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Fungicide Resistance: are we winning the battle but losing the war?

Plants for predators - a participatory experiment

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Summary

Encouraging natural enemies by growing attractant plants is a highly effective method of pest control in organic systems. However, it is important to establish which plants are most effective at attracting beneficial insects. Experiments were carried out by 179 HDRA members, who grew four plant species (Coriander, Corn Marigold, Fennel and Phacelia) in their gardens and allotments. Over the course of the growing season, assessments were made on the growth and flowering of the plants and the presence of four key groups of beneficial insect (ladybirds, hoverflies, lacewings and parasitic wasps). Phacelia established quickly and its long flowering period meant it attracted insects throughout the summer. However, Phacelia was only the most attractive plant at the end of the season and insects preferred the other trial plants when they were in flower. Results highlight the importance of growing a range of flowering plants to provide resources for beneficials throughout their activity period.

Key words: Beneficial insects, attractant plants, organic pest control, *Coriandrum sativum, Glebionis segetum/Chrysanthemum segetum, Foeniculum vulgarum, Phacelia tanacetifolia*

Introduction

Natural enemies can reduce pest populations and contribute to the establishment of healthier plants and crops. Researchers observed reduced pest problems in flower rich orchards as early as 1926 (Crowder, 1994) and it is widely acknowledged that flowering plants encourage natural enemies which regulate pest numbers (Verkerk, 2001; Solomon *et al*., 1999). The growth of attractant plants to increase the presence of natural enemies is therefore an essential tool for organic growers.

Flowers are vital sources of amino acids and carbohydrates which many species of beneficial insects including hoverflies, lacewings and some species of ladybirds require for egg production and energy (Altieri & Whitcomb, 1979). Nectar and pollen are also the sole energy resources for adult parasitic wasps (HDRA, 1993).

Many species of flowering plant have been documented as being attractive to beneficial insects. However, floral attractiveness is dependent on a number of factors including colour, pollen, nectar and morphology (Colley & Luna, 2000) and there remains a lack of consensus as to which plants are most attractive. Identifying the plant species, quantity and planting management that supports beneficial insects is important, otherwise pest populations may be encouraged (Dufour, 2000) or activity, such as egg laying, not significantly or positively influenced (Morris & Li, 2000).

The aim of this experiment was to assess the efficacy of four attractant plants in small-scale

allotments and garden plots. The four plants assessed - Coriander (*Coriandrum sativum*), Corn Marigold (*Glebionis segetum*, syn. *Chrysanthemum segetum*), Fennel (*Foeniculum vulgarum*) and Phacelia (*Phacelia tanacetifolia*) - have been previously reported as effective attractants (Verkerk, 2001; Colley & Luna, 2000; Morris & Li, 2000; Solomon *et al*., 1999). Assessments were made on the growth and the attractiveness of each plant to four key beneficial insect groups - ladybirds, hoverflies, lacewings and parasitic wasps.

Materials and Methods

Over 400 HDRA members were sent materials and experiment protocols, with 179 members returning results. Participants were supplied with seed of each of the four plants (2 g Coriander seed, 0.15 g Corn Marigold seed, 1 g Fennel seed, 0.5 g Phacelia) and instructed to grow at least one, 1 m long row of each of the four plants. These were preferably separated by approximately 2 m and adjacent to a vegetable plot. An April sowing time was advised, ensuring that all species were planted at the same time under similar growing conditions.

Participants recorded the growing conditions in the plot, the sowing date, germination rates, establishment, flowering time and abundance of flowers on each species, and any special care plants required. Once all the plants were established, participants made regular observations of insect abundance in each flowering strip. Insect abundance was scored on a scale of 0 to 3 (0 = none to 3 = abundant), noting date, time and weather conditions. Finally participants were asked whether they would grow any of these plants again, giving reasons for their choices.

Data from the 179 respondents was analysed using chi-squared, ANOVA and Tukey-Kramar tests. A value to represent the total insect visitation frequency (relative attractiveness) for each plant in each month of the trial period was calculated by adding the assigned abundance scores together and dividing by the total number of observations on each plant.

Results

Germination and establishment

The germination performance varied significantly between the four plants ($\chi 2$, $P < 0.01$, df = 12, N = 684 plant strips). Phacelia performed best, with over 63% of the participants reporting good or excellent germination. Corn Marigold performed poorly, with seeds failing to germinate in 41% of cases. Slugs posed the greatest problem and were noted as being detrimental to the establishment of plants in 12% of the plant strips. Damage severity varied significantly depending on plant ($\chi 2$-, $P < 0.05$, df = 3, N = 81); Phacelia was least affected by slug damage.

Flowering

The average start date and end date of flowering varied between plant species (Fig. 1); Phacelia was the first to flower and Fennel flowered last, continuing into early Autumn. Length of flowering period varied significantly between plant species ($\chi 2$, $P < 0.05$, df = 3, N = 402). The flowering profusion varied significantly between the four plants ($\chi 2$, $P < 0.01$, df =12, N = 402); Phacelia exhibited the greatest profusion of flowering and Fennel the poorest.

Relative attractiveness to insects

The relative attractiveness of the plants to insects was compared during each month of the trial (Fig. 2). Attractiveness of plant species varied from month to month depending on when the plants were in flower; differences between the attractiveness of the four plants were highly significant ($\chi 2$, $P < 0.01$, df =18).

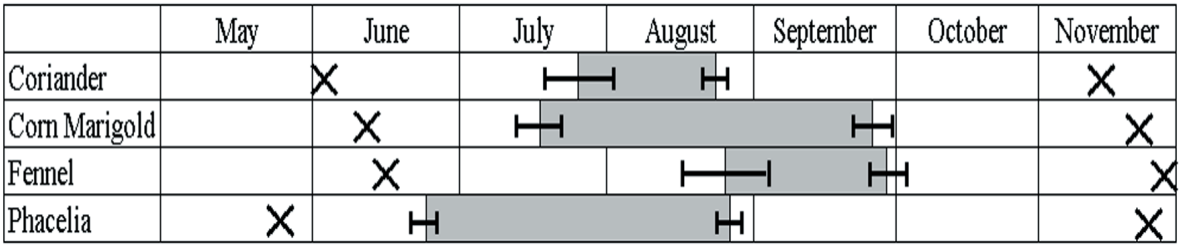

Fig. 1. Flowering periods of the four plants recorded by 179 HDRA members. Grey shading denotes the period between average start and average end dates of flowering; black bars indicate least significant difference for these averages ($P < 0.05$); crosses represent first and last reported flowering dates.

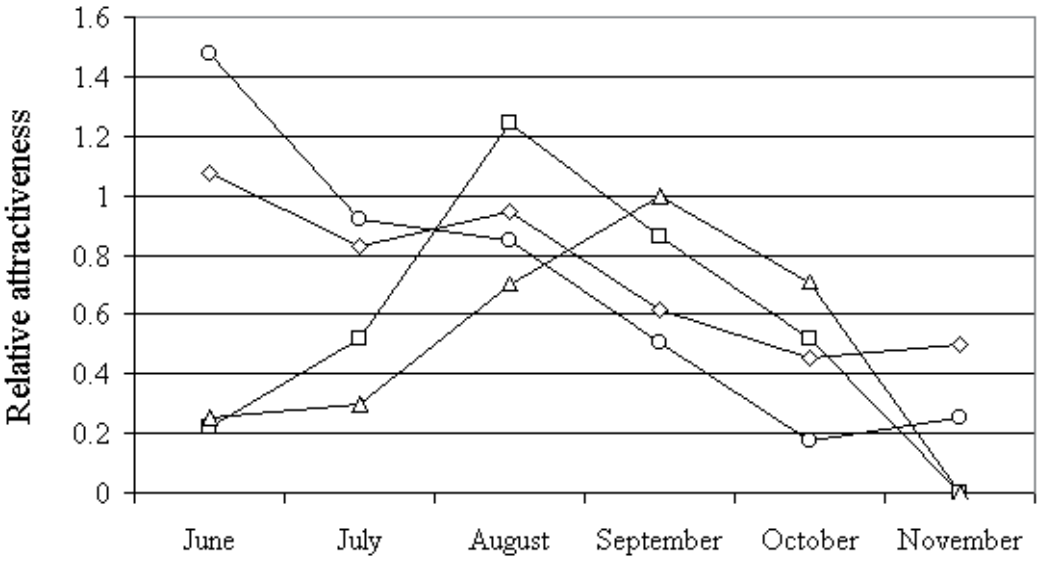

Fig. 2. Relative attractiveness of the four plants during each month of the trial period. Coriander ○; Corn marigold □; Fennel Δ; Phacelia ◊.

Participants' opinions

The most popular plant was Phacelia, with 109 of the 175 participants who grew the plant saying that they would grow it again. However, only 32 of these respondents would do so because it worked well at attracting predators. Appearance, culinary use and growth were also stated as key factors influencing members' preferences for the different plants.

Discussion

The successful application of attractant plants is dependant on growing the most attractive species with minimum cost and effort (Lagerlöf *et al*., 1992). Phacelia is renowned for being easy to grow and care for (Hickman & Wratten, 1996), which was reflected in this trial. The poor performance of other plants was largely due to slug herbivory, a problem which participants noted did not seem to affect Phacelia. The vigorous growth and persistence of Phacelia, however, may make it unsuitable for small gardens and for growing in mixed plots. Despite this, Phacelia was very popular with participants, particularly as it flowers profusely.

Phacelia consistently attracted insects throughout the summer, although it was only the most effective attractant plant in November. Work by Northing (2003) showed that Phacelia was not as attractive to hoverflies as Umbelliferous species such as Yarrow and Hogweed.

The other plants in this trial showed peaks in insect attractance that reflected the observed

flowering times; Colley & Luna (2000) note that preferences for nectar sources are influenced by the availability of other flowering plants and these change when highly attractive species cease flowering. This demonstrates the importance of growing a range of attractant plants, to create a succession of floral resources. Plants that flower in early spring and in autumn, such as Coriander and Fennel, are particularly important since nectar sources can be scarce during these periods (HDRA, 1993).

It is important to remember that different species of insect may show preferences for different flowers depending on their physiological constraints and seasonal activity. Hoverflies have been used as the model beneficial insect in several studies (Hickman & Wratten, 1996; Colley & Luna, 2000), and being the most abundant insect during this trial, had the greatest influence on overall attractiveness patterns. The presence of parasitoids may have been underestimated as many participants found them difficult to identify. It has been suggested that parasitoids are the single most important group of beneficial insects (Verkerk, 2001); consequently further investigation into parasitoid preferences would be advantageous.

The growth of attractant plants can be a highly successful tool for organic pest control. However, the selection of appropriate plants is vital. Rapid establishment and profuse flowering, as demonstrated by Phacelia, must be weighed up against attractiveness to beneficial insects, with Umbelliferous species frequently proving most attractive. A range of different plants should be grown to attract beneficial insects into crops, creating a succession of floral resources spanning the entire activity period of beneficial insects.

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