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Effect of Trap Designs and Colours on the Landing Rate of *Aphis gossypii* Glover, the Major Insect Pest of Chilli in Malaysia

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Abstract: Effects of different trap designs (cylindrical bottle, flat wood set up horizontally and vertically, and the water-pan traps) coloured with yellow, green, blue, red or black on the landing rate of alate *Aphis gossypii* Glover were studied. Results showed that traps designs and traps colours significantly influence the number of alate aphids collected. The water-pan trap collected significantly ($P<0.05$) more aphids than those of other traps. Traps coloured with yellow were also found to collect significantly ($P<0.05$) more aphids than traps coloured with other colours. The yellow water-pan trap collected the highest number of aphids compared to other traps with yellow in color. Interestingly that aphid collection of traps coloured with yellow other than yellow water-pan traps was not significantly different between them. The mean number of aphids collected by the water-pan traps was highest in early hours and lowest in the late hours of the day, and of this trap when coloured yellow collected almost all the aphids collected by the water-pan trap. Result also showed that the ladybird beetle adults were only collected in a water-pan trap and none in the other traps. Again, the beetle was mostly caught in yellow water-pan trap and none in the blue, red and black water pan traps. The possible use of yellow water-pan trap for monitoring and forecasting the aphid infestation on chilli field is discussed.

Key words: Traps, *A. gossypii*, *Capsicum annum*, cultural control, chilli

Introduction

Chilli is one of the major fruit vegetable planted in Malaysia (DOA, 1998–personal communication) mainly because of its high nutritional and economic value. There seems to be several problems associated with the chilli production. This includes the price fluctuation, high cost of production and pests and diseases problems (Ng and Mohamad Roff, 1992). The problems caused by pests and diseases on chilli have become more serious recently especially those caused by viruses. The virus diseases have escalated with the opening of commercial chilli farms where chilli is planted as monocrop and the practice of calendar pesticide spraying by farmers (Mohamad Roff and Ong, 1992). Although pesticides have proved very effective at protecting crops against aphids, the level of control achieved is not sufficient enough to prevent the spread of viral diseases especially of non-persistent viruses (Ng and Mohamad Roff, 1992). Chilli varieties resistant or tolerant to viruses are not yet available in Malaysia although chilli variety with short and open plant architecture was reported to have low aphid infested and virus disease incidence (Idris *et al.*, 2001). Consequently, other available control measures developed for the control of virus diseases in Malaysia are by intercropped chilli with maize (Idris *et al.*, 1999; Idris and Mohamad Roff, 1999), spraying insecticide against vectors (Ng and Mohamad Roff, 1992) and cultural method mainly using of reflective plastic mulch (Mohamad Roff and Ong, 1992, 1991; Mohamad Roff and Ho, 1991). The use of silver plastic mulch control of aphids is widely used by farmers (Mohamad Roff and Ong, 1992). However, its effectiveness as a ground cover to reduce aphid landing declines with plant age as chilli leaves overshadow the plastic mulch. As such, trapping is another alternative method to plastic mulch, as the plant leaves that overshadow the effect of the traps would not influence it. The use of trap for controlling aphid species other than *A. gossypii* was reported by Tylor and Palmer (1982), Helbert *et al.* (1981), Coon (1968), Zettler *et al.* (1967), Moricke (1951) and Broadbent (1948). However, the efficiency of various traps should be tested on *A. gossypii*. This is because the behavior and responses of a particular aphid species to the traps may be different as compared to other species.

The objective of this study was to investigate the ability of various trap designs and colours in trapping the alate aphids or reducing its landing rate. Information obtained from this study would be incorporated into an IPM program formulated for chilli growers in order to control aphids and viral diseases of the crop.

Materials and Methods

Study was conducted at Plot E4 (113.5x13.5m^2), MARDI (Malaysian Agriculture Research and Development Institute) Research Station Jalan Kebun, Klang, Selangor from 19 March to 30 Jun 1998.

Traps used and experimental layout: Four traps of different designs, namely a cylindrical plastic bottle (500 ml; 4.0 diameter and 30 cm high)(= cylinder trap), plastic basin (15 and 10 cm diameter for top and bottom portion, respectively, 10 cm high) (=water-pan trap), horizontal and vertical traps, were used. The horizontal and vertical traps were made of rectangular flat wood (26x27x1cm^3). All traps types were coloured (painted) yellow, green, blue, red or black (ICI Dulux Sdn. Bhd), and wrapped up with transparent plastic after which sticky glue (Neopeace™, Agricultural Chemicals Malaysia (Bhd)) was sprayed on it. To avoid water overflow during heavy rain two lids (0.5 cm diameter) were made at 6 cm high on both side of water-pan traps. A liquid detergent was added to a pan that already filled up with water at the ratio of 1 to 10 (v/v). The traps were placed or tied on wooden pole at 90 cm above ground and 150 cm apart. Each experimental plot was 26.9 m^2 in size and separated with other plots by 1.5 m distance. The experiment was a two factorial (trap design x trap colors) design and arranged following the randomized complete block design. Aphids and ladybirds trapped were recorded weekly, after which the plastic with glue on each trap was replaced with the new one. However, aphids collected using water-pan trap were recorded every 2 h started from 0800 until 1800 h. This means that the weekly data of water-pan trap were totaled up on a week basis from this data. The abiotic data namely wind speed, relative humidity, light intensity, temperature and rainfall were recorded using adometer, relative humidity meter, sunshine recorder, thermometer, and rainfall gauge, respectively.

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Data analysis: Two-way ANOVA was used to analyze the difference in the total number of alate aphids or ladybirds beetle recorded per traps designs and colours of the trap. Whenever ANOVA test was significant means were differentiated by the Tukey's test. The number of aphids trapped by the water pan traps per week was also analyzed using two- way ANOVA. Simple regression was used to analyze the relationship between number of aphid recorded and each abiotic factor. All analysis were run on the Minitab statistical program (MINITAB, release version 13.0, USA).

Results

The mean total number of alate aphids collected per trap was significantly different among treatments ($F=14.91$; $df=3, 1020$; $P<0.05$) (Fig. 1). The mean number of aphids collected was significantly higher ($P<0.05$) using water-pan trap than using other traps. The cylindrical bottle and flat wood (vertical or horizontal) traps caught statistically similar number of aphids. There was a significant interaction ($F=15.47$; $df=1, 1020$; $P<0.05$) between trap designs and colours in influencing the mean number of aphids collected per treatment (Fig. 2). There was a significant different ($F=37.14$; $df=4, 1020$; $P<0.05$) in the number of aphids collected on traps colored with yellow than on traps with other colors (Fig. 2). A yellow water-pan trap collected significantly higher ($P<0.05$) number of aphids than other traps with yellow color.

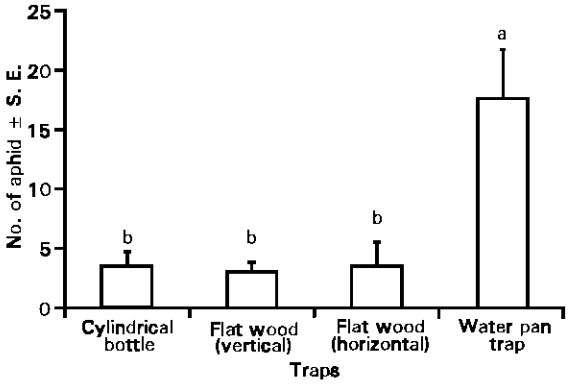

Fig.1: Total mean number of alate aphid collected by different traps from 29 March to June 2001

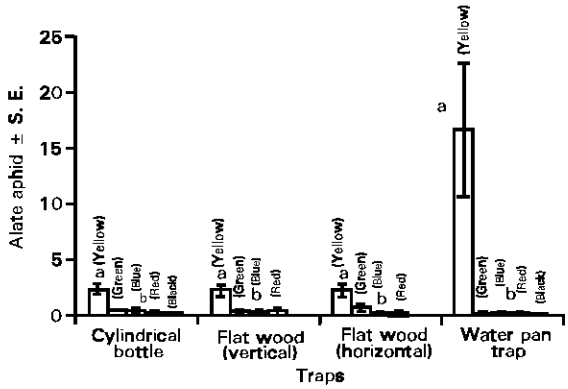

Fig. 2: Total mean number of alate aphid per treatment (traptype with various colour) recorded from 26 March to 29 June 2001

was a significant interaction ($F=21.7$; $df=20, 1650$; $P<0.05$) between coloured water-pan traps and times of data collected

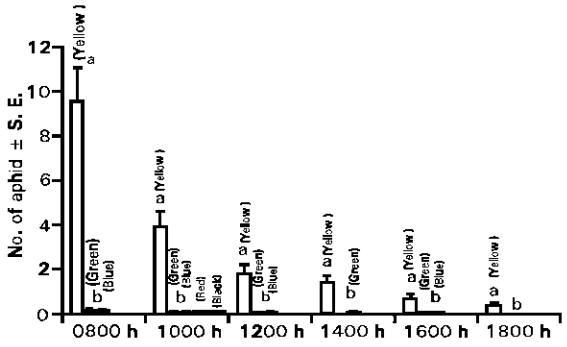

Fig. 3: Mean total number of alate aphid per two hour collected in water pan trap with different colour from 26 March to 29 June 2001

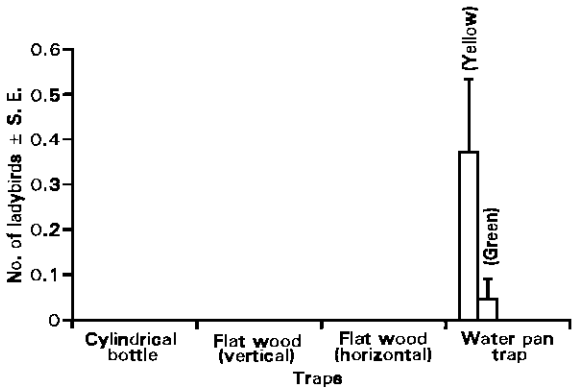

Fig. 4: Mean total number of ladybirds beetle collected by various traps with different colour from 26 March to 29 June 2001

(0800 to 1800 h) (Fig. 3). The number of aphids collected in yellow water-pan trap was significantly higher ($F=22.6$; $df=5, 1650$; $P<0.05$) in early hours than in the late hours of the day. There was a significant difference ($F=83.0$; $df=4, 1650$; $P<0.05$) in the number of aphid collected among water-pan trap of different colours. There was almost no aphid collected on traps other than yellow colour.

The number of ladybird beetle adults collected on different colored traps was significantly influenced ($F=5.1$; $df=12, 1020$; $P<0.05$) by the interaction between trap designs and trap colors (Fig. 4). There was a significant difference ($F=6.8$; $df=3, 1020$; $P<0.05$) in the number of aphids collected among traps. It was found that only water-pan trap successfully caught the beetles through out the experimental periods. The yellow water-pan trap collected significantly higher ($P<0.05$) number of aphids than the green water-pan trap. There were no aphids collected by the blue, red and black water-pan traps.

The biotic factors (temperatures, light intensity, rainfall and wind speed) were found to have no significant ($P>0.5$) relationship with the mean total number of aphid collected per trap throughout the experimental periods. However, the number of ladybird beetles collected had a positive and significant relationship with rainfall (mm/day) ($r=0.59$; $F=5.85$; $df=1, 11$; $P=0.034$) and wind speed (km/day) ($r=0,79$; $F=16.98$; $df=1, 11$; $P=0.002$).

Discussion

Previous studies on aphid species other than *A. gossypii* had reported that trap designs and trap colours could contribute to differential effects on the number of aphid species collected per

unit time (Frech and Tylor, 1965; Prokopy, 1972; Halbert *et al*., 1981; Labonne *et al*., 1983). Results of this study also showed that there was a significant difference in the mean number of *A. gossypii* collected by the traps with different colours. The water-pan trap collected significantly higher ($P < 0.05$) number of aphids than that of cylindrical bottle and flat wood (vertical and horizontal) traps (Fig. 1). The presence of water in a pan might have reflected ultra violet light (UV light) that attracted the alate *A. gossypii* to landing (Kring, 1970). The flying aphids might have experienced light illumination from the ground that eventually stimulated them to change flying direction to the light source (water in the pan trap) (Kring, 1969; Moericke, 1955). This is true because there was no significant difference in the number of aphids collected among cylindrical and vertical or horizontal flat wood traps. This also indicates that different trap designs without water such as in water-pan traps is not a good tool for monitoring alate aphid population in the field. According to Tylor (1962) and Labonne *et al*. (1983) traps other than water-pan trap depend very much on wind speed to collect alate aphids. The effect of traps position (90 cm above ground which was not a bare ground) in relation to crop top canopy on the different numbers of aphid collected among traps could not be ruled out. This because traps placed immediately above the top of the young wheat plants caught 540 females whereas traps placed 1 m above the plants only caught 12 insects (Powel and Zhang, 1983).

Many winged insects are attracted to certain colours during flight, most commonly to yellow (Southwood, 1978). Result of this study also showed that yellow traps collected significantly ($P < 0.05$) more alate *A. gossypii* than traps coloured with green, blue, red or black (Fig. 2). The possible reason is that the yellow color traps, in interpretation of human eyes, create contrast between traps and the background that effect the optomotor landings response of the flying aphids (Smith, 1976). Interestingly, yellow water-pan trap collected the highest number of aphids as compared with other traps coloured with yellow. This is probably a combination effect of water and yellow color that reflected the UV light and other long wave light to short wave light. The short wave light (500–580 nm) is known to arrest the flying insects including aphids (Kring, 1967; Halgren, 1970 a, b; Prokopy, 1972). The low number of catches by the traps with green, blue, red and black indicated that *A. gossypii* did not response to these colours (Fig. 2). Kring (1969) also reported that many aphid species did not response to blue, orange and red colour. As such, the shallow and yellow coloured trays or bowls filled with water is a good tool for use as traps to sample alate *A. gossypii*.

The number of aphids collected by the water-pan trap was significantly ($P < 0.05$) influenced by the colours and collection times (Fig. 3). This indicates that the trap designs and colors are not the only factors but the time is also important in sampling of insects (Dingle, 1972). It is obvious that yellow water-pan traps installed and left overnight or set in early morning hours collected significantly higher ($P < 0.05$) number of aphids than those installed in the later hours of the day. Although aphids are active during the day (Wiktelius, 1981), the flight occurred more at night than during the day hours (Berry and Tylor, 1968). Traps with colour other than yellow collected almost zero aphids, therefore, it should not be considered for use in aphid sampling program.

The yellow water-pan traps in this study collected significantly more ($P < 0.05$) ladybirds than water-pan trap with other colours (Fig. 4). This is tends to agree with previous reports that the principally designed for trapping phytophagous insects, yellow-coloured water traps also catch some groups of natural enemies (Helenius, 1990). In fact traps other than yellow water-pan traps failed to collect ladybirds beetles this study (Fig. 4). The yellow water-pan trap might have a potential to be used for quantifying the relative abundance of the ladybirds beetle adults attacking *A. gossypii*. This trap has been used as one of the tools for monitoring the adult hover-flies, anthocorid bugs and several parasitoids (Smiths, 1976). However, the attractiveness of yellow water traps to individuals insect will depend to some extent on the latter's physiological condition, and probably caught more readily when they are newly emerged and hungry and when food sources are scare (Schneider, 1969). As such, the preference of yellow colour over white and blue traps may be related to the more abundance of yellow flowers (provide pollen and nectars) in the fields or at the time of the samplings (Schneider, 1969; Dixon, 1959). However, colours used in this study are based on human interpretations. It may be different from what insects interpret that is based on ultra violet reflectance spectra (Kirk, 1984). This is probably true as ladybird beetle adults were reported to be caught more on yellow sticky traps without bait (lures) than that of with lures (Ricci, 1986).

Although weather factors play major role in aphid infestation on crops (Wellings and Dixon, 1987), these result showed that the biotic factors seemed to have no significant relationship with the number of aphid collected. This indicates that the weather factors such as temperature, rainfall, relative humidity, wind speed or light intensity did not reach the threshold that stimulated the flight behavior of aphid (Walters and Dixon, 1984). Therefore, other factors such as crowding, food quality and vegetation surrounding the field might have influenced the flight behavior of the aphids (Banks, 2000; Jansson and Smilowitz, 1985; Harris and Maramorosch, 1977; Tylor, 1963). In contrast, the number of ladybird beetles recorded had a positive and significant relationship with rainfall and wind speed. Probably, ladybird adult flight activity is more sensitive or easily stimulated by lower amount of rainfall and slower wind speed than that of aphids. For example, *Diadegma insulare* flight activity was significantly correlated with wind speed 4 ms^{-1} (Idris and Grafius, 1998) while aphids did not response to it (Walters and Dixon, 1984). However, the presence of ladybirds in the traps might also due to the abundance of its preys (aphids) in the trap (Wratten, 1973) or yellow colour of the traps as discussed above (Dixon, 1959).

Trap designs play important role in trapping alate *A. gossypii* and trap coloured with yellow seemed to be superior over traps with other colours, irrespective of trap design. Yellow water pan trap could be useful tool that provide simple population counts of *A. gossypii* and a mean by which a forecast can be determined. This is important for judicious spraying of insecticide in controlling the aphids.

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