‘Attract and Kill’ - a sustainable strategy`

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Mediterranean fruit fly, *Ceratitis capitata.* Photo: Shutterstock

The Mediterranean fruit fly, *Ceratitis capitata* is one of the world’s most important fruit flies. The “Medfly” has been recorded in about 350 species of fruit, nuts, and vegetables, the majority of which are of tropical origin. In Mediterranean fruit growing regions Medfly is one of the most destructive pests of citrus and peach crops. It has been traditionally controlled by using organophosphate insecticides which are effective but also kill beneficial entomofauna.

However, *C. capitata* has developed reduced susceptibility to conventional synthetic insecticides, showing resistance to malathion, lambda-cyhalothrin and methyl-chlorpyrifos. An alternative approach is urgently needed to control this pest. Several potentially effective alternatives are being investigated including mass-trapping and attract and kill (AK) techniques.

The AK technique uses an attractant and an insecticide to control *C. capitata* by first luring the insect into the trap and then killing it. AK is an integrated pest management (IPM) system that ensures no pesticide is applied directly onto the crop and this also reduces the impact on the environment. A further benefit is that growers can harvest fruits which are completely free from pesticide residues.

Russell IPM has developed the Ceranock AK system to control Medfly. It is an innovative technology, that consists of a powerful *C. capitata* female food attractant mixed with the insecticide alpha-cypermethrin. The system remains active in the field for four months, so that the entire fruit season can be covered by one “treatment”.

Ceranock AK does not affect natural enemies of *C. capitata* or non-target species and can provide a good level of control, reducing the crop damage caused by Medfly. It has been evaluated against Medfly in the peach orchards of Northern Tunisia. The trial sites have a Mediterranean climate with average rainfall between 300 mm and 500 mm per

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year. In summer (July-August) the average daily temperature often exceeds 26°C.

The system is an innovative Medfly control technology based on fruit fly female attractant and a very low dose of pesticide in a bait station. The bait station contains the protein hydrolysate and a plant extract (5g/bait station) as a female attractant and insecticide alpha-cypermethrin (0.02%) as a killing agent. The female Medfly is attracted to the hydrolysed protein as it searches for protein sources to support egg maturation.

The system is made up of three parts: a plastic hook to be hung on a tree branch, a plastic case, and a felt-like spongy material impregnated with attractant and insecticide (Fig. 1). It is placed in the field 4-6 weeks before fruit colour change because early placement provides better protection. It is best hung at a height of 1.5 m above the ground in a shaded part of the tree to avoid strong sunlight. Longevity in the field is 120 days which provides protection for the whole season.

Prior to the trial, Medfly populations were monitored in all the plots. Six weeks before fruit colour change nine male lure (Trimedlure) and nine female (Femilure) attractant baited traps were placed at 50m intervals on the borders and in the centre of each plot. The Trimedlure and Femilure monitoring traps were assessed weekly, the trapped insects were identified, counted, sexed, and discarded.

Trap catches determined the AK treatment timing: when the capture rate exceeded the economic threshold (0.5-1 females per trap per day or 1-2 males per trap per day), then 400 AK bait stations were deployed in the two experimental plots A and B. Both control plots were untreated and only contained monitoring traps.

Fruit damage was assessed on 800 fruits per hectare in each treated and control plot (40 fruits collected from 20 randomly selected trees). The number of dropped fruits and the number of softened fruits remaining on the tree were also counted. The number punctured could not be counted as punctures are not visible on peach (unlike citrus) so softening was selected as a proxy indicator of puncture damage.

Softened fruits were brought to the laboratory and put in a cage with two parts: in the upper part, we placed the fruit and the lower part contained soil. If the fruit softening is due to Medfly, then pupae or larvae will be found in the soil. Their number was recorded daily for fruit collected from both the treated and control plots. The percentage of fruit damaged was then calculated by dividing the number of infested fruits by the total number of sampled fruits in each plot. At harvest the yield of each selected tree was also evaluated by counting the number of healthy fruits per trees. The data was then compared between the treated and the control plots.

Fig. 1: Attract and kill bait station in use. Photo: Dr Sarra Bouagga

The Ceranock system was implemented at the beginning of May in both plots A and B. To evaluate the efficacy of the Medfly control system, male and female monitoring traps were placed outside and inside on the border and in the centre of each experimental plot. Trap catch data was collected weekly and statistically analysed. A significant difference was observed between the number of Medfly captured outside, on the border and the central areas of both plots A and B.

As seen in Figure 2, the pressure of Medfly outside the orchard, where no treatment was applied, was significantly higher than the inside. However, traps inside the orchard and near the border trapped 82% and 87% of the total trapped insects respectively for plots A and B.

In the centre, the number caught was negligible, 18% and 13% respectively for plots A and B. In addition, data from the monitoring traps showed that the percentage of male fruit flies captured was higher than females, ranging between 80% and 85%. This shows that males are not as readily attracted as females, and it was expected that females would be selectively removed, while the male population remained constant. From these observations, we concluded that the monitoring trap system allowed us to assess the effectiveness of the AK system.

Catch data from the monitoring traps baited with Trimedlure was collected weekly in AK treated plots A and B and then compared to the control. Statistical analysis using ANOVA, where the level of difference was determined by the LSD test, showed a significant difference between treatment and control.

For plot A, a maximum of 59.33 flies per trap per week was recorded (8.47 flies per trap per day - FTD). In the control field, capture rates were double at 120.33 flies per trap per week (FTD=17.19). Similarly, in plot B we recorded a maximum of 24 flies per trap per week (FTD=3.42) in →

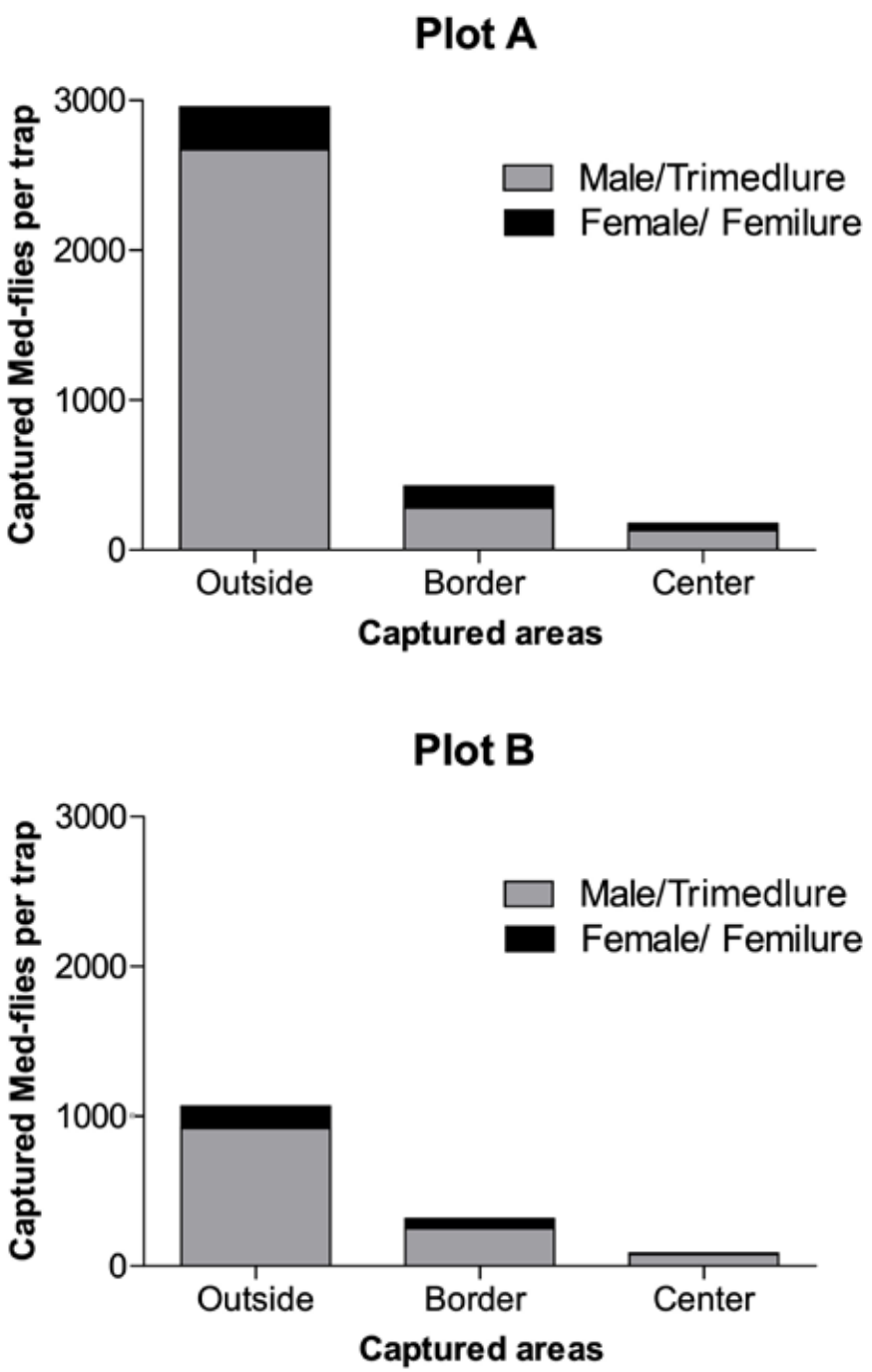

Fig. 2: Male and female C. capitata rate of captures using Trimedlure and Femilure outside the orchard, border and centre of Ceranock treated plots. Figures: Dr Hassan Nayem

the AK treated area but 63.33 flies per trap per week (FTD=9.04) in the control area (see Figure 3).

The efficacy of this AK system was also assessed by estimating the rate of Medfly population reduction (TR%). TR was calculated using data from monitoring traps and the *C. capitata* reduction observed in experimental plots A and B was 63% and 70% respectively so the data showed that the Ceranock system was able to reduce the Medfly population by more than half.

The impact of AK treatment on peach fruit damage was also evaluated during the season and the data is presented in Table 1.

Statistical analysis showed a significant difference between number of dropped and softened fruits in the AK treated plots and control plots. The AK system reduced fruit damage and the egg laying activity of Medfly.

At the end of the season, the percentage of total fruit losses ranged between 31% and 35% in control plots but in the AK treated plots A and B it is reduced seven times to 5.3% and 4%, respectively.

Total yield in treated and control plots was also recorded by counting the number of healthy fruits per tree. The number of healthy fruits in the treated plots was 240 fruits/tree, whereas in the control plot it was 143 fruits/tree. Statistical analyses of fruit yield data showed a significant difference between AK treated and control plots. In fact, the AK system prevented the total loss of between 35,000 and 80,000 fruits/ha.

Our trial has proven 'Attract and Kill' technology has the potential to reduce Medfly populations substantially and can be used as an alternative to direct chemical or bait spray.

This preliminary study showed the effectiveness of the AK system in the control of Med-fly in Tunisian peach orchards. In fact, the protection level of peach fruits had reached 96% in plot A and 94.5% in plot B. It was confirmed that this system acts not only as an 'attract and kill' technology reducing the pressure of the insect but also by creating an environment in the field which helps in the reduction of females laying eggs and this is a useful finding.

This technique may offer an efficient alternative to conventional spraying of chemical pesticides. The development of the AK fruit fly bait station has provided fresh fruit industries with an integrated pest management tool that is safe to both the environment and the consumer. There is no danger of pesticide residues occurring on the fruit, as the bait station removes the need for the farmer to spray orchards for fruit flies.

In the study efficacy was above farmers' expectation but it was not cost effective. The high number of Ceranock bait stations per hectare made it expensive. To reduce the cost, we conducted a further study in Morocco against Medfly using a reduced number of Ceranock stations and an entomopathogenic fungi *Metarhizium*

anisopliae. It was found that the Ceranock system combined with a *M.anosopliae* application in the root zone gave more protection than chemical sprays.

The first control strategy (S1) used 100 Ceranock female bait stations and 100 g of Ceranock male gel per hectare while the second strategy (S2) involved 50 Ceranock female bait stations, 50 g of Ceranock male gel per hectare and a ground application of *M.anisopliae*.

Results indicated that both strategies S1 and S2 restricted fruit infestation to 0.7% and 0.72% respectively (compared with 1.66% infected fruits in the control plots), they have proved also to be successful in substantially reducing the Medfly population to 44.9 % and 41.7%, respectively. A population reduction of up to 45% was observed when the combined strategy was used to control Medfly.

In conclusion a male and female attract and kill system combined with a microbial soil treatment could become a cost-effective control strategy of Medfly. It provides a significantly higher level of protection than chemical control of *Ceratitis capitata*. A similar strategy is being evaluated against other fruit fly species including oriental fruit fly, *Bactrocera dorsalis* and Cucurbit fruit fly, *Bactrocera cucurbitae*. Trial results are promising and seemed to provide effective control for over four months. It is a one-off treatment which covers the whole growing season. Therefore this technique could become popular among large as well as small scale farmers in Asia and Africa. ■

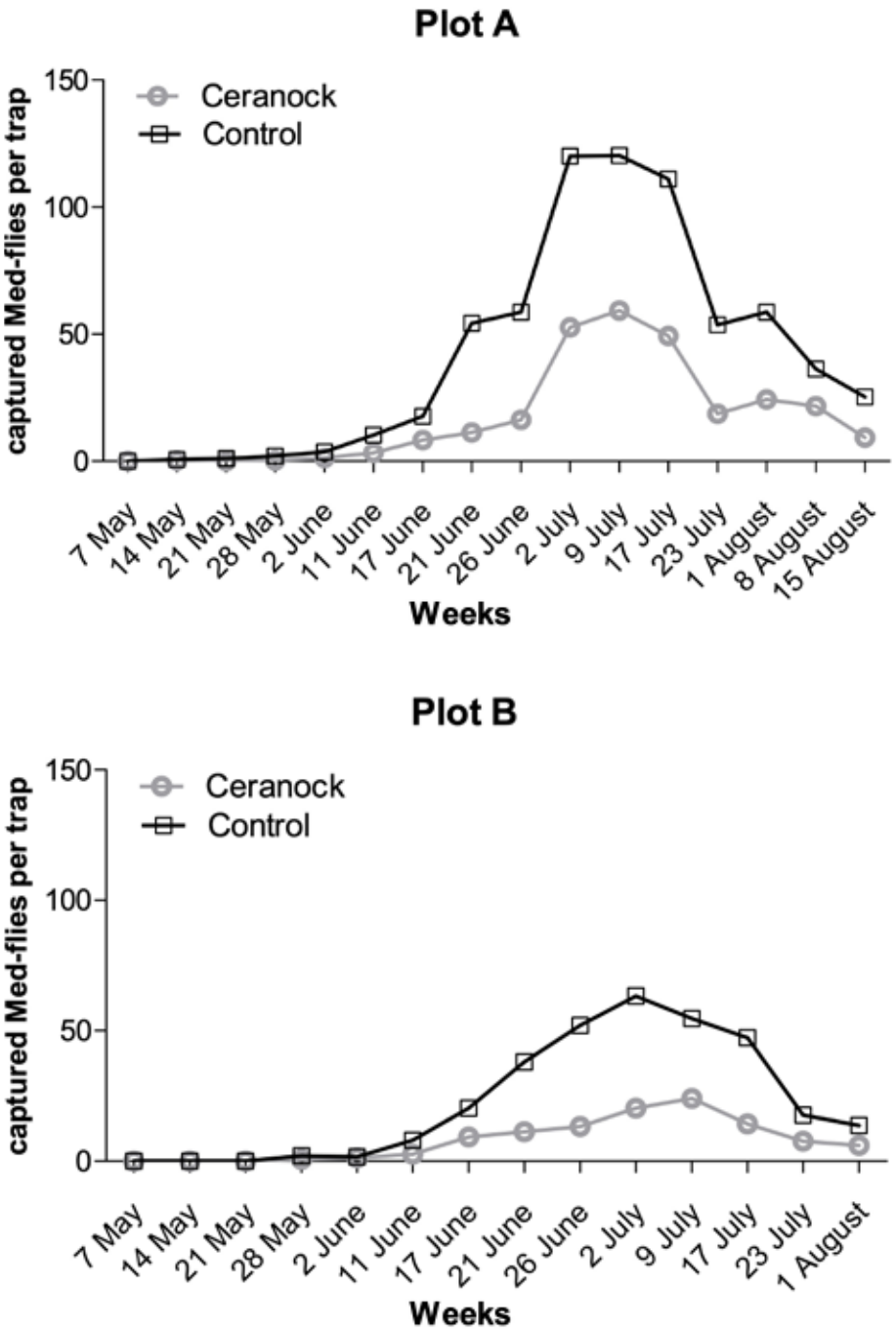

Fig. 3: Evaluation of C. capitata monitoring trap catches in plots A, B and control.
Figures: Dr Hassan Nayem

TABLE 1

FRUIT DAMAGE RATES FROM CERANOCK 'ATTRACT AND KILL – AK' TREATED PLOTS AND CONTROL PLOTS

	TREATMENT	DROPPED FRUITS	DROPPED-SOFTENED FRUITS	SOFTENED FRUITS ON THE TREE	MEAN NUMBER OF LARVAE PER FRUIT	TOTAL LOSSES
Plot A	AK	5.0%	2.5%	2.8%	3.8	5.3%
	Control	28.8%	23.8%	11.7%	11.0	35.4%
Plot B	AK	3.5%	1.5%	2.5%	2.8	4.0%
	Control	24.0%	19.5%	11.5%	9.5	31%