Technology & Product Reports

UCC-C4243 Desiccation of Potato Vines

Alexander D. Pavlista¹

ADDITIONAL INDEX WORDS. vine kill, diquat, reglone, regrowth, skinning, *Solanum tuberosum*

SUMMARY. Chemical vine desiccation of potato (*Solanum tuberosum* L.) is widely used in the USA. Diquat is the major vine desiccant but has some drawbacks such as incomplete stem desiccation allowing regrowth. A new herbicide, UCC-C4243, was evaluated as a replacement for diquat. The potato cultivar 'Atlantic' was treated with UCC-C4243 (a.i.) at 0.25 to 2.5 oz/acre (17.5 to 175 g·ha⁻¹), and leaf and stem desiccation efficiency was compared to diquat (a.i.) at 4 oz/acre (280 g·ha⁻¹). Split applications of UCC-C4243 were compared to double applications of diquat. Subjective evaluations were made on regrowth and tuber skinning, and objective measurements on specific gravity and yield. Trials were conducted from 1991 to 1995 at Scottsbluff, NE. UCC-C4243 at 1.5 oz/acre (105 g·ha⁻¹) and higher significantly increased leaf and stem desiccation compared to diquat. There

was no difference between single and split applications of UCC-C4243.

UCC-C4243 suppressed regrowth at 1 oz/acre (70 g·ha⁻¹) and prevented it at 2.5 oz/acre at 3 weeks after treatment while diquat did not. Skin set of tubers was promoted equally by all desiccants. Specific gravity was not lowered by UCC-C4243 but was by diquat. Yields were not affected by either UCC-C4243 at 1.5 oz/acre or diquat at 4 oz/acre. UCC-C4243 was more effective than diquat as a vine desiccant without the regrowth and tuber specific gravity effects associated with diquat.

Vine desiccation (vine kill) has been a major production practice in potato for many years. There are several reasons justifying the use of chemical and mechanical desiccation (Murphy, 1968). These include minimizing tuber malformation, over-sizing and disease spread, and eliminating vines for easier harvest. Rapid desiccating of vines can cause disadvantages such as inducing vascular discoloration within tubers (Cunningham et al., 1952) and lowering yield and solids (Nelson and Nylund, 1969). However, the positives favoring vine desiccation outweigh the negatives leading it to become a common production practice.

One of the reasons for desiccation is to promote skin set of tubers (skin or periderm maturation). With good skin set, bruising of tubers during harvest is minimized (Mohsenin, 1965). Skin set on tubers takes 10 to 20 d after vine desiccation (Terman et al., 1952). Continuous vine growth and regrowth after desiccation also are major concerns for the spread of diseases (Ivany et al., 1986).

Since the loss of dinoseb (Haderlie et al., 1989), diquat with and without mechanical techniques has become the standard vine desiccating practices used today (Renner, 1991). However, diquat does not desiccate as well as dinoseb (Conlon et al., 1989; Halderson et al., 1985a; Renner, 1991) and its performance is unsatisfactory to many growers (personal communications). Another weakness of diquat is its tendency to allow regrowth after application (Misener and Everett, 1981).

Vine desiccation studies have been conducted on several chemicals (Haderlie et al., 1989; Murphy, 1968; Renner, 1991). These focused on total vine desiccation, but stem desiccation lags considerably behind leaf desiccation (Ivany et al., 1986; Sanderson, 1984). Chemicals may differ in organ-related desiccation (Sieczka, 1988), which could explain regrowth resulting from diquat applications (Misener and Everett, 1981).

UCC-C4243, a substituted uracil (Devlin et al., 1996; Wright et al., 1995a), is a broad spectrum, pre- or post-emergence herbicide that desiccates weeds upon exposure to sunlight (Davis et al., 1992; Wright et al., 1995b). Its mode of action is inhibition of porphyrin synthesis (Wright et al., 1995b) and several enzymes (Devlin et al., 1996). Preliminary data on split applications of UCC-C4243 suggested that it could be a better potato vine desiccant than diquat (Pavlista, 1993). The objectives of this study are to determine the dose response of UCC-C4243 for leaf and stem desiccation, and compare single versus split applications. Also, UCC-C4243's effect on regrowth, tuber skinning, yield, and specific gravity were determined.

Materials and methods

'Atlantic' potato was used in all trials. Trials were conducted near Scottsbluff, Nebr., from 1991 to 1995. Planting dates were between 6 and 18 May. The first desiccation treatments were applied on 21 to 31 Aug. and second applications were made 7 to 14 d later. Plots were harvested 3 weeks after the first applications.

Plots were two rows, 3 ft (91 cm) apart and 36 ft (11 m) long. Treatments were replicated four times in a randomized complete block design. Data were analyzed using SAS proc GLM and means were separated by least significant differences (LSD) for a 95% confi-

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¹Extension potato specialist and associate professor, University of Nebraska-Lincoln, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361.

dence level. Treatment differences were significant within each year and trial; therefore, data are presented averaged across years with trials as replicates. The same two people took desiccation read-

ings on each row of a plot in all trials. At 2 and 3 weeks after treatment (WAT), plants in one row of a plot were dug to gather ten uniform, round, greater than 2.25 inches (5.7 cm) diameter tubers

for skinning measurements using a small cement mixer rotated for one minute for 11 revolutions. Percent skinning was visually estimated. At 3 WAT, from the same row, 8 lb (3.63 kg) of tubers greater than 2.25 inches were also dug for specific gravity determination using a hydrometer. The other row was harvested at 3 WAT for yield of tubers greater than 1.88 inches (4.8 cm) diameter.

Standard cultural practices were used for pest control in the area. Fertilization rates varied for years ranging from 120 to 160 lb/acre (134 to 179 kg·ha⁻¹) for N and from 25 to 35 lb/acre (28 to 39 kg·ha⁻¹) for P according to soil tests. No K was added. Overhead sprinkler irrigated water was applied as needed.

UCC-C4243 50%WP (Uniroyal, Middlebury, Conn.) was applied over plants at rates (a.i.) of 0.25, 0.5, 1.0, 1.5, 2.0, and 2.5 oz/acre (17.5 to 175 g·ha⁻¹). Split applications of UCC-C4243 were made 14 d apart (2 WAT) as suggested by manufacturer. Diquat 2L (Zeneca, Wilmington, Del.) was used as the standard at a single application (a.i.) at 4 oz/acre and two applications of the same rate made 7 d apart according to the U.S. label. Crop oil at 1.25% (v/v) was added to UCC-C4243 treatments and to check plots; X77 at 0.125% (v/v) was used as the surfactant in the diquat treatments. Plants were sprayed at 20 gal/acre (187 L·ha⁻¹) at a pressure of 40 lb/inch² (2.8 kg·cm⁻²) with 9502E nozzle tips.

Results

Leaf desiccation was significantly increased above checks by single applications of all rates of UCC-C4243, 0.25 to 2.5 oz/acre, and by diquat at 4 oz/acre (Fig. 1). Significant improvement in leaf desiccation was obtained with UCC-C4243 applied at 1.5 oz/acre and higher over diquat at 4 oz/acre 2 weeks after treatment (WAT). All single-application treatments of UCC-C4243 significantly desiccated stems (Fig. 2). UCC-C4243 rates of 1 oz/acre and higher caused more stem desiccation than diquat at 4 oz/acre up to 2 WAT. At 3 WAT, rates of 1.5 oz/acre and higher caused greater stem desiccation than diquat at 4 oz/acre. Diquat-treated plants showed 56% stem desiccation at 3 WAT while UCC-C4243 at 2 oz/acre desiccated stems 94%.

Two split applications of UCC-C4243 treatments, 1 oz/acre followed

Fig. 1. UCC-C4243, single applications, on leaf desiccation of 'Atlantic' potatoes, 1993–95. Closed symbols = UCC-C4243 rates; open symbols = diquat at 4 oz/acre. Triangles = 4 d after treatment (DAT), circles = 7 DAT, squares = 14 DAT, and pyramids = 21 DAT; 1 oz/acre = 70 g·ha⁻¹.

Fig. 2. UCC-C4243, single applications, on stem desiccation of 'Atlantic' potatoes, 1993–95. Closed symbols = UCC-C4243 rates; open symbols = diquat at 4 oz/acre. Triangles = 4 d after treatment (DAT), circles = 7 DAT, squares = 14 DAT, and pyramids = 21 DAT; 1 oz/acre = 70 g·ha⁻¹.

Table 1. Comparison of the effect of single and double applications of UCC-C4243 and diquat on vine desiccation and tuber skinning, 1991–94.

Treatment	Rate a.i. (oz/acre) ^z	% Leaf desiccation		% Stem desiccation		% Tuber skinning	
		2 WAT ^y	3 WAT	2 WAT	3 WAT	2 WAT	3 WAT
Check ^x	0	15	52	0	12	66	40
C4243	2.5	95	100	76	95	40	13
C4243	1.0 + 1.5 ^w	88	100	71	95	44	14
C4243	1.5 + 1.0 ^w	93	100	77	98	45	11
Diquat	4.0	80	91	35	59	55	26
Diquat	4.0 + 4.0 ^v	90	99	55	84	43	18
LSD _(0.05)		9	7	20	10	11	NS

^z1 oz/acre = 70 g·ha⁻¹.

^yWAT = weeks after treatment.

^xCheck data were significantly different from all treatment data but were not included in calculating significance between treatments.

^wSecond treatment was made 14 d after first.

^vSecond treatment was made 7 d after first.

^{ns}Nonsignificant.

Table 2. Regrowth, tuber specific gravity and yield as affected by UCC-C4243 and diquat 3 weeks after treatment.

Treatment	Rate a.i. (oz/acre) ^z	Regrowth 0–3 scale ^y (1994–95)	Specific gravity (1991–94)	Yield cwt/acre (1991–93)
Check	0	0.9	1.090	320
C4243	1.0	0.3	1.090	353
C4243	1.5	0.25	1.090	339
C4243	2.0	0.25	---	---
C4243	2.5	0	---	---
Diquat	4.0	1.1	1.087	327
Diquat	4.0 ^x	0.7	---	---
LSD		0.5 ($P < 0.05$)	0.002 ($P < 0.1$)	NS

^z1 oz/acre = 70 g·ha⁻¹.

^yRegrowth scale: 0 (none) to 3 (all stems with regrowth).

^xA second application at the same rate was made 7 d after the first.

^{ns}Nonsignificant.

by 1.5 oz/acre 14 d later and the reverse, were compared to a single application of UCC-C4243 at 2.5 oz/acre, a single application of diquat at 4 oz/acre and two applications of diquat at 4 oz/acre applied 7 d apart. No significant difference occurred in defoliation between the double applications of UCC-C4243 and the single high rate application, nor were these treatments different from the double application of diquat (Table 1). However, these treatments showed more leaf desiccation than the single application of diquat at 4 oz/acre. With stem desiccation, differences were greater. UCC-C4243 treatments showed more stem desiccation than either diquat treatments at 3 WAT while the double application of diquat was better than the single application (Table 1).

Regrowth after vine desiccation is a major problem in some years depending on conditions after treatment. In 1991, 1992 and 1993, no regrowth was detected in the trials; in 1994 and 1995,

regrowth was a factor. At harvest (3 WAT), regrowth was visually estimated on a scale of 0 (none) to 3 (all plants). UCC-C4243 at 1 to 2.5 oz/acre decreased regrowth below that of the check and diquat at 4 oz/acre treated plots (Table 2). A single application of UCC-C4243 at 2.5 oz/acre allowed no regrowth while a double application of diquat at 4 oz/acre still allowed regrowth.

Skin bruising is a key tuber quality factor. UCC-C4243 at 1 oz/acre and higher lowered the amount of tuber surface skinned compared to checks at both 2 and 3 WAT (Fig. 3). No significant difference occurred between single and split applications of UCC-C4243 (Table 1). No significant difference in surface skinning between UCC-C4243 and diquat was observed. Tuber specific gravity was not affected by UCC-C4243 at 1 and 1.5 oz/acre but was lowered ($P < 0.1$) by diquat applied at 4 oz/acre (Table 2). Yield was not significantly affected by UCC-C4243 at 1 and 1.5 oz/acre nor by diquat at 4 oz/acre (Table 2).

Discussion

UCC-C4243 at 1.5 oz/acre and higher resulted in greater vine desiccation of 'Atlantic' potatoes grown for 99 to 103 d, planting to desiccation, than diquat applied once or twice, 7 d apart, at 4 oz/acre as labeled. UCC-C4243 applied once at 1.5 oz/acre desiccated stems 67% to 77% at 2 WAT while diquat applied twice desiccated stems 55% and a single application desiccated them just 30% to 35%. At harvest (3 WAT), comparing single applications, UCC-C4243 at 1.5 oz/acre desiccated stems 89% while diquat at 4 oz/acre desiccated them 56%. Nelson and Nylund (1969) reported that there was no difference on vine desiccation when diquat was applied once at 8 oz/acre or higher, and two applications at 4 oz/acre or higher, applied 7 d apart. On the other hand, Ivany et al. (1986) reported that, for the same cultivar 'Kennebec,' two applications of diquat at 6 oz/acre improved desiccation over a single application of 12 oz/acre. Both reports used diquat rates greater than registered label in the United States.

Fig. 3. UCC-C4243, single applications, on tuber surface skinning of 'Atlantic' potatoes, 1993–95. Closed symbols = UCC-C4243 rates; open symbols = diquat at 4 oz/acre. Squares = 14 d after treatment (DAT) and circles = 21 DAT; 1 oz/acre = 70 g·ha⁻¹.

Regrowth, which was a problem in 2 years with diquat at both single and double applications, was insignificant with UCC-C4243 at 1 oz/acre and higher. Regrowth is reported as one of the major drawbacks with diquat (Ivany et al., 1986; Misener and Everett, 1981).

All vine desiccants promoted skin set at harvest and there was difference between UCC-C4243 at 0.5 oz/acre (35 g·ha⁻¹) and higher, and diquat. Skin set is a key reason for vine desiccation. It took 3 weeks to reach an acceptable level of skinning considering the harsh method to skin tubers used in these experiments. This finding agrees with others (Ivany et al., 1986; Mohsenin, 1965).

Yields of 'Atlantic' tubers larger than 1.88 inches diameter were not adversely affected by desiccation. This observation agrees with many researchers (Ivany et al., 1986; Haderlie et al., 1989; Halderson et al., 1985b; Renner, 1991, and Terman et al., 1952). Yield decrease has also been reported (Nelson and Nylund, 1969) but usually associated with early desiccation during the late bulking period (Halderson et al., 1985b).

Specific gravity of harvested tubers was not decreased by UCC-C4243 but was decreased 0.003 by diquat. A decrease in specific gravity of 0.002 to 0.004 of harvested tubers has been re-

ported for diquat and other desiccants (Halderson et al., 1985b; Renner, 1991) agreeing with the findings on diquat reported here. UCC-C4243 did not show this effect even though it desiccated vines more rapidly and completely than diquat.

UCC-C4243 is a better vine desiccant than diquat in western Nebraska on 'Atlantic' potato. UCC-C4243 requires only one application; there is more complete desiccation; less regrowth occurs, and specific gravity is not reduced. Its use should be considered. It is expected to be safe since, although systemic, it moves only in an acropetal direction in the plant (Davis et al., 1992).

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