and 1.5 lb.a.i./acre (Table 3). This difference in phytoxicity at the lower and higher rates of cinmethylin may have been due to some initial translocation of herbicide at the lower rates (0.5 to 1.0 lb.a.i./acre) and little to no translocation at the higher rates (2.0 and 4.0 lb.a.i./acre as greater contact injury with the higher rates might have limited movement by rapidly damaging tissue. Leaves contacted with low rates had some marginal necrosis, whereas foliage treated with the higher rates tended to have more damage along the veins and other areas where spray deposits tend to collect. While the pattern with low rates was not concentrated, higher rates produced more spotting of the foliage.

Neither relative humidity nor cinmethylin rate had a significant effect on yield of marketable or cull peppers (Table 4).

In summary, results indicate relative humidity can have an effect on the phytotoxic response of pepper to cinmethylin, but the effect of cinmethylin rate is greater. Little damage occurred with the suggested use rate range of 0.75 to 1.0 lba.i/acre for fine sandy, low organic matter soils. Although some phytotoxicity and vigor loss was observed, the effect was not lasting and thus had no effect on pepper yield. Additionally, these results indicate temperature at cinmethylin application may be more important than relative humidity. Considering the limited number of effective herbicides available for use on pepper and that in Florida most applications would be in row middles, it appears that cinmethylin might be useful in pepper production.

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EFFECT OF ADJUVANT ON NIGHTSHADE CONTROL WITH PARAQUAT AND DIQUAT

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Abstract. **Tank mixes of paraquat (0.50 and 1.0 lb./acre) with 9 adjuvant treatments, diquat (0.25, 0.50, and 1.0 lb./acre) with 8 adjuvant treatments, and diquat (2 applications of 0.50 lb./acre) with 20 adjuvant treatments were evaluated for control of American black nightshade (*Solanum americanum* L.) in field experiments. Adjuvant had some effect on efficacy of paraquat and diquat; however, there were few large differences. Most of the observed differences among adjuvants occurred with either the lower rate of herbicide or single applications. Generally, as herbicide rate increased or a second application was made, the differences among adjuvants decreased. Safer's surfactant was incompatible with paraquat. LI700 adjuvant with 0.50 lb./acre paraquat performed poorly, but when applied with 1.0 lb. of paraquat, LI700 was similar to the other adjuvants. There was an interaction between diquat rate and adjuvant for nightshade control. Nightshade control with SurpHtac was lower than that obtained with X-77 and LI700 at the 0.25 lb. rate of diquat, whereas control was similar with the same 3 adjuvants at higher rates of diquat. When applied twice with diquat (0.50 lb./acre), most of the commercially available adjuvants provided similar control with the exception of Sunspray 6E which was not as good as Induce.**

Although weed control has always been an important component of tomato production, its importance has increased with the introduction of the sweet potato whitefly and development of the associated irregular ripening of tomato. Increased incidence of several viral disorders in tomatoes also reinforces the need for good weed control. Common weeds, such as the various species of nightshade, are hosts to many tomato pests, inluding sweet potato whitefly, bacterial spot, and viruses. Control of these pests is often tied, at least in part, to control of weed hosts.

The greatest row middle weed control problem confronting the Florida tomato industry today is nightshade, principally American black nightshade (4). Research (2, 3) and grower experience (4) have demonstrated the low efficacy of paraquat for control of this nightshade species. Although several preemergence and postemergence herbicides have provided good control of nightshade in research (2, 3, 4), none of the currently labeled preemergence herbicides work that well (2) and only diquat

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and monocarbamide dihydrogansulfate (MCDH) (Enquik) are labeled for postemergence control of nightshade in tomato row middles. Both diquat and the combination of MCDH and paraquat frequently require 2 applications for best control (1). Growers' results with these herbicides have varied and varying with them have been several factors, including the adjuvant used. Adjuvants have been shown to differ in their effects on the efficacy of glyphosate for perennial weed control (5). Many adjuvants are currently marketed in Florida. Preliminary research (J. P. and P. R. Gilreath, unpublished data) suggested adjuvants could influence efficacy of both paraquat and diquat. Therefore, some of the more popular commercially available and several experimental adjuvants were evaluated in three field experiments to determine if adjuvant choice could affect nightshade control with paraquat or diquat.

Materials and Methods

Three experiments were conducted on commercial farms near Parrish, Fla. The paraquat study was conducted in the fall of 1988 and the diquat studies were conducted in the spring of 1989. An area heavily and uniformly infested with American black nightshade was selected as the experimental site for each study. Treatments were assigned to plots 30 feet long by a single 33 inches-wide row middle arranged in a randomized complete block design and replicated 4 times. Each treated row middle was separated from adjacent middles by at least one plant row. Beds were spaced 6 feet apart from center to center with 3 beds between ditches in the first 2 experiments and 2 beds between ditches in the third experiment. Germination of additional nightshade seedlings and regrowth were not significant problems in the fall paraquat study, but did occur in the spring diquat studies. All herbicide applications were made with a CO_2 back pack sprayer fitted with a 2 nozzle boom. Paraquat treatments in the first experiment were applied at 27.1 gal/acre, and application volume for diquat was 50 gal/acre. Data were subjected to analysis of variance and means were separated by T test (LSD) at the 5% level of significance.

Paraquat Experiment. Nine adjuvant treatments (Table 1) were applied with single applications of each of 2 rates of paraquat (0.5 and 1.0 lb./acre) to 2- to 4-inch tall nightshade plants with 4 to 6 leaves in row middles of 'Sunny' tomatoes on 19 Sept. 1988. Percentage nightshade control was evaluated 3 and 41 days after application (DAT).

Diquat Experiment 1. Eight adjuvant treatments (Table 2) were applied with single applications of each of 3 rates of diquat (0.25, 0.50 and 1.0 lb./acre) to 8-inch tall nightshade plants in row middles of 'Sunny' tomatoes on 3 Apr. 1989. Initial nightshade control was evaluated 4 DAT.

Diquat Experiment 2. Twenty adjuvant treatments (Table 3) were applied in each of 2 applications of diquat (0.50 lb./acre) to 2 sizes of nightshade plants in row middles of 'NVH 4459' tomatoes on 4 May and 23 May 1989. Nightshade plant sizes at the time of the first application were small (2 inches tall) and large (8 to 12 inches tall). Percentage control of nightshade was evaluated by size 5 days after the first application. Since size distinctions were not as clear-cut after the second application, nightshade control was evaluated overall and not by size after 10 days.

Results and Discussion

Adjuvant choice had some effect on efficacy of paraquat and diquat; however, there were few large differences and most differences were observed with either the lower herbicide rates or single applications of each herbicide. Generally, as rate increased and/or a second application was made, the differences in efficacy decreased.

Paraquat Experiment. There was a significant interaction between paraquat rate and adjuvant; thus, nightshade control with a given adjuvant varied with paraquat rate (Table 1). When 0.5 lb./acre of paraquat was applied, only LI700 was inferior to X-77 (considered by many to be an industry standard), whereas Agridex was superior to all of the other adjuvants 3 DAT. Thirty-eight days later (41 DAT) results were similar for the 0.5 lb./acre rate, except LI700 was now superior to X-77 and comparable to Agridex. Induce, and Buffer PS + Induce (0.5 + 0.5%) were similar to Agridex for control of nightshade when used with 0.5 lb./acre of paraquat. Safer's Surfactant was incompatible with

Table 1. Effect of adjuvant and paraquat rate on control of 2 to 4 inch tall nightshade plants in row middles of 'Sunny' tomatoes 3 and 41 days after application (DAT). Parrish, FL, 22 September and 2 November 1988.

Adjuvant	Rate (%)	Paraquat (lb./A) 0.50 3 DAT	0.50 41 DAT	1.0 3 DAT	1.0 41 DAT
		% control			
X-77	0.25	11.2[z]	31.2	51.2	76.2
Agridex	1.0	25.0	47.5	52.5	65.0
Induce	0.5	13.8	36.2	52.5	67.5
Surfix	0.25	16.2	23.8	42.5	46.2
HMT	0.5	13.8	21.2	45.0	66.2
Safer's Surfactant	0.5	7.5	18.8	0.0	12.5
Buffer PS + Induce	0.25 0.5	8.8	12.5	45.0	61.2
Buffer PS + Induce	0.5 0.5	8.8	40.0	51.2	57.5
LI 700	1.0	5.0	47.5	38.8	45.0
LSD (0.05)		5.8	13.3	22.4	21.9

[z]Mean separation within each column by T test (LSD) at the 5% level of significance. There was a significant rate by adjuvant interaction for each date.

Table 2. Effect of adjuvant and diquat rate on control of 8 inch tall nightshade plants in row middles of 'Sunny' tomatoes 4 days after a single application. Parrish, FL, 7 April 1989.

Adjuvant	Rate (%)	Diquat (lb./A) 0.25	0.50	1.0
		% control		
X-77	0.75	31[z]	49	59
Agridex	1.0	26	46	48
Induce	0.5	26	60	45
HMT	1.0	29	55	66
Chem-nut 80/20	0.5	25	39	64
LI 700	0.5	38	45	56
SurpHtac	0.5	16	41	62
SurpHtac	1.0	17	36	64
LSD (0.05)		13	17	13

[z]Mean separation within rate by T test (LSD) at the 5% level of significance. There was a significant interaction between adjuvant and diquat rate.

Table 3. Effect of adjuvant on control of small (2 inches tall) and large (8 to 12 inches tall) nightshade plants in row middles of 'NVH 4459' tomatoes 5 days after the first application and overall control 10 days after a second application of 0.50 lb./acre diquat. Parrish, FL, 9 May and 2 June 1989.

Adjuvant	Rate (%)	1 Application: Plant size: Small	1 Application: Plant size: Large	2 Applications: Overall control
		% control		
X-77	0.75	85.8[z]	82.5	86.2
Agridex	1.0	82.5	82.5	87.8
Induce	1.0	87.0	82.0	95.2
HMT	4.0	94.0	80.0	86.8
Chem-nut 80/20	0.5	87.5	80.8	87.5
LI 700	0.5	72.5	71.2	83.4
SurpHtac	1.0	67.5	65.0	82.5
UCDN1S610	0.25	81.2	70.8	82.8
HM 8903	0.5	70.0	60.0	77.0
HM 8903 + HM 8904	0.25 + 0.25	70.0	57.5	70.0
HM 8807	0.125	85.0	78.2	93.8
HM 8902	0.25	68.0	63.2	81.2
Sunspray 6E	1.0	66.2	60.0	77.5
Sunspray 11E	1.0	68.2	62.5	83.8
Chem-nut ActiPierce	0.25	71.2	62.0	88.8
Chem-nut Z-88	0.125	78.8	65.0	80.8
Passage	0.25	83.8	73.2	93.2
AFCX-87	0.5	80.0	72.5	92.5
Saf-T-Oil	2.0	75.8	65.8	80.0
HM 8807	0.25	92.0	85.8	87.5
LSD (0.05)		15.6	17.6	13.8

[z]Mean separation within column by T test (LSD) at the 5% level of significance.

paraquat and efficacy was low, although this was not as readily evident with 0.5 lb./acre as with 1.0 lb./acre of paraquat. Initial nightshade control was similar with all adjuvants except Safer's Surfactant, when applied with 1.0 lb./acre paraquat. Forty-one DAT the best control with 1.0 lb./acre paraquat was obtained with X-77, Agridex, Induce, HMT, and Buffer PS + Induce; whereas, control with Safer's Surfactant and LI700 was poor.

Diquat experiment 1. Adjuvant and diquat rate interacted for nightshade control with a single application of diquat at 0.25, 0.50, or 1.0 lb./acre (Table 2). Generally, most adjuvants were as good as X-77 at a given diquat rate. SurpHtac (both rates) did not perform as well as X-77 or LI700 with 0.25 lb./acre diquat; however, as diquat rate increased, these differences disappeared. Interestingly, Induce provided the highest percentage control with 0.50 lb./acre diquat and was superior to Chem-nut 80/20 and both rates of SurpHtac, but when diquat was increased to 1.0 lb./acre Induce was not as good as these same adjuvants or HMT.

Diquat experiment 2. The rate of HMT in this experiment was increased over that used in the previous experiment because that batch had been formulated with a lower concentration of active ingredient than originally believed. Five days after the first application, control of small nightshade was not as good with SurpHtac, HM 8903, HM 8903 + HM 8904, HM 8902, Sunspray 6E, or Sunspray 11E as it was with X-77, Induce, HMT, Chem-nut 80/20, or HM 8807 (0.25% rate) (Table 3). Control of large nightshade followed a similar trend with the exceptions that ActiPierce was not as good as X-77 and SurpHtac did not differ from any of the adjuvants except HM 8807 (0.25% rate). Ten days after a second application most of the adjuvants + diquat provided good nightshade control. The highest percentage control (95%) was obtained with Induce which provided better control than HM 8903, HM 8902, Sunspray 6E, Chem-nut Z-88, and Saf-T-Oil. Only HM8903 + HM 8904 provided less control than X-77.

Generally, little difference in adjuvants existed other than those due to incompatibility. When marked differences were observed, it was when using lower rates of paraquat or diquat or when making single applications. Effect of adjuvant on herbicide performance varied with herbicide rate. All of the adjuvants tested with paraquat performed similarly, except the incompatibility noted with Safer's Surfactant and the poor performance of LI700 with 0.50 lb./acre paraquat as compared to the efficacy observed with the 1.0 lb. rate. Even with 1.0 lb./acre, paraquat did not provide acceptable nightshade control. When applied twice at 0.50 lb./acre, diquat provided greater than 90% control of nightshade with Induce, HM 8807, Passage, and AFCX-87. Most of the commercially available adjuvants provided similar performance with the exception of Sunspray 6E which did not perform as well as most.

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