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Efficiency of sticky traps for monitoring aphids in wheat under North-Western Plains and Peninsular zones of India

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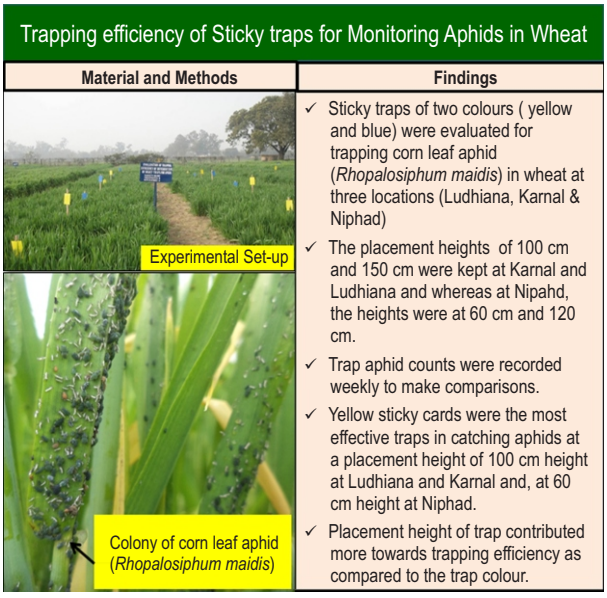
Abstract

Aim: To evaluate the efficiency of most effective trap among two types of sticky traps of, *i.e.,* card or tray of two colours (yellow and blue) and their placement height within wheat crop for catching alate of *R. maidis*, the most abundant aphid species in selected locations.

Methodology: Sticky card and tray traps of two colours; yellow and blue were placed at different heights within wheat crop and the effects of trap parameters (type, colour and height) were evaluated to determine the trapping efficiency of *R. maidis* alate. The traps were installed at two heights above ground level; 100 cm and 150 cm at Karnal and Ludhiana and at 60 cm and 120 cm above ground level at Niphad location. Alate aphid counts were recorded weekly to make comparisons.

Results: The highest number of *R. maidis* alate were caught on yellow coloured sticky card traps placed within the crop canopy at 100 cm height above ground and the lowest on blue coloured sticky tray traps at 150 cm height above ground at Ludhiana and Karnal. At Niphad, the highest population was caught on yellow coloured sticky card traps placed at 60 cm height above ground and the lowest number on blue coloured sticky tray traps at 120 cm height above ground. Correlation analysis revealed that all three trap parameters (trap type, colour and placement height) were correlated with mean alate trap catches. Backward stepwise regression modelling indicated that trap type and placement height had a maximum influence on the *R. maidis* alate trapping.

Interpretation: This study indicated that the yellow sticky card traps were most effective in catching *R. maidis* alate as compared to other tested traps.



Key words: Aphids, Insect sampling, Trapping efficiency, Trap parameters, *Triticum aestivum*,

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Introduction

Aphids are one of the most important insect-pests of wheat crop causing around 3-21 per cent yield losses in all the six wheat growing zones of India (Katare *et al.,* 2018). Besides aphids, the other major insect-pests that attack wheat crop include termites, shootfly, brown wheat mite, armyworm and pink stem borer. The three key species of aphids that have been found damaging wheat are corn leaf aphid (*Rhopalosiphum maidis* Fitch), bird cherry oat aphid (*Rhopalosiphum padi* L.) and English grain aphid (*Sitobion avenae* F.). Amongst these three species, corn leaf aphid, *R. maidis* is the major species reported to attack wheat crop in India (Jasrotia *et al.,* 2018; 2022). The aphids start appearing on wheat crop during October-November when crop is in seedling stage but are not easily detected due to their small size and green colour. The level of aphid infestation and damage incurred are very unpredictable in time and space. Under favorable conditions, corn leaf aphid feeding can cause heavy damage to wheat in a short period of time (Katare *et al.,* 2018).

Monitoring long-term changes in aphid population is important as population vary widely between different years and sites. However, there is no simple, rapid and cost-effective method for assessing aphid densities. Previous studies have relied on counting aphids *in situ* in the field (Katare *et al.,* 2018). But this method is time-consuming and only few sites can be sampled in a limited period of time. Monitoring aphid population through traps is easy, less intensive and can help to determine the proper timing for implementation of control measures. These traps can attract and capture flying aphid alatae (winged aphid form) and help growers to detect early pest activity more effectively (Murtaza *et al.,* 2019). Several types of insect monitoring traps *viz.,* sticky card, tray, pan or delta traps, pheromone lures etc., are commercially available in market that can be used for monitoring flying insect population. These insect traps gives accurate information on the population dynamics of insect-pests and can be used to develop forecasting models to predict the timing of pest occurrence and estimate damage caused to a particular crop (Prasad and Prabhakar, 2012). Moreover, these traps are rapid, simple to install, cost effective, provides systematic, continuous information on pest population build-up with greater details.

Insect trap efficacy is found to be dependent on trap colour attractiveness, size, shape, placement and orientation (Prasad and Lal, 2001; Esker *et al.,* 2004), besides wind speed, temperature and rainfall (Nayak *et al.,* 2019; Antolínez *et al.,* 2022;). Yellow coloured traps are often more preferred in the field for monitoring due to their greater attraction towards yellow colour (Kirchner *et al.,* 2013; Doris 2014), though other colours have also been preferred (Straw *et al.,* 2011). Flight height of the insect is another parameter that determines the trap efficiency. Aphids are recognised as high-altitude migrants and the flight height for many aphid species were found in range between 1.0 to1.2 m above the ground (Loxdale, 2018). Although, feeding ecology and life-cycle of an insect also influence the efficiency of an insect trap (Straw *et al.,* 2011). In wheat crop, corn leaf aphid, *R. maidis* is the predominant species in wheat under North-Western Plains and Peninsular zones of India. There is no reliable method available for assessing *R. maidis* population. Keeping this mind, this study was planned to investigate the efficiency of two types of sticky traps (cards and trays) of two different colours (yellow and blue) at two placement heights for monitoring aphid numbers in wheat crop at Karnal, Ludhiana and Niphad covering two wheat growing zones *viz.,* North-Western Plains Zone (NWPZ) and Peninsular Zone (PZ) of India.

Materials and Methods

Study sites and crop sowing: The study was conducted under All India Co-ordinated Research Project (AICRP) on Wheat and Barley during *Rabi* seasons (October-April) of 2017-18 and 2018-19 at three sites *viz.,* Indian Institute of Wheat and Barley Research (IIWBR), Karnal, Haryana, Research Farm of Punjab Agricultural University (PAU), Ludhiana, Punjab and Niphad, Maharashtra. Out of three selected sites, the two sites *viz.,* Karnal and Ludhiana falls in the North-Western Plains Zone (NWPZ), while Niphad, Maharashtra falls under Peninsular Zone (PZ) of wheat growing regions. The popular wheat variety of the region, HD 2967 was sown at Karnal and Ludhiana during second week of November 2017 and 2018, and variety NIDW-295 was sown at Niphad during second week of October 2017 and 2018 for monitoring aphid population. The plot size was kept as 6 m x 6 m with row to row spacing of 20 cm. The crop was maintained throughout the year by following the recommended package of practices, except chemical spray which could have negative influence on aphid population.

Trap type and placement height: Sticky traps of two types; cards and trays of two colours; yellow and blue colour were used. Sticky cards traps of two colours were made up of cardboard and were procured from Chipku Company Ltd., and the size of each trap measured 20 cm × 15 cm. The tray traps were simply plastic trays measuring 30 cm (length) × 25 cm (width) × 5 cm (height) and were made sticky by using sticking glue of Chipku Gum Brand. The traps of each colour were installed within plots at two heights above ground level; 100 cm and 150 cm at Karnal and Ludhiana and at 60 cm and 120 cm above ground level at Niphad location. The reason for selecting different heights at Niphad location is that aphids appear early when crop is small as compared to Karnal and Ludhiana where crop canopy gets taller when aphids arrive in the field. Sticky card traps were installed vertically within crop by tying to bamboo sticks whereas tray traps were kept horizontally on iron stands of customized height. The traps were left out for one week and the number of alate aphids caught on sticky surface of the traps were recorded. The traps were changed every week.

Insect sampling: The sticky traps were collected on weekly basis and were brought to the laboratory for making population counts of the alates. The aphid samples were identified to species level and it was found that majority of the aphids captured on the traps

were *R. maidis* at all three selected locations. Therefore, the counts of *R. maidis* species was only reported in this study. The number of aphids present on each trap per week was counted under microscope in laboratory. The aphids were counted during the months of January to March at Karnal and Ludhiana, and from November to February at Niphad site. As the size of sticky card and tray traps was different, therefore, area of each trap type was measured. The *R. maidis* alate population counts per trap was then represented in 100 cm^2 for each trap to avoid any biased conclusion based on the size of the trap.

Statistical analyses: The weekly population of aphids trapped on each trap in 100 cm^2 recorded during the sampling periods was averaged and then tested using analysis of variance (ANOVA). Aphid numbers were square-root transformed to normalize variances. The number of aphids caught during each year were analyzed with respect to week, trap type (sticky card and sticky tray), trap color (yellow and blue), and position (height), The means of tested parameters were separated by Tukey's honestly significant difference tests for paired comparisons at a probability level of 5 %. Analysis of variance, correlation analysis and backward stepwise multiple regression modeling at 95 and 99 % significance levels were worked out. All the statistical functions were performed using SPSS version 23.0 (SPSS, IBM Corp 2015).

Results and Discussion

At Ludhiana and Karnal, the alate *R. maidis* were caught on both types of sticky traps from first week of January to last week of March (1st and 12th standard metrological weeks) (Fig. 1 and 2). However, the majority of alate population was caught during third and fourth week of February (8th and 9th standard metrological weeks) during both seasons of 2017-18 and 2018-19 on four types of tested traps (Fig. 2,3). At Niphad, which is situated in the Peninsular India, the population of *R. maidis* appeared from third week of November to second week of February (47th and 6th standard metrological weeks) (Fig. 3). The peak population of alate appeared during first or second week of January (1st and 2nd standard metrological weeks) during 2017-18 and 2018-19 (Fig. 3). It was recorded that the sticky tray traps

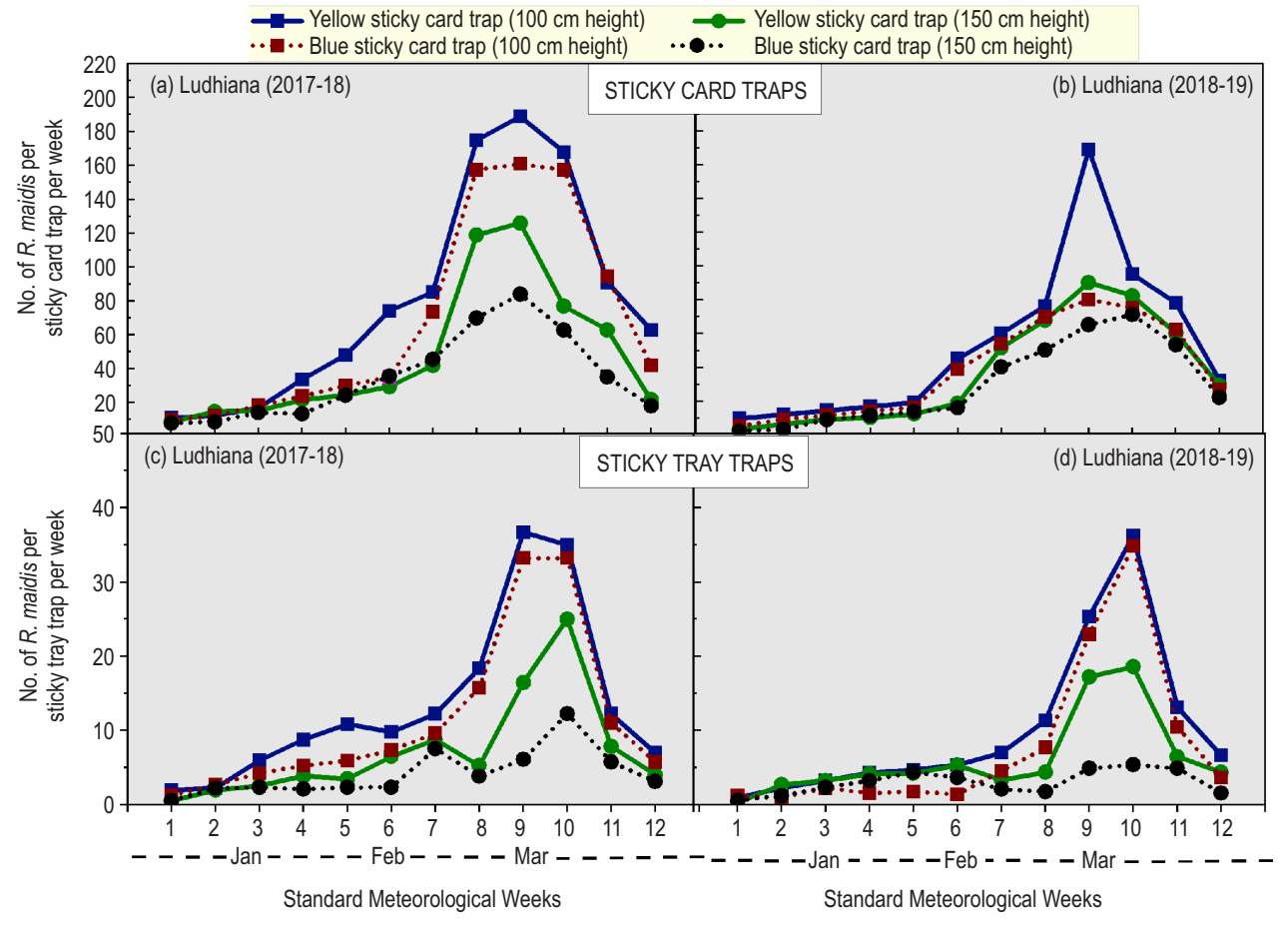

Fig. 1: Alate trap catches of *R. maidis* alate caught on sticky card traps and sticky tray traps at different heights during 2017-18 and 2018-19 at Ludhiana, Punjab.

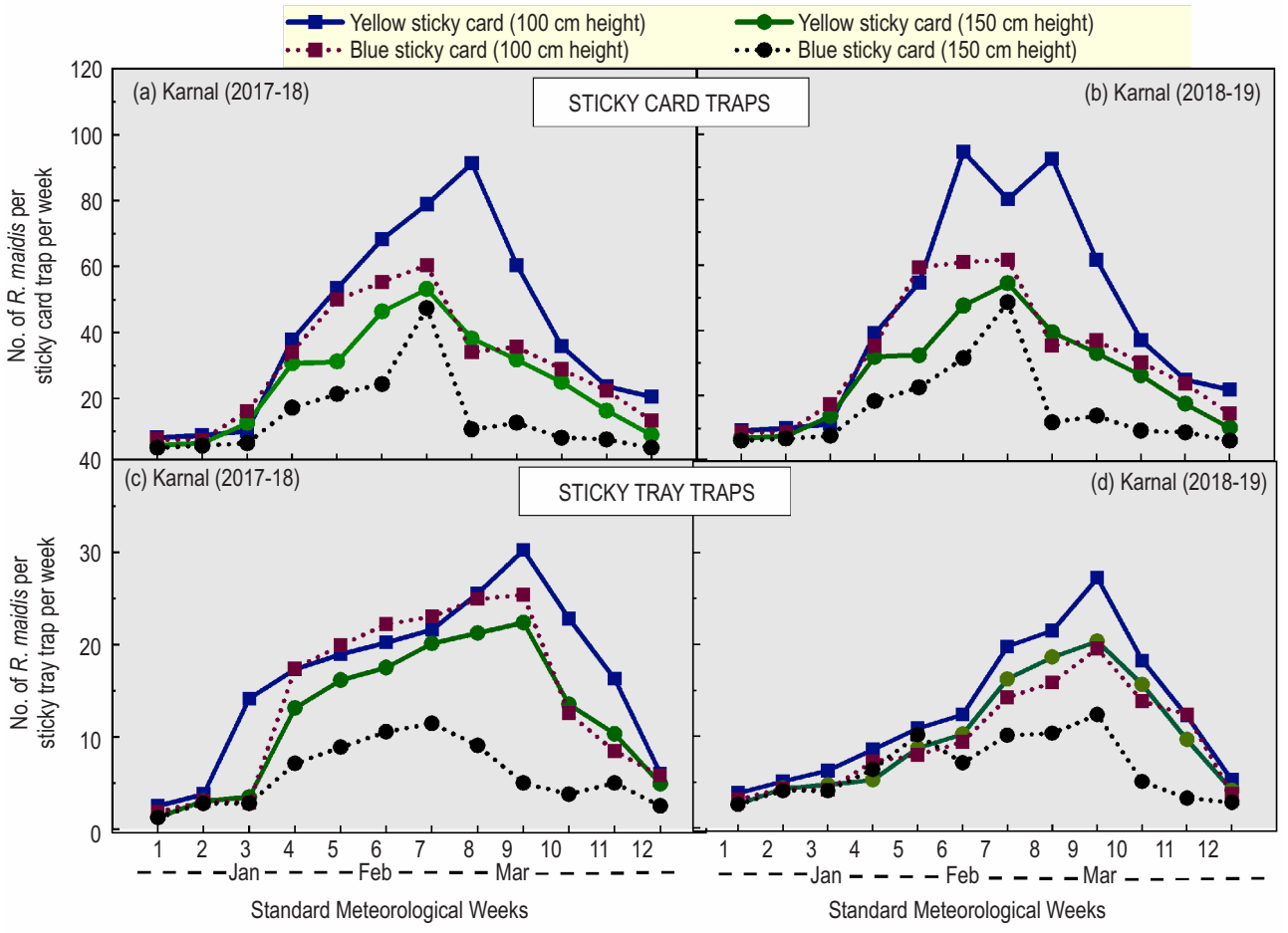

Fig. 2: Alate trap catches of *R. maidis* alate caught on sticky card traps and sticky tray traps at different heights during 2017-18 and 2018-19 at Karnal, Haryana.

caught comparatively lesser number of alate than sticky card traps (Fig. 1 to 3). Overall amongst the tested traps at Ludhiana and Karnal, the mean population trend over two seasons indicated the highest numbers of *R. maidis* were caught on yellow sticky card traps placed 100 cm above the ground level, while the lowest number of alate population was captured on blue sticky tray traps installed at 150 cm height. When seasonal mean comparisons were made, the yellow sticky card traps placed at 60 cm height captured significantly the highest mean number of aphids (35.49 alate/trap during 2017-18 and 54.63 alate/trap during 2018-19) followed by yellow sticky traps placed at 120 cm height above ground (29.60 alate/ trap during 2017-18 and 41.77 alate/ trap during 2018-19).

The lowest number of aphids were captured on blue tray traps installed at 120 cm height (2.84 alate/trap during 2017-18 and 2.09 alate/ trap during 2018-19). Overall, with interaction effects of three factors; trap type, colour and height were found to be non-significant. However, the individual trap parameters such as trap type and trap colour have significant effect on aphid alate trapping efficiency at all the three locations. But the trap height was also statistically significant for capturing aphid alatae, except at Niphad. It may be due to small crop height at Niphad and environmental factors such as high temperature that led to early appearance of aphid alatae. Overall trend showed that the mean trap catches of aphid alatae were higher in case of sticky card traps as compared to tray traps, and the yellow colour was more preferred by the aphids as compared to blue colour.

At Ludhiana and Karnal, the placement of traps at 100 cm height was found more efficient as compared to 150 cm trap height. Higher mean trap catches were observed in case of yellow sticky card traps placed at 60 cm height at Niphad. The possible reason is that the crop age and height was small at the time of alatae appearance and therefore, the traps placed at 60 caught higher number of alate aphids. Even the crop was sown one month earlier at Niphad than other two sites. The findings of the study are in line many previous researchers who suggested that the yellow coloured traps were more attractive to aphids than those of yellow-green, orange, green and blue (Park *et al.,* 2001;

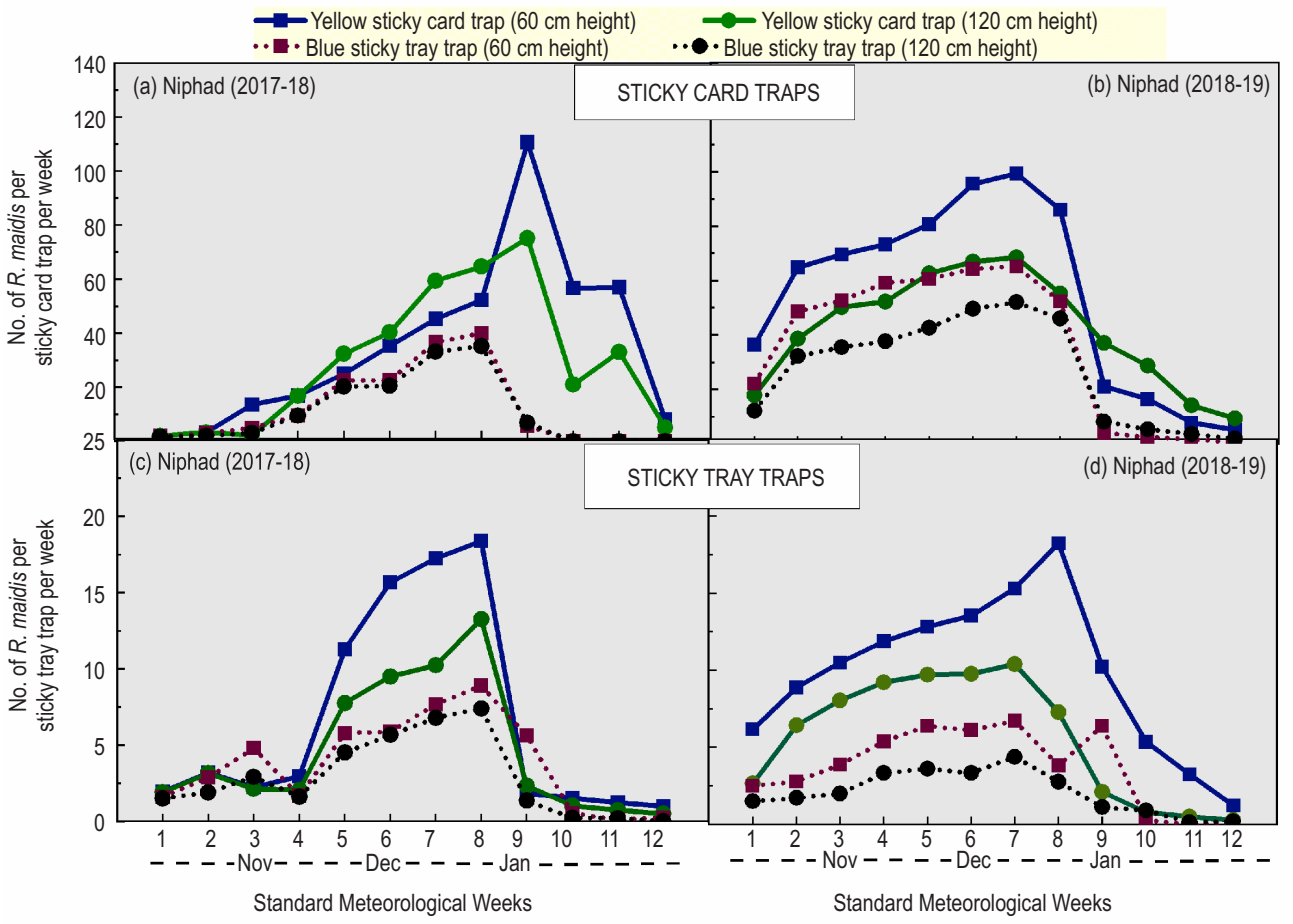

Fig. 3: Alate trap catches of *R. maidis* alate caught on sticky card traps and sticky tray traps at different heights during 2017-18 and 2018-19 at Niphad, Maharashtra.

Döring, 2014; Jasrotia *et al.,* 2016; Perring *et al.*, 2018; Holland *et al.,* 2019). The possible reason for greater attraction to yellow colour is associated with young, senescing or infected foliage that tends to indicate higher availability of nutrients such as amino-acids (Hodge and Powell, 2010; Farnier *et al.,* 2014). Similarly, Spehia *et al.* (2017) reported that the yellow coloured sticky traps were more effective as compared to orange and blue coloured traps and can be used in combination with reflective mulches for the management of aphids. Straw *et al.* (2011) found that yellow sticky traps placed above the canopy were most effective in catching green spruce aphid (*Elatobium abietinum*). Sticky tray traps were used to monitor cereal aphids and natural enemies in winter wheat fields (Ramsden *et al.,* 2017).

At all three locations, the mean number of aphid alatae trapped was negatively correlated with trap type, colour and height. As trap type shifted from sticky to tray traps, the trapping efficiency decreased and the mean number of trap catches also reduced. Similarly, when the colour of the traps changed to blue from yellow, *i.e.,* with upward movement in VIBGYOR sequence, the trapping efficiency again decreased. Also, at Ludhiana and Karnal, as the height of sticky card traps increased from 100 cm to 150 cm and 60 cm to 120 cm at Niphad, the mean number of aphid alatae trapped reduced, respectively. Atakan and Canhilal (2004) also confirmed that the number of trapped sucking pests were negatively correlated with trap height. The regression analysis indicated that the three trap parameters contributed a total of 67.4 and 65.1 % towards alate trapping efficiency at Ludhiana during 2017-18 and 2018-19, respectively.

During 2017-18, trap height alone contributed 59.9% whereas during 2018-19, the contribution was 57.0 %. At Karnal, the three trap parameters contributed a total of 29.6 and 29.7% during 2017-18 and 2018-19, respectively. During both the years, trap height was the main factor and alone contributed 23.7 and 23.8%, respectively. However, during both the years, contribution of trap type was least. At Niphad, the three trap parameters contributed a total of 26.2 and 50.8 % during 2017-18 and 2018-19, respectively. Contrary to Karnal, trap type was the main factor and alone contributed 17.8 and 45.5 %, respectively whereas trap height contributed least towards the trap efficiency at Niphad location. Backward stepwise regression modelling indicated that

overall trap colour and trap height were the main contributing factors towards trapping efficiency. Overall, at Ludhiana and Karnal, trap height had the maximum contribution because the number of tapped aphid alatae was also higher on blue sticky card traps placed at 100 cm height. This confirms our findings that at these locations, trap height contributed more towards trapping efficiency as compared to trap colour. Alternatively, at Niphad, trap type was the main contributing factor as the effect of trap height was nullified due to small size of crop plants because of early appearance of aphid alatae. This showed that the plant canopy was an important factor for alatae trapping because aphids required tender upper portion such as flag leaf and earhead for feeding and multiplication and the traps placed near to plant canopy were more efficient. Overall, at Ludhiana and Karnal, the yellow sticky card traps placed near the crop canopy at 100 cm height and at Niphad, 60 cm height above ground were most efficient in trapping aphid alatae and the mean aphid catches were highest for these heights.

Previous studies have shown that the placement of traps in fields also influences trapping efficiency and trap catches vary spatially and are affected by trap height, orientation, position or distance from field margins (Butler and Trimble, 2012; Taylor *et al.,* 2014). Higher number of aphids, leafhoppers and leaf beetles were caught on sticky traps that were placed near crop canopy level (Esker *et al.,* 2004; Murtaza *et al.,* 2019). Atakan and Canhilal (2004) suggested that the trap height is an important factor and has a significant effect on mean trap catches for different sucking pests and found that the mean adult leafhopper catches were higher at 60 to 100 cm trap heights as compared to 120 cm height. Gencsoylu (2006) also demonstrated that the trap height had significant effect on mean captured population of leaf miner (*Liriomyza trifolii*).

The conducted study revealed that the yellow sticky cards were most effective in trapping aphid alate of corn leaf aphid; *R. maidis*, at a placement height of 100 cm at Ludhiana and Karnal and 60 cm at Niphad and hence, can be recommended to achieve the highest number of trappings for aphid monitoring. Placement height of trap contributed more towards trapping efficiency as compared to trap colour.

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Add-on Information

Authors' contribution: P. Jasrotia, B. Singh and S.D. Patil: Conceptualised, conducted analysed result findings and wrote manuscript; **J. Yadav, S. Kumar and G.P. Singh:** Helped in analysis and writing of the manuscript.

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Ethical approval: Not applicable.

Conflict of interest: The authors declare that there is no conflict of interests.

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