

## **FEATURED WEED VOLUNTEER ROUNDUP READY CANOLA CONTROL IN SUGARBEET**

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### **Summary**

1. Use sequential applications of UpBeet at 0.75 and 1.0 oz/A beginning when volunteer Roundup Ready (RR) canola is at the 2-leaf stage.
2. Experiments planted in April suggest sugarbeet injury from UpBeet when applied under cool and excessively wet conditions.
3. Ethofumesate PRE at 7.5 pt/A did not provide acceptable volunteer canola control.
4. Betamix or ethofumesate plus UpBeet did not improve volunteer canola control compared to UpBeet alone.

### **Introduction**

Canola is planted in sequence with sugarbeet fields in northern counties in the Red River Valley. In the course of growing and harvesting canola, seeds are inadvertently scattered on the soil surface and germinate and emerge in subsequent crops. Gulden reported average canola losses of 3,000 viable seeds per meter square or a seed number greater than the normal canola seeding rates (2). Canola may also arrive in a field inconspicuously. Canola allegedly has been found at trace levels with phosphorus or potassium fertilizer spread on fields.

Volunteer canola has been reported to persist in soils for at least four years and as many as seven years (1, 4). However, the majority of volunteer canola seeds germinate and emerge the year following the canola crop (3). Weedy characteristics such as long seedbank persistence and secondary dormancy contribute to the abundance and recurrence of canola as a weed in fields planted to sugarbeet. These occurrences have been compounded by the development and commercial release of herbicide-resistant canola genotypes containing the Roundup Ready trait.

Growers must implement a strategic approach for controlling volunteer canola by carefully considering crop sequence and herbicide options. Like many crops, volunteer canola is primarily Roundup Ready, requiring sugarbeet farmers to manage canola in sugarbeet much like they manage corn or soybean in sugarbeet. Further compounding the problem, canola is difficult to distinguish from wild mustard at the early vegetative stage when it is easiest to control.

The objective of this experiment was to determine an herbicide program including the best herbicide application timing for control of volunteer RR canola in sugarbeet.

### **Materials and Methods**

Experiments were conducted at the North Dakota State University, Prosper Research Farm in 2015. The experimental area was seeded with Roundup Ready canola using a hand-operated spreader to simulate volunteer RR canola. Wheat stubble was prepared for planting using a Kongskilde s-tine field cultivator equipped with rolling baskets on April 16, 2015 (first experiment) and on May 27, 2015 (second experiment). Hillehog HM4022RR sugarbeet seed treated with Cruiser 5FS at 60 gm a.i., Apron XL at 15 gm a.i., and Maxim 4FS at 2.5 gm a.i., respectively, per 100,000 seeds was seeded 1.25 inches deep in 22 inch rows at 60,825 seeds per acre on April 16 and May 27, 2015.

Herbicide treatments were multiple herbicide applications beginning when canola was at the cotyledon or two-leaf stage. In the first experiment, herbicides were applied preemergence (PRE) on April 17, 2015 and postemergence (POST) on May 9, May 20, May 24, June 5 and June 19, 2015, depending on treatment and application timing. In the second experiment, herbicides were applied PRE on May 27, 2015 and POST on June 8, June 19, June 24 and July 9, 2015. UpBeet herbicide was applied at 0.25, 0.5, and 0.75 oz/A in the first experiment. Herbicide rate was increased to 0.5, 0.75, and 1 oz/A in the second following conversation with technical specialists at Dupont. All treatments were applied with a bicycle sprayer in 17 gpa spray solution through 8002 XR flat fan nozzles

pressurized with CO<sub>2</sub> at 40 psi to the center four rows of six row plots 30 feet in length in an experimental area with a moderate level infestation of RR canola. Ammonium sulfate (AMS) in all treatments was a liquid formulation from Winfield Solutions called 'N-Pak' AMS.

Sugarbeet injury was evaluated on June 10, June 29, and July 8, 2015 and weed control was evaluated on June 10, June 29, July 8, and August 2, 2015 for the first experiment. Sugarbeet injury was evaluated on July 13 and August 2, 2015 while weed control was evaluated on July 13, August 2, and August 24, 2015 for the second experiment. All evaluations were a visual estimate of percent fresh weight reduction in the four treated rows compared to the adjacent untreated strip. Experimental design was randomized complete block with 4 replications. Data were analyzed with the ANOVA procedure of ARM, 2015.6 software package and with the ANOVA procedure as a factorial analysis to determine effects between application timings using SAS Data Management version SAS 9.3 software package.

**Table 1. Application information for April 17 planting, volunteer RR canola control, Prosper, ND, 2015.**

Application code	A	B	C	D	E	F
Date	April 17	May 9	May 20	May 24	June 5	June 19
Time of Day	4:00 PM	12:00 PM	6:00 PM	8:30 AM	10:00 AM	9:00 AM
Air Temperature (F)	70	40	67	64	68	68
Relative Humidity (%)	16	52	23	45	53	58
Wind Velocity (mph)	12	9.5	5	4	6	12
Wind Direction	NW	NE	NW	NE	ESE	W
Soil Temp. (F at 6")	47	42	58	59	60	59
Soil Moisture	Dry	Good	Good	Dry	Dry	Good
Cloud Cover (%)	5	90	40	100	90	40
Sugarbeet stage (avg)	PRE	Cot.	2 lf	4 lf	6 lf	10 lf
Canola (untreated avg)	-	Cot.	2 lf	2 lf	5 lf	18"

**Table 2. Application information for May 27 planting, volunteer RR canola control, Prosper, ND, 2015.**

Application code	A	B	C	D	E
Date	May 27	June 7	June 19	June 24	July 9
Time of Day	10:40 AM	1:00 PM	9:00 AM	9:00 AM	10:30 AM
Air Temperature (F)	75	81	68	76	74
Relative Humidity (%)	46	32	58	50	50
Wind Velocity (mph)	3.5	5	12	4	2
Wind Direction	N	NW	W	W	N
Soil Temp. (F at 6")	58	64	59	68	68
Soil Moisture	Dry	Dry	Good	Good	Good
Cloud Cover (%)	0	5	50	25	10
Sugarbeet stage (avg)	PRE	Cot.	4 lf	5 lf	12 lf
Canola (untreated avg)	-	Cot.	2 lf	4 lf	24"

## Results and Discussion

Sugarbeet injury from herbicide treatments was dependent on environment (early or late planting) and timing of the first UpBeet application (Table 3,4). In the early planting, sugarbeet injury was greatest at the first evaluation timing and decreased at the second and third evaluation (Table 3). Herbicide treatments at the cotyledon canola stage caused greater sugarbeet injury than herbicide treatments at the 2-leaf canola stage. UpBeet was applied at 0.25, 0.5 and 0.75 oz/A plus Roundup PowerMax. Sugarbeet injury from UpBeet at 0.25 /0.25 / 0.25 oz/A plus Roundup PowerMax was similar to sugarbeet injury from UpBeet at 0.5 / 0.5 / 0.5 oz/A. UpBeet at 0.75 / 0.75 / 0.75 oz/A plus Roundup PowerMax caused more sugarbeet injury, especially when herbicide treatments were initiated at the cotyledon canola stage. However, there was no difference in sugarbeet injury across UpBeet rates when treatments were initiated at the 2-leaf stage. UpBeet at 0.5 / 0.5 / 0.5 plus Betamix at 8 / 12 / 16 fl oz/A, respectfully, plus Roundup PowerMax caused more sugarbeet injury than UpBeet plus Roundup PowerMax alone when averaged across evaluations and application timing.

There was much less sugarbeet injury in the late planted experiment even though UpBeet rates were increased from 0.25, 0.5 and 0.75 oz/A to 0.5, 0.75 and 1.0 oz/A (Table 4). There was no difference in sugarbeet injury from herbicide treatments initiated at the cotyledon canola stage compared to the same herbicide treatments initiated at the 2-leaf canola stage. Similar to the early experiment, Betamix or ethofumesate applied in combination with UpBeet plus PowerMax caused more sugarbeet injury than UpBeet plus Roundup PowerMax alone.

**Table 3. Sugarbeet injury from multiple applications of UpBeet alone and in tank mixtures at cotyledon and 2-leaf canola stage, early planting, Prosper, ND, 2015.**

Treatment <sup>1</sup>	Rate	Cotyledon stage <sup>5</sup>			2-leaf stage			Treatment Means <sup>4</sup>
		Jun 10	Jun 29	July 8	Jun 10	Jun 29	July 7	
PMax <sup>2</sup> / PMax / PMax	pt, fl oz/or oz/A 28 / 28 / 28	0	5	11	-	-	-	5
Etho / PMax / Pmax / PMax	7.5 / 28 / 28 / 22	3	0	8	-	-	-	4
UpBeet + P Max <sup>6</sup> /	0.25 + 28 /							
UpBeet + PMax /	0.25 + 28 /	29	15	11	10	15	3	14
UpBeet + PMax	0.25 + 22							
UpBeet + PMax /	0.5+ 28 /							
UpBeet + PMax /	0.5+ 28 /	25	8	11	14	5	3	11
UpBeet + PMax	0.5+ 22							
UpBeet + PMax /	0.75 +2 8 /							
UpBeet + PMax /	0.75 + 28 /	40	8	11	8	15	3	14
UpBeet + PMax	0.75 + 22							
UpBeet + Bmix + PMax /	0.25 +8 + 28 /							
UpBeet + Bmix + PMax /	0.25 +12+28 /	23	10	10	19	10	13	14
UpBeet + Bmix + PMax	0.25 +16+22							
UpBeet + Bmix + PMax /	0.5 + 8 + 28 /							
UpBeet + Bmix + PMax /	0.5 + 12 + 28 /	38	20	11	25	13	11	20
UpBeet + Bmix + PMax	0.5 + 16 + 22							
UpBeet + Etho + PMax /	0.25 + 4 + 28 /							
UpBeet + Etho + PMax /	0.25 + 4 + 28 /	30	11	9	15	18	13	16
UpBeet + Etho + PMax	0.25 + 4 + 22							
Evaluation Timing Means		31	14	10	15	13	8	
Application Timing Means <sup>3</sup>			18			12		

<sup>1</sup>Treatments of Roundup PowerMax contained Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v. All other treatments contained Destiny HC at 1.5 pt/A plus N-Pak AMS at 2.5% v/v.

<sup>2</sup>PMax=Roundup PowerMax; Etho=Ethofumesate 4SC; Bmix=Des&Phen 8+8.

<sup>3</sup>LSD (0.10) across application timing averages = 4

<sup>4</sup>LSD (0.10) between treatment averages = 6

<sup>5</sup>LSD (0.10) treatment means within an application timing = 11

<sup>6</sup>LSD (0.10) for treatment means across application timings = 10

**Table 4. Sugarbeet injury from sequential applications of UpBeet alone and in tank mixtures at cotyledon and 2-leaf canola stage application timing, late planting, Prosper, ND, 2015.**

Treatment <sup>1</sup>	Rate pt, fl oz or oz/A	Cotyledon stage <sup>5</sup>		2-leaf stage		Treatment Means <sup>4</sup>
		Jul 13	Aug 2	Jul 13	Aug 2	
PMax <sup>2</sup> / PMax / PMax	28 / 28 / 28	0	0	-	-	0
Etho / PMax / Pmax / PMax	7.5 / 28 / 28 / 22	0	0	-	-	0
UpBeet + PMax <sup>6</sup> /	0.5 + 28 /					
UpBeet + PMax /	0.5 + 28 /	0	0	11	0	3
UpBeet + PMax	0.5 + 22					
UpBeet + PMax /	0.75 + 28 /					
UpBeet + PMax /	0.75 + 28 /	3	0	0	3	2
UpBeet + PMax	0.75 + 22					
UpBeet + PMax /	1.0 + 28 /					
UpBeet + PMax /	1.0 + 28 /	3	3	8	3	4
UpBeet + PMax	1.0 + 22					
UpBeet + Bmix + PMax /	0.5 + 8 + 28 /					
UpBeet + Bmix + PMax /	0.5 + 12 + 28 /	16	8	10	5	10
UpBeet + Bmix + PMax	0.5 + 16 + 22					
UpBeet + Bmix + PMax /	1.0 + 8 + 28 /					
UpBeet + Bmix + PMax /	1.0 + 12 + 28 /	11	5	17	3	9
UpBeet + Bmix + PMax	1.0 + 16 + 22					
UpBeet + Etho + PMax /	1.0 + 4 + 28 /					
UpBeet + Etho + PMax /	1.0 + 4 + 28 /	10	0	3	3	4
UpBeet + Etho + PMax	1.0 + 4 + 22					
Evaluation Timing Means		7	3	8	3	
<b>Application Timing Means<sup>3</sup></b>		5		6		

<sup>1</sup>Treatments of Roundup PowerMax contained Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v. All other treatments contained Destiny HC at 1.5 pt/A plus N-Pak AMS at 2.5% v/v.

<sup>2</sup>PMax=Roundup PowerMax; Etho=Ethofumesate 4SC; Bmix=Des&Phen 8+8.

<sup>3</sup>LSD (0.10) across application timing averages = NS

<sup>4</sup>LSD (0.10) between treatment averages = 5

<sup>5</sup>LSD (0.10) treatment means within an application timing = 9

<sup>6</sup>LSD (0.10) for treatment means across application timings = 9

Precipitation and air temperature may partially explain the differences in sugarbeet injury across planting dates and application timing. Postemergence herbicides were sprayed on May 9 and May 20, depending on canola growth stage. Temperatures averaged 47 F during this 11-day interval and 4.8 inches of precipitation. Temperatures averaged 66 F with 2.0 inches of precipitation during the same interval in the second planting.

Canola control was percent visual growth reduction noted by comparing the treated rows to the border rows of the plot (Table 5). Close attention was given to flowering canola during the third evaluation since flowers would imply potential development of new seed and further proliferation of volunteer canola. Canola control from herbicide treatments applied at the 2-leaf canola stage was greater than treatments initiated at the cotyledon stage. Canola control improved as UpBeet rate increased. UpBeet at 0.5 / 0.5 / 0.5 oz/A plus Roundup PowerMax gave greater canola control than UpBeet at 0.25 / 0.25 / 0.25 oz/A plus Roundup PowerMax. UpBeet at 0.75 / 0.75 / 0.75 oz/A plus Roundup PowerMax gave greater canola control than UpBeet at 0.5 / 0.5 / 0.5 oz/A plus Roundup PowerMax and similar control to UpBeet at 1.0 / 1.0 / 1.0 oz/A plus PowerMax. Addition of Betamix or ethofumesate did not improve control compared to UpBeet and Roundup PowerMax alone.

Canola control was greater in the late planted experiment than the early planting and is attributed to increasing the UpBeet rate from 0.25, 0.5 and 0.75 oz/A to 0.5, 0.75 and 1.0 oz/A (Table 6). Canola control was greater as the UpBeet rate increased. There was no statistical difference in canola control from herbicide treatments initiated at the cotyledon stage compared to canola treatments initiated at the 2-leaf stage. Adding Betamix or ethofumesate with UpBeet and PowerMax tended to improve canola control when herbicide application began at the cotyledon stage but did not improve control when applications began at the 2-leaf stage.

**Table 5. RR Canola control from sequential applications of UpBeet alone and in tank mixtures at cotyledon and 2-leaf canola stage application timing, early planting, Prosper, ND, 2015.**

Treatment <sup>1</sup>	Rate	Cotyledon stage <sup>5</sup>			2-leaf stage			Treatment Means <sup>4</sup>
		Jun 29	July 8	Aug 2	Jun 29	July 8	Aug 2	
	pt, fl oz/A or oz/A	-----%						
PMax <sup>2</sup> / PMax / PMax	28 / 28 / 28	0	0	0	-	-	-	0
Etho / PMax / Pmax / PMax	7.5 / 28 / 28 / 22	43	31	30	-	-	-	35
UpBeet +PMax <sup>6</sup> /	0.25 + 28 /							
UpBeet + PMax /	0.25 + 28 /	69	56	58	75	60	60	63
UpBeet + PMax	0.25 + 22							
UpBeet + PMax /	0.5 + 28 /							
UpBeet + PMax /	0.5 + 28 /	81	68	65	93	78	75	77
UpBeet + PMax	0.5 + 22							
UpBeet + PMax /	0.75 + 28 /							
UpBeet + PMax /	0.75 + 28 /	89	79	66	95	81	74	81
UpBeet + PMax	0.75 + 22							
UpBeet + Bmix + PMax /	0.25 +8+ 28 /							
UpBeet + Bmix +PMax /	0.25 + 12+ 28 /	79	56	59	74	61	68	66
UpBeet + Bmix + PMax	0.25 + 16 +22							
UpBeet + Bmix + PMax /	0.5 + 8 + 28 /							
UpBeet + Bmix + PMax /	0.5 + 12+ 28 /	81	66	61	83	71	69	72
UpBeet + Bmix + PMax	0.5 + 16 +22							
UpBeet + Etho + PMax /	0.25 + 4 +28 /							
UpBeet + Etho + PMax /	0.25 + 4 +28 /	78	60	51	83	63	59	66
UpBeet + Etho + PMax	0.25 + 4+22							
Evaluation Timing Means		80	64	60	84	69	68	
<b>Application Timing Means<sup>3</sup></b>			68			73		

<sup>1</sup>Treatments of Roundup PowerMax contained Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v. All other treatments contained Destiny HC at 1.5 pt/A plus N-Pak AMS at 2.5% v/v.

<sup>2</sup>PMax=Roundup PowerMax; Etho=Ethofumesate 4SC; Bmix=Des&Phen 8+8.

<sup>3</sup>LSD (0.10) across application timing averages = 2

<sup>4</sup>LSD (0.10) between treatment averages = 4

<sup>5</sup>LSD (0.10) treatment means within an application timing = 3

<sup>6</sup>LSD (0.10) for treatment means across application timings = 6

Canola germinated pattern may have influenced results from both the early and late planted experiments. Canola continued to germinate and emerge, even after herbicide sprays were initiated. Later application timing (2-leaf canola) tended to provide greater canola control presumably because herbicide treatments were applied over a broader window of time and may have been sprayed over later germinating canola that was missed when herbicide treatments were initiated at the cotyledon canola stage. Late germinating canola that did not receive repeat herbicide applications grew and in some cases began to flower.

Delaying application timing conflicts with experience. Volunteer canola control in Canada historically was best when herbicide treatments began when canola was at the cotyledon stage (conversation with Peter Regitnig, Agronomist, Lantic Sugar). However, reduction in the UpBeet price has made it affordable to use UpBeet at greater rates, which possibly has expanded the application window.

Additional use of Betamix or ethofumesae with UpBeet plus Roundup Power Max gave conflicting results in these experiments. Canola control from addition of Betamix or ethofumesate did not improve canola control from UpBeet plus Roundup in the early planted experiment. Canola control tended to increase when Betamix or ethofumesate was mixed with UpBeet and PowerMax in the late planted experiment and when herbicide treatments were initiated at the cotyledon stage; however, the Betamix or ethofumesate plus UpBeet and PowerMax did not improve canola control when herbicide treatments were initiated at the 2-leaf stage in the second experiment. Ethofumesate at 7.5 pt/A followed by Roundup PowerMax did not provide adequate canola control in either experiment and, as expected, Roundup PowerMax alone did not provide any control of RR canola.

**Table 6. RR Canola control from sequential applications of UpBeet alone and in tank mixtures at cotyledon and 2-leaf canola stage application timing, late planting, Prosper, ND, 2015.**

Treatment <sup>1</sup>	Rate pt, fl oz/A or oz/A	Cotyledon stage <sup>5</sup>			2-leaf stage			Treatment Means <sup>4</sup>
		July 13	Aug 2	Aug 24	July 13	Aug 2	Aug 24	
PMax <sup>2</sup> / PMax / PMax	28 / 28 / 28	0	23	14	-	-	-	12
Etho / PMax / Pmax / PMax	7.5 / 28 / 28 / 22	45	44	38	-	-	-	42
UpBeet + PMax <sup>6</sup> /	0.5 + 28 /							
UpBeet + PMax /	0.5 + 28 /	86	80	60	85	78	66	76
UpBeet + PMax	0.5 + 22							
UpBeet + PMax /	0.75 + 28 /							
UpBeet + PMax /	0.75 + 28 /	92	86	65	93	80	65	80
UpBeet + PMax	0.75 + 22							
UpBeet + PMax /	1.0 + 28 /							
UpBeet + PMax /	1.0 + 28 /	94	93	66	96	91	76	86
UpBeet + PMax	1.0 + 22							
UpBeet + Bmix + PMax /	0.5 + 8 + 28 /							
UpBeet + Bmix + PMax /	0.5 + 12 + 28 /	91	81	56	91	78	56	76
UpBeet + Bmix + PMax	0.5 + 16+22							
UpBeet + Bmix + PMax /	1.0 + 8+28 /							
UpBeet + Bmix+ PMax /	1.0 + 12+ 28 /	97	91	68	88	79	63	81
UpBeet + Bmix+ PMax	1.0 + 16 +22							
UpBeet + Etho + PMax /	1.0 +4 + 28 /							
UpBeet + Etho + PMax /	1.0 +4 + 28 /	97	96	75	95	86	73	87
UpBeet + Etho + PMax	1.0 + 4 +22							
Evaluation Timing Means		93	91	54	88	82	67	
<b>Application Timing Means<sup>3</sup></b>			80			82		

<sup>1</sup>Treatments of Roundup PowerMax contained Prefer 90 NIS at 0.25% v/v plus N-Pak AMS at 2.5% v/v. All other treatments contained Destiny HC at 1.5 pt/A plus N-Pak AMS at 2.5% v/v.

<sup>2</sup>PMax=Roundup PowerMax; Etho=Ethofumesate 4SC; Bmix=Des&Phen 8+8.

<sup>3</sup>LSD (0.10) across application timing averages = 2

<sup>4</sup>LSD (0.10) between treatment averages = 6

<sup>5</sup>LSD (0.10) treatment means within an application timing = 11

<sup>6</sup>LSD (0.10) for treatment means across application timings = 10

## Conclusions

Treatments applied at the cotyledon stage caused greater sugarbeet injury and less canola control than treatments initiated at the 2-leaf stage. Canola control was better from UpBeet at 0.75 and 1 oz/A than from UpBeet at 0.25 and 0.5 oz/A across application timing. However, sugarbeet injury potential increased as UpBeet rate increased, especially under cold and wet conditions experienced in the first planting. There was no advantage to adding Betamix or ethofumesate to UpBeet in these experiments.

## Literature Cited

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## **Future Research**

Future experiments shall include sequential applications of UpBeet at 0.5, 0.75, and 1 oz/A since UpBeet at 0.25 oz/A did not provide adequate control. Canola was sprayed at the cotyledon or two-leaf stage to maximize control. Farmers and Agriculturalist that attended the Prosper field tour indicated volunteer canola frequently is misidentified and often is at the four-leaf stage before herbicide application. They suggested it would be useful to evaluate canola control at the cotyledon and two-leaf stage with canola control at the four-leaf stage.