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Control of *Musca domestica* (House Fly) in Poultry Units using Delta Traps

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ABSTRACT

Background: House fly menace is a major problem in poultry farms and nearby households. Though application of insecticides is one of the major approaches in house fly control, development of insecticide resistance is widely prevalent. Use of house fly traps is an ecofriendly alternate strategy in control of house flies. In the present study, delta traps were used to control house flies in poultry units.

Methods: Red acrylic delta traps with two different pellet baits (FMP and FMPB) were placed at ground level in poultry units housing caged layer chicken with a distance of 90 cm between two traps for seven days continuously and trial was replicated six times. Trapped flies were counted, sexed and species identified. Spot cards were used to determine house fly density pre-and post-trapping. Correlation of house fly population with meteorological parameters was assessed.

Result: Out of the 80410 flies trapped, 52.74 per cent (42415 flies) and 47.25 per cent (37994 flies) were trapped in FMPB and FMP pellet baited traps, respectively. Daily fly trapping pattern showed variations. Overall trap catches were dominated by female flies. Reduction in spot card count was 36.34 per cent after deployment of traps. Trap catches correlated positively with temperature, relative humidity and wind velocity. Two species *Musca domestica domestica* and *Musca domestica vicina* were identified.

Key words: (Z)-9-Tricosene, Delta traps, Housefly, Poultry unit.

INTRODUCTION

One of the common synanthropic pest in poultry farms and nearby households is *Musca domestica* (House fly) causing great menace and nuisance. Apart from irritation and nuisance they cause, house flies are efficient transmitters of several notable diseases such as cholera, typhoid, paratyphoid, tuberculosis, Salmonella dysentery, bacillary diarrhea, leptospirosis, poliomyelitis, infectious hepatitis, amoebic dysentery and giardiasis.

They also act as intermediate hosts and mechanically transmit several helminth parasites affecting animals and birds. Heavy economic losses are incurred by house flies in poultry industry indirectly by decreasing the productivity due to fly worry.

Several managemental, physical, chemical and biological approaches are being used to control house flies, but still effective ways elude us. Baited traps play a vital role in attracting flies towards traps. Insecticides are widely used and are successful in house fly control in field conditions. However, the emerging issues related to development of insecticide resistance due to continuous usage in flies is a real challenge in fly control practices. When failure in fly control using insecticides is noticed in a farm, alternate non-insecticide-based fly control strategies are helpful. Traps using pheromones is one of the alternatives to insecticides in fly control and traps can be used in Integrated Fly Management strategies. Pheromones are highly specific and eco-friendly. Therefore, insecticide usage can be minimized and trapping of non-target flies which are beneficial can be prevented (Butler *et al.,* 2007; Chapman *et al.,* 1998a; Hanley *et al.,* 2004); Butler and Mullens, 2010; Colacci *et al.,* 2020; Hinkle and Hogsette, 2021; Geden *et al.,* 2021; Guarino *et al.,* 2022). Pheromones are volatile chemical compounds produced by insects and arachnids for communication. They include sex pheromones, alarm pheromones and assembly pheromones. Among

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these pheromones, sex pheromones are involved in attracting flies for mating. The house fly sex pheromone (Z)-9-Tricosene is produced by female house flies to attract male flies and is widely used in fly control strategies especially insect traps. Since pheromones are highly volatile, addition of antioxidants will facilitate sustained release of pheromones and prolong their activity. Hence this study was undertaken to fabricate delta traps for house flies using pheromone-based baits as lures with and without addition of antioxidant and to evaluate the field efficacy of delta traps in poultry unit.

MATERIALS AND METHODS

The research work was carried out at the Department of Veterinary Parasitology, Madras Veterinary College, Vepery, Chennai from the year 2016-2019. Pellet baits for Delta traps (Fig 1) were prepared using (Z)-9-tricosene, fish meal powder and molasses. Baits using fish meal and pheromone (FMP), had 94.88 g of fish meal, 5.00 g of molasses and 0.22 g of (Z)-9-tricosene. Baits using fish meal, pheromone and antioxidant (FMPB), had 94.66 g of fish meal, 5.00 g of molasses, 0.22 g of (Z)-9-tricosene and 0.22 g of Butylated hydroxy toluene as antioxidant. Fish meal base of 100 g yielded 32 pellets each with diameter of 10 mm and length of 20 mm. Red acrylic delta traps were fabricated with length 28 cm, width 20 cm, height 15 cm and sides 20 cm with 20 ´ 20 cm insert at base where yellow sticky insert of 20 ´ 20 cm dimension was placed (Fig 2). The pellets were placed into polythene vial (5 cm height, 1 cm diameter and 2.5 ml capacity) with pinholes and suspended from the roof of the trap. Sixteen traps were fabricated out of which eight were baited with FMP pellets and eight with FMPB pellets. All traps were placed at ground level in poultry units housing caged layer chicken at Poultry Research Station, Madhavaram, Chennai with inter-trap distance of 90 cm (Fig 3). Traps were monitored at 24 h intervals, daily counts of trapped flies made. Traps were daily cleaned thoroughly, yellow sticky insert replaced. Trap positioning changed daily; bait was not replaced. Each trial lasted for 7 days and 6 trials done. Fly density assessed by spot cards (12.5 ´ 7.5 cm) before and after trapping (Fig 4). House Fly trap catches were correlated with temperature, relative humidity and wind velocity. House flies trapped were random sampled and species identified morphologically. Estimation of the presence of (Z)-9-tricosene and BHT in pellet baits was carried out by Fourier transform infrared spectroscope (Thermoscientific AKX1200660) at Pharmacovigilance laboratory for animal feed and food safety, Madhavaram, Chennai. Experimental Data was analyzed by Chi square test, paired t test and Man Whitney U test using Microsoft Excel and IBM ™ SPSS™ Version 20.0 for Windows™.

RESULTS AND DISCUSSION

Delta trap trial in poultry unit

Out of the 80410 house flies trapped over a period of six weeks, 52.74 per cent (42415 flies) were trapped in FMPB pellet baited traps whereas 47.25 per cent (37994 flies) were trapped in FMP pellet baited traps (χ^2 value = 485.93** $p<0.01^{HS}$) and except the first trial, all the other trials recorded more number of flies getting trapped in the trap with the antioxidant (Table 1) with varying daily trapping patterns. Overall trapping was 239.31 flies/trap/day. There was a reduction in fly number from day one to day four followed by a rise till day seven. A sudden drop in trap catch was observed on day four of fifth trial and day three of sixth trial (Fig 5). The trap was user friendly to assemble, efficient and easy to stock and carry.

Hogsette (2008) compared the efficacy of electric traps baited with UV light and (Z)-9-tricosene with sticky traps and found glue traps to be effective compared to electric traps. Time taken to trap 50 per cent of the released flies

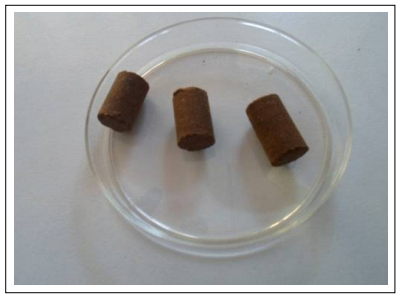

Fig 1: Pellet baits.

Fig 2: Red acrylic delta trap with pellet bait.

Fig 3: Placement of red acrylic delta traps in poultry unit.

Fig 4: Placement of spot cards to assess fly density in poultry unit.

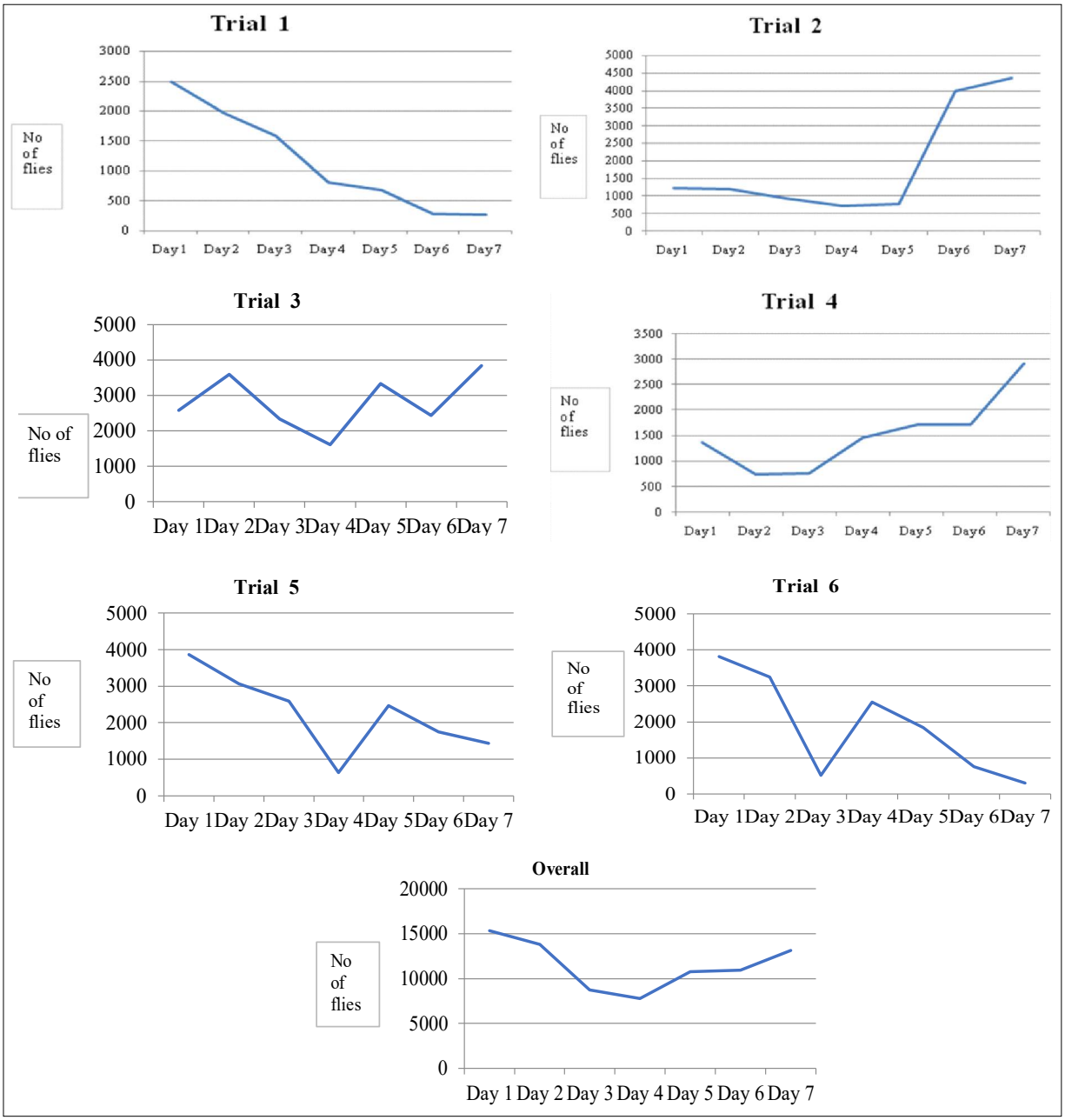

Fig 5: House fly daily trapping pattern in delta traps.

was less and trap catches were more with glue-based traps compared to electric traps. Pickens *et al.* (1986) used pyramid traps covered with white sticky paper to trap adult house flies and found that the traps were highly effective in trapping house flies when placed on the ground. The results of the present study are in accordance with the above findings. Rutz *et al.* (2000) evaluated Spider web™ sticky traps in dairy farms, Kaufman *et al.* (2005) used large sticky traps, Gerry *et al.* (2011) used Alsynite sticky traps and sticky ribbons and Sundar *et al.* (2013) used glue traps for house flies. All of them recommended the use of sticky traps for house fly control.

Johnson and Campbell (1987) evaluated four sticky-trap designs *viz.,* pyramid trap, cylindrical trap, square panel trap and blood board sticky trap for their effectiveness in capturing *Musca autumnalis*, from three different locations in an irrigated pasture. Pyramid traps were more effective. Pickens *et al.* (1994a, 1994b) advocated the use of baited cone traps and white pyramidal traps covered with sticky sheets in outdoor conditions to trap house flies. The delta trap and pellet baits used in the present study were also effective for up to 20 weeks. Weekly variations were also observed in the number of flies trapped during the study similar to the observations of Hanley *et al.* (2009), Morgan (1968) and Snell (2002) which could be attributed to weather, temperature, colour of light, number of recruited and lost flies per day, visual cues, air movement and other odours.

Antioxidants slow down the deterioration of pheromones and prolong their activity ensuring sustained release of pheromones and thereby use of antioxidants along with pheromones when used as attractant baits definitely improves the trap efficiency and pheromones therefore remain attractive over a longer time period and would minimize the frequent replacement of pellet baits. It was clearly evident in the present observation wherein a greater number of house flies were trapped towards pellets containing antioxidant in all the replicates except the first trial. The variation in the first trial trapping more flies towards the bait without antioxidant could be attributed to the distribution of fly population in the vicinity, due to saturation of traps or could be by chance.

Overall observations revealed that delta traps with pellet baits using a combination of pheromones and antioxidant as attractant baits can be effectively used to lure house flies towards traps and thereby help in house fly control programmes in poultry units.

Sex variations in trapped house flies

Overall trap catches were dominated by female flies. In traps baited with FMP pellets, out of 38325 flies trapped, 47.73 per cent (18295 flies) were males and 52.26 per cent (20030

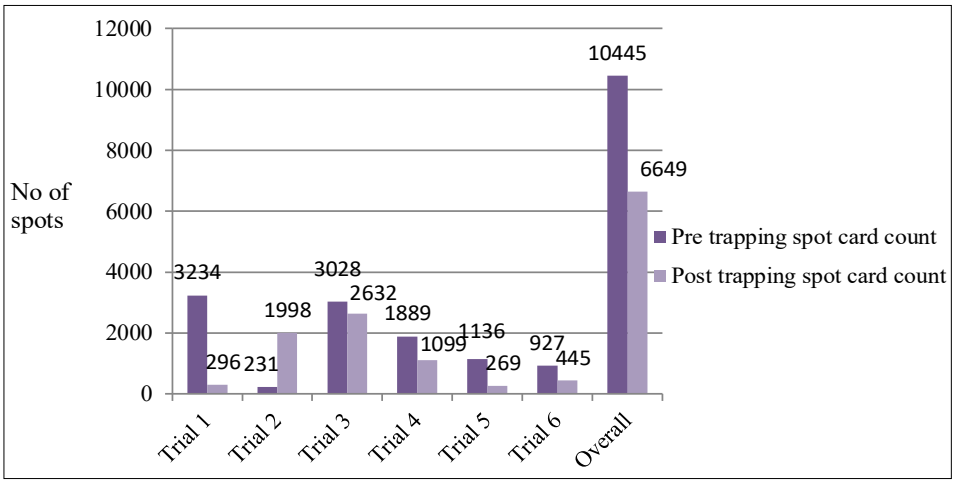

Fig 6: Spot card counts pre and post trapping in delta trap field evaluation.

Table 1: House flies trapped in Delta traps with pellet baits in poultry unit.

Trial no	FMP pellet		FMPB pellet		Total number of flies trapped
	No of flies	Per cent	No of flies	Per cent	
1.	4532	56.09	3547	43.90	8080
2.	6210	47.29	6919	52.71	13129
3.	9638	48.98	10037	51.01	19675
4.	4528	42.27	6183	57.72	10711
5.	7614	48.21	8178	51.78	15792
6.	5472	42.01	7551	57.98	13023
Total	37994	47.25	42415	52.74	80410

χ^2 value = 485.93** $(p<0.01)^{HS}$.

flies) were females and in traps baited with FMPB pellets, out of the 46002 flies trapped, 42.66 per cent (19625 flies) were males and 57.33 per cent (26377 flies) were females. Dominance of female flies in trap catches was observed by Johnson and Campbell (1987). However, observations by Butler and Mullens (2010) revealed male dominance in trap catches. Presence of fish meal base in the pellet baits could have attracted more female flies. Protein food sources such as fish meal are essential for complete maturation of ovaries in female flies and thereby improve their reproductive efficiency. Effective traps should capture large number of flies of both sexes as opined by Chapman *et al*. (1998a), Katsoyannos *et al*. (1999) and Robacker (1999). Hence pellet baits using fish meal as base component can be prepared and used in traps to enhance the trapping of both sexes of flies especially female flies and this could facilitate reduction in the total fly population over a period of continuous trapping.

Spot card counts pre-and post-trapping

Mean pre-and post-trapping spot card count was 1740.83 SE 490.44 and 1123.17 SE 404.81, respectively and corresponding total spots was 10445 and 6649, respectively. Per cent reduction in spot card count was 36.34 (Fig 6). Indoor house fly populations can be effectively monitored by spot cards as observed by Ponnudurai and Harikrishnan (2011), Beck and Turner (1985) and Geden *et al*. (1999). Counts over 100 spots per card per week indicate a high level of house fly activity as per Stafford (2008). Kaufmann *et al.* (2001) observed that spot card indices correlated well with house fly populations similar to those observations in the present study.

Variations of trap catches with fresh and aged pellets

Trap catches varied with fresh and aged pellet baits (Table 2). The fish meal pellet baits were active for a period of 20 weeks with aged pellets more attractive than fresh ones. Protein bait used by Das (1994) in Redtop Flycatcher sticky traps remained active for 35-42 days without rebaiting. Bead matrix formulation of (Z)-9-tricosene used by Chapman *et al*. (1998a) persisted for at least 24 weeks. In the present study, the pellet baits persisted for 20 weeks.

Estimation of (Z)-9-tricosene and BHT in pellet baits

FTIR analysis of FMP and FMPB pellets revealed presence of (Z)-9-tricosene (95 per cent) in FMP and FMPB pellets. The match for the presence of BHT in FMPB pellets was 11.04.

Correlation of trap catches with meteorological parameters

House fly trap catches were found to correlate positively with temperature, relative humidity and wind velocity. Maximum trap catches were observed at a temperature range of 30-32°C compared to lower temperatures. Maximum number of flies were trapped at a range of 90-100 per cent relative humidity compared to lower levels.

Table 2: Delta trap field evaluation -variation in trap catches with pellet baits of different shelf life.

Trial no	FMP pellet (Aged 9 weeks)		FMP pellet (Aged 7 weeks)		FMP pellet (Fresh)		FMPB pellet (Aged 9 weeks)		FMPB pellet (Aged 7 weeks)		FMPB pellet (Fresh)		No. of flies
	No of flies	Per cent	No of flies	Per cent	No of flies	Per cent	No of flies	Per cent	No of flies	Per cent	No of flies	Per cent	
1.	1335	22.06	940	15.53	1129	18.66	1022	16.89	723	11.95	901	14.89	6050
2.	1696	17.05	1536	15.44	1489	14.97	1829	18.38	1701	17.10	1695	17.04	9946
3.	2531	16.97	2431	16.30	2313	15.51	2669	17.90	2561	17.17	2404	16.12	14909
4.	1345	16.75	998	12.42	1093	13.61	1294	16.11	1708	21.27	1591	19.81	8029
5.	1941	16.55	1604	13.68	2035	17.35	2002	17.07	2109	17.98	2034	17.34	11725
6.	1504	15.37	1388	14.18	1290	13.18	2078	21.23	1576	16.10	1949	19.91	9785
Total	10352	17.12	8897	14.71	9349	15.46	10894	18.02	10378	17.16	10574	17.49	60444

χ^2 value = 174.52** ($p<0.01$)^{HS} and 19.92** ($p<0.01$)^{HS}, respectively for FMP and FMPB pellets.

Trap catches also positively correlated with wind velocity with maximum trap catches at 4-6 kmph. Meteorological parameters cause alterations in house fly populations as opined by Kenawy *et al.* (2014) and Jin and Jaal (2009). Studies by Ponnudurai and Harikrishnan (2011) revealed high house fly population at 35±3°C and relative humidity of 80±5 per cent. In the present study, a sudden drop in trap catches was observed in fifth trial and sixth trial, 377 and 513 flies, respectively on a particular day compared to 1310 and 1130 flies, respectively and 3243 and 2551 flies, respectively on previous day and subsequent day and this was due to "Vardah cyclone" on the particular day when premises witnessed extremely high velocity winds exceeding 130 kmph and this could have carried away flies from traps.

Speciation of trapped house flies

Speciation of the flies selected randomly from the trap catches revealed that 44.5 per cent of *Musca domestica domestica* and 55.5 per cent of *Musca domestica vicina* based on morphological characteristics. Male *M. domestica* flies had a wide frons which is about half the width of the eye and three times as wide as the third antennal segment, abdomen largely infuscate in female, at least third and fourth segments infuscate in male. Male *M. vicina* flies had a narrow frons which is approximately one-third the width of the eye and less than three times as wide as the third antennal segment, abdomen more or less bright orange, especially at sides of base, usually darkened on fourth segment of abdomen.

Delta traps provide a sensitive and continuous system to trap house flies effectively with an advantage of less contamination of environment. In high voltage electric traps, trapped flies are shattered facilitating the release of body fragments of flies, microparticles and bacteria leading to food contamination as observed by Pickens (1989), Ananth *et al*. (1992) and Urban and Broce (2000). Delta traps are also cost effective, weightless, easy to carry and stock.

CONCLUSION

It can be concluded that lure and kill trap systems for house flies such as delta traps used in this study can be effectively used as integral components of integrated pest management strategies in poultry units as an Eco sensitive alternative to insecticide use. The socioeconomic impact associated with use of traps and its feasibility also needs to standardized even though traps are successful. Glue traps are not a "silver bullet" for house fly management in poultry farms but can be important component in the overall Integrated Fly Management strategy.

Conflict of interest: None.

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