CONTROLLING DODDER (*CUSCUTA* SPP.) IN ROUNDUP READY® SUGAR BEETS IN THE TREASURE VALLEY

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Introduction

Dodder (*Cuscuta* spp.) is an annual obligate parasitic weed known to attach itself to plants and cause severe damage. There are about 150 dodder species in the world, all parasitizing different crops and weeds. One species in particular, *Cuscuta campestris*, has been found parasitizing many crops and weed species including alfalfa (*Medicago sativa*), asparagus (*Asparagus officinalis*), melons (*Cucumis* spp.), safflower (*Carthamus tinctorius*), sugar beet (*Beta vulgaris*), tomato (*Lycoperscum esculentum* L.), pigweeds (*Amaranthus* spp.), lambsquarters (*Chenopodium album*), and field bindweed (*Convolvulus arvensis*). Dodder seems to lack an elaborate dispersal mechanism, and it is believed that soil movement within and between fields helps to move it from one field to another. Dodder produces a copious number of seeds that last up to 60 years in the soil. The plant is characterized by cream-colored trailing stems that strangle plant leaves. Unlike other parasitic plants, dodder does not need a host to germinate, but it must find a host and attach within 10 days or it risks dying. Mature stems that have been removed from infested plants are known to reattach to green vegetation at the disposal site.

Commercial production of Roundup Ready® sugar beets (RRsb) was launched in Oregon in 2008. Over 90 percent of the sugar beet fields in eastern Oregon were planted to RRsb hybrids in 2008. Grower field surveys at the end of the season indicated most fields were treated with two to three sequential Roundup applications to control weeds. Glyphosate (Roundup PowerMax®) rates ranged from 0.56 to 0.84 lb ae/acre (16 to 24 fl oz/acre) and 0.70 to 1.13 lb ae/acre (20 to 32 fl oz/acre) for the first and second application, respectively. Growers using three Roundup applications used glyphosate at 0.56 to 1.13 lb ae/acre (16 to 32 fl oz/acre) for the final applications. Initial indications were that growers were satisfied with the level of weed control provided by Roundup applications.

However, some growers experienced mid-season dodder emergence and our late-season field survey confirmed this observation. Roundup provided early season dodder control, but late-emerging cohorts succeeded in attaching to sugar beet plants. The objective of this study was to evaluate the effectiveness of soil-applied herbicides ethofumesate at 6 oz ai/acre (Nortron® at 12 fl oz/acre), ethofumesate at 6 oz ai/acre (Ethotron™ at 12 fl oz/acre), and s-metolachlor at 1.27 lb ai/acre (Dual Magnum® at 1.33 pt/acre) as tank-mix partners with glyphosate applied at 0.75 lb ae/acre (Roundup

PowerMax at 22 fl oz/acre) to inhibit dodder seedling emergence and attachment to sugar beet plants.

Materials and Methods

A field study was established in 2009 in a grower field near Ontario, Oregon. The study followed a randomized complete block design with four replications. The experiment was established on May 12, and plots measured 7.33 ft wide (four rows) by 30 ft. Herbicides were applied using a CO_2-pressurized backpack sprayer equipped with a four-nozzle (8002EVS) boom calibrated to deliver 12 gal/acre. Treatments varied by application of glyphosate alone or with ethofumesate at 6 oz ai/acre (Nortron at 12 fl oz/acre), s-metolachlor at 1.27 lb ai/acre (Dual Magnum at 1.33 pt/acre), or ethofumesate at 6 oz ai/acre (Ethotron at 12 fl oz/acre) herbicides as tank-mix partners at different sugar beet growth stages. Treatment details are presented in Tables 1 and 2. The initial herbicide treatments were applied on May 13 when sugar beet plants were at the 2-leaf stage. Plants were treated with glyphosate again on May 21, and treatments requiring a third application were treated on June 9 when sugar beets were at about the 10-leaf stage. Evaluations to assess crop injury and weed control were done using a visual scale of 0-100 percent (0 = no injury or no weed control and 100 percent = total crop kill or complete weed control). Visual evaluations for weed control were done on July 6 and October 6, 2009.

All field operations including fertilizer application, irrigation timing, and preventative sprays for diseases and insects were conducted by the cooperating grower. Sugar beet roots were hand harvested from the two center rows on October 6 and samples transported to the Snake River Sugar factory to determine sugar content and other sugar variables. The data were subjected to analysis of variance to determine treatment variations and means compared using Least Significant Difference (LSD) at the 5 percent level of significance.

Results and Discussion

The first dodder emergence was observed on May 6, 2009 and the newly emerged plants were growing towards sugar beet seedlings. Early attachment was observed on May 10 (Fig. 1). Visual evaluation on July 6 indicated reduced sugar beet growth in the untreated control plots (data not shown). Dodder control on July 6 ranged from 81 to 99 percent for different herbicide treatments (Table 1). Application of glyphosate alone at the 2- and 4-leaf stage provided dodder control similar to treatments that included soil residual herbicides at the 2-leaf stage followed by glyphosate alone at the 4-leaf stage. The best dodder control was achieved when glyphosate was applied alone at the 2-leaf stage followed by tank-mixtures of glyphosate plus soil residual herbicides at 4-leaf and glyphosate alone at the 10-leaf stage. Common lambsquarters control ranged from 92 to 100 percent, with application of glyphosate alone at the 2- and 4-leaf stage providing the lowest control. Control for pigweed species was excellent across treatments and ranged from 96 to 100 percent.

Visual evaluations on October 6 indicated continued reduction in growth for sugar beet plants in the untreated control (data not shown). Dodder control was still high for treatments that included soil-residual herbicides in the intermediate application timing (Table 1). Common lambsquarters control ranged from 91 to 100 percent and pigweed species from 94 to 100 percent. Survey of grower fields indicated very little dodder growth in 2009 with similar yield and sugar content for plants parasitized by dodder and those growing in non-parasitized areas (data not shown). Timing of glyphosate application seems to be the key in managing dodder in Roundup Ready sugar beets. The results indicate that glyphosate alone may provide an acceptable level of dodder control. However, yearly weather variations may be the driving factor in the level of dodder emergence during mid- to late season.

Root sugar content ranged from 15.4 to 16.6 percent and did not appear to be affected by herbicide treatments (Table 2). Root yield (ton/acre) and estimated recoverable sugar (lb/acre) were low in treatments that included Dual Magnum and Ethotron SC herbicides at the 4-leaf stage. Root yield for the other herbicide treatments ranged from 26 to 32 ton/acre and 23 ton/acre for the untreated control.

Figure 1. Dodder attachment on sugar beet on May 12, 2009 in a field near Ontario, OR, 2009.

Table 1. Weed control in response to herbicide application timing on Roundup Ready sugar beet near Ontario, OR, 2009.

Treatment	Rate	Timing[†]	Weed control[‡]					
			Field dodder	Common lambsquarters	Pigweed spp.	Field dodder	Common lambsquarters	Pigweed spp
			July 6, 2009			October 6, 2009		
			%					
Roundup PowerMax Ammonium sulfate Roundup PowerMax Ammonium sulfate	22 fl oz/a 2.5 V/V 22 fl oz/a 2.5 V/V	2-leaf 5-leaf 	83 b	92 c	97 ab	81 c	91 c	97 abc
Roundup PowerMax Ammonium sulfate Roundup PowerMax Ammonium sulfate Roundup PowerMax Ammonium sulfate	22 oz/a 2.5 V/V 22 oz/a 2.5 V/V 22 fl oz/a 2.5 V/V	2-leaf 5-leaf 10-leaf 	95 a	100 a	100 a	91 ab	100 a	100 a
Roundup PowerMax Ammonium sulfate Dual Magnum Roundup PowerMax Ammonium sulfate	22 fl oz/a 2.5 V/V 2.5 V/V 22 fl oz/a 2.5 V/V	2 leaf 5-leaf 	83 b	96 b	96 b	79 c	94 bc	95 bc
Roundup PowerMax Ammonium sulfate Roundup PowerMax Ammonium sulfate Dual Magnum Roundup PowerMax Ammonium sulfate	22 fl oz/a 2.5 V/V 22 fl oz/a 2.5 V/V 1.33 pt/a 22 fl oz/a 2.5 V/V	2-leaf 5-leaf 10-leaf 	99 a	100 a	100 a	99 a	100 a	100 a
Ammonium sulfate Roundup PowerMax Nortron Roundup PowerMax Ammonium sulfate	2.5 V/V 22 fl oz/a 12 fl oz/a 22 fl oz/a 2.5 V/V	2-leaf 5-leaf 	88 b	96 b	96 b	84 bc	96 ab	94 c
Roundup PowerMax Ammonium sulfate Roundup PowerMax Ammonium sulfate Nortron Roundup PowerMax Ammonium sulfate	22 fl oz/a 2.5 V/V 22 fl oz/a 2.5 V/V 12 fl oz/a 22 oz/a 2.5 V/V	2-leaf 5-leaf 10-leaf 	99 a	99 ab	98 ab	98 a	96 ab	97 abc
Roundup PowerMax Ammonium sulfate Ethotron SC Roundup PowerMax Ammonium sulfate	22 oz/a 2.5 V/V 12 fl oz/a 22 fl oz/a 2.5 V/V	2-leaf 5-leaf 	81 b	97 b	99 ab	79 c	95 bc	99 ab
Roundup PowerMax Ammonium sulfate Roundup PowerMax Ammonium sulfate Ethotron SC Roundup PowerMax Ammonium sulfate	22 fl oz/a 2.5 V/V 22 fl oz/a 2.5 V/V 12 fl oz/a 22 fl oz/a 2.5 V/V	2-leaf 5-leaf 10-leaf 	95 a	100 a	100 a	93 a	100 a	100 a
Untreated check			0 c	0 d	0 c	0 d	0 d	0 d

[†]Herbicide applied when sugar beets were at the 2-leaf stage (5/13); herbicides applied when sugar beets were at the 5-leaf stage (5/21); herbicides applied when sugar beets were at the 10-leaf stage (6/9).
[‡]Means within a column followed by same letter do not significantly differ (P = 0.05, LSD).

Table 2. Sugar yield in response to herbicides and application timing on Roundup Ready sugar beet near Ontario, OR, 2009.

				Sugar yield[‡]				
Treatment	Rate	Timing[†]	Conduc-tivity	Nitrate	Sugar content	Yield	Extractable sugar	ERS
			mmhos	%	%	t/a	%	lb/a
Roundup PowerMax AMS	22 fl oz/a 2.5 V/V	2-leaf	0.76 a	133 a	15.8 ab	25.6 ab	84.62 b	6881 ab
Roundup PowerMax AMS	22 fl oz/a 2.5 V/V	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 oz/a 2.5 V/V	2-leaf	0.70 ab	118 a	16.2 a	26.0 ab	85.44 ab	7166 ab
Roundup PowerMax Ammonium Sulfate	22 oz/a 2.5 V/V	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	10-leaf						
Roundup PowerMax Ammonium Sulfate Dual Magnum	22 fl oz/a 2.5 V/V 2.5 V/V	2 leaf	0.74 ab	115 a	16.2 a	22.5 b	84.98 ab	6183 b
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	5-Leaf						
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	2-leaf	0.71 ab	138 a	15.4 b	33.0 a	85.14 ab	8635 a
Roundup PowerMax Ammonium Sulfate Dual Magnum	22 fl oz/a 2.5 V/V 1.33 pt/a	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	10-leaf						
Ammonium Sulfate Roundup PowerMax Nortron	2.5 V/V 22 fl oz/a 12 fl oz/a	2-leaf	0.65 b	102 a	16.5 a	27.6 ab	86.19 a	7850 ab
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	2-leaf	0.71 ab	104 a	16.3 a	25.8 ab	85.39 ab	7172 ab
Roundup PowerMax Ammonium Sulfate Nortron	22 fl oz/a 2.5 V/V 12 fl oz/a	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 oz/a 2.5 V/V	10-leaf						
Roundup PowerMax Ammonium Sulfate Ethotron SC	22 oz/a 2.5 V/V 12 fl oz/a	2-leaf	0.69 ab	87 a	16.3 a	21.3 b	85.60 ab	5941 b
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	2-leaf	0.73 ab	118 a	16.4 a	31.5 a	85.11 ab	8804 a
Roundup PowerMax Ammonium Sulfate Ethotron SC	22 fl oz/a 2.5 V/V 12 fl oz/a	5-leaf						
Roundup PowerMax Ammonium Sulfate	22 fl oz/a 2.5 V/V	10-leaf						
Untreated Check			0.65 b	80 a	16.3 a	22.8 b	86.11 a	6372 b

[†]Herbicide applied when sugar beets were at the 2-leaf stage (5/13); herbicides applied when sugar beets were at the 5-leaf stage (5/21); herbicides applied when sugar beets were at the 10-leaf stage (6/9).
[‡] Means followed by same letter do not significantly differ (P = 0.05, LSD).