

Update on Weed Control and Crop Tolerance to Paraquat Applied At-Cracking to Chickpeas

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The objective of these studies was to evaluate chickpea crop tolerance to paraquat in a field setting with the addition of a nonionic surfactant and weed efficacy by paraquat.

The 2016 study and repeated study of 2017 were both established at the Cook Agronomy Farm near Pullman, WA. Treatments were applied post emergence (POST) at several different timings starting at chickpea cracking, detailed in Table 1, 2, 3 & 4. Each study was conducted in a randomized complete block with 4 replications with 10' by 30' long plots. In 2016, glyphosate was applied as a pre-plant burndown, two weeks prior to planting while in 2017 the pre-plant burndown application of glyphosate was applied on May 8, 2017 just 2 days prior to planting. Studies were planted with chickpea variety 'Billy Bean' on May 4, 2016 and May 10, 2017. Outlook at 21 fl oz A⁻¹ and Lorox at 1.5 lb A⁻¹ was applied preemergence (PRE) at planting. Due to heavy Italian ryegrass pressure in 2017, Clethodim 2 EC at 16 fl oz A⁻¹ with Hellfire at 0.25 % v/v was applied POST on June 19, 2017.

Crop injury was visually rated 9, 17, 36, and 102 days after treatment (DAT16) of application A for the 2016 study (Table 4). Common lambsquarters control was visually assessed 36 and 102 DAT16 of application A (Table 3). For the repeated 2017 study, crop injury was visually rated 9 and 28 DAT17 of application A (Table 5). Crop heights were recorded 28 DAT17 after application A by measuring 3 chickpea plants per plot. Italian ryegrass control was visually assessed 9, 28 and 50 DAT17 of application A (Table 3). Common lambsquarters and mayweed chamomile control was also visually assessed 50 DAT17 of application A (Table 3). Plots were harvested using a plot combine on September 20, 2016. All data were subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

Plots were harvested using a plot combine on September 7, 2017. All data were subjected to an analysis of variance using the statistical package built into the Agricultural Research Manager software system (ARM 8.5.0, Gylling Data Management).

In 2016, all treatments had significant control of common lambsquarters compared to the nontreated. There were no observed differences in lambsquarters control within the treatments based on application timing (Table 3). Approximately 5 to 9 days after each paraquat application timing, significant crop injury was present. More severe injury was observed after the later paraquat application timings with greater than 68% injury 9 DAT16 for plants treated at 7 days after crop-cracking and greater than 59% injury 7 DAT16 for plants treated at 9 days after crop-cracking (Table 4). Crop injury was no longer present by August 26, 2016 with no significant difference in crop injury compared to the nontreated control. The earlier crop injury did not cause a lasting effect to yield. No differences in yield observed for any of the treatments (Table 4).

The repeated study in 2017, significant crop injury was observed 2 days after treatment C, while there was no significant crop injury 9 DAT17 of application A and 6 DAT17 of application B on the same rating date (Table 6). No significant stand reduction was observed for any treatment or application timing 28 DAT17 of application A (Table 6). The addition of a nonionic surfactant had no effect on injury.

On June 1, 2016, significant Italian ryegrass control was present for all paraquat treatments applied (application D not applied at this time) compared to the nontreated control. Paraquat applied at a rate of 8 fl oz A⁻¹ 4 and 8 days after cracking and applied at a higher rate (16 fl oz A⁻¹) at cracking provided significantly greater percent control of Italian ryegrass compared to Sharpen applied at chickpea cracking (Table 5). Paraquat applied at cracking provided 59 to 60% at (8 fl oz A⁻¹ & 8 fl oz A⁻¹ with NIS) and 76 to 83% (16 fl oz A⁻¹ & 16 fl oz A⁻¹ with NIS) control of Italian ryegrass. Paraquat applied 4 days after cracking had 86 to 83% (8 fl oz A⁻¹ & 8 fl oz A⁻¹ with NIS) control and applied at 7 days after

cracking paraquat control 92 to 93% (8 fl oz A⁻¹ & 8 fl oz A⁻¹ with NIS) of Italian ryegrass (Table 5). Later observations of Italian ryegrass indicated diminished control as the season progressed. On June 20, 2017, there is a significant reduction in Italian ryegrass control for application A compared to applications C and D. Application A had less than 25% control for any treatment compared to greater than 53% for application C & D (Table 5). By July 12, 2017, Italian ryegrass control had reduced to less than 40% for all treatments, except for paraquat applied at 8 fl oz A⁻¹ 7 days after cracking which had 66% control of Italian ryegrass. Due to the diminishment of Italian ryegrass control, the entire site was treated with clethodim and crop oil concentrate on July 19, 2017.

The earliest application timing, at chickpea cracking (A), provided significantly greater common lambsquarters control compared to the nontreated and later application timings for both paraquat and sharpen 50 DAT17 with greater than 46% control (Table 5). Although paraquat applied with NIS applied 11 days after cracking also provided significant common lambsquarters control (46%) (Table 5). The addition of a nonionic surfactant did not significantly impact the percent control of Italian ryegrass and common lambsquarters control for any application timing.

Overall, all treatments provided significant control of mayweed chamomile compared to the nontreated control (Table 5). The greatest percent controls were for paraquat applied 8 days after cracking with and without NIS provided 96 and 98% control of mayweed chamomile, respectively. Paraquat applied 11 days after cracking with NIS also provided 97% control as well as the at cracking treatment of Sharpen which provided 93% control 50 DAT17 (Table 5). No significant difference in yield were observed in the repeated 2017 study for any treatment (Table 6).

Even though no significant effect on yield was observed in either study, all treatments of paraquat with and without NIS and the Sharpen treatment provided greater yields compared to the nontreated control for both studies.

In conclusion, when paraquat is applied early in chickpea establishment weed control in chickpeas can be significantly increased and although significant crop injury occurred, injury does not translate into yield loss, possibly due to the reduction in weed competition early in the season.



Fig 1. 2017 Study. Italian ryegrass control with paraquat in chickpeas. Left: Nontreated control 22 days after chickpea emergence. Center: 14 days after application of paraquat at 8 fl oz A⁻¹ applied 8 days after chickpea emergence. Right: 11 days after application of paraquat at 8 fl oz A⁻¹ applied 11 days after chickpea emergence.

Table 1. 2016 study treatment application details

Study Application	A	B	C	D
Date	May 16, 2016	May 20, 2016	May 24, 2016	May 26, 2016
Application volume (GPA)	15	15	15	15
Crop stage	At Cracking	4 DA Crack	7 DA Crack	10 DA Crack
Air temperature (°F)	58	56	54	60
Soil temperature (°F)	55	55	51	58
Wind velocity (mph, direction)	5, NW	12, NW	5, E	9, S
Next rain occurred on	May 17, 2016	May 20, 2016	June 8, 2016	June 8, 2016

Table 2. 2017 study treatment application details

Study Application	A	B	C	D
Date	May 23, 2017	May 26, 2017	May 30, 2017	June 2, 2017
Application volume (GPA)	15	15	15	15
Crop stage	At Cracking	4 DA Crack	8 DA Crack	11 DA Crack
Crop size	Emerging	0.5 to 1”	3 to 4”	4 to 7”
Air temperature (°F)	84	63	86	73
Soil temperature (°F)	68	57	66	64
Wind velocity (mph, direction)	7, W	1.1, W	10.2, E	4.1. NW
Cloud Cover	0%	0%	15%	10%
Next rain occurred on	May 31, 2017	May 31, 2017	May 31, 2017	June 4, 2017

Table 3. Percent common lambsquarters control in chickpea following applications of paraquat with and without a nonionic surfactant at different application timings. Pullman, WA, 2016. DAT = days after treatment for the 2016 study. Means followed by the same letter are not statistically significantly different ($\alpha=0.05$).

Treatment	Application Code	Rate		June 21, 2016	August 26, 2016
		field rate	lb ai/A	36 DAT	102 DAT
				Common lambsquarters control	Common lambsquarters control
				%	%
Nontreated	-	-	-	-	-
Paraquat	A	8 fl oz/A	0.125	67	73
Paraquat	A	8 fl oz/A	0.125	95	71
Paraquat	A	0.25 % v/v			
Paraquat	B	8 fl oz/A	0.125	70	71
Paraquat	B	8 fl oz/A	0.125	64	58
Paraquat	B	0.25 % v/v			
Paraquat	C	8 fl oz/A	0.125	66	55
Paraquat	C	8 fl oz/A	0.125	67	55
Paraquat	C	0.25 % v/v			
Paraquat	D	8 fl oz/A	0.125	68	55
Paraquat	D	8 fl oz/A	0.125	85	76
Paraquat	D	0.25 % v/v			
Paraquat	A	16 fl oz/A	0.250	91	81
Paraquat	A	16 fl oz/A	0.250	86	65
Paraquat	A	0.25 % v/v			
Sharpen	A	2 fl oz/A	0.045	63	61
Paraquat	A	0.25 % v/v			
LSD				NS	NS

Table 4. Percent crop injury for chickpea and yield following applications of paraquat with and without a nonionic surfactant at different application timings. Pullman, WA, 2016. DAT = days after treatment for the 2016 study. Means followed by the same letter are not statistically significantly different ($\alpha=0.05$).

Treatment	Application Code	Rate		May 25, 2016		June 2, 2016		June 21, 2016		August 26, 2016		September 20, 2016
		field rate	lb ai/A	Crop Injury	DAT	Crop Injury	DAT	Crop Injury	DAT	Crop Injury	DAT	Yield
				%		%		%		%		lb/A
Nontreated	-	-	-	-	-	-	-	-	-	-	-	1090
Paraquat	A	8 fl oz/A	0.125	25 ab	9	8 ab	17	5 a	36	0	102	1380
Paraquat	A	8 fl oz/A	0.125	14 ab	9	0 a	17	0 a	36	0	102	1640
Paraquat	A	0.25 % v/v										
Paraquat	B	8 fl oz/A	0.125	55 b	5	14 ab	13	8 ab	32	0	98	1440
Paraquat	B	8 fl oz/A	0.125	45 ab	5	31 b	13	4 a	32	0	98	1100
Paraquat	B	0.25 % v/v										
Paraquat	C	8 fl oz/A	0.125	21 ab	1	71 c	9	35 ab	28	5	96	1400
Paraquat	C	8 fl oz/A	0.125	5 a	1	68 c	9	10 ab	28	0	96	1560
Paraquat	C	0.25 % v/v										
Paraquat	D	8 fl oz/A	0.125	6 a	-	59 c	7	11 ab	26	0	94	1430
Paraquat	D	8 fl oz/A	0.125	15 ab	-	73 c	7	33 ab	26	13	94	1720
Paraquat	D	0.25 % v/v										
Paraquat	A	16 fl oz/A	0.250	48 ab	9	14 ab	17	3 a	36	0	102	1510
Paraquat	A	16 fl oz/A	0.250	35 ab	9	3 a	17	3 a	36	0	102	1250
Paraquat	A	0.25 % v/v										
Sharpen	A	2 fl oz/A	0.045	91 c	9	56 c	17	38 a	36	0	102	1230
Paraquat	A	0.25 % v/v										
LSD				30		19		21		NS		NS

Table 5. Percent common lambsquarters control in chickpea following applications of paraquat with and without a nonionic surfactant at different application timings. Pullman, WA, 2017. DAT = days after treatment for the 2017 study. Means followed by the same letter are not statistically significantly different ($\alpha=0.05$).

Treatment	Application Code	Rate		June 1, 2016	June 20, 2017	July 12, 2017		
		field rate	lb ai/A	9 DAT	28 DAT	50 DAT		Mayweed chamomile control
				Italian ryegrass control	Italian ryegrass control	Italian ryegrass control	Common lambsquarters control	
				%	%	%	%	%
Nontreated	-	-	-	-	-	-	-	-
Paraquat	A	8 fl oz/A	0.125	59 ab	25 b	21 ab	55 abcd	89 abc
Paraquat NIS	A	8 fl oz/A	0.125	60 ab	10 b	13 ab	46 abcd	78 c
Paraquat	B	8 fl oz/A	0.125	86 a	41 ab	15 ab	33 bcd	91 ab
Paraquat NIS	B	8 fl oz/A	0.125	83 a	15 b	28 ab	15 cd	79 c
Paraquat	B	0.25 % v/v						
Paraquat	C	8 fl oz/A	0.125	92 a	81 a	66 a	8 d	98 a
Paraquat NIS	C	8 fl oz/A	0.125	93 a	79 a	36 ab	13 cd	96 a
Paraquat	C	0.25 % v/v						
Paraquat	D	8 fl oz/A	0.125	0 c	53 ab	13 ab	16 cd	80 bc
Paraquat NIS	D	8 fl oz/A	0.125	0 c	66 ab	40 ab	46 abcd	97 a
Paraquat	D	0.25 % v/v						
Paraquat	A	16 fl oz/A	0.250	76 a	15 b	0 b	71 ab	89 abc
Paraquat NIS	A	16 fl oz/A	0.250	83 a	25 b	23 ab	66 abc	86 abc
Paraquat	A	0.25 % v/v						
Sharpen	A	2 fl oz/A	0.045	43 b	10 b	0 b	95 a	93 a
Paraquat NIS	A	0.25 % v/v						
<i>LSD</i>				25	36	35	35	8

Table 6. Percent crop injury for chickpea and yield following applications of paraquat with and without a nonionic surfactant at different application timings. Pullman, WA, 2017. DAT = days after treatment for the 2017 study. Means followed by the same letter are not statistically significantly different ($\alpha=0.05$).

Treatment	Application Code	Rate		June 1, 2017		June 20, 2017		June 20, 2017		September 7, 2017
		field rate	lb ai/A	Crop Injury	DAT	Stand Reduction	DAT	Plant Ht.	DAT	Yield
Nontreated	-	-	-	-	-	-	-	27 ab	-	1945
Paraquat	A	8 fl oz/A	0.125	0 a	9	0	28	26 ab	28	2695
Paraquat NIS	A	8 fl oz/A	0.125	0 a	9	0	28	28 a	28	2203
Paraquat	A	0.25 % v/v								
Paraquat	B	8 fl oz/A	0.125	0 a	6	0	25	26 ab	25	2486
Paraquat NIS	B	8 fl oz/A	0.125	1 a	6	0	25	26 ab	25	2695
Paraquat	B	0.25 % v/v								
Paraquat	C	8 fl oz/A	0.125	20 b	2	6	21	23 b	21	2357
Paraquat NIS	C	8 fl oz/A	0.125	20 b	2	8	21	24 ab	21	2499
Paraquat	C	0.25 % v/v								
Paraquat	D	8 fl oz/A	0.125	0 a	-	6	18	22 b	18	2079
Paraquat NIS	D	8 fl oz/A	0.125	0 a	-	9	18	24 ab	18	2061
Paraquat	D	0.25 % v/v								
Paraquat	A	16 fl oz/A	0.250	0 a	9	3	28	23 ab	28	2076
Paraquat NIS	A	16 fl oz/A	0.250	0 a	9	5	28	25 ab	28	2600
Paraquat	A	0.25 % v/v								
Sharpen	A	2 fl oz/A	0.045	0 a	9	9	28	25 ab	28	2098
Paraquat NIS	A	0.25 % v/v								
<i>LSD</i>				1		NS		3		NS

Disclaimer

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