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ABSTRACT

Field experiments were conducted in 2005 to evaluate potential weed control interactions when MON 3539 (glyphosate) was applied with several insecticides and a plant growth regulator to RoundupReady Flex® cotton. Applications were made at the 1-3 leaf stage, the 6-8 node stage, and at the 12-14 node stage. Different combinations of tank mixes were used in each of the three applications. In the first application, all plots received the same treatment: MON 3539 at a rate of 0.75 lb ae/a. A second application was made to evaluate crop injury. Only the MON 3539 + Dimate (dimethoate) mixture significantly increased crop injury 7 days after treatment two (DAT2) when compared with MON 3539 alone (20 vs. 13% injury). Bidrin (dicrotophos), Trimax (imidacloprid), Mustang Max (zeta-cypermethrin), Karate Z (lambda-cyhalothrin), Baythroid (cyfluthrin), Intrepid (methoxyfenozide), Steward (indoxacarb), Denim (emamectin benzoate), insecticides or Mepichlor (mepiquat chloride) plant growth regulator in combination with MON 3539 showed less than 8% crop injury at 7 DAT2, which was significantly less than MON 3539 applied alone (13% injury). Crop injury ratings were taken following a third application and only the MON 3539 + Mepichlor mixture significantly increased crop injury at 7 days after treatment three (DAT3) when compared with MON 3539 alone (13 vs. 5% injury). None of the remaining treatments in the third application significantly differed from that of MON 3539 alone. Weed control rating indicated that MON 3539 + Centric (thiamethoxam) significantly reduced weed control at 15 DAT2 when compared with MON 3539 alone (72 vs. 84% control). MON 3539 tank mixed with each of the following significantly differed from the 95% rating of MON 3539 alone at 14 DAT3: Bidrin at 75%, Centric at 72%, and Denim at 79%.

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INTRODUCTION

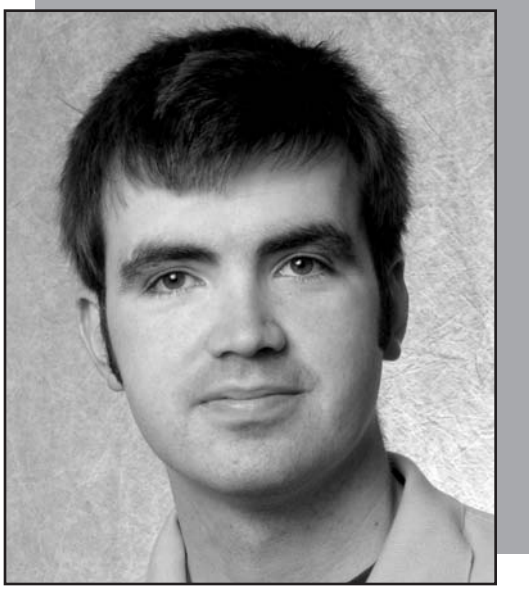
RoundupReady® cotton, which is tolerant to glyphosate herbicides, requires over-the-top herbicide applications before the cotton plant reaches the 5-leaf growth stage. During this period, environmental conditions such as rain and wind can make these applications difficult. RoundupReady Flex® cotton cultivars provide the ability to make over-the-top applications after the 5-leaf growth stage with higher rates of glyphosate. RoundupReady Flex® cotton has been found to show "excellent tolerance to POST glyphosate applications up to the 14-leaf cotton growth stage at rates two to three times higher than the current use rate in RoundupReady cotton" (Keeling et al., 2004). The ability to apply glyphosate later in the season allows mixing with insecticides as well as combining with the plant growth regulator (PGR), mepiquat chloride to control plant height.

During the 2002 growing season, an estimated 10% of the total cotton crop was lost due to weed infestation of grasses and broadleaves. This equates to 130,000 bales lost out of a total of 1,300,000 bale yield potential. From 1,615,035 bales classed, the revenue lost in Arkansas was $130,000 with the assumed price reduced by $0.03 per pound of lint (Byrd, 2003). Currently in Arkansas cotton, glyphosate is used in preplant-burndown situations for annual grasses and broadleaf weeds. It is also used in postemergence applications for the control of emerged annual grasses, johnsongrass, and numerous other weeds, including cocklebur, sicklepod, pigweed, morningglory, prickly sida, velvetleaf, hemp sesbania, northern jointvetch, and smartweed (Scott, 2004).

Antagonism/synergism resulting from the tank-mixture of glyphosate products with various insecticides have become important considerations in recent years. It has become a serious question as to whether it is feasible for a grower to mix glyphosate with insecticides to save application time and money. The ability to apply herbicides over-the-top of cotton past the 5-leaf growth stage will create an opportunity for growers to reduce production costs by the combination of glyphosate and

MEET THE STUDENT-AUTHOR

I am a 2002 graduate of Carlisle High School in Carlisle, Ark. I am currently a senior majoring in crop management and pest management with minors in agricultural business and environmental, soil & water science. Through the University I have received the Chancellor's Scholarship, and I have also received the Governor's Scholarship from the Arkansas Department of Higher Education. My future plans include attending graduate school to obtain my master's degree in entomology, and eventually, my doctorate. During the summer following my sophomore year of high school, I began working with the University of Arkansas Cooperative Extension Service in the Department of Entomology.



Jarrod T. Hardke

For the past six summers I have continued to work there as an agricultural technician. While working with Dr. Gus Lorenz over the years, I have had the opportunity to learn a great deal about agricultural research in the field of entomology. I have had the privilege of presenting my research at the Arkansas Crop Protection Association Conference in Fayetteville, Ark., and at the Beltwide Cotton Conference in San Antonio. I have participated in many activities at the University of Arkansas including serving as Vice President and House Manager of Kappa Sigma; serving as Event Coordinator for Greeks Advocating Mature Management of Alcohol; serving as a member of Student Alumni Board where I have been in charge of the homecoming parade the past two years; and being inducted into the Greek honor society, Order of Omega.

insecticides in a single operation (Mascarenhas and Griffin, 1997). This study investigate the mixing of various insecticides and a PGR, mepiquat chloride tank-mixed with glyphosate to determine any positive and/or negative effects.

MATERIALS AND METHODS

The experiment was conducted on Hooker Farms, Pine Bluff Ark., (Jefferson County) in 2005. MON B2RF, a non-commercial Monsanto cultivar, was planted on 6 May. The planted field was subdivided into plots of four rows (38-inch spacing), 30-feet in length. Plots were set up in a randomized complete block with four replications. Treatments were made according to statewide threshold recommendation. Treatments were applied with a CO_2 backpack applicator using a 4-row boom with Tee-Jet TXVS 6 nozzles on 19-inch spacing. Operating pressure was 40 pounds per square inch and volume applied was 10 gallons per acre. Three separate applications were made in this test. The first application was made 26 May at the 1-3 leaf stage. All plots were treated with MON 3539 (glyphosate) at a rate of 0.841 kg/ha (0.75 lb ae/a). The second application was made 14 June at the 6-8 node stage and consisted of MON 3539 alone as a control, or MON 3539 tank-mixed with selected insecticides or mepiquat chloride to determine the potential for crop injury (phytonecrosis) and/or loss of weed control. Treatments included MON 3539 at 0.841 kg/ha (0.75 lb ae/a) alone or mixed with one of the following: Orthene (acephate) at 1.12 kg/ha (1 lb a/a), Bidrin (dicrotophos) at 0.56 kg/ha (0.5 lb ai/a), Vydate C-LV (oxamyl) at 0.529 kg/ha (0.47125 lb ai/a), Dimethoate at 0.56 kg/ha (0.5 lb a/a), Trimax (imidacloprid) at 0.053 kg/ha (0.0469 lb ai/a), Centric (thiamethoxam) at 0.056 kg/ha (0.05 lb ai/a), Mustang Max (zeta-cypermethrin) at 0.028 kg/ha (0.025 lb ai/a), Karate Z (lamba-cyhalothrin) at 0.045 kg/ha (0.04 lb ai/a), Baythroid (cyfluthrin) at 0.056 kg/ha (0.05 lb ai/a), Intrepid (methoxyfenozide) at 0.18 kg/ha (0.16 lb ai/a), Steward (indoxacarb) at 0.123 kg/ha (0.11 lb ai/a), Tracer (spinosad) at 0.095 kg/ha (0.085 lb ai/a), Denim (emamectin benzoate) at 0.017 kg/ha (0.015 lb ai/a), and a Mepichlor (mepiquat chloride) at 1.76 l/ha (24 oz/a). The third application was made 30 June at the 12-14 node stage. All treatments remained the same as in the second application, except that Bidrin at a rate of 0.35 kg/ha (0.312 lb ai/a) was added to the tank mix with Mustang Max, Karate Z, and Baythroid. Weed control was visually rated on a scale of 0 to 100% where 0 = no control and 100 = all weeds dead. Crop injury was visually rated on a scale of 0 to 100% where 0 = no crop injury and 100 = total crop injury/all plants dead. Observations were conducted for crop injury on 21 June at 7 days after treatment two (DAT2), and for weed control on 29 June at 15 DAT2. For the third application, crop injury ratings were taken on 7 July at 7 DAT3 and ratings for weed control were taken on 14 July at 14 DAT3. Data were analyzed using Agricultural Research Manager Version 7 using Analysis of Variance and LSD (P=0.10).

RESULTS AND DISCUSSION

Results from the ratings after the second application for crop injury indicated that the 0.841 kg/ha (0.75 lb ae/a) rate of MON 3539 showed 13% phytonecrosis at 7 days after treatment two (DAT2)(Table 1). All other treatments ranged from 4 to 20% phytonecrosis. MON 3539 tank mixed with Dimate had the highest rating of 20% phytonecrosis, which significantly differed from that of MON 3539 alone. Several treatments (tank-mixed with MON 3539) showed significantly lower phytonecrosis than MON 3539 alone at 7 DAT2 (Table 1): Bidrin, Trimax, Mustang Max, Karate, Baythroid, Intrepid, Steward, Denim, and Mepichlor. All other treatments did not differ significantly. Weed control in all treatment combinations ranged from 71% to 98% when evaluated 15 DAT2, with MON 3539 having a rating of 84% weed control (Table 1). The only treatment that significantly differed from MON 3539 in weed control at 15 DAT2 was Centric mixed with MON 3539. All other treatments did not significantly differ from that of MON 3539 alone. However, three treatments – Mustang Max, Trimax, and Steward – differed significantly from MON 3539 + Bidrin and MON 3539 + Centric.

Results from evaluations after the third application are indicated MON 3539 had a rating of 5% phytonecrosis at 7 DAT3 (Table 2). All other treatments ranged from 5 to 13% phytonecrosis. Only the treatment of MON 3539 tank-mixed with Mepichlor had significantly higher phytonecrosis than MON 3539 alone and than MON 3539 tank mixed with Vydate, Baythroid + Bidrin, and Intrepid (Table 2). Weed control in all treatment combinations ranged from 72% to 98% at 14 DAT3, with MON 3539 alone having a rating of 95% control (Table 2). MON 3539 tank mixed with Bidrin, Centric, and Denim showed ratings of 75, 72, and 79% percent control, respectively, which significantly differed from MON 3539 alone and from all other treatments (Table 2).

It should be noted that problems occurred in the tank when mixing certain compounds with MON 3539. Severe flocculation was observed when tank-mixing Trimax with MON 3539. This tank mix was repeated in

the lab with the same general results. A new container of Trimax was used to attempt the tank mix again, causing only minimal flocculation, which was difficult to detect. Finally, the latest experimental formulation of Trimax was used and no flocculation was observed. Settling was observed when Orthene was tank-mixed with MON 3539. When the tank was allowed to remain at rest for more than a few minutes, material in the tank settled to the bottom. This phenomenon was easily corrected by simple agitation. It should be noted that proper, steady agitation may be needed to prevent settling of materials when tank-mixing Orthene with MON 3539.

Certain compounds tank-mixed with MON 3539 in this study showed a significant difference in weed-control effectiveness of MON 3539. MON 3539 tank-mixed with Centric showed a loss of weed control 15 DAT2 and at 14 DAT3. MON 3539 tank-mixed with Bidrin and with Denim showed losses of weed control at 14 DAT3. In regard to crop phytonecrosis, Dimate significantly differed from that of MON 3539 alone at 7 DAT2, as did Mepichlor at 7 DAT3.

ACKNOWLEDGMENTS

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Table 1. Weed control and phytonecrosis ratings of MON 3539 alone and tank-mixed with selected compounds

Ratings based on a scale of 0-100% phytonecrosis and 0-100% weed control			
		Phytonecrosis[z]	Weed Control[z]
Treatment and Rate	Rate	7 DAT2	15 DAT2
MON 3539 (Glyphosate)	0.841 kg/ha (0.75 lb ae/a)	13 b[y]	84 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Orthene (Acephate)	1.12 kg/ha (1.0 lb ai/a)	9 bcd	94 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Bidrin (Dicrotophos)	0.56 kg/ha (0.5 lb ai/a)	6 cd	80 b
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Vydate C-LV (Oxamyl)	0.529 kg/ha (0.47125 lb ai/a)	11 bc	92 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Dimate (Dimethoate)	0.56 kg/ha (0.5 lb ai/a)	20 a	94 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Trimax (Imidacloprid)	0.053 kg/ha (0.0469 lb ai/a)	6 cd	97 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Centric (Thiamethoxam)	0.056 kg/ha (0.05 lb ai/a)	13 b	71 c
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
cypermethrin)	0.028 kg/ha (0.025 lb ai/a)	4 d	98 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Karate Z (Lamba-cyhalothrin)	0.045 kg/ha (0.04 lb ai/a)	4 d	90 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Baythroid (Cyfluthrin)	0.056 kg/ha (0.05 lb ai/a)	4 d	95 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Intrepid (Methoxyfenozide)	0.18 kg/ha (0.16 lb ai/a)	8 cd	90 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Steward (Indoxacarb)	0.123 kg/ha (0.11 lb ai/a)	7 cd	97 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Tracer (Spinosad)	0.095 kg/ha (0.085 lb ai/a)	9 bcd	94 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Denim (Emamectin benzoate)	0.017 kg/ha (0.015 lb ai/a)	6 cd	83 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Mepichlor (Mepiquat chloride)	1.76 l/ha (24 oz/a)	5 d	89 ab

[z] Application date: 14 June (second application)

Evaluation date: 21 June (7 DAT), 29 July (15 DAT)

[y] Means followed by same letter do not significantly differ (P=0.10, Student-Newman-Keuls).

Table 2. Weed control and phytonecrosis ratings of MON 3539 alone and tank-mixed with selected compounds

Ratings based on a scale of 0-100% phytonecrosis and 0-100% weed control			
		Phytonecrosis[z]	Weed Control[z]
Treatment and Rate	Rate	7 DAT3	14 DAT3
MON 3539 (Glyphosate)	0.841 kg/ha (0.75 lb ae/a)	5 b[y]	95 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Orthene (Acephate)	1.12 kg/ha (1.0 lb ai/a)	6 b	96 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Bidrin (Dicrotophos)	0.56 kg/ha (0.5 lb ai/a)	9 ab	75 c
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Vydate C-LV (Oxamyl)	0.529 kg/ha (0.47125 lb ai/a)	5 b	91 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Dimate (Dimethoate)	0.56 kg/ha (0.5 lb ai/a)	10 ab	96 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Trimax (Imidacloprid)	0.053 kg/ha (0.0469 lb ai/a)	6 b	90 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Centric (Thiamethoxam)	0.056 kg/ha (0.05 lb ai/a)	6 b	72 c
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
cypermethrin) +	0.028 kg/ha (0.025 lb ai/a)		
Bidrin (Dicrotophos)	0.35 kg/ha (0.312 lb ai/a)	6 b	98 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
cyhalothrin) +	0.045 kg/ha (0.04 lb ai/a)		
Bidrin (Dicrotophos)	0.35 kg/ha (0.312 lb ai/a)	6 b	85 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Baythroid (Cyfluthrin) +	0.056 kg/ha (0.05 lb ai/a)		
Bidrin (Dicrotophos)	0.35 kg/ha (0.312 lb ai/a)	5 b	89 ab
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Intrepid (Methoxyfenozide)	0.18 kg/ha (0.16 lb ai/a)	5 b	95 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Steward (Indoxacarb)	0.123 kg/ha (0.11 lb ai/a)	8 b	97 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Tracer (Spinosad)	0.095 kg/ha (0.085 lb ai/a)	8 b	97 a
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Denim (Emamectin benzoate)	0.017 kg/ha (0.015 lb ai/a)	9 ab	79 bc
MON 3539 +	0.841 kg/ha (0.75 lb ae/a)		
Mepichlor (Mepiquat chloride)	1.76 l/ha (24 oz/a)	13 a	86 ab

[z]Application Date: 30 June (Third Application)

Evaluation Date: 7 July (7 DAT), 14 July (14 DAT)

[y]Means followed by same letter do not significantly differ (P=0.10, Student-Newman-Keuls).

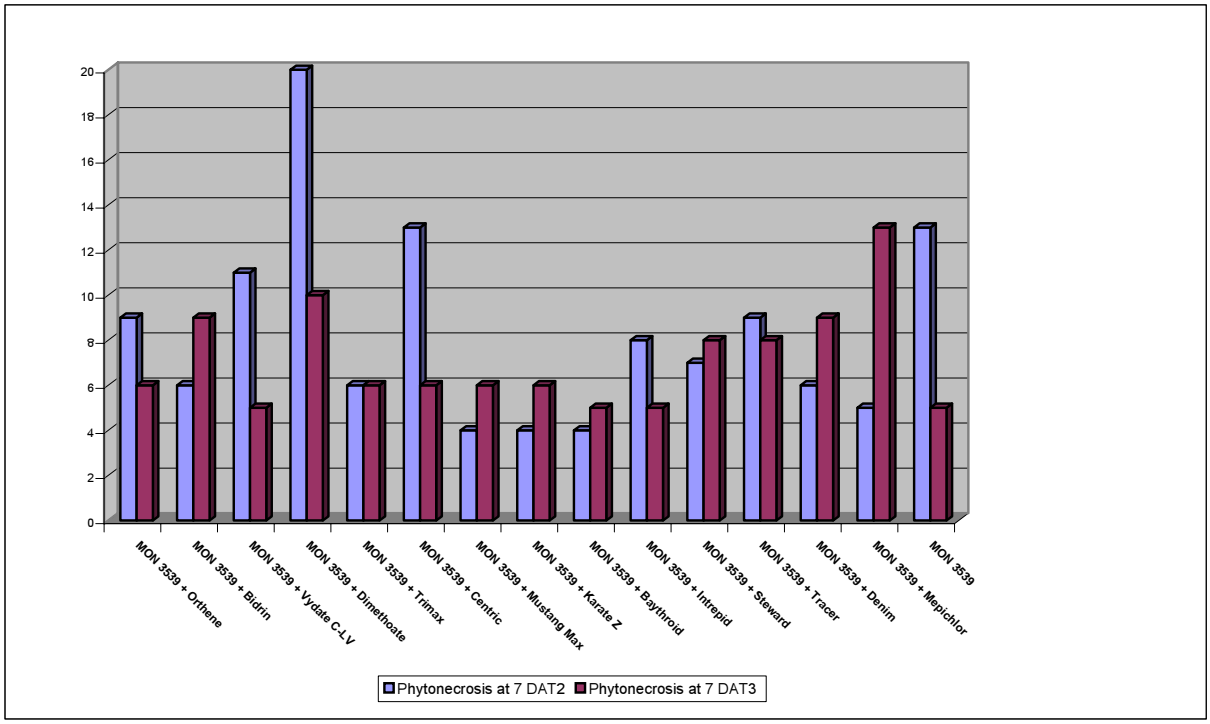

Fig. 1. Comparison of phytonecrosis ratings after treatments 2 & 3

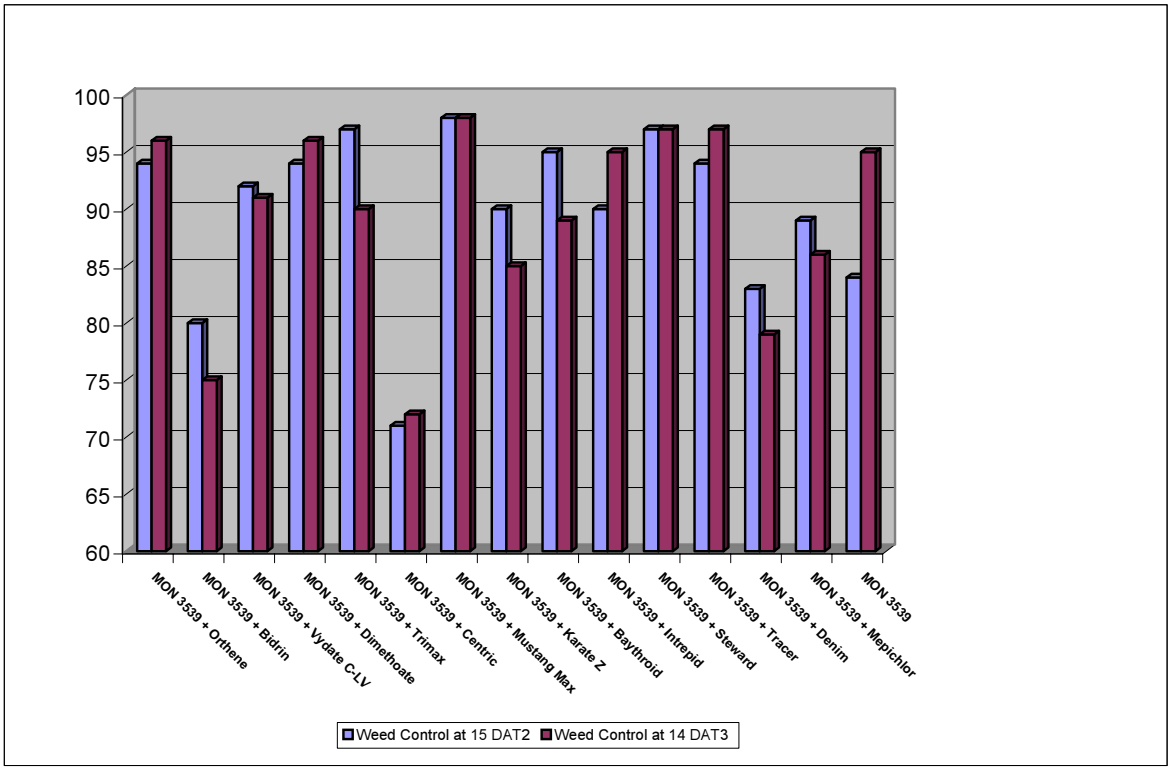

Fig. 2. Comparison of weed control ratings after treatments 2 & 3