

Effect of Roundup and chloroacetamide herbicide tank mixes, with and without Cobra, and two COC rates on soybean injury and weed control at Rosemount, MN - 2016. Gunsolus, Jeffrey L, Douglas W. Miller, Bradley D. Kinkaid, Maria Karis, and Rafael Pedroso da Silva. The objective of this experiment was to evaluate soybean injury with Roundup plus AMS in tank mixes with four chloroacetamide herbicides (Dual II Magnum, Outlook, Warrant, and Zidua), with and without Cobra, and Crop Oil Concentrate (COC) rates of 1X (1 pt/A) or 0.5X (0.5 pt/A). The experiment was conducted at Rosemount, MN on a Waukegon silt loam soil with pH 6.6 and 4.2% organic matter. Soil test P and K were 24 and 216 lbs/A respectively. Following oats, the experimental area was chisel plowed in fall 2015. On April 11, 2016, the area was field cultivated, fertilized with 60 lbs/A P and 60 lbs/A K, and field cultivated a second time. On May 20, the area was field cultivated and Asgrow RR2 AG1435 soybeans were seeded in 30 inch rows at a rate of 150,000 seeds/A. The experimental design was a randomized complete block with four replications. Plot size was 10 by 35 feet. Herbicide treatments were applied with a tractor mounted, compressed air sprayer with an eight nozzle boom, 15 inch nozzle spacing, 110015VS XR Teejet flat-fan nozzles at 35 psi pressure producing a spray volume of 15 gpa. All treatments were applied postemergence on June 16 (application data below). Spray drift from an adjacent corn production field caused visible injury to the soybeans prior to the first rating date (June 23). The injury resulted from the growth regulator herbicide Status and caused soybean leaf deformation. The injury was greatest in replication 1 (closest to the corn field) and diminished to replication 4 (furthest), however symptoms were still evident in replication 4. A sequential postemergence application of Roundup + AMS was broadcast over the entire trial on July 22 to control late emerging weeds. Crop injury response was measured by several methods weekly beginning on June 23 (7 DAT) until July 14 (28 DAT). Injury was rated visually on June 23, June 30, and July 14. Normalized Difference Vegetative Index (NDVI) was measured with a Crop Circle ACS-210 plant canopy reflectance sensor on June 23, June 30, and July 7. Sensor data were collected by holding the unit over a single row at an approximate height of 36 inches above the soil surface, while walking the length of the plot. The sensor unit collected consecutive readings, resulting in about 110 data points per plot, which were averaged to a single measurement per plot. Fractional Green Canopy Cover (FGCC) was determined on June 30, July 7, and July 14. Overhead digital photographs of a section from a single soybean row were taken with a digital camera mounted on a tripod. For a given date, the photos from all plots were taken at the same height above the canopy and with the same lens zoom level. Resulting images were analyzed with the application CANOPEO via the desktop computing application MATLAB. CANOPEO determined the percentage of green pixels in each photo and for this purpose, correlated to the amount of soybean growth reduction caused by the herbicide treatments. Canopy width was measured on July 21. Soybean height was measured on October 3. Yields were determined by harvesting the center two rows of plots on October 3. Weed control was visually rated on June 23, June 30, and July 14. Data means were separated utilizing Duncan's Multiple Range Test and are presented in the Tables below.

Treatment Date	June 16
Air Temperature (°F)	79
Relative humidity (%)	62
Dewpoint (°F)	60
Soil Moisture	moist at 0.1"
Soil Temperature (°F)	88
Sky	clear
Wind (mph)	NE 0-5

Rainfall before Application	
Week 2 (inch)	0.46
Week 1 (inch)	1.08
Rainfall after Application	
Week 1 (inch)	1.65
Week 2 (inch)	1.20
Soybean	
Stage	V2-V3 (most V3)
Height (inch)	7-9

Weed species	densities (#/ft²)	height (inch)
Common Lambsquarters (Colq)	13	1-4 (most 1.5-3)
Common Ragweed (Corw)	13	1.5-5 (most 2-4)
Eastern Black Nightshade (Ebns)	1	0.5-2 (most 1-2)
Pigweeds (powell amaranth and redroot pigweed)	4	2-6 (most 3-5)
Grasses	11	2-10
- Barnyardgrass 3%		
- Giant foxtail 30%		
- Green foxtail 2%		
- Yellow foxtail 59%		
- Woolly cupgrass 6%		

Results

Normalized Difference Vegetative Index (NDVI) in general, is a measure of a plants photosynthetic activity while Fractional Green Canopy Cover (FGCC) measures the percentage of green material. These measurements, in addition to visual injury ratings of necrosis and growth reduction, were highly correlated.

Pearson Correlation Coefficients at each Rating Date

June 23

NDVI and Necrosis	-0.891
NDVI and Growth Reduction	-0.889
Necrosis and Growth Reduction	0.963

June 30

NDVI and FGCC	0.790
NDVI and Growth Reduction	-0.775
FGCC and Growth Reduction	0.942

July 7

NDVI and FGCC	0.817
---------------	--------------

July 14

FGCC and Growth Reduction	-0.870
FGCC and Canopy Width (July 21)	0.848

As was expected, the addition of Cobra was the main factor that influenced soybean injury. At all rating dates, soybean injury measures (NDVI, FGCC, visual necrosis, visual growth reduction, and canopy width) showed the greatest injury caused by the Cobra tank mixes compared to those without Cobra (Table 1). Average soybean height on October 3 was generally less for the Cobra tank mixes compared to the treatments without Cobra.

COC rate showed little or no significant effects on soybean injury over the rating periods. Dual II Magnum and Outlook tank mixes generally showed greater soybean injury compared to Warrant or Zidua tank mixes or those with no chloroacetamide herbicide.

Comparing only treatments that did not receive Cobra, NDVI values did not significantly differ at any of the rating dates. Visual necrosis ratings on June 23 were greatest with the Outlook mixes followed by Dual II Magnum mixes and the Warrant + 1X COC treatment. Visual growth reduction ratings did not differ significantly between these treatments on June 23. On June 30 and July 7, the Outlook mixes showed slightly greater growth reduction (based on FGCC and visual growth reduction ratings) than the other treatments. FGCC for the Outlook treatments did not significantly differ from the other chloroacetamide tank mixes by the July 14 rating date but remained significantly lower than the Roundup + AMS check.

Comparing only the treatments that included Cobra, injury measures (NDVI, FGCC, visual necrosis, visual growth reduction, and canopy width) did not differ significantly between the Cobra mixes without any chloroacetamide herbicide, and the Warrant and Zidua tank mixes. On June 23, the Dual II Magnum treatment with the 1X rate of COC and the Outlook treatments with either rate of COC showed increased soybean injury (based on NDVI, visual necrosis and growth reduction) compared to the other treatments. The Dual treatment with the 1X COC rate tended to show the greater injury throughout the rating periods while the Outlook treatment differences became less apparent. There were no significant differences in canopy width between treatments on July 21. Soybean height was greatest for the Cobra + 0.5X COC rate + no chloroacetamide herbicide treatment and was significantly greater than the Outlook mixes or the Dual or Warrant mixes with the 0.5X COC rates.

Soybean yields did not differ significantly among most of the treatments. Compared to the Roundup/AMS check, only three treatments had significantly higher yields with no treatment having a significantly lower yield. Roundup/AMS + Zidua + 0.5X COC was the highest yielding treatment (70 bu/A) and Roundup/AMS + Cobra + Dual II Magnum + 0.5X COC had the lowest yield (59 bu/A). Weed control was very good to excellent for all treatments (Table 2). The July 22 broadcast Roundup application effectively controlled any late emerging weeds for the remainder of the growing season.

Effect of Roundup and chloroacetamide herbicide tank mixes, with and without Cobra, and two COC rates on soybean injury and weed control at Rosemount, MN - 2016 (Gunsolus, Miller, Kinkaid, Karis, and da Silva).

Table 1. Soybean injury and yield.

Treatment	COC Rate	Injury Ratings										Canopy		Yield 10/3 (bu/A)
		June 23 (7 DAT)			June 30 (14 DAT)			July 7 (21 DAT)		July 14 (28 DAT)		Width	Height	
		NDVI ¹	Necrosis	G.R. ²	NDVI	FGCC ³	G.R.	NDVI	FGCC	FGCC	G.R.	7/21	10/3	
--	---(%)---	---(%)---	--	---(%)---	---(%)---	--	---(%)---	---(%)---	---(%)---	---(%)---	---(%)---	----- (inches)	-----	
Postemergence June 6														
Roundup ⁴ + AMS ⁵	no COC	0.79 a ⁶	0 a	0 a	0.78 a	44 a	0 a	0.86 a	49 a	80 a	0 a	25 ab	36 abc	63 cd
Roundup + AMS + Dual II Magnum ⁷ + COC ⁸	1 pt	0.76 a	9 cde	0 a	0.79 a	40 ab	0 a	0.86 a	44 abc	75 ab	0 a	25 a	38 ab	66 abc
Roundup + AMS + Dual II Magnum + COC	0.5 pt	0.78 a	10 cde	3 a	0.78 a	39 ab	1 a	0.85 a	43 bc	72 b	8 bc	24 abc	38 a	69 ab
Roundup + AMS + Outlook ⁹ + COC	1 pt	0.76 a	14 e	5 a	0.76 a	33 d	6 bc	0.84 a	39 c	73 b	4 ab	24 abc	37 abc	66 abc
Roundup + AMS + Outlook + COC	0.5 pt	0.75 a	12 de	4 a	0.75 a	34 cd	8 c	0.84 a	41 c	71 b	3 ab	23 b-e	38 a	67 abc
Roundup + AMS + Warrant ¹⁰ + COC	1 pt	0.80 a	8 bcd	4 a	0.80 a	41 ab	1 a	0.86 a	47 ab	75 ab	1 a	24 a-d	38 ab	69 ab
Roundup + AMS + Warrant + COC	0.5 pt	0.76 a	4 abc	3 a	0.79 a	38 bcd	3 ab	0.86 a	45 abc	74 ab	1 a	25 ab	36 bcd	62 cd
Roundup + AMS + Zidua ¹¹ + COC	1 pt	0.79 a	2 ab	0 a	0.79 a	39 abc	0 a	0.86 a	47 ab	74 ab	0 a	25 a	37 ab	70 a
Roundup + AMS + Zidua + COC	0.5 pt	0.78 a	5 abc	3 a	0.80 a	38 bcd	1 a	0.85 a	44 abc	74 ab	0 a	25 ab	37 ab	66 abc
Roundup + AMS + Cobra ¹² + COC	1 pt	0.62 bc	41 f	18 bc	0.55 b	22 e	24 d	0.77 b	26 de	60 cd	11 cd	21 f	34 de	65 bc
Roundup + AMS + Cobra + COC	0.5 pt	0.63 b	43 f	19 bc	0.57 b	21 e	24 d	0.77 bc	29 d	62 c	11 cd	23 c-f	36 abc	64 bc
Roundup + AMS + Cobra + Dual II Magnum + COC	1 pt	0.55 cd	55 h	29 d	0.52 b	14 f	43 g	0.66 d	20 f	50 e	18 e	21 f	35 cde	66 abc
Roundup + AMS + Cobra + Dual II Magnum + COC	0.5 pt	0.62 bcd	46 fg	25 cd	0.49 b	17 ef	35 f	0.74 bc	23 def	55 de	15 de	21 f	35 de	59 d
Roundup + Cobra + AMS + Outlook + COC	1 pt	0.56 cd	51 gh	23 bc	0.51 b	17 ef	35 f	0.73 bc	24 def	54 de	15 de	22 def	35 de	65 bc
Roundup + Cobra + AMS + Outlook + COC	0.5 pt	0.55 d	53 h	25 cd	0.50 b	17 ef	34 f	0.71 cd	21 ef	54 de	14 de	21 f	34 e	62 cd
Roundup + Cobra + AMS + Warrant + COC	1 pt	0.60 bcd	45 f	20 bc	0.58 b	20 e	26 de	0.77 bc	27 d	56 cde	11 cd	22 ef	34 e	64 bc
Roundup + Cobra + AMS + Warrant + COC	0.5 pt	0.64 b	44 f	19 bc	0.62 b	20 e	25 de	0.76 bc	29 d	56 cde	10 cd	21 f	36 cde	64 bc
Roundup + Cobra + AMS + Zidua + COC	1 pt	0.62 bc	46 fg	21 bc	0.52 b	21 e	29 e	0.77 b	29 d	59 cd	11 cd	22 def	35 cde	65 bc
Roundup + Cobra + AMS + Zidua + COC	0.5 pt	0.64 b	43 f	21 bc	0.49 b	20 e	24 d	0.72 bc	27 d	56 cde	10 cd	23 c-f	35 cde	65 bc

¹ NDVI = Normalized Difference Vegetation Index.

² G.R. = Visual Growth Reduction.

³ FGCC = Fractional Green Canopy Cover.

⁴ Roundup PowerMax 4S (32 oz/A) = glyphosate.

⁵ AMS (3 qts/A) = N-Pak ammonium sulfate solution (3.4 lbs/gal).

⁶ Means separated utilizing Duncan's Multiple Range test.

⁷ Dual Magnum 7.62E (16 oz/A) = s-metolachlor.

⁸ COC = Crop Oil Concentrate.

⁹ Outlook 6EC (16 oz/A) = 6.0 lbs ai/gal dimethenamid-P.

¹⁰ Warrant 3CS (3 pts/A) = acetochlor.

¹¹ Zidua 4.17SC (3.25 oz/A) = pyroxasulfone.

¹² Cobra 2EC (10 oz/A) = lactofen.

Effect of Roundup and chloroacetamide herbicide tank mixes, with and without Cobra, and two COC rates on soybean injury and weed control at Rosemount, MN - 2016 (Gunsolus, Miller, Kinkaid, Karis, and da Silva).

Table 2. Weed control.

Treatment	COC Rate	Weed Control																			
		Colq			Corw			Rrpw		Grasses											
		6/23	6/30	7/14	6/23	6/30	7/14	6/23	7/14	6/23	7/14										
----- (%) -----																					
Postemergence June 6																					
Roundup ¹ + AMS ²	no COC	100	a ³	100	a	97	a	97	ab	100	ab	99	a	100	a	99	a-d	98	a	97	b
Roundup + AMS + Dual II Magnum ⁴ + COC ⁵	1 pt	100	a	100	a	98	a	97	ab	99	abc	99	a	100	a	99	a-d	99	a	99	a
Roundup + AMS + Dual II Magnum + COC	0.5 pt	100	a	100	a	99	a	95	bcd	98	d	99	a	100	a	99	a-d	98	a	99	ab
Roundup + AMS + Outlook ⁶ + COC	1 pt	100	a	100	a	98	a	93	d	98	cd	99	a	99	a	99	cd	98	a	99	a
Roundup + AMS + Outlook + COC	0.5 pt	100	a	100	a	98	a	93	d	99	abc	99	a	100	a	99	bcd	98	a	99	a
Roundup + AMS + Warrant ⁷ + COC	1 pt	100	a	100	a	99	a	93	d	99	a-d	99	a	100	a	99	a-d	99	a	98	ab
Roundup + AMS + Warrant + COC	0.5 pt	100	a	100	a	98	a	95	cd	99	a-d	99	a	100	a	100	ab	99	a	99	a
Roundup + AMS + Zidua ⁸ + COC	1 pt	100	a	100	a	98	a	98	a	100	a	99	a	100	a	100	ab	99	a	99	ab
Roundup + AMS + Zidua + COC	0.5 pt	100	a	100	a	99	a	94	d	99	a-d	99	a	100	a	100	abc	99	a	99	a
Roundup + AMS + Cobra ⁹ + COC	1 pt	100	a	100	a	97	a	97	abc	98	bcd	98	a	100	a	99	a-d	97	a	95	c
Roundup + AMS + Cobra + COC	0.5 pt	100	a	100	a	95	a	98	a	99	abc	99	a	100	a	98	d	98	a	94	c
Roundup + AMS + Cobra + Dual II Magnum + COC	1 pt	100	a	100	a	98	a	99	a	100	ab	99	a	100	a	100	ab	97	a	98	ab
Roundup + AMS + Cobra + Dual II Magnum + COC	0.5 pt	100	a	100	a	97	a	98	a	100	ab	99	a	100	a	100	abc	98	a	98	ab
Roundup + Cobra + AMS + Outlook + COC	1 pt	100	a	100	a	98	a	98	a	100	a	99	a	100	a	100	abc	97	a	99	ab
Roundup + Cobra + AMS + Outlook + COC	0.5 pt	100	a	100	a	99	a	99	a	100	ab	99	a	100	a	100	a	98	a	99	a
Roundup + Cobra + AMS + Warrant + COC	1 pt	100	a	100	a	98	a	98	a	100	a	99	a	100	a	100	abc	98	a	97	b
Roundup + Cobra + AMS + Warrant + COC	0.5 pt	100	a	100	a	98	a	99	a	100	a	99	a	100	a	100	ab	98	a	98	ab
Roundup + Cobra + AMS + Zidua + COC	1 pt	100	a	100	a	98	a	99	a	100	ab	99	a	100	a	99	a-d	98	a	98	ab
Roundup + Cobra + AMS + Zidua + COC	0.5 pt	100	a	100	a	99	a	99	a	100	ab	99	a	100	a	100	a	97	a	98	ab

¹ Roundup PowerMax 4S (32 oz/A) = glyphosate.

² AMS (3 qts/A) = N-Pak ammonium sulfate solution (3.4 lbs/gal).

³ Means separated utilizing Duncan's Multiple Range test.

⁴ Dual Magnum 7.62E (16 oz/A) = s-metolachlor.

⁵ COC = Crop Oil Concentrate.

⁶ Outlook 6EC (16 oz/A) = 6.0 lbs ai/gal dimethenamid-P.

⁷ Warrant 3CS (3 pts/A) = acetochlor.

⁸ Zidua 4.17SC (3.25 oz/A) = pyroxasulfone.

⁹ Cobra 2EC (10 oz/A) = lactofen.