traps are being widely used for sampling of harmful insects in wild and cultivated plants worldwide. Our study partially agrees with those [9] Most insect predators (e.g. lady beetles, hoverflies, and minute pirate bugs), and parasitic wasps also exhibited preferences to particular trap color characteristics, An effective attraction radius was calculated for each color of trap and species. leafhoppers and hoverflies were captured on red and yellow traps placed 0.1 m above the canopy; while captures of lady beetles were highest on traps placed 0.5 m above the canopy. The current study partially agrees with [25] an experiment conducted that the sticky colored traps blue, yellow and clear were used use of coloured sticky traps clear to control insect pests. The traps were mounted in the middle of the plots 60 cm above the ground just before flowering. The study demonstrated that sticky colored traps have a role to play in the management of insect pests can be used in an integrated pest management strategy to reduce pesticide use in small scale farmers' fields. Coloured sticky insect traps are usually used to monitor pests but can also be used to mass trap insects and reduce the rate of increase of pests. Our study also partially agrees with those [36] Capture of beneficial insects was 1.7 times higher on yellow. The main natural enemies were the predatory ladybird beetles and the pirate insects Orius spp., Followed by a series of less representative predators and parasitoids.

The present study agrees with those [34] reported the responses by adults of *Plutella xylostella* to various colored sticky traps. The vinyl chloride plates showed that more adults were caught on yellow than the other colors tested, including clear, blue and red. Our study also agrees with those [29] suggested that the sticky traps catch pests. Sticky traps a very useful tool for early detection and management of pest populations such as winged aphids, whiteflies, thrips, leafminers, fungus gnats, shore flies and beneficial insects such as the whitefly parasitoid, *Encarsia formos.* Sticky trap colors that reflect certain wavelengths of yellow or blue are often used. White or red traps are also effective for some insects. The most studies show that blue traps are better at capturing western flower thrips and shore flies. The finding of [33], [14] and [12] also favor the use of this technique, they reported that sticky traps are most common types of traps in use, and it employs a sticky surface to retain or immobilize the attracted insects. Sticky traps are generally more efficient at trapping attract to insects. [21] reported that yellow sticky traps can be used to monitor and control many pests. [35] also suggested yellow sticky cards to be used to trap the flying male mealy bugs. Result further showed that the appearance of adults was recorded from April 10, 2019 to May 1st, 2019. However, maximum catches were recorded on April 24th 2019. These finding are in agreement with those of [29] who reported migration of mealy bugs from the tree downwards to the ground and oviposition in the soil are generally confined to the months from April to June. Our study also agrees with those [20] mentioned the emergence period of adults from April to May. The traps installed on the

branches of Sindhri mango variety caught maximum male followed by Sonaro, Chaunsa and Langra mango variety. The maximum male catches on the branches of Sindhri variety reflects maximum population of mealy bug on Sindhri variety. However, the findings of [16] are little deviated; who reported that Chausa retained maximum population. This could be due to maximize plantation of Sindhri variety in Sindh conditions. The impact of male trapping on population of mealy bugs was determined through the fecundity of females, only 30% females laid their eggs, which were collected from the branches having yellow color sticky traps followed by the female collected from green and blue sticky traps. The trapping of males reducing the chance of mating with females, consequently majority of females went down the tree without mating. [35] mentioned that trapping of flying adult male mealy bugs is nothing but to preventing them from mating. Similarly, [37] mentioned that catching of male through pheromone sticky traps diminishing the chance of mating and reproduction of *Planococcus kraunhiae* and successfully reduce damages on fruits by this *Drosicha mangiferaein* in Japanese persimmon orchards.

5. CONCLUSION

On the basis of the study results is concluded that:

The maximum mango hopper attracted yellow sticky traps followed by mealy bug and predators. In the branches of the Sindhri mango variety, the maximum of the male mango hopper and the floury mango mealy bug was captured, followed by the variety Neelum, Chaunsa and Saroli. The capture of the adult males, the hopper and the mealy insect, reduce the possibility of mating with females, so that only 40% of the females of yellow sticky traps were fertilized compared to 60% of females of orange and brown , respectively.

REFERENCES

[1]Adnan, S.M., Uddin, M.M., Alam, M.J., Islam M.S., Kashem, M.S., Rafii, M.Y, Latif, M.A. (2014). Management of Mango Hopper, *Idioscopus clypealis*, Using Chemical Insecticides and Neem Oil, The Scientific World Journal. 2014, Article ID 709614 pages 5 http://dx.doi.org/10.1155/2014/709614

[2]Ahwiyah, E.S., Fatahuddin, Asman, Andi, N. (2017). Effect of sticky trap color and height on the capture of adult oriental fruit fly, Bactrocera dorsalis (Hendel) (Diptera: Tephritidae) on chili pepper. American Journal of Agricultural and Biological Sciences 12 (1): 13.17 DOI:10.3844/ajabssp. 2017.13.17

[3]Anonymous (2019). Mango Description: PlantVillage, https://plantvillage.psu.edu/topics/mango/infos#info-Description

[4]Anonymous (2010). Long tailed Mealybug, UC pest management guideline. http://www.ipm.ucdavis.edu/PMG/r8301811.html

[5]Anonymous (2015). Honey Mango: Mango, the king of fruits is the second major fresh fruit in Pakistan, http://honeymango.se/about.php

[6]Atakan, E. Pehlivan, S. (2015). Attractiveness of various colored sticky traps to some pollinating insects in apple Ekrem. Turkish J. of Zoology 39: 474-481

[7]Böckmann, E. Meyhöfe, R. (2017). Sticky trap monitoring of a pest–predator system in glasshouse tomato crops: are available trap colours sufficient? Journal of App. Ent, Vol. 141(5): 339-351

[8]Bukhari, A.S.S., Khoso, A.G., Ahmed, S.S. (2017). A Quiz of Entomology 1st Ed,, Ch-07, Page,113. Students' Aid Foundation (SAF) Pakistan , ISBN: 978-969-9388-06-4

[9]Cesar, R.S., Byers, J.A., Schiffhauer, D.E. (2012) Effect of trap color and height on captures of blunt-nosed and sharp-nosed leafhoppers (Hemiptera: Cicadellidae) and non-target arthropods in cranberry bogs Crop Protection Vol. 40: 132-144 DOI:10.1016/j.cropro.2012.05.005

[10]Devi, S.M., Roy, K. (2017). Comparable study on different coloured sticky traps for catching of onion thrips, Thrips tabaci Lindeman Journal of Entomology and Zoology Studies 5(2): 669-671

[11]Eason, G., Noble, B., Sneddon, I. N. (1995). On certain integrals of Lipschitz-Hankel type involving products of Bessel functions, Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551.

[12]FAO. (2010). Production Year book, Food and Agricultural Organization of the United Nations, Rome.

[12]Gu, X.S., Bu, W.J., Xu, W.H., Bai, Y.C., Liu, B.M., Liu, T.X. (2008). Population suppression of *Bemisia tabaci* (Hemiptera: Aleyrodidae) using yellow sticky traps and *Eretmocerus nr.rajasthanicus* (Hymenoptera: Aphelinidae) on tomato plants in greenhouses. *Insect Science* 15: 263-270.

[14]Hwang, J.S., Hung, C.C. (2007). Encyclopedia of Pest Management, Edited by David Pimentel, CRC Press 2: 502–506.

[15]Ishaq, M., Usman, M., Asif, M., Khan, I.I.A. 2004. Integrated Pest Management of Mango against Mealy Bug and Fruit Fly. International Journal Of Agriculture & Biology 06 (3):452–454

[16]Karar, H. (2010). Bio-ecology and management of mango mealybug *Drosicha mangiferae* Green in mango orchards of Punjab, Pakistan. Ph.D thesis, University of Agriculture, Faisalabad.

[17]Karar, H., Malik A.B. (2018). Effect of host plant on abundance of mango hoppers, *Idioscopus clypealis* (Lethierry) (Hemiptera: Cicadellidae). Pak. Entomol., 40(1):57-61.

[18]Kehkishan (2011). Mango. Mostly known as the king of fruit in Pakistan. Date Published : May 19.

[19]Kondo, A., Sano, T., Tanaka, F. (1994). Automatic record using camera of diel periodicity of pheromone trap catches. Japanese Journal of Applied Ento. and Zool. August; 383: 197-199

[20]Kumar A. (2015). Population dynamics of Mango hopper Amritodus atkinsoni Leth. and its relationship with temperature International Journal of Pure & Applied Bioscience. 3 (3): 129-135

[21]Lua, Y., Yawei, B., Zhangc, J. (2012). Are yellow sticky traps an effective method for control of sweet potato whitefly, *Bemisia tabaci*, in the greenhouse or field? Journal of Insect Science 12(13):1-12

[22]MINFAL. (2011). Agriculture Statistics of Pakistan. Govt. of Pakistan, Min.of Food, Agri. and Livestock Economic Wing, Islamabad.

[23]Mohyuddin, A.I., Mahmood, R. (1993). Integrated control of mango pests in Pakistan. Acta Horticulturae, 341:467-483.

[24]Murali, R.K.B., Jayaraj, J. (2013). Agriculture: Management tips for controlling mango hoppers, https://www.thehindu.com/sci-tech/agriculture/management-tips-for-controlling-mango-hoppers/article4651094.ece

[25]Mwangi, F.N. (2015). M.Sc thesis: Evaluation of Botanical Pesticides and Coloured Sticky Insect Traps for The Management of Insect Pests (Thrips, Whiteflies And Aphids) In French Beans (Phaseolus Vulgaris L.) Crop Protection, University of Nairobi, Department of Plant Science and Crop Protection, Nairobi.

[26]Nair, M.R.G.K. (1975). *Insect and Mites of Crops in India*. The book first printed in Sep, 1975 for ICAR, New Delhi: 239-240pp.

[27]Nancy, D.E., Wendell, L., Morrill, R.W., Mankin. (2008). Trap for Capturing Insects. In Capinera, John L. (Ed.). Ency. of Ento, 3887–3901.

[28]Pakissan. (2017). Magnificent Mangoes of Pakistan, https://www.pakissan.com

[29]Pasian, C., Lindquist, R.K. (2000). Sticky Traps: a useful tool for pest scouting programs. Florinet Floriculture Newsletter- Poinsettia Trials, https://ohiofloriculture.osu.edu/sites/ohioflori/files/d6/files/file/using-yellow-sticky-traps.pdf

[30]Saeed, M.S. (2019). Mango Processing PPT of Pakistan: Mango Processing Of Pakistan. Analysis of Pakistani Industries.

[31]Shafqat, S., Abrar, M., Amin1, Qamar, S. Farooq, M. (2013). Attraction of Idioscopus clypealis (Leith) (Cicadellidae: Homoptera) to Sticky Colored Traps in Mango Orchard *American Journal of Plant Sciences* 4: 2275-2279. http://dx.doi.org/10.4236/ajps.2013.411281

[32]Shaikh, M.S., Abbasi, Z.A. (2019). Mango Processing Industry, https://www.scribd.com/presentation/62973666/Mango-Processing-Industry

[33]Shen, B.B., Ren, S.X. (2003). Yellow card traps and its effects on populations of *Bemisia tabaci*. *Journal of South China Agricultural University* 24(4): 40-43.

[34]Sivapragasam. A., Saito, T. (1986). Yellow sticky trap for the diamondback moth *Plutella xylostella* (L.). Applied Entomology and Zoology, 21(2): 328- 333.

[35]Suzanne, W.E. (2012). All About Mealybugs. www.learn2grow.com.27-12-2012.

[36]Tang, L.D., Zhao, H.Y., Fu, B.L., Han, Y., Liu, K. Wu, J.H. (2016). Colored Sticky Traps to Selectively Survey Thrips in Cowpea Ecosystem Neotropical Entomology Vol. 45 (1): 96–101 https://doi.org/10.1007/s13744-015-0334-1

[37]Teshiba, M., Shimizu, N., Sawamura, N., Narai, Y., Sugie, H., Sasaki, R., Tabata, J., Tsutsumi, T. (2009). Use of a sex pheromone to disrupt the mating of Planococcus kraunhiae (Kuwana) (Hemiptera: Pseudococcidae). Jpn J Appl Entomol Zool 53:173–180

[38]Wali, M., Iqbal, N., Saeed, S., Javed, M., Khalid, M.K. (2013). Monitoring and Varietal Preference of Mango Midge, Procontarinia mangicola (Diptera: Cecidomyiidae) Pakistan J. Zool., vol. 45(5), pp. 1273-1278, 2013

[39]Wikipedia (2019). Mango wikipedia last updated 18 June 2019 https://en.m.wikipedia.org/wiki/Mango