Harvest Aid Defoliation and Regrowth Suppression in Castor (*Ricinus communis* L.) in a Semi-Arid Environment

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ABSTRACT

Historically, U.S. castor production up to the early 1970s simply allowed a killing freeze to terminate the crop then castor was mechanically harvested 10 to 14 days later. This practice, however, often allowed for substantial shattering loss of castor capsules which matured many weeks before the freeze. With the routine use of harvest aids in cotton, whether for defoliation or regrowth suppression or both, harvest aid use in castor could help manage the end of the cropping season so as to minimize shattering losses and reduce weather risks. The objective was to evaluate nine common harvest aids, defoliants, and herbicides in castor to evaluate defoliation and suppression of regrowth of castor. Chemicals were applied to reduced-ricin 'Brigham' castor in mid-October 2010-2011 approximately two weeks before the first historical 0ºC freeze. These chemicals were sodium chlorate, glyphosate, thidiazuron/diuron, diquat, paraquat, glufosinate-ammonium, carfentrazone-ethyl, and ethaphon. Defoliation ratings were initiated 4 days after application, and regrowth ratings began 10 days after application. Among potential harvest aids, paraquat and diquat provided the highest degree of rapid defoliation, and carfentrazone-ethyl also was effective at defoliation. Other chemicals, to some extent, left remaining green leaf matter on the plants. Suppression of regrowth was significantly better from paraquat and glyphosate, and carfentrazone-ethyl also performed well. Although diquat was highly effective at defoliation the regrowth potential in castor was not acceptable, which would interfere with harvest. Further harvest aid work appears to best focus on rates, timing, and application method for paraquat, carfentrazone-ethyl, and glyphosate.

HISTORICAL HARVEST MANAGEMENT OF CASTOR

Castor production in the late1960s and early 1970s in the Texas South Plains around Plainview totaled ~20,000 ha annually. Production then relied on a killing freeze to defoliate the plant in advance of mechanical harvest. Current world castor production in sub-tropical to tropical regions does not often experience killing freeze conditions, but since castor harvest in India, Brazil, and China is largely by hand, the freeze is not important.

Removal of leaf matter can lead to cleaner harvest, however, current research at Texas Tech University suggests that the base temperature for seed maturation may be as high as 26ºC (L. Severino, personal communication). Most semi-dwarf castor lines in the U.S. are highly indeterminant (Severino et al., 2012) which results in castor racemes of highly divergent maturity, and the older racemes—which are subject to shattering—maturing as much as 2 months before harvest (Fig. 1). This can lead to unacceptable losses of castor seed, reducing yields and contributing to unwanted volunteer castor which might contaminate other agricultural commodities (Trostle et al., 2012a).

If castor maturation slows well in advance of a killing freeze then the additional shattering potential of mature capsules in mature racemes may be reduced by harvest aids to defoliate and dry the plant—while minimizing regrowth—and enable earlier harvest. Castor production in the semi-arid U.S. Southwest routinely uses a combination of harvest aids to hasten cotton harvest and preserved fiber quality. These same chemicals may assist castor harvest as well.

This issue gains importance in the U.S. due to a new reduced-ricin semi-dwarf castor var. 'Brigham', having 78-85% lower ricin vs. conventional lines. This variety is the focal point of a potential future U.S. castor production (Trostle et al., 2012b).

Figure 1. Small semi-dwarf, reduced-ricin castor var. 'Brigham' with an early maturing primary castor raceme (top) which is subject to shattering (bottom) while other racemes develop and mature (Lubbock, TX; 2011).

OBJECTIVE

Evaluate nine herbicide and defoliation chemicals as potential harvest aids in castor for defoliation and prevention of regrowth.

MATERIALS & METHODS

Nine active ingredients (Table 1) were applied to ' Brigham' castor (3 replications per treatment, four 1.01 m rows X 7.5 m) using 168 liters/ha of water (non-ionic surfactant, NIS, was added when recommended on the label. Applications were made 10/12/2010 (light freeze 11/6/2010) and 10/22/2012 (light freeze 11/9/2011)—the historical average first freeze of 0ºC is October 31—using a pressurized CO2 backpack sprayer using flat fan nozzles.

Initial ratings of defoliation were made 3 or 4 days after harvest aid application and then weekly until the first freeze using the following rating scale: Regrowth ratings commenced 16 to 18 days after application of harvest aid.

Leaf dry down/leaf loss:
- 0, no effect of harvest aids (0% leaf loss);
- 1 = poor (20%)
- 2 = fair (40%)
- 3 = good (many leaves drying, 60%)
- 4 = very good, 80%
- 5 = excellent (all leaves drying or dead, 100%)

Regrowth
Regrowth over time after applying chemicals in desiccation and harvest aid treatments:
- 0 = no regrowth
- 1 = slight regrowth
- 2 = minimal
- 3 = moderate
- 4 = high
- 5 = highest or unchecked regrowth/continued regrowth

Table 1. Active ingredients and rates of test harvest aid chemicals for castor in 2009-2011 (Lubbock, TX).

Active Ingredient	Common Trade Name	Application Rate	Unit	NIS† (%)
Sodium chlorate	Drexel Defol	14.0	liters/ha	0
Glyphosate	Roundup	2.3	liters/ha	0
Thidiazuron/diuron	Ginstar	1.2	liters/ha	0
Diquat	Reglone	2.3	liters/ha	0.25
Paraquat	Gromoxone Inteon	1.2	liters/ha	0.25
Glufosinate-NH4+	Ignite	2.1	liters/ha	0
Carfentrazone-ethyl	Aim	146	mls/ha	0
Ethaphon	ET	146	mls/ha	0.25
None	Control	.---	.---	0

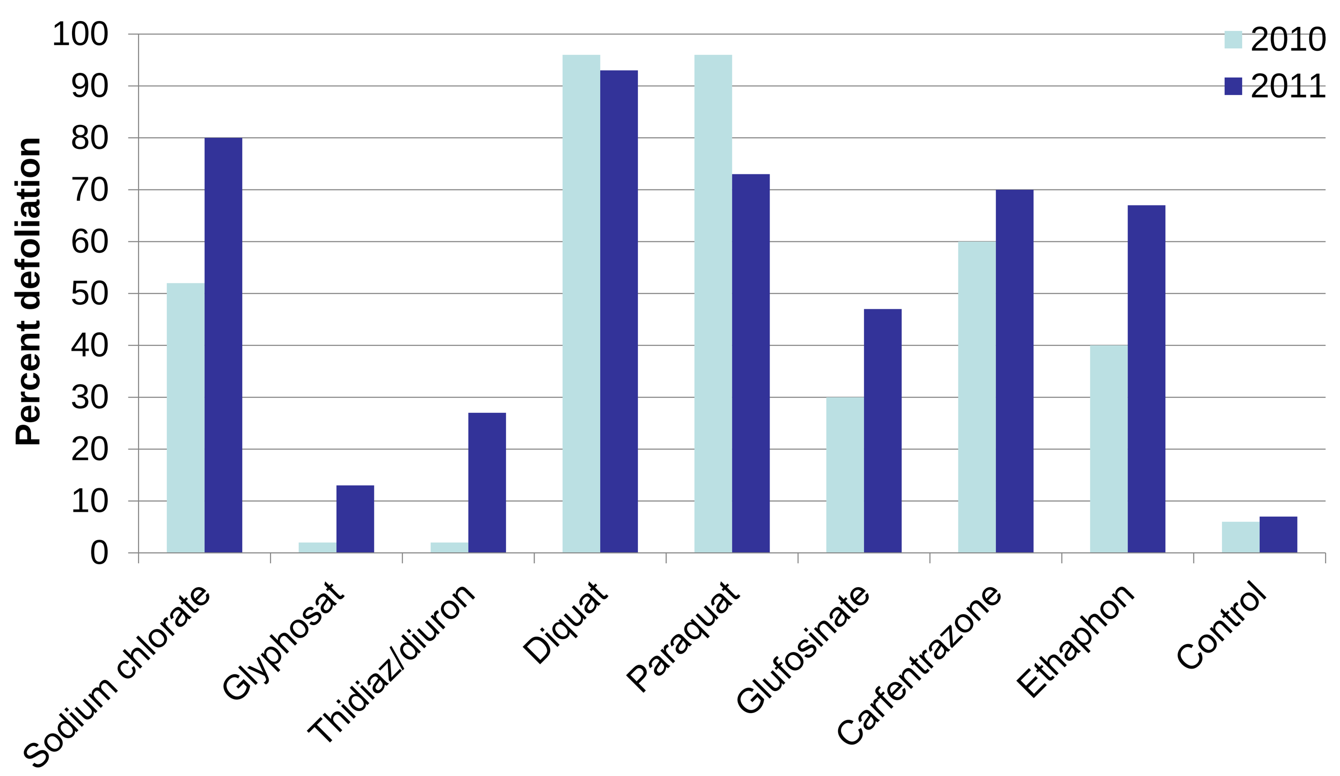

Figure 2. Percent defoliation of castor 3 and 4 days after harvest aid application for nine tests harvest aids, 2010-2011, Lubbock, TX.

RESULTS

Defoliation was rapid in particular with diquat and paraquat (Fig. 2). Carfentrazone also demonstrated fairly good defoliation averaging 65% within four days. Sodium chlorate demonstrated more variability in defoliation, but this harvest aid is well known in the region in grain sorghum and other crops to suffer from full regrowth potential. Quick defoliation is not to be expected from glyphosate and similar acting harvest aids which work more slowly to kill the plant (Fig. 3).

Figure 3. Plant foliar response four days after harvest aid application, Lubbock TX, 2010. Sodium chlorate (left) has defoliated ~50% of leaf area so far whereas glyphosate (right) must be absorbed , translocated, and may take two weeks to defoliate the plant. Harvestable racemes (brown) are present on each plant.

Regrowth potential was mixed with substantially higher regrowth in 2011 for most harvest aids vs, 2010 results (Fig 4). Both paraquat and glyphosate initially demonstrated minimal regrowth in 2010, but regrowth was much more in 2011, perhaps due to varying environmental conditions. When used for weed control of volunteer castor glyphosate has mixed results in that larger plants (>0.3 m) require full rates in order to achieve minimal control. As 3 is a moderate level of regrowth several harvest aids may provide tolerable control of regrowth, but harvest should occur in timely fashion to minimize harvest difficulties.

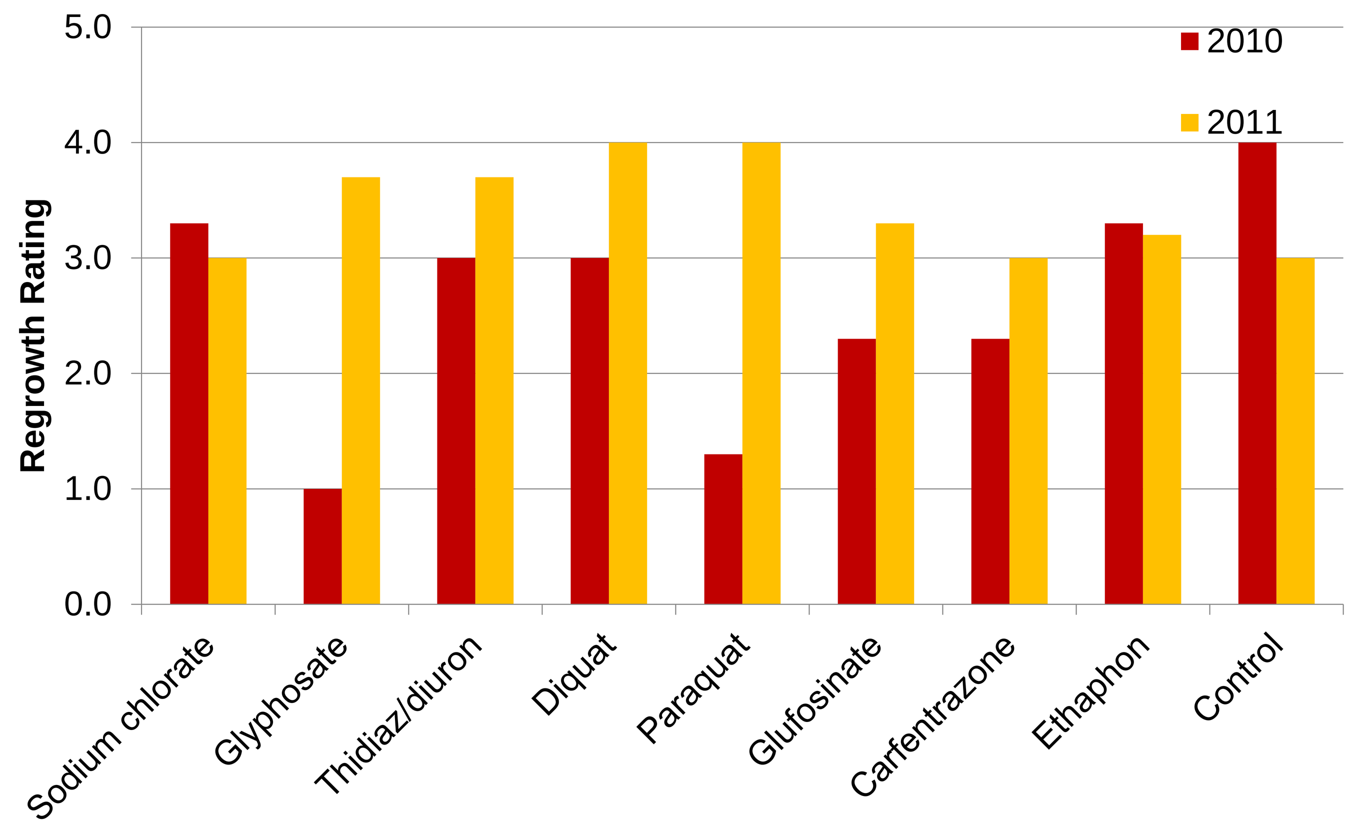

Figure 4. Castor regrowth potential of nine potential harvest aids in castor at ~16 days after application, Lubbock, TX.

SUMMARY

Tests sought to identify harvest aids that are the best candidates for further testing on rate, timing, and how quickly the harvest aids work. Diquat, paraquat, glyphosate, and carfentrazone appear to merit further work to develop an appropriate harvest aid program for managing castor to allow earlier harvest and reduce yield losses due to shattering which in turn will reduce volunteer castor potential.

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