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Evaluation of various colored sticky traps for the monitoring of mango hoppers

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Abstract
Monitoring of insect pest is an important basic tool for a successful IPM programme. Timely identification of insect pest makes timely management in order to avoid economic damage and save money. Therefore, a field experiment was carried out to evaluate the different colored sticky traps for monitoring mango hoppers in mango orchard during flowering and fruiting season from March to June in year 2018. For this experiment ten various coloured tough papers viz., yellow, light yellow, blue, light blue, white, orange, pink, grey, green and brown were selected and polybutene was used to prepare sticky traps. Observations of hoppers on sticky traps were recorded at weekly interval. Results revealed that highest number of mango hoppers attracted towards yellow traps (18.50 hoppers/ trap/week) followed by blue (11.50 hoppers/ trap/week). Although light blue coloured traps 7.00 hoppers/ trap/week, light yellow (7.50 hoppers/ trap/week) and white (4.75 hoppers/ trap/week). However, lowest number of hoppers was captured by orange trap (3.50 hoppers/ trap/week) captured higher number of hoppers (3.50 hoppers/ trap/week) as compare to grey (2.25 hoppers/ trap/week) pink trap (2.00 hoppers/ trap/week), brown (1.50 hoppers/ trap/week) and green (1.25 hoppers/ trap/week) sticky traps. Hence the effectiveness of sticky traps in descending order of yellow > blue > light blue > light yellow > white > orange > pink > grey > brown > green. Because of low cost, easily availability, no need of skilled labour and environment friendly, theses traps can be used to achieve a significant pest management programme.

Keywords: Mango hoppers, monitoring, colored sticky traps, polybutene

1. Introduction
Mango (*Mangifera indica* Linn.) is a very important and popular fruit in the world. It is the choicest fruit of the subcontinent and is known as king of all fruits. Its popularity is mainly due to its excellent flavour, delicious taste, and high nutritive value. India is the largest producer of mango in the world producing 185.27 lakh tonnes in an area of 21.63 lakh hectare with a productivity of 8.6 MT/ ha (Anonymous, National mango database, 2019) [1]. India exported 43063.70MT mango worth of 53.80 million USD in 2018-19. Uttarakhand contributes 152.89 thousand MT of total production of mango in India 22352 during 2018-19 (Anonymous, Press Information Bureau, 2019) [2].

Production of mango is enormously handicapped by number of insect pests from seedling to their maturity stages. More than 300 insect pests have been recorded to attack mango crop in different regions of world (Patel *et al.,* 2004**)** [8]. Among the mango insect pests, mango hoppers are most serious and widespread insect pests throughout the country (Verghese, 2000**)** [16]. *Amritodus atkinsoni* (Lethierry), *Idioscopus clypealis* (Lethierry) *I. niveosparsus* (Lethierry) and *I. nitidulus* (Walker), are serious pests of mango at flowering and fruiting stages and could cause yield loss up to 100% (Rahman and Kuldeep, 2007; Prabhakara *et al.*, 2011) [11, 12]. Mango hopper, *A. atkinsoni* and *I. clypealis* colonized the crop both during flushing, flowering and fruiting stages (January to June and September to December). However, high incidence in flowering stage (March to April) (Kaushik *et al.,* 2013) [7].

Frequent and reliable monitoring of pest populations is one of the most critical components of integrated pest management (IPM) program. Use of different coloured sticky is one of such tools of IPM which can be employed to ensure the effective management. Insect sticky traps can be either used to monitor and or to directly reduce populations of insect pests. These traps are sometimes used in pest management programs for mass trapping but are more often used to assess the seasonal and distributional patterns of pest occurrence. This information may then be used in other approaches in pest management. As monitoring provide information on pest densities, their dispersion, and dynamics.

Through monitoring, accurate information is obtained to make accurate decisions which should be based on knowledge of the pest's economic threshold (Peña, 2004) [10]. Since, colored sticky traps could be a simple and a low-cost method for determining the relative abundance of harmful insects in wild and cultivated plants worldwide (Atakan and Pehlivan 2015) [3].

The aim of this experiment was to evaluate different coloured sticky traps for monitoring of mango hoppers in mango orchard through polybutene based sticky traps.

2. Materials and Methods

2.1 Experimental site

This present experiment was carried out during panicle initiation stage to harvesting stages from 3rd week of February to 1st week of June in year 2018 at Horticulture Research Centre (HRC), Pattharchatta, G.B. Pant University of Agriculture and Technology, Pantnagar on 25-30 years old mango trees c.v, Dashehari, infested heavily with mango hoppers.

2.2. Preparation and installation of sticky traps

For this experiment, sticky traps have been prepared by coating insect gum (polybutene) on ten different colored tough papers size of 30x 21 cm^2 (yellow, light yellow, blue, light blue, white, green, grey, pink, orange and brown. Each color considered as a treatment and replicated thrice. Prepared traps were installed vertically with the help of bamboo and rope under the canopy of mango tree at the height of 2 meter.

2.3 Observations

Observations of mango hoppers on sticky traps were recorded at weekly interval from panicle initiation stage to harvesting stage (3rd week of February to 1st week of June).

2.4 Statistical analysis

The different observations will be subjected to statistical analysis by using randomized block design (RBD) (Gomez and Gomez, 1984) [6]. Mean difference were tested by F-test at 5 per cent level of significance. A critical difference (CD) at 5 per cent level of probability was used for comparison among treatments by one-way analysis of variance (ANOVA) following Snedecor and Cochran (1967) [13]. The results were presented by way of Tables and Figures. Duncan Multiple Range Test (DMRT) was used to compare the means at ($P \leq 0.05$) (Duncan, 1955) [5].

3. Results and discussion

A perusal of data presented in Table 1 & Fig. 1 revealed that at panicle initiation stage hoppers population per sticky trap ranged from 15.25 hoppers/ trap/week to 1.75.00 hoppers/trap/week on yellow and green sticky trap, respectively. While, at flowering stage, gradual increase in hoppers population recorded on yellow trap (18.25 hoppers/ trap/week) followed by blue trap (9.25 hoppers/ trap; 1.97 times lower than yellow trap), light yellow trap (7.25 hoppers/ trap/week; 2.51 times lesser than yellow trap). Light blue and white traps captured 6.50 and 5.25 hoppers/ trap/week which were higher compare to orange traps (4.00 hoppers/ trap/week). Pink, brown and green sticky traps recorded non-significantly lowest number of hoppers with 2.00, 1.50 and 1.25 hoppers/ trap/week, respectively.

At pea stage, significantly highest number of hoppers trapped on yellow trap (18.50 hoppers/ trap) followed by blue trap (11.50 hoppers/ trap; 1.60 times lower than yellow trap). Although, light yellow and light blue sticky traps captured 7.50 and 7.00 hoppers/ trap and were statistically at par with each other, whereas white and orange sticky traps recorded lower hoppers population (with 4.75 and 3.50 hoppers/ trap/week, respectively) but comparatively higher from pink, brown and green (2.00, 1.50 and 1.25 hoppers/ trap/week, respectively).

A gradual decline in number of hoppers observed at marble stage of fruits where yellow trap captured highest number of hoppers with 16.50 hoppers/ trap/week followed by blue trap (10.50 hoppers/ trap/week; 1.57 times lower than yellow trap), light yellow trap (7.50 hoppers/ trap/week; 2.20 times lower than yellow trap), light blue trap (6.50 hoppers/ trap/week; 2.53 times lower than yellow trap) and white (5.75 hoppers/ trap/week; 2.86 times lower than yellow trap). Orange, grey, brown and green captured number of hoppers population below ETL (3-5 hoppers/ panicle) with 3.75, 2.25, 1.50 and 1.25 hoppers/ trap/week, respectively.

Similarly, at maturity stage of fruits, number of hoppers attracted above ETL on yellow and blue, light blue, light yellow and white traps with 13.00, 11.00, 7.25, 6.25 and 5.00 hoppers/ trap/week, respectively. While, orange trap recorded 4.00 hoppers/ trap/week which was higher than rest of the traps i.e. pink, grey, green and brown.

At harvesting number of hoppers per trap was higher on blue trap (9.50 hoppers/ trap/week) followed by yellow trap (7.50 hoppers/ trap/week), light yellow (7.25 hoppers/ trap/week), white (5.50 hoppers/ trap/week). Light blue and orange sticky traps were statistically at par with each other with 4.25 and 4.00 hoppers/ trap/week, while rest of the traps obtained hoppers below ETL.

Overall Results revealed that among all these sticky traps yellow, blue, light blue, light yellow and white were effective to capture hoppers and recorded hoppers population above ETL. Although, orange sticky traps also attracted significant number of hoppers, while, rest of the sticky traps such as pink, grey, green and brown sticky traps were least effective and attracted less number of hopper which were below ETL.

It has been observed that during the experiment, number of hoppers was higher on sticky traps (yellow and blue sticky traps with 18.50 and 11.50 hoppers/ trap/week) compare to per panicle, while traps such as light blue, light yellow, white and orange traps had almost similar number of hoppers as on per panicle. These finding are in agreement with Saeed *et al.* (2013) [12] who reported yellow colour was found most attractive with highest number of adults of *I. clypealis* (11.53 adults/trap). While pink and purple colours were found less attractive. Devi and Roy (2017) [4] also stated that blue coloured sticky trap attracted more number of thrips than white yellow and florescent green colour sticky traps. Sridhar and Naik (2015) [14] observed blue coloured sticky trap attracted highest number of *Scirtothrips dorsalis* Hood adults, followed by yellow and pink. Thein *et al.* (2011) [15] reported that a higher number of the putative vectors, *M. hiroglyphicus* and *Y. flavovittatus* were trapped on blue followed by yellow as compared to white, orange, green and colorless (control) sticky traps.

Table 1: Hopper population trapped on different colored sticky traps in mango

Treatments (Different colored traps)	Number of mango hoppers/ trap/week at various crop stages					
	Panicle initiation stage	Flowering stage	Pea stage of fruit	Marble stage of fruit	Maturity stage of fruit	Harvesting stage
Yellow (T_1)	15.25 (3.99)^{a}	18.25 (4.35)^{a}	18.50 (4.38)^{a}	16.50 (4.15)^{a}	13.00 (3.71)^{a}	7.50 (2.89)^{ab}
White (T_2)	5.50 (2.52)^{bc}	5.25 (2.45)^{bcde}	4.75 (2.33)^{cde}	5.75 (2.59)^{cde}	5.00 (2.42)^{bcd}	5.50 (2.52)^{bc}
Orange (T_3)	4.00 (2.17)^{c}	4.00 (2.18)^{cde}	3.50 (2.07)^{de}	3.75 (2.13)^{cdef}	4.00 (2.18)^{cde}	4.00 (2.22)^{bc}
Light yellow (T_4)	8.25 (3.03)^{b}	7.25 (2.84)^{bc}	7.50 (2.89)^{c}	7.50 (2.89)^{bc}	6.25 (2.69)^{bc}	7.25 (2.84)^{ab}
Pink (T_5)	2.25 (1.77)^{c}	2.00 (1.71)^{de}	2.00 (1.71)^{e}	2.75 (1.91)^{def}	2.50 (1.84)^{de}	2.00 (1.371)^{c}
Grey (T_6)	2.50 (1.86)^{c}	2.25 (1.78)^{de}	2.25 (1.78)^{e}	2.25 (1.78)^{ef}	2.75 (1.93)^{de}	2.25 (1.78)^{c}
Blue (T_7)	12.50 (3.64)^{a}	9.25 (3.09)^{b}	11.50 (3.52)^{b}	10.50 (3.36)^{b}	11.00 (3.45)^{b}	9.50 (3.13)^{a}
Light blue (T_8)	8.00 (2.95)^{b}	6.50 (2.63)^{bcd}	7.00 (2.77)^{cd}	6.50 (2.63)^{cd}	7.25 (2.83)^{b}	4.25 (2.23)^{bc}
Green (T_9)	1.75 (1.64)^{c}	1.25 (1.43)^{e}	1.25 (1.43)^{e}	1.25 (1.43)^{f}	1.75 (1.61)^{e}	2.50 (1.86)^{c}
Brown (T_{10})	2.00 (1.71)^{c}	1.50 (1.57)^{e}	1.50 (1.57)^{e}	1.50 (1.57)^{f}	1.50 (1.57)^{e}	2.25 (1.79)^{c}
CD (5%)	3.18**	3.41**	2.64**	3.34**	2.31**	2.92**
CV%	35.39	40.90	30.55	39.57	29.02	42.94
SEM	1.09	1.17	0.91	1.15	0.79	1.00

Data presented in parentheses are √x+ 0.5(square root transformed);** Data in indicate significant at P = 0.05 %; Mean followed by common letters in a column do not differ significantly by DMRT ($P \leq 0.05$)

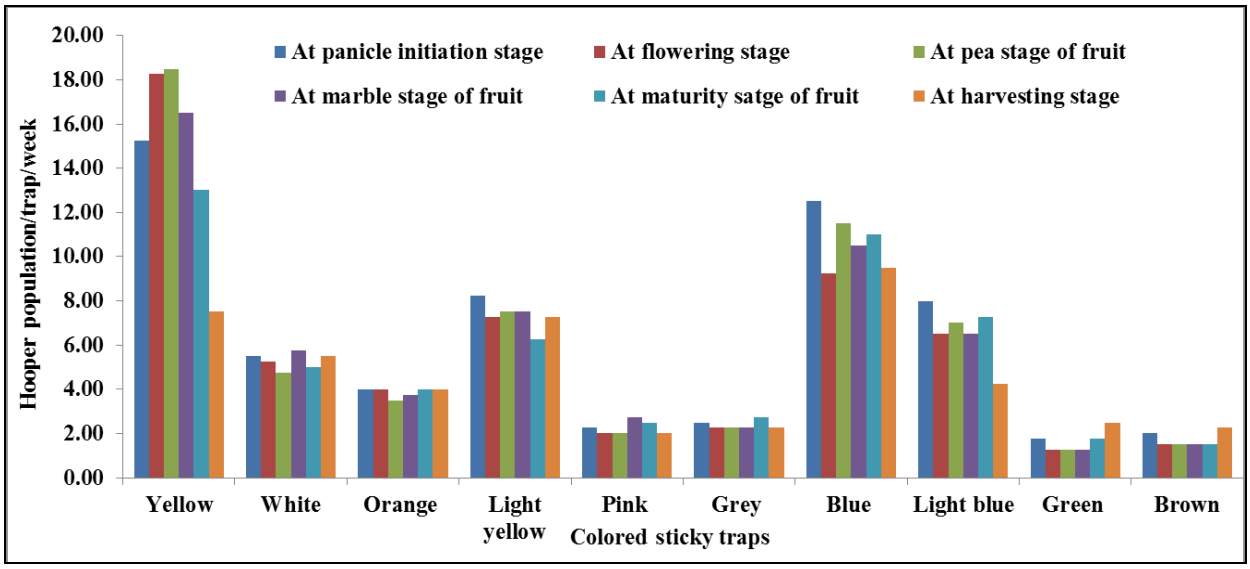

Fig 1: Monitoring of mango hoppers by different colored stick traps

4. Conclusion

Hence, it is clear from the experiment that the color of sticky traps has significantly effect of on the attraction of mango hoppers. Effectiveness of attraction of colored sticky traps to hoppers was arranged in the order as yellow > blue > light blue > light yellow > white > orange > pink > grey > brown> green. However, Attraction of hoppers toward sticky traps also influenced by various factors *viz.*, colours of sticky traps, stickiness of insect gum on sticky traps and mango hoppers population available in different stages of mango.

Thus, the coloured sticky traps can be used to monitor mango hoppers population in the mango orchard. The purpose of monitoring is to know the incidence, diversity of mango hoppers and their population which may cause severe infestation to mango; also some other beneficial and harmful insects present in that macro and micro climate. These traps were economic, easy to prepare and install as well as ecofriendly approach to hopper population for the effective management.

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