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Comparative assessment of two traps for aphid monitoring in wheat under varying growth stages and environmental conditions

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Abstract

Yellow Moericke traps (YMT) and yellow sticky traps are critical components of integrated pest management (IPM), providing accurate data for population abundance and behavior. Two traps were assessed at various wheat growth stages to evaluate their effectiveness. Yellow Moericke Traps (YMT) consistently captured more aphids than Yellow Sticky Traps (YST) from the Booting to Ripening stages. Trap catches increased with rising temperatures peaking during the Heading stage. YMT consistently captured a higher number of aphids compared to YST across all nine sampling sites, with peak catches observed at the SW-12 site in both years. Aphid populations were notably higher in 2022, with YMT catches ranging from 10 to 401 and YST from 8 to 141. In 2023, a marked decline was observed, with YMT ranging from 5 to 320 and YST from 5 to 97. These facts make YMT a more reliable tool for monitoring populations trends. The correlation analysis during 2022-23 revealed a significant positive relationship between aphid catches and temperature for both trap types, with stronger correlations observed in 2023. In contrast, humidity showed a weak, no significant negative correlation with aphid catches in both years. No significant difference in correlation between the years and traps was found. The results show that Yellow Moericke Traps (YMT) consistently captured higher numbers of aphids (16,383) compared to Yellow Sticky Traps (YST) (7,098) during 2022-23, with significant differences observed ($p < 0.05$). *Rhopalosiphum padi* and *Schizaphis graminum* were the most abundant species, peaking during SW 03-09 and SW 05-13, respectively. YMT demonstrated greater efficiency, consistently capturing higher numbers across all aphid species and peak activity periods. This indicates higher efficacy in both attracting and capturing aphids. YMT proved to be a more dependable tool for monitoring aphid populations and tracking seasonal variations. Traps attracted thirteen species, with *S. graminum*, *R. padi*, *S. avenae*, and *R. maidis* were identified as major species.

Keywords: Dominance, Species, Traps, Wheat, Yield

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Introduction

Wheat (*Triticum aestivum* L.) is a crucial cereal crop with immense nutritional and economic value, feeding over 35% of the global population, including both Pakistan and the rest of the world (Iqbal et al., 2018; Abbas & Shafique, 2019; Alamgeer et al., 2022) however, several factors contribute to its low production (Sharma et al., 2015; Mehmood et al., 2020; Dinsa & Balcha, 2024). Among these, aphids are a major cause of reduced yields, significantly damaging crops, vegetables, ornamental plants, and fruits by feeding on plant sap. Often referred to as plant lice, aphids comprise over 5,000 species worldwide (Panwar et al., 2023). In Pakistan, four species are recognized as significant pests of wheat: green bug (*Schizaphis graminum* R.), bird cherry-oat aphid (*Rhopalosiphum padi* L.), corn aphid (*Rhopalosiphum maidis* F.) and English grain aphid (*Sitobion avenae* B.) (Hussain et al., 2024). The three cereal aphid species differ in their preferred feeding sites and their ability to transmit viruses. Notably, all three serve as vectors of Barley Yellow Dwarf Virus (BYDV) (Hu et al., 2015). Aphid colonization on host plants is a complex process influenced by various stimuli and responses, which govern their selection and settlement behavior. Aphid infestations can reduce wheat yields by up to 90%, depending on the crop growth stage and severity of the attack (Zhang et al., 2022).

Continuous monitoring of aphids is crucial to minimizing losses. Various methods for monitoring and bio-ecological studies are documented, including examining host plants or parts, shaking insects off plants, using suction or scooping devices, and installation of colored insect traps. Among these, Yellow Moericke water traps (YMT) and yellow sticky traps (YST) are recognized as the most effective (Baideng et al., 2017; Borowiak-Sobkowiak et al., 2010; Husain et al., 2022; Peraz et al., 2007). Yellow Moericke traps, also known as pan or bowl traps, are painted yellow to attract aphids and filled with water mixed with detergent or chemicals, resembling yellow flowers to insects (Murchie et al., 2023). These traps are widely preferred by researchers due to their simplicity, affordability, and ability to provide systematic, continuous data on pest population dynamics without human intervention. Proper trap placement at a visible height enhances their efficiency (Portman et al., 2020). Yellow sticky traps, constructed from cardboard coated with a sticky substance, trap insects upon landing and are equally effective for monitoring whiteflies, aphids, and leaf miners (Gu et al., 2008; Hanafi et al., 2017). They are used extensively in both field and greenhouse settings and help reduce pesticide use, contributing to environmental protection (Nestel et al., 2019; Shi et al., 2020). The efficiency of these traps is influenced by factors such as their shape, placement, and abiotic conditions. The present experiments were designed to evaluate the comparative effectiveness of Yellow Moericke Traps (YMT) and Yellow Sticky Traps (YST) in monitoring aphid population fluctuations over the cropping season, with a specific focus on how abiotic factors influence trap performance and aphid population fluctuations.

Materials and Methods

Experimental site

The research was conducted at the AZRI (Arid Zone Research Institute) Bhakkar (31°3 N, 71°02 E), Punjab, during 2022-23 to assess the effectiveness of yellow moericke traps (YMT) and yellow sticky traps (YST) at different growth stages of wheat. Four aphid species i.e. *Schizaphis graminum* R., *Rhopalosiphum padi* L., *Rhopalosiphum maidis* F. and *Sitobion avenae* B., previously reported in this region were targeted for monitoring, and species richness was analyzed to identify all aphid species present in the locality. AZRI is located in the southern region of Punjab, with a 100-acre research area characterized by sandy soil with a typical pH of 7.5–8.2 and low organic matter content. The soil texture is predominantly sandy loam, with poor water retention and nutrient-holding capacity, typical of arid environments. The climate is characterized by prolonged hot and dry conditions with minimal rainfall, making it ideal for cultivating chickpea, mungbean, and wheat as the primary crops.

Trap design and sampling procedure

In the current study, two trap types were utilized: Yellow Moericke Traps (YMT) And Yellow Sticky Traps (YST). YMT consisted of rectangular iron bowls measuring 20" × 12" × 3", painted yellow on the inside to attract aphids, and filled with water. These traps were mounted on iron frames above the ground. A total of 18 traps were installed, equally distributed across these heights, and placed at uniform distances. Yellow sticky traps included yellow-colored paper sheets smeared with highly sticky glue. These sheets were mounted on wooden sticks in the field with adjusted heights according to the crop stage. 25 sticky traps were installed per acre, maintaining the same distribution and distances. All traps were deployed from mid-November to mid-April, with data on mean aphid collections recorded fortnightly. The water in the YMT and the glue on the sticky traps were replaced every two weeks after data collection. Collected aphid species were identified based on morphological characteristics using a binocular microscope, concerning pre-identified species for comparison. Records of total aphid collections for each species and trap type were maintained separately. Aphid collections during different standard weeks were compared and analyzed with corresponding data on abiotic factors. The identification process involved comparing the morphological features of collected specimens, such as body shape, antennae length, and siphunculi structure, against known descriptions to ensure accurate species identification.

Statistical analysis

The effectiveness of both traps in capturing aphids, in terms of abundance, was compared using the non-parametric Kruskal-Wallis test. Differences in species diversity and total aphid samples between the two trap types were analyzed, with mean separations performed by Tukey's HSD test (Steel et al., 1960). Simple correlation and multiple linear regression analysis were applied to assess the impact of temperature (°C) and humidity (%) on aphid population fluctuations. The goodness of fit and coefficient of determination (R^2) were calculated for the regression models using Minitab 13 statistical software to assess their accuracy and reliability at a 5 % significance level (Minitab, 2013).

Results

Comparison of aphid catches in YMT and YST

Aphid collections and population trends between the two traps were significantly different in yellow moericke traps (YMT) and yellow sticky traps (YST) during the years 2022 and 2023. These traps play a crucial role in integrated pest management (IPM) as effective tools for monitoring aphid populations and serve as reliable indicators of population trends and fluctuations during their active periods. Table 1 provides an overview of aphid catches recorded using two different trapping methods, Yellow Moericke Traps (YMT) and Yellow Sticky Traps (YST), across two consecutive years, 2022 and 2023. Data was collected from nine sampling sites, coded from SW-02 to SW-18. In 2022, aphid catches were notably higher in both trap types compared to 2023. For YMT, the number of aphids caught increased progressively from 10 at SW-02 to a peak of 401 at SW-12, after which catches decreased to 21 at SW-18. Similarly, YST catches in 2022 followed a similar trend, starting at eight at SW-02, peaking at 141 at SW-12, and declining to 7 at SW-18. The YMT consistently captured more aphids than the YST, often by a substantial margin, highlighting its effectiveness. In 2023, aphid catches declined significantly across all sampling sites for both YMT and YST.

YMT catches ranged from a minimum of 5 at SW-02 to a high of 320 at SW-12, while YST captures ranged from 5 at SW-18 to a maximum of 97 at SW-14. Despite the overall decline, the pattern of higher catches in YMT relative to YST remained consistent. These results suggest two key trends: first, aphid populations showed a notable year-on-year reduction from 2022 to 2023, and second, YMT proved to be a more effective trapping method compared to YST in capturing aphids consistently at all sites and during both years. Yellow moericke traps were most effective due to their greater attraction and killing rate as compared to the yellow sticky traps.

Table 1 Aphids trend in various standard weeks of 2022 and 2023

Sr. No	YMT±SE		YST±SE	
	2022	2023	2022	2023
SW-02	10.0±0.23	5.00±0.8	8.00±3.4	5.00±0.9
SW-04	33.0±1.2	12.0±1.6	13.0±3.4	9.00±1.3
SW-06	45.0±2.3	30.0±3.6	22.0±2.5	11.0±3.4
SW-08	88.0±3.6	70.0±5.9	37.0±4.3	29.0±4.6
SW-10	205±5.6	130±9.1	103±8.5	65.0±3.2
SW-12	401±11.0	320±12.6	141±12.7	95.0±7.2
SW-14	110±3.6	95.0±6.5	65.0±6.8	97.0±13
SW-16	51.0±2.9	35.0±3.6	21.0±3.4	15.0±2.6
SW-18	21.0±3.7	15.0±2.1	7.00±2.1	5.00±0.6
CV (%)	14.6	16.9	9.63	12.7
P Value	0.000	0.009	0.001	0.000

YMT = Yellow Moericke Traps; SE = Standard error

Relation of aphid catches with abiotic factors in YMT and YST

The correlation analysis during 2022-23 shows the relationship between aphid catches in yellow moericke traps (YMT) and yellow sticky traps (YST) with temperature and humidity in Table 2. In 2022, aphid catches in YMT exhibited a significant positive correlation with temperature (r = 0.712, p = 0.050) but showed no significant correlation with humidity (r = -0.361, p = 0.251). Similarly, YST catches were significantly positively correlated with temperature (r = 0.737, p = 0.039) and non-significantly negatively correlated with humidity (r = -0.410, p = 0.228). In 2023, both traps showed a stronger significant positive correlation with temperature, with YMT having r = 0.782 (p = 0.037) and YST r = 0.882 (p = 0.007). However, the correlation with humidity remained not significant for both traps, with YMT having r = -0.353 (p = 0.365) and YST r = -0.577 (p = 0.077). These results suggest that temperature plays a significant role in influencing aphid catches, while humidity shows a weak and non-significant negative relationship during both years. The regression analysis for the years 2022 and 2023 examined the impact of temperature (X_1) and humidity (X_2) on aphid catches in yellow moericke traps (YMT) and yellow sticky traps (YST) in Table 3. In 2022, the regression models for both traps show temperature (X_1) to have a significant positive effect on aphid catches, while humidity (X_2) had no significant impact. The model for YMT had an impact of 45%, with a significant effect of temperature (p = 0.176), while for YST, the temperature's impact was 57%, with a similar non-significant effect of humidity (p = 0.138). During 2023**,** the temperature continued to have a significant positive impact, especially in the case of YST, where the effect of temperature was stronger (impact = 80%, p = 0.005). For YMT, the effect of temperature remained significant (impact = 50%, p = 0.057), while humidity remained non-significant in both trap types. Overall, temperature was a key factor affecting aphid catches, while the effect of humidity was relatively weak across both years and trap types.

Table 2 Correlation analysis traps efficiency in relation to abiotic factors

Traps	2022		2023	
	Temperature (°C)	Humidity (%)	Temperature (°C)	Humidity (%)
YMT	0.712* (0.050)	-0.361^{ns} (0.251)	0.782* (0.037)	-0.353^{ns} (0.365)
YST	0.737* (0.039)	-0.410^{ns} (0.201)	0.882* (0.007)	-0.577^{ns} (0.077)

Table 3 Regression analysis traps efficiency in relation to abiotic factors

Year	Equation	Impact (%)		F value	P value
		X_1	X_2		
2022	YMT = - 267 + 22.4 X_1*+ 0.64 X_2 ^{ns}	45	0.8	4.10	0.176
	YST = - 121 + 9.55 X_1*+ 0.46 X_2 ^{ns}	57	0.5	3.79	0.138
2023	YMT = - 1056 + 42.3 X_1* + 12.3 X_2 ^{ns}	50	12	4.45	0.057
	YST = - 322 + 16.2 X_1*+ 2.99 X_2 ^{ns}	80	04	13.9	0.004

Comparison of aphid species collection in YMT and YST

The results suggest a stronger dependency on temperature, especially in 2023. The installed traps attracted thirteen species, having four wheat aphid species, *S. graminum*, *R. padi*, *S. avenae*, and *R. maidis* were identified as major wheat pests. The remaining species, including *Aphis craccivora*, *Brevicoryne brassicae*, *Macrosiphum rosae*, *Myzus persicae*, *Toxoptera citricida*, *Toxoptera aurantii*, *Aphis gossypii*, *Aphis nerii* and *Aphis fabae*, originated from different sources in the vicinity and were already reported in the area (Husain et al., 2022). Table 4 presents the results of aphid species captured in yellow moericke traps (YMT) and yellow sticky traps (YST) during 2022-23, highlighting total captures, mean aphid counts with standard error (SE), and the dominant activity periods based on standard weeks (SW). A total of 16,383 aphids were captured in YMT and 7,098 in YST, showing significant differences between the two traps ($p < 0.05$) and moderate variation (CV = 21.8% for YMT, 24.6% for YST). The most abundant species was *Rhopalosiphum padi*, with 4,135 ± 148 individuals in YMT and 1,726 ± 61 in YST, peaking during SW 03-09. *Schizaphis graminum* followed with 3,048 ± 114 in YMT and 1,548 ± 35 in YST, with dominant activity in SW 05-13. Other species like *Sitobion avenae* (YMT: 1,985 ± 75; YST: 1,328 ± 19) and *Brevicoryne brassicae* (YMT: 3,695 ± 271; YST: 1,365 ± 16) showed relatively high captures during SW 09-14 and SW 52-05, respectively. Less abundant species included *Rhopalosiphum maidis* (YMT: 841 ± 17; YST: 353 ± 16) and *Myzus persicae* (YMT: 954 ± 35; YST: 301 ± 16), while species such as *Aphis craccivora*, *Toxoptera citricida*, and *Aphis fabae* showed low captures with their activity confined to specific weeks. Rare species like *Macrosiphum rosae* and *Aphis nerii* had minimal catches in both traps, with captures below 150 individuals. Overall, YMT captured significantly higher numbers of aphids compared to YST, emphasizing its efficiency across all species.

Aphid catches at different wheat growth stages

Aphid trap catches and corresponding environmental conditions across different wheat growth stages: Seedling, Stem Elongation, Booting, Heading, and Ripening are given in Fig. 1. During the Seedling stage, Yellow Sticky Traps (YST) captured slightly more aphids (31) than Yellow Moericke Traps (YMT) (28), under the lowest temperature (10.4°C) and highest humidity (60.5%) recorded across all stages. As the crop progressed to Stem Elongation, catches increased modestly, with YMT (41) slightly outperforming YST (36), accompanied by a rise in temperature to 16.3°C and a decline in humidity to 55.4%. A significant increase in aphid activity was observed during the Booting stage, where YMT captured 189 aphids compared to 125 by YST, coinciding with a temperature of 19.6°C and humidity of 51.6%. The highest catches occurred during the Heading stage, with YMT recording 362 aphids and YST 175, under a temperature of 23.4°C and humidity of 53.9%. At the Ripening stage, trap catches declined, though YMT still captured a higher number (214) compared to YST (95), with the highest temperature observed (26.4°C) and the lowest humidity (50.1%). Overall, YMT consistently captured more aphids than YST from the Booting to Ripening stages, with trap effectiveness appearing to increase with rising temperature and decreasing humidity.

Table 4 Comparison of aphid species collection in two traps (P≤0.05)

Sr. No.	Aphid species	Traps efficacy		Prevailing Period
		YMT±SE	YST±SE	
1	*Rhopalosiphum padi (L.)*	4135±148 a*	1726±61 a*	SW 03-09
2	*Sitobion avenae* (B.)	1985±75 b*	1328±19 ab*	SW 09-14
3	*Schizaphis graminum* (R.)	3048±114 a*	1548±35 a*	SW 05-13
4	*Brevicoryne brassicae* (L.)	3695±271 a*	1365±16 b*	SW 52-05
5	*Rhopalosiphum maidis* (F.)	841±17 c	353±16 c	SW 06-11
6	*Aphis craccivora* (K.)	382±10 d	105±9 d	SW 11-12
7	*Myzus persicae* (S.)	954±35 c	301±16 c	SW 11-13
8	*Macrosiphum rosae* (L.)	119±5 e	84±06 d	SW 04-09
9	*Aphis gossypii* (G.)	558±15 d	36±05 e	SW 05-09
10	*Aphis nerii* (B.)	126±29 e	26±03 e	SW 19-21
11	*Toxoptera aurantii* (B.)	123±11 e	75±07 d	SW 04-06
12	*Toxoptera citricida* (K.)	305±13 d	111±08 d	SW 01-05

13	*Aphis fabae* (S.)	64±06 e	19±02 e	SW 02-08
Total samples during 2022-23		16383	7098	
CV (%)		21.8	24.6	
P Value		0.002	0.006	

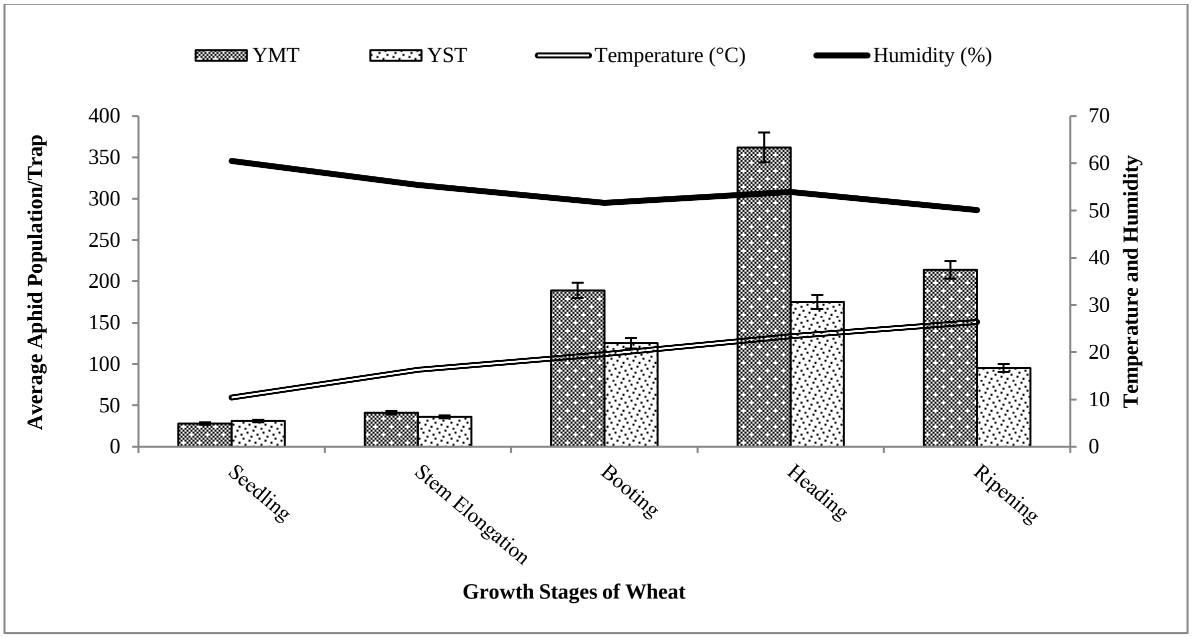

Fig. 1 Aphid trap catches at different wheat growth stages corresponding with environmental conditions

Discussion

The efficacy and significance of Moericke traps in the current study have been supported and validated by numerous researchers. Population trends in traps and temperature effects were confirmed by Husain et al. (2022), who reported population peaks in Yellow Moericke Traps (YMT) during standard weeks (SW) 08-14 and in Yellow Sticky Traps (YST) during SW 10-14. Temperature exhibited a positive-significant correlation with the aphid populations captured in both traps, while humidity showed a negative non-significant correlation with aphid attraction per unit. Temperature accounted for 47 and 53% of the variation in aphid populations in YMT during 2022 and 2023, respectively, whereas in YST, temperature impact was higher, explaining 55 and 83% of the population changes during the same years. Mazon et al. (2008) evaluated the effectiveness of Malaise traps and moericke yellow pan traps for capturing flying insects, finding Moericke traps to be more effective, particularly in capturing members of the family Orthocentrinae.

Similarly, Saljoqi et al. (2009) successfully eradicated *Myzus persicae* potato-berseem mix cropping by using yellow sticky sheets. Nebreda et al. (2004) used moericke green and yellow traps to monitor aphid flights, where yellow moericke traps proved highly effective. Wilkaniec et al. (2012) compared the efficacy of moericke and light traps for capturing aphids, recording 61 species overall, with 44 species captured using moericke traps significantly higher than the 14 species identified in the present study. However, the reported study collected only 8,000 specimens, far fewer than the 23,194 specimens captured in the current study using both traps. This discrepancy may be attributed to differences in localities and the limited trapping period in the present study, which focused only on aphid active periods. Additionally, temperature was found to have a significant impact on insect catches, aligning with the findings of this study. Singh et al. (2010) presented differing results, reporting that yellow pan traps were less effective than sticky traps for studying aphid population dynamics. Lasue et al. (2009) effectively controlled flying aphids by using yellow moericke traps. Bonneau et al. (2019) compared yellow pan traps with sticky traps and reported that sticky traps were more efficient in capturing alates. Similarly, Perez et al. (2007) highlighted the significant contribution of Moericke and suction traps in monitoring damson hop aphids. Abbas et al. (2018) studied aphid biology in locations matching the current study and confirmed peak aphid populations aligned with the present findings.

Dominant species, including *R. padi*, *S. graminum*, and *S. avenae*, peaked from 15th February to 15th March, March to April, and 20th March to 15th April, respectively. Ramzan et al. (2020) similarly observed peak aphid activity during standard weeks 10-11 for wheat aphid species. Wilkaniec et al. (2012) identified a comparable relationship between aphid population peaks and abiotic factors such as temperature and relative humidity. Population dynamics studies (Wains et al., 2010) showed a strong positive correlation between aphid numbers and temperature, while (Jan et al., 2017) reported a negative non-significant correlation with relative humidity. (Jagadish et al., 2003) confirmed a significant positive relationship between total aphid collections and temperature. Prasad et al. (2008) observed similar trends during both the Rabi and Kharif seasons, where temperature and relative humidity influenced the development of alate aphids.

Jasrotia et al. (2016) studied aphid populations using three different yellow sticky traps in relation to weather parameters and found a strong correlation, with weather accounting for 61% of population variation. This is consistent with the present study, where weather conditions contributed to 57-80% of population variation in yellow sticky trap catches. Thirteen species, having four wheat aphid species, *S. graminum*, *R. padi*, *S. avenae*, and *R. maidis* were identified as major wheat pests were similar as reported by Husain et al. (2022) but his findings regarding population at different growth stages differed with our results where he reported that at seedling stage, the maximum aphid population recorded was 45 aphids/trap in YMT and 50 aphids/trap in YST, while the minimum was 15 and 10 aphids/trap, respectively. During the tillering stage, YMT and YST recorded maximum aphid catches of 60 and 50 aphids/trap, with corresponding minimum counts of 20 and 15 aphids/trap. Similarly at the dough stage, the maximum aphid population reached 70 aphids/trap in YMT and 67 aphids/trap in YST, respectively. This difference might be due to the use of traps at different heights at various growth stages of wheat. Where in our case the traps were installed at fixed height throughout the cropping season.

Conclusion

Our study demonstrates that Yellow Moericke Traps (YMT) and Yellow Sticky Traps (YST) are valuable tools in integrated pest management (IPM), effectively monitoring aphid populations and tracking population trends. YMT consistently outperformed YST, capturing significantly higher numbers of aphids across all sampling sites and species ($p < 0.05$). Aphid populations peaked in 2022 and declined in 2023, with temperature showing a significant positive effect on trap efficiency. The higher efficiency of YMT can be attributed to its greater attraction and killing rate, influenced by factors such as trap size, shape, and placement. *R. padi* and *S. graminum* were the most abundant species, emphasizing the critical role of YMT in detecting and managing aphid infestations. Yellow Moericke Traps (YMT) consistently captured more aphids than Yellow Sticky Traps (YST) from the Booting to Ripening stages. Trap catches increased with rising temperatures peaking during the Heading stage. The current significance of YMT stems from its capacity to deliver precise pest monitoring, facilitating more informed decision-making for pest control and contributing to improved efficiency and sustainability in agricultural practices. Moving forward, future research should prioritize the optimization of trap design and strategic placement to maximize their effectiveness across varied environmental conditions. Furthermore, there is a critical need to assess the potential of YMT for the development of resistance over time.

References

Abbas, M., Hussain, N., Ghaffar, A., & Ramzan, M. (2018). Occurrence and abundance of different aphid species on various growth stages of wheat crop and their losses at Faisalabad and Bhakkar. *International Journal of Current Agricultural Sciences, 8*(4), 283-287.

Abbas, Q., & Shafique, A. (2019). Integrated use of organic and inorganic fertilizers improves soil health, growth and yield of wheat (*Triticum aestivum* L.). *Advances in Agriculture and Biology, 2*(1), 48-54. https://doi.org/10.63072/aab.19007

Alamgeer, M., Chaudhry, L. A., Anum, W., Ali, A., Zafar, D., Hamid, A., & Abbas, R. (2022). Effect of different sowing dates, planting methods and irrigation intervals on performance of wheat varieties under agro-climatic conditions of Bahawalpur region. *Advances in Agriculture and Biology, 5*(1), 35-45. https://doi.org/10.63072/aab.22006

Baideng, E., Memah, V. & Tallei, T. E. (2017). Monitoring of species and population of important insect pest of tomato plants using yellow sticky trap during conventional and integrated pest management system. *Journal of Animal Plant Sciences, 34*(1), 5404-5412.

Bonneau, P., Brisson, J. D., Tellier, S., & Fournier, V. (2019). Flight phenology and trap selection for monitoring potential viral vector Aphididae and Aleyrodidae (Hemiptera) in strawberry (Rosaceae) fields of Quebec, Canada. *The Canadian Entomologist, 151*(3), 378-390.

Borowiak-Sobkowiak, B., & Wilkaniec, B. (2010). Occurrence of aphids (Hemiptera, Aphidoidea) on tree and shrubs in Cytadela Park in Poznan. *Aphids Other Hemipterous Insects, 16*, 27-35.

Dinsa, T., & Balcha, U. (2024). Evaluation of agronomic performance and grain yield stability of bread wheat (*Triticum aestivum*) genotypes in East Shewa zone, Oromia. *Advances in Agriculture and Biology, 7*(1), 58-67. https://doi.org/10.63072/aab.24007

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*(3), 263-270.

Hanafi, A., & Rapisarda, C. (2017). Integrated pest management and good agricultural practice recommendations in greenhouse crops. In Integrated pest management in tropical regions (pp. 204-228): CABI Wallingford UK.

Hu, X. S., Liu, X. F., Thieme, T., Zhang, G. S., Liu, T. X., & Zhao, H. Y. (2015). Testing the fecundity advantage hypothesis with *Sitobion avenae*, *Rhopalosiphum padi* and *Schizaphi graminum* (Hemiptera: Aphididae) feeding on ten wheat accessions. *Scientific Reports, 5*, 18549.

Husain, K., Abbas, M., Hussain, N., Irshad, M., Khaliq, M., Parveen, Z., Abbas, S., Raza, A., & Ghaffar, A. (2022). Study on Species Richness of Aphid through Integrated Pest

Management. *Pakistan Journal of Agricultural Research, 35*(3), 483-489.

Hussain, D., Saleem, U., Asrar, M., Saleem, M., Ghaffar, A., Hussain, S., Shaheen, T., & Saleem, M. (2024). A review on identification characters and IPM of wheat aphid by using non-conventional methods. *International Journal of Tropical Insect Science, 44*(2), 419-432.

Iqbal, J., Shah, S. F. H., & Ahmad, I. (2018). Effect of sowing time, advanced genotype, and potassium application on seed cotton yield in relay cropping with wheat. *Advances in Agriculture and Biology, 1*(1), 15-22. https://doi.org/10.63072/aab.18003

Jagadish, K., Jayaramaiah, M., & Seenappa, K. (2003). A model to forecast the occurrence of VFC tobacco aphid and its predators. *Environment Ecology, 21*(3), 552-555.

Jan, H., Akhtar, M. N., Akhtar, Z. R., Naveed, W. A., Latif, M., & Shah, S. Z. A. (2017). Effect of biotic and abiotic factors on the population dynamics of wheat aphids. *Journal of Entomology and Zoology Studies, 5*(6), 2349-2353.

Jasrotia, P., Nataraja, M., Harish, G., Dutta, R., & Savaliya, S. (2016). Effect of trap design and weather factors on relative efficiency of yellow sticky traps for sampling aphids in groundnut. *Legume Research, 39*(5), 834-839.

Lasue, P., & Pinchon, V. (2009). Comparison of two types of yellow water traps for sampling alate aphids. *Journal Redia, 92*, 243-245.

Mazon, M., & Bordera, S. (2008). Effectiveness of two sampling methods used for collecting Ichneumonidae (Hymenoptera) in the Cabañeros National Park (Spain). *European Journal of Entomology, 105*(5), 879-888.

Mehmood, K., Arshad, M., Ali, G. M., Razzaq, A., & Qureshi, R. (2020). Optimization of factors affecting callus-based gene transformation by *Agrobacterium tumefaciens* in wheat (*Triticum aestivum* L.). *Advances in Agriculture and Biology, 3*(1), 23-31. https://doi.org/10.63072/aab.20004

Minitab, L. (2013). Minitab: State College, Centre County, Pennsylvania, United States. PA 16801. Data Universal Number System (DUNS) number. 107326043.

Murchie, A. K., Hodgson, E. W., Dean, A. N., Huseth, A., Hutchison, W. D., Manoukis, N. C., Mankin, R. W., Drake, V. A., Guyer, D., & Whitfield, C. [Ed.] (2023). Advances in monitoring of native and invasive insect pests of crops (Vol. 128): Burleigh Dodds Science Publishing.

Nebreda, M., Moreno, A., Perez, N., Palacios, I., Seco-Fernandez, V., & Fereres, A. (2004). Activity of aphids associated with lettuce and broccoli in Spain and their efficiency as vectors of Lettuce mosaic virus. *Journal of Virus Research, 100*(1), 83-88.

Nestel, D., Cohen, Y., Shaked, B., Alchanatis, V., Nemny-Lavy, E., Miranda, M. A., Sciarretta, A., & Papadopoulos, N. T. (2019). An integrated decision support system for environmentally-friendly management of the Ethiopian fruit fly in greenhouse crops. *Agronomy, 9*(8), 459.

Panwar, N., Thirumurugan, S., & Kumar, S. (2023). Host plant resistance in Brassicaceae against aphids. In S. Kumar (Ed.), Brassica – Recent advances. InTechOpen. https://doi.org/10.5772/intechopen.110204

Peraz, N., Seco, M., Valenciano, J., & Lorenzana, A. (2007). Use of suction-trap and Moericke traps for monitoring the migration of damson-hop aphid (*Phorodon humuli*). *New Zealand Journal of Crop Horticultural Science, 35*(4), 455-461.

Portman, Z. M., Bruninga-Socolar, B., & Cariveau, D. P. (2020). The state of bee monitoring in the United States: a call to refocus away from bowl traps and towards more effective methods. *Annals of the Entomological Society of America, 113*(5), 337-342.

Prasad, T., Nandagopal, V., & Gedia, M. (2008). Effect of abiotic factors on the population dynamics of Aphis craccivora koch in groundnut in Saurashtra region of Gujarat. *Indian Journal of Entomology, 70*(4), 309-313.

Ramzan, M., Abbas, M., Abbas, S., Hussain, N., Aslam, M., Shah, J. A., Irshad, M., & Khaliq, M. (2020). Incidence of Different Aphid Species on Various High Yielding Wheat Varieties. *Pakistan Journal of Agricultural Research, 33*(4), 911-916.

Saljoqi, A., Khan, K., & Rahman, S. (2009). Integrated management of potato-peach aphid, Myzus persicae (Sulzer). *Sarhad Journal of Agriculture, 25*(4), 573-580.

Sharma, I., Tyagi, B., Singh, G., Venkatesh, K., & Gupta, O. (2015). Enhancing wheat production-A global perspective. The *Indian Journal of Agricultural Sciences, 85*(1), 03-13.

Shi, L., He, H., Yang, G., Huang, H., Vasseur, L., & You, M. (2020). Are yellow sticky cards and light traps effective on tea green leafhoppers and their predators in Chinese tea plantations. *Insects, 12*(1), 14.

Singh, N. J., Konar, A., & Mondal, P. (2010). Incidence of aphids in different traps on potato in Gangetic plains of West Bengal. *Journal of Plant Protection Sciences, 2*(1), 96-99.

Steel, R. G. D., & Torrie, J. H. [Eds.] (1960). Principles and procedures of statistics. McGraw-Hill, New York (pp 190).

Wains, M. S., Ali, M. A., Hussain, M., Anwar, J., Zulkiffal, M., & Sabir, W. (2010). Aphid dynamics in relation to meteorological factors and various management practices in bread wheat. *Journal of Plant Protection Research, 50*(3), 386-392.

Wilkaniec, B., Borowiak-Sobkowiak, B., & Lewandowski, R. (2012). The effectiveness of catching aphids (Hemiptera: Sternorrhyncha: Aphidinea) in Moericke and light traps. *Journal of Plant Protection Research, 52*(2), 259-263.

Zhang, K. X., Li, H. Y., Quandahor, P., Gou, Y. P., Li, C. C., Zhang, Q. Y., Haq, I. U., Ma, Y., & Liu, C. Z. (2022). Responses of six wheat cultivars (*Triticum aestivum*) to wheat aphid (*Sitobion avenae*) infestation. *Insects, 13*(6), 125-136.