Efficiency of Different Shapes and Heights of Sticky Traps on Capturing Muscid Flies (Diptera: Muscidae) on Dairy Cattle Farms in Saraburi Province, Thailand

ประสิทธิภาพของรูปทรงและความสูงของกับดักกาวเหนียวต่อการจับแมลงวัน (Diptera: Muscidae) ในฟาร์มโคนม จังหวัดสระบุรี ประเทศไทย

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บทคัดย่อ: แมลงวันจัดเป็นแมลงศัตรูสำคัญในโคและอาจก่อให้เกิดความสูญเสียทางเศรษฐกิจในฟาร์มโคนม แต่การศึกษาการใช้กับดักกาวเหนียวกับแมลงศัตรูเหล่านี้ในประเทศไทยยังมีจำกัด ดังนั้นวัตถุประสงค์ของงานวิจัยนี้เพื่อประเมินประสิทธิภาพรูปทรงที่แตกต่างและความสูงของกับดักกาวเหนียวสีน้ำเงินและสีขาวในการจับตัวเต็มวัยของแมลงวัน โดยดำเนินการทดลองในฟาร์มโคนม จังหวัดสระบุรี ในช่วงเดือนพฤษภาคมถึงกันยายน พ.ศ. 2567 ทำการเปรียบเทียบประสิทธิภาพของรูปทรงกับดักกาวเหนียว 4 แบบ ได้แก่ วงกลม สามเหลี่ยม สี่เหลี่ยมผืนผ้า และสี่เหลี่ยมจัตุรัส และระดับความสูงของกับดักจากพื้นดิน 3 ระดับ ได้แก่ 20, 50 และ 80 เซนติเมตร ผลการทดลองพบว่า จำนวนแมลงวันที่จับได้ไม่มีความแตกต่างกันอย่างมีนัยสำคัญระหว่างรูปทรงต่าง ๆ ของกับดัก แต่กับดักกาวเหนียวทั้งสีน้ำเงินและขาวขอบด้านล่างอยู่สูงจากพื้นดิน 20 เซนติเมตร สามารถดักจับแมลงวันได้มากที่สุด และมีแนวโน้มในการจับแมลงวันกลุ่มปากไม่กัดได้มากกว่าแมลงวันกลุ่มปากกัด ผลการศึกษาชี้ให้เห็นว่าการปรับความสูงของกับดักให้เหมาะสมสามารถเพิ่มประสิทธิภาพการดักจับ และช่วยให้การติดตามชนิดเป้าหมายในฟาร์มโคนมมีความแม่นยำยิ่งขึ้น

คำสำคัญ: แมลงวันกินเลือด, กับดักกาวเหนียว, ประเทศไทย

Abstract: Muscid flies are major pests of cattle and may cause significant economic losses on dairy farms. In Thailand, there have been few reported studies on using sticky traps for these pests. This study aimed to assess the efficiency of different shapes and heights of blue and white sticky traps for capturing adult muscid flies. Trap shape and height were investigated through two field studies conducted on dairy farms from May to September 2024. The effectiveness of blue and white sticky traps was compared across four shapes (circle, triangle, rectangle, and square shapes) and three heights (20, 50, and 80 cm above ground). Based on the results, it is shown that the numbers of captured adult flies were not significantly different among the different shapes of sticky traps. The highest numbers of muscid flies were caught on both blue and white sticky traps with their bottom edges set at 20 cm above ground level, and both colors tended to capture more non-biting than biting muscid flies. These findings indicate that optimizing trap height can increase capture efficiency and improve monitoring of these target species on dairy farms.

Keywords: Hematophagous flies, sticky trap, Thailand

Introduction

The stable fly, *Stomoxys calcitrans* and the cattle fly, *Musca crassirostris* are an important group of dipteran insects belonging to the family Muscidae. The latter species was considered to be one of the most abundant of the muscid flies, especially on bovine farms (Desquesnes *et al*., 2018). Both adult males and females of these two species are hematophagous flies and are commonly found in cattle farms of many countries, including Thailand (Boonsaen *et al*., 2024; Desquesnes *et al*., 2018; Nangoy *et al*., 2022; Ngoen-Klan *et al*., 2024; Ola-Fadunsin *et al*., 2020; Onju *et al*., 2020). In addition, other muscid flies have been reported in livestock areas in Thailand, including *M. ventrosa*, *M. pattoni*, *M. sorbens*, and *M. domestica* (Ngoen-Klan *et al*., 2024), as well as *Haematobia exigua*, a blood - feeding species found in cattle and buffalo (Ngoen-Klan *et al*., 2024; Phetcharat *et al*., 2024). These flies can cause direct effects on hosts due to their annoyance factor, painful bites, and blood loss, resulting in reduced weight gain and milk production; in addition, they are transmitters of many pathogens (Crosskey, 1993). They are a major nuisance in livestock farming and cause economic losses to the agricultural industry by direct damage to livestock and as a result of causing diseases requiring veterinary intervention (Lehane, 2005).

Sticky trap made from Alsynite fiberglass have been commonly used for monitoring and managing stable fly populations (Rochon *et al*., 2021; Taylor *et al*., 2020). In addition to Alsynite fiberglass, some corrugated plastic materials or Coroplast ® (known under various trade names in North America) are convenient, inexpensive, and simple materials to use for making stable fly traps (Rochon *et al*., 2021). The effectiveness of a sticky trap to capture stable flies may be influenced by various factors such as trap color, design, placement, and height. For example, trap color can influence *Stomoxys calcitrans* captures, with some studies reporting higher captures on blue plasticized corrugated boards (Cilek, 2003), while others found white to be more effective (Beresford and Sutcliffe, 2006). Previous findings indicated that stable fly captures can be increased by modifying traps to include black backgrounds (Murchie *et al*., 2018). Traps placed closer to host animals are more likely to encounter and capture the flies attracted to those animals (Gilles *et al*., 2007; Hogsette and Ose, 2017). In addition, the height of surrounding grasses or vegetation can influence the optimal trap placement. Trap height is an important factor influencing stable fly captures, with lower traps generally more effective (Beresford and Sutcliffe, 2008; Sharif *et al*., 2020), although higher placements have also been reported in some studies for collecting stable flies (Bunthong *et al*., 2019; Cilek, 2003; Khumalo and Galloway, 1996; Taylor and Berkebile, 2006).

In Thailand, cloth traps and adhesive traps have been used for the survey and study of stable and cattle flies (Boonsaen *et al*., 2024; Ngoen-Klan *et al*., 2024; Onju *et al*., 2020). The cloth traps were made from blue and black fabrics and white mosquito netting, particularly the Vavoua and Nzi traps that are commonly used for studying hematophagous flies such as *Stomoxys* and tabanids (Boonsaen *et al*., 2024; Ngoen-Klan *et al*., 2024; Onju *et al*., 2020; Phetcharat *et al*., 2024; Tunnakundacha *et al*., 2017). Phasuk *et al.* (2025) compared different sticky trap colors for capturing *S. calcitrans*, whereas Bunthong *et al*. (2019) investigated the effects of both color and shape. However, the efficacy of sticky traps made from corrugated plastic for capturing blood-feeding flies in Thailand remains limited. Therefore, this study was conducted to provide baseline data for monitoring muscid flies and to guide future improvements in trap design and fly management on dairy farms.

Materials and Methods

Study site

The study was conducted on two dairy farms (referred to as farms A and B) located in Wang Muang district, Saraburi province, central Thailand from May to September 2024. Farm A (14° 52'06.11" N, 101°10'58.40" E) had 40 dairy cows and 2 young cattle, while farm B (14° 52'08.23" N, 101°10'42.80" E) had 50 dairy cows, 4 bulls, and 16 young cattle. In the present study, blue sticky traps were placed at farm A, with white sticky traps at farm B. The two colors used in this study were selected based on the findings of a previous color study (Phasuk *et al*., 2025).

Traps and study designs

Different shapes of blue and white sticky traps were made from commercial corrugated plastic sheets and cut into four distinct shapes. All shapes had an area on one side of approximately 624–625 cm^2: circle (28.2 cm diameter), equilateral triangle (38 cm per side), rectangle (21 cm high and 29.7 cm wide), and square (25 cm per side) (Figure 1). Both sides of the traps were painted with Beetle-Glue® colorless insect glue (Green plana Co., Ltd., Thailand) and secured on wooden stakes at 20 cm above the ground. Four different shapes of the same color were set up outside the cattle pens about 1 m from the fence and 1 m from each other at two locations, with a distance of 5 m

Figure 1. Sticky traps used to test different shapes and heights. Top panels show shapes; bottom panels show heights

between the locations. The sticky traps were left in the field for 4 days. On both farms, the four trapping periods were 27–31 May, 17–21 June, 1–5 July, and 15–19 July, except for the last trapping period on farm A (1–5 August). At each collection period, the traps were removed and replaced with new ones and the trap positions were rotated to avoid position effects.

In a second study, sticky traps were made of corrugated plastic sheets (29.7 cm long and 21 cm wide) coated with glue on both sides. The trap bottoms were located at 20, 50, and 80 cm above the ground (Figure 1). The sticky traps were fixed on wooden stakes and placed 1 m from the outside of the fence. Traps were placed 2 m apart at two locations with a distance of 5 m between the locations. Traps were deployed at each farm for 3 days at a time, then collected and replaced with new ones for each trapping period and the trap positions were rotated at each collection. On both farms, the three trapping periods were 5–8 August, 23–26 August, and 10–13 September.

In both studies, treatments were rotated between trap positions according to a Latin-square design. After each trapping period, all sticky traps (Figure 2) were transported to the laboratory for later sorting and fly identification. Flies trapped on the sticky surfaces were removed from the traps using a small paintbrush and pointed forceps and placed on white paper until identification. Unfortunately, identification could be made only to the genus level due to the condition of the flies after being removed from the sticky traps. Adult flies were identified to genus using the taxonomic key of Tumrasvin and

Figure 2. Examples of muscid flies attached to sticky traps during the sampling periods

Shinonaga (1978), based on key morphological characters, including proboscis type, wing venation, and setal distribution. Stomoxyini flies (e.g., *Stomoxys*, *Haematobia, Haematobosca*) were separated from *Musca* by their elongated piercing–sucking proboscis, characteristic of biting muscid flies, whereas *Musca* possesses a sponging proboscis typical of non-biting muscid flies. Genus-level identification within Stomoxyini was supported by diagnostic characters, including the number and arrangement of sternopleural and notopleural bristles, the presence and form of arista hairs, and maxillary palp length.

Data analysis

Data were normalized using a log (x + 1) transformation and processed using one-way analysis of variance (ANOVA) for comparison among treatments (trap shape and height) for each farm. When a significant difference was found, the least significant difference (LSD) *post hoc* test was applied. Chi-square (χ^2) analysis was used to determine significant differences in the numbers of *Stomoxys* spp. and *Musca* spp. captured on different shapes and heights of sticky traps at each farm. All differences were considered significant at $P < 0.05$. The data were analyzed using the R software (R Core Team, 2023).

Results

Trap shape

No significant difference was observed in the numbers of *Stomoxys* spp. captured among different sticky trap shapes for either blue (farm A: F = 0.375, df = 3, 28, P = 0.771) or white traps (farm B: F = 1.584, df = 3, 28, P = 0.215). Similarly, the numbers of *Musca* spp. captured did not differ significantly among trap shapes for blue (farm A: F = 0.226, df = 3, 28, P = 0.877) or white traps (farm B: F = 0.394, df = 3, 28, P = 0.758) (Figure 3).

Based on the chi-square test, there were significant different between the numbers of *Stomoxys* spp. and *Musca* spp. according to the shape of the sticky traps (farm A: blue sticky trap, χ^2 = 10.486, df = 3, P < 0.05; farm B: white sticky trap, χ^2 = 17.169, df = 3, P < 0.05). All shapes of both the blue and white sticky traps captured more *Musca* spp. than *Stomoxys* spp. (Table 1).

Trap height

The numbers of *Stomoxys* spp. captured were significantly affected by trap height for both blue sticky traps (farm A: F = 13.87, df = 2, 15, P < 0.05) and white sticky traps (farm B: F = 22.2, df = 2, 15, P < 0.05). The highest captures were recorded at 20 cm above the ground, with no significant difference between 50 and 80 cm (Figure 4). For *Musca* spp., trap height significantly affected captures in blue traps (farm A: F = 12.09, df = 2, 15, P < 0.05), with the highest numbers at 20 cm. No significant differences was observed between 50 and 80 cm. In contrast, no significant differences was found in white traps (farm B: F = 1.5, df = 2, 15, P = 0.238), although more flies were caught at 20 cm (Figure 4).

Chi-square analysis indicated no significant difference in the proportions of *Stomoxys* spp. and *Musca* spp. captured at different heights of blue traps (farm A: χ^2 = 4.582, df = 2, P = 0.101). Conversely, significant differences were observed in white traps (farm B: χ^2 = 13.845, df = 2, P < 0.05), with traps at 20 cm above the ground capturing more *Stomoxys* spp., whereas those at 50 or 80 cm were more attractive to *Musca* spp. (Table 2).

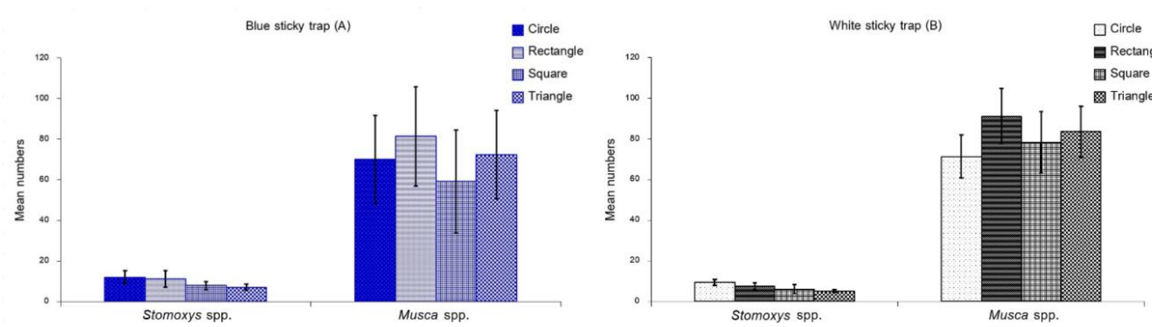

Figure 3. **Mean numbers of adult *Stomoxys* and *Musca* collected on different shapes of sticky traps. Bars represent the standard error of the mean. (A): farm A and (B): farm B. No significant differences observed among treatments. Untransformed data shown**

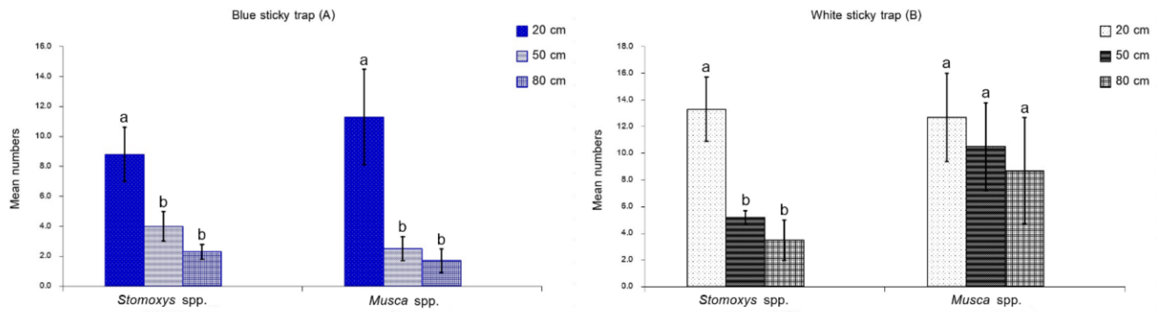

Figure 4. Mean numbers of adult *Stomoxys* and *Musca* collected by using sticky traps at different heights above the ground. Bars represent the standard error of the mean. (A): farm A and (B): farm B. Means with the same letter are not significantly different based on one-way ANOVA followed by LSD test, $P < 0.05$. Untransformed data shown

Table 1. Numbers of adult *Stomoxys* and *Musca* captured on different shapes of sticky traps

Trap color	Genus	Trap shape				χ^2	*P*-value
		Circular	Rectangular	Square	Triangular		
Blue	*Stomoxys* spp.	96 (14.6%)	89 (12.0%)	63 (11.8%)	56 (8.8%)	10.486	$P < 0.05$
	Musca spp.	560 (85.4%)	651 (88.0%)	473 (88.2%)	579 (91.2%)		
	Total	656	740	536	635		
White	*Stomoxys* spp.	74 (11.5%)	59 (7.5%)	48 (7.1%)	40 (5.6%)	17.169	$P < 0.05$
	Musca spp.	570 (88.5%)	729 (92.5%)	626 (92.9%)	668 (94.4%)		
	Total	644	788	674	708		

Table 2. Numbers of adult *Stomoxys* and *Musca* captured on different heights of sticky traps

Trap color	Genus	Trap height (cm)			χ^2	*P*-value
		20	50	80		
Blue	*Stomoxys* spp.	53 (43.8%)	24 (61.5%)	14 (58.3%)	4.582	*P* = 0.101
	Musca spp.	68 (56.2%)	15 (38.5%)	10 (41.7%)		
	Total	121	39	24		
White	*Stomoxys* spp.	80 (51.3%)	31 (33.0%)	21 (28.8%)	13.845	*P* < 0.05
	Musca spp.	76 (48.7%)	63 (67.0%)	52 (71.2%)		
	Total	156	94	73		

Discussion

The present study showed that the shape (circular, triangular, rectangular, and square) of both blue and white sticky traps did not significantly affect the numbers of *Stomoxys* spp. and *Musca* spp. captured. Although Bunthong *et al.* (2019) tested traps of both yellow and blue colors, the triangular yellow trap was the most effective at attracting stable flies. As the present study did not include yellow traps, only the effect of trap shape is directly comparable. Color contrast can also influence fly attraction. For example, Murchie *et al*. (2018) found that white sticky traps on a black background were more attractive to *S. calcitrans* than white or yellow backgrounds. Other studies reported that yellow traps are generally less attractive to stable flies compared to white, blue, gray, or red traps (Beresford and Sutcliffe 2006; Getahun *et al*., 2024; Phasuk *et al*., 2025), while some findings suggested that red, yellow, and green traps can be more effective than blue traps (Beresford and Sutcliffe, 2006). These variations may be due to differences in trap design, methodology, environmental conditions, and fly populations. Based on the present results, both colored traps captured more *Musca* spp. than *Stomoxys* spp., likely reflecting species-specific behavioral responses.

Trap height, however, was a critical factor influencing trapping efficiency. Low sticky traps, with the bottom edge positioned 20 cm above the ground, captured significantly higher numbers of both *Stomoxys* spp. and *Musca* spp. compared to higher traps (50 or 80 cm), except that white trap height did not significantly affect *Musca* spp. captures. These results are consistent with Sharif *et al*. (2020), who reported that most stable flies tend to land on the lower half of sticky screen traps, and with Beresford and Sutcliffe (2008), who recommended positioning traps with the bottom edge about 20 cm above surrounding grass. Stable flies typically fly short distances around 90 cm above the ground and move between hosts and resting sites to feed and mate, with males and unmated females generally perching near their hosts while mated females move closer to the substrate to lay eggs (Showler and Osbrink, 2015). Such behaviors are consistent with the species' preference for lower perching sites (Black and Krafsur, 1985), which likely contributes to the higher capture rates observed with low-positioned traps in this study.

Conclusion

Trap height had a significant effect on the captures of *Stomoxys* spp. and *Musca* spp., while trap shape showed no significant impact. These results suggest that selecting an appropriate trap height is essential for effectively capturing host-seeking flies on dairy farms. Placing traps approximately 20 cm above the ground improved capture efficiency and provided practical guidance for fly management and future studies.

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