Relative attractiveness of colour traps to pear psylla in relation to seasonal changes in pear phenology

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Abstract—Monitoring of pear psylla (Cacopsylla pyricola ( Förster), Hemiptera: Psyllidae) prior to spring bud break could aid in predicting the size of subsequent spring populations and lead to improved proactive management decisions. Yellow traps are commonly used to monitor hemipteran pests including pear psylla, but very little is known regarding seasonal changes in attractiveness of yellow traps or relative attractiveness of colours other than yellow. This study presents seasonal colour-trap preferences of pear psyllas based on pear (Pyrus communis L., Rosaceae) phenological stages in the mid-Atlantic region of the United States of America. Black, blue, brown, clear (colourless), green, orange, red, white, and yellow traps were assayed against wild adult psylla populations over a 2-year period. Pear psyllas had a strong preference for yellow and orange when green leaves were present; however, we found no statistically significant difference between traps of different colours prior to spring bud break. Significantly more female psyllas were caught overall, but there was no gender-based colour bias. None of our colour traps caught significantly fewer psyllas than did clear (background hue) traps, suggesting that no traps were repellent.

Résumé—La surveillance des psylles du poirier (Cacopsylla pyricola ( Förster), Hemiptera : Psyllidae) avant l‘éclosion printanière des bourgeons pourrait aider à prédire les populations subséquentes du printemps et permettre une amélioration des décisions proactives de gestion. On utilise généralement des piéges jaunes pour la surveillance des hémiptères ravageurs, y compris du psylle du poirier, bien qu‘on connaisse peu les changements saisonniers dans l‘attraction des piéges jaunes ou l‘attraction relative des couleurs autres que le jaune. Notre étude présente les préférences saisonnières pour les piéges de couleur chez le psylle du poirier en fonction des stades phénologiques du poirier (Pyrus communis L., Rosaceae) dans la région atlantique moyenne des États-Unis. Nous avons fait l‘essai de piéges de couleur noire, bleue, brune, claire, verte, orangée, rouge, blanche et jaune avec les populations sauvages de psylles du poirier pendant une période de deux ans. Les psylles du poirier montrent une forte préférence pour le jaune ou l‘orangé lorsque les feuilles vertes sont présentes, mais il n‘y a pas de différence significative entre les piéges de couleur avant l‘éclosion printanière des bourgeons. Il y globalement une plus forte capture de femelles, mais il n‘y a pas de préférence particulière de couleur en fonction du sexe. Aucun de nos piéges de couleur ne récolte significativement moins de psylles que les piéges clairs (teinte de fond), ce qui laisse croire qu‘aucun des piéges n‘est répulsif.

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Phytophagous insects use visual colour cues in the initial stages of host-plant finding (Finch and Collier 2000). Searching insects typically land indiscriminately on green objects such as leaves of host or nonhost plants, but may avoid landing on brown surfaces such as soil (Finch and Collier 2000). Many insects have three types of photoreceptors with maximal sensitivity in green, blue, and ultraviolet wavelengths (Briscoe and Chittka 2001; Kirchner et al. 2005; Döring and Chittka 2007). Leaves reflect visible energy between 500 and 600 nm (yellow), but very little below 500 nm (blue). Certain phytophagous insects respond positively to yellow, and yellow traps are commonly used to monitor adult populations of agriculturally important hemipteran insects (Wilde 1962; Kring 1967; Adams et al. 1983). Using traps to monitor certain phytophagous insect populations during winter or early spring prior to bud break could aid in predicting subsequent spring populations and lead to improved proactive management decisions. However, very little is known about the seasonal efficacy of yellow traps during different host phenological stages.

We assessed the relative attractiveness of colour traps to pear psylla (Cacopsylla pyricola (Förster), Hemiptera: Psyllidae). Pear psylla is a key pest of pear (Pyrus communis L., Rosaceae), causing leaf necrosis and defoliation, reducing yield (Robert et al. 1999), andvectoring pear decline disease (Carraro et al. 2001). Pear psylla has four generations per year and is present in pear orchards year-round. Fourth-generation adults overwinter and begin oviposition in the spring, concurrently with bud break. The goals of this study were to (i) survey a range of colour traps for attractiveness and (or) repellency to pear psylla, (ii) evaluate seasonal changes in colour preferences, and (iii) evaluate potential colour bias between male and female psylla.

Field preference assays were conducted at the USDA Agricultural Research Service's Appalachian Fruit Research Station in Kearneysville, West Virginia (39°21'19"N, 77°52'37"W), in three different 4-year-old Bartlett pear orchards (blocks). Plots used in our study did not receive insecticidal treatments. Trees (2.5–3.0 m height) were spaced 3.1 m apart within rows and 5.5 m apart between rows. Round (25.4 cm diameter) black, blue, clear (colourless), green, red, white, and yellow plastic plates (Solo Cup Company, Highland Park, Illinois) and clear plates painted walnut brown (ColorPlace, Bentonville, Arkansas) or pumpkin orange (Kylon, Cleveland, Ohio) were used as colour traps. Traps were attached to 1.5 m high wooden stakes and coated with Tangle Trap insect-trap coating (Tanglefoot Company, Grand Rapids, Michigan). Each colour was replicated three times within each orchard (n = 27 traps per orchard; n = 81 in total). Traps were placed in an east–west orientation between trees and within rows in a completely randomized design. Traps were monitored for adult pear psyllas and replaced biweekly from March 2001 through February 2003 (24 months). Males and females were recorded separately during peak occurrences during the second year (April through September 2002).

Based on pear phenology observed and recorded in our experimental plots during the study years (G.J.P., unpublished data), data were assigned to four groups as follows: (1) bud break (green tips and expanding buds), (2) bloom/flush (green flush leaves and white blooms), (3) green (mature) leaves, and (4) dormancy (leaf drop and winter dormancy). These phenological stages corresponded to March, April, May through November, and December through February, respectively. Data were natural-log-transformed to stabilize variances, and analyzed using SAS 9.2 (2008). Untransformed means and standard errors are presented. Differences between the genders during the bloom/flush and green-leaf phenological stages in year 2 were analyzed by factorial analysis (PROC MIXED) with gender, phenological stage, colour, and their interactions as independent variables, psylla/trap/date as the dependent variable, and block and block / main effect interactions as the random variables. Psylla trap catch over the 2-year collection period was analyzed with study year, phenological stage, colour, and their interactions as independent variables, psylla/trap/date as the dependent variable,
and block and block / main effect interactions as the random variables. The “slice” option of the LSMEANS statement was used when significant interactions were detected among main effects; post-hoc Tukey’s HSD comparisons were used to measure differences within main-effect groups.

Analysis of data collected according to gender during the bloom/flush and green-leaf stages in year 2 revealed no significant interactions among main effects, indicating similar effects of colour and phenological stage between genders (Table 1A). There was a significant gender effect (Table 1A), with more females caught per trap (0.9, averaged over all dates) than males (0.4).

Psyllas were caught in our pear orchards throughout the year (Table 2). An analysis of psylla trap catch did not reveal a significant three-way interaction between phenological stage, trap colour, and year, but there was a significant interaction between trap colour and phenological stage (Tables 1B, 2). As expected, significantly more psyllas were caught on yellow and orange traps during the bloom/flush and green-leaf stages ($F_{[8,142]} = 7.4$, Table 2).
$P < 0.01$, and $F_{[8,142]} = 5.4$, $P < 0.01$, respectively) (Table 2), which is consistent with the results of previous studies (Wilde 1962; Kring 1967; Adams et al. 1983). In contrast, there were no significant differences in numbers caught on traps of different colours during the bud break and dormant stages ($F_{[8,142]} = 0.1$, $P = 0.99$, and $F_{[8,142]} = 0.1$, $P = 0.99$, respectively) (Table 2). None of the colour traps caught significantly fewer psyllas than did the clear (background hue) traps regardless of host phenology, suggesting that none of the colour traps evaluated were repellent (Table 2).

Sampling winter populations could help to predict the size of subsequent spring populations and improve proactive management decisions. Although psyllas were caught prior to bud break, numbers were low when leaves were absent. Further studies are needed to determine whether sampling of small over-wintering psylla populations can be used to predict whether or not spring populations will be injurious. Yellow traps are commonly used to monitor pear psylla populations. Our study supports this practice by showing that yellow and orange traps are more attractive to adult pear psyllas than the other colours tested. However, we found no statistically significant difference between colour traps prior to spring bud break, when leaves are not present. This corroborates the results of a previous study that showed no significant differences in psylla numbers caught on clear or yellow traps prior to leaf expansion (Krysan and Horton 1991), but our study differed by including a broader range of colours. Potential seasonal changes in the colour preference (or lack of preference) of psyllas deserve further investigation.

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