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Relative Attraction of Color Traps to Western Black Flea Beetle, *Phyllotreta pusilla* Horn (Chrysomelidae: Coleoptera), on Spring Canola in Colorado

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Abstract: The Western Black Flea Beetle (WBFB), *Phyllotreta pusilla* Horn (Chrysomelidae: Coleoptera), is one of the most significant pests on the spring canola in Colorado (USA). Different color traps were tested to learn of attraction to WBFB. Yellow, neon yellow, neon green and neon orange sticky color traps were the most attractive for WBFB. However, the blue and silver sticky color traps were less attractive to WBFB.

Key words: Western Black Flea Beetle, *Phyllotreta pusilla* Horn (Chrysomelidae: Coleoptera), color trap, spring canola, *Brassica napus* L.

INTRODUCTION

The genus *Phyllotreta* (Coleoptera: Chrysomelidae) is one of the largest and most economically important groups of flea beetles (Newton, 1928; Edward *et al.*, 2002). The genus contains several important agricultural pest species that mainly attack brassicas (Newton, 1928; Chittenden, 1909). In addition, the most severe pests of oilseed *Brassica* cultivars in Europe and North America are *P. cruciferae*, *P. striolata*, *P. undulata* (Lamb, 1989) and *P. pusilla* (Chittenden and Marsh, 1920; Al-Doghairi, 2000; Demirel, 2003; Demirel and Cranshaw, 2005, 2006). The latter, known as the western black flea beetle (WBFB), *Phyllotreta pusilla,* is a key pest of cruciferous plants grown in the Rocky Mountain region of Colorado (Chittenden, 1920; Demirel, 2003; Demirel and Cranshaw, 2005, 2006). WBFB overwinters as adults under clods of earth, or under heaps of weeds, dead leaves, or other rubbish (Chittenden and Marsh, 1920). There are apparently three generations annually in Colorado. Egg lying begins as early as mid-April and continues into early September (Chittenden and Marsh, 1920). Primary feeding injury is done by adults, which chew small pits ("shotholes") into leaves (Chittenden and Marsh, 1920; Demirel, 2003; Demirel and Cranshaw, 2006). Seedlings are frequently killed or severely stunted by these injuries and also very high populations can also defoliate established plants (Demirel, 2003; Demirel and Cranshaw, 2006). The flea beetle species causes significant injury on canola. Previous study indicated that the most important damage of *Phyllotreta* spp. to the canola crop occurs within three weeks of germination (Turnock, 1982; Lamb, 1984; Bracken and Bucher, 1986; Gavloski *et al.*, 2000). Surviving seedlings grow slowly and more susceptible to effects of further attack. Seedling damage is ultimately important in contributing to yield reduction (Lamb, 1984; Bracken and Bucher, 1986).

The sticky color traps can be used as a method for monitoring and controlling adult flea beetle on cultivated crop in the field. Visually-based traps have been used effectively for monitoring a variety of insect pests, especially on tree fruits (Prokopy, 1972; Adams *et al.*, 1983). In addition, the Saturn green, Saturn yellow and white sticky color trap were significantly the most attractive to WBFB compared to the transparent control (Al-Doghairi, 2000). In addition, the Wisley turnip-fly trap, which gave excellent results in capturing adults of two flea beetle species, *P. consobrina* Curtis and *P. undulate* Kutschera, in turnip plantings (Lefroy, 1914). In addition, Saturn yellow and lightning yellow traps captured significantly more corn flea beetles, *Chaetocnema pulicaria* Melsheimer, than other colors tested in sweet corn fields (Adams and Los, 1986). Moreover, the white traps attracted more flea beetles for monitoring and/or reducing infestation in brassica plantings can also affect trap catch (Vincent and Stewart, 1986).

The purpose of this study was the identification of the trap components that could be used for optimal WBFB capture in spring canola.

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Table 1: Capture of WBFB, *P. pusilla* Horn, on different colored sticky traps at Cargill Oilseed Research Center (CORC) Ft. Collins, Colorado in 2000.

Trap color	No. of insects (means±S.E) per four traps[z] *P. pusilla*
Trial I	
Yellow	46.0±6.7a
Blue	7.8±2.1c
Neon Yellow	20.5±4.1b
Neon Green	20.0±5.5b
Neon Pink	13.5±2.3bc
Orange	20.5±4.6b
Trial II	
Yellow	0.8±0.3a
Blue	1.5±0.6a
Neon Green	2.0±1.1a
Neon Yellow	2.0±0.4a
Neon Orange	2.3±0.5a
Neon Pink	3.3±2.0a
White	1.5±0.3a
Silver	1.3±0.9a
Trial III	
Yellow	1.8±0.5ab
Blue	2.3±0.5ab
Neon Green	1.5±0.6ab
Neon Yellow	2.0±0.9ab
Neon Orange	3.3±1.0a
Neon Pink	3.0±0.6ab
White	1.8±0.6ab
Silver	1.3±0.3b

[z] Means within a column not followed by the same letter (s) are significantly different (p<0.05) by LSD

MATERIALS AND METHODS

All trials were conducted during summer 2000 and 2002 at two different locations in which Cargill Oilseed Research Center and Colorado State University Horticultural Field Research Center the vicinity of Ft. Collins, Colorado (USA). Three sticky color trap trials were conducted at the CORC in Ft. Collins, CO in 2000. The first trap trial (Trial I) was conducted from 5 to 12 July and consisted of six color-traps as treatments; yellow, blue, neon yellow, neon green, neon pink and orange (Table 1). The second trap trial was repeated at two intervals; the first running (Trial II) was from 16 to 21 July, the second running (Trial III) was from 18 to 23 July. Each of them contained eight different color traps as treatments; yellow, blue, neon green, neon yellow, neon orange, neon pink, white and silver (Table 1).

Two additional sticky color trap trials were conducted during the same season at the HFRC Ft. Collins, CO in 2000. The first trial (Trial IV) was conducted from 7 to 14 July and consisted of eight color-traps as treatments; yellow, blue, neon yellow, neon green, neon pink, orange, white and silver (Table 2). In the second trial (Trial V) was conducted from 14 to 21 July and also contained eight color-traps as treatments; yellow, orange, neon yellow, neon green, aluminum foil dull surface, aluminum foil shiny surface, white and silver (Table 2).

Three sticky color trap trials were conducted at the HFRC in Ft. Collins, CO in 2002. Those trials were repeated three times with the same treatments. The trials were conducted as following dates: 10-21 May (Trial VI), 21 May to 3 June (Trial VII), and 7-19 June (Trial VIII). All trials consisted of five color-traps treatments; yellow, neon yellow, neon green, neon orange and neon red (Table 2).

A trap consisted of a colored 13x8 cm index card covered, on each side, with a transparent sheet stapled to the card. Each of the colored sticky traps placed on wood stake crosses with the horizontal bar 60 cm above the ground. The two outer surfaces of each trap were coated with a thin layer of Tanglefoot[R] (The Tanglefoot Co., Grand Rapids, MI). Each trap-stake was spaced 6 m apart within the respective canola fields. For each evaluation trial date, upon collection each sticky color trap was wrapped with a clear plastic wrap and transferred to the lab for counts of the captured Western Black Flea Beetle (WBFB). All experimental designs were completely randomized block with four replications. All data were analyzed by analysis of variance (ANOVA) with using the SAS software and means were separated using the Least Significant Difference (LSD) Multiple Comparison Tests (SAS Institute Inc., 1990).

RESULTS AND DISCUSSION

In a three sticky color trap trials were conducted at CORC in 2000. In the first trial (Trial I) at CORC site the highest WBFB numbers were found on yellow sticky color trap, while the lowest WBFB numbers were found on blue sticky color trap ($F = 8.424$, df = 5, 18, $p = 0.0001$) (Table 1). However, there was no statically different among treatment in the second trial (Trial II) ($p = 0.640$, df = 7, 24, $p = 0.718$) (Table 1). In last trial (Trial III), the highest WBFB numbers were found on neon yellow sticky color trap, whereas the lowest WBFB numbers were found on silver sticky color trap ($F = 1.120$, df = 7, 24, $p = 0.0383$) (Table 1).

In a two sticky color trap trials were conducted at HFRC in 2000. In the first trial (Trial IV), the highest WBFB numbers were found on orange sticky color trap ($F = 1.943$, df = 7,24, $p = 0.0106$) (Table 2). In the second trial (Trial V), the highest WBFB numbers were found on yellow sticky color trap ($F = 2.396$, df = 7, 24, $p = 0.048$) (Table 2).

Table 2: Capture of WBFB, *P. pusilla* Horn, on different colored sticky traps at Horticultural Field Research Center (HFRC) Ft. Collins, Colorado in 2000 and 2002

Trap color			Number of insects (means±S.E) per four traps[w] *P. pusilla*
	Trial IV		
Yellow			6.0±1.2b
Blue			3.5±1.0b
Neon Yellow			8.8±1.4ab
Neon Green			6.3±1.3b
Neon Pink			6.0±1.6b
Orange			12.5±2.5a
White			8.8±3.2ab
Silver			8.8±2.3ab
	TrialV		
Yellow			22.0±5.7a
Orange			12.0±2.3b
Neon Yello			7.3±1.1b
Neon Green			7.8±1.3b
Aluminum foil dull surface			12.5±4.3ab
Aluminum foil shiny surfac			14.8±5.5ab
White			7.8±2.2b
Silver			5.8±1.1b
	Trial VI	Trial VII	Trial VIII
Yellow	7.3±1.9b	55.0±9.6b	97.3±14.4a
Neon Yellow	20.0±3.0a	97.0±21.0ab	59.5±13.6ab
Neon Green	22.0±3.1a	123.3±27.5a	81.8±4.8ab
Neon Orange	16.3±2.1ab	91.3±7.9ab	43.0±8.0ab
Neon Red	17.5±1.9ab	81.3±9.2ab	53.3±6.1ab

[w] Means within a column not followed by the same letter(s) are significantly different (p<0.05) by LSD

In a three sticky color trap trials were conducted at HFRC site in 2002. In the first trial (Trial VI) and second trial (Trial VII), the highest WBFB numbers were found on neon green sticky color trap ($F = 5.312$, $df = 4,15$, $p = 0.007$; $F = 2.133$, $df = 4,15$, $p = 0.0123$, respectively) (Table 2). In addition, in the first trial (Trial VI), neon yellow sticky color trap were also caught the highest WBFB numbers ($F = 5.312$, $df = 4, 15$, $p = 0.007$). In the last trial (Trial VIII), the highest WBFB numbers were found on yellow sticky color trap ($F = 4.729$, $df = 4,15$, $p = 0.011$) (Table 2).

Color preference of flea beetle species has produced variable results. In addition, the Saturn green, Saturn yellow and white sticky color trap were significantly the most attractive to WBFB compared to the transparent control (Al-Doghairi, 2000). In addition, the flea beetles were strongly attracted to yellow and white colors (Vincent and Stewart, 1986). Saturn yellow and lightning yellow traps also captured significantly more corn flea beetles, *Chaetocnema pulicaria* Melsheimer, than other colors tested in sweet corn fields (Adams and Los, 1986). Moreover, the white traps attracted more flea beetles for monitoring and/or reducing infestation in brassica plantings can also affect trap catch (Vincent and Stewart, 1986). Furthermore, The Wisley turnip-fly trap, which gave excellent results in capturing adults of two flea beetle species, *P. consobrina* Curtis and *P. undulate* Kutschera, in turnip plantings (Lefroy, 1914). In current study indicated that the treatment of silver were caught the lowest WBFB numbers. However, previous mulch study conducted by Demirel and Cranshaw (2005) reported that plants surrounded by aluminum mulch had the highest number of WBFB compared with the rest of treatments in 1999 and 2000.

In this current study and previous study indicated that the yellow sticky color trap and green sticky color trap were attractive for flea beetle species due to plant foliage release visual stimuli in the green-yellow region of the spectrum (Prokopy *et al*., 1983; Prokopy and Owens, 1983) and thus flea beetles may similarly prefer the same color range to stimulate food and host-finding behavior. This makes the yellow appear as a large attractive feeding surface compared to the less reflective foliage background (Prokopy, 1968; 1972). As a result, yellow and green sticky color traps were significantly attractive for monitoring flea beetle population density prior to causing significant injury on the canola crop.

In conclusion, different color traps were tested to learn of attraction to WBFB. Yellow, neon yellow, neon green and neon orange sticky color traps were the most attractive for WBFB. However, the blue and silver sticky color traps were less attractive to WBFB.

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