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Hexazinone, a Promising Herbicide for Highbush Blueberries[1]

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***Abstract*. The herbicide hexazinone [3-cyclohexyl-6-(dimethyl-amino)-1-methyl-1,3,5-triazine-2,4 (1*H*,3*H*)-dione was selective in high blueberries (*Vaccinium corymbosum* L.) when applied as a directed spray at rates that controlled a broad spectrum of perennial grass and broadleaf weeds. Early spring applications to the soil before weed emergence gave significantly better weed control than fall treatments. Container grown, 3-year-old 'Berkeley' and 'Bluecrop' blueberries were injured by 1 and 2 kg/ha, respectively, of soil applied hexazinone which suggests differential tolerance among cultivars. Applications to blueberry foliage caused severe injury. In field trials, however, injury was observed only at 4 kg/ha, but 2 kg/ha was sufficient for the control of quackgrass [*Agropyron repens* (L.) Beauv.] goldenrod (*Solidago* spp.), hawkweed (*Hieracium* spp.), sheep sorrel (*Rumex acetosella* L.) and many other weeds.**

Hexazinone, a relatively new broad spectrum triazine-dione herbicide, gives selective weed control in Christmas tree plantations, conifer reforestations, and pineapple and alfalfa plantings (1, 5). Both preemergence soil treatments and foliar postemergence treatments are effective against susceptible weed species. Some *Vaccinium* species have shown tolerance when hexazinone is selectively applied. For example, lowbush blueberries (*Vaccinium angustifolium* Ait.) are tolerant to 1.5 to 3 kg/ha hexazinone when applied after the pruning burn, but before the new shoots have emerged (Jensen, unpublished data). When applied to the blueberry shoots before or after the leaves emerge, considerable foliar injury results, but the plants generally recover (2). In a trial with highbush blueberries (3), hexazinone at 1.5 kg/ha applied in late-June gave excellent weed control, but spray drift caused significant foliar injury to the crop. However, no injury that could be attributed to subsequent root uptake of hexazinone was observed on the blueberries. The following studies were conducted to evaluate (i) tolerance of highbush blueberries to various hexazinone treatments and (ii) control of some common weed species with these treatments.

On November 16, 1979 and April 8, 1980 hexazinone was applied at 1, 2 and 4 kg/ha to the soil surface as a directed spray within the rows of a 12-year-old commercial planting established on a Somerset sand (O.M. < 1%). Plots consisted of 8 m of row with six plants. The treatments were replicated four times and repeated twice, once in a 'Burlington' planting and again in a mixed planting consisting primarily of 'Jersey'. The weed stand within the plot area was variable due to past herbicide applications.

Weed control with hexazinone was more effective with spring applications than with fall applications (Table 1). When spring applied at 2 kg/ha, hexazinone gave better weed control than 4 kg/ha applied in the fall. Most common weed species in this trial, except *Equisetum arvense* L., were controlled with spring applications of 1 or 2 kg/ha. Other species not listed in Table 1 that were controlled at these rates included: *Ranunculus acris* L., *Potentilla recta* L., *Agrostis* spp., *Matricaria chamomilla* L. and a *Carex* spp., Rohrbough (5) has given a lengthy list of herbaceous and woody species and their relative tolerance to hexazinone.

The water solubility of hexazinone is 33,000 ppm at 25°C (5). This high solubility favors its mobility in the soil which, in part, accounts for its activity against perennial weeds and its apparent loss from the soil surface. In addition, hexazinone is readily degraded by soil microorganisms and its ½-life in Delaware and Illinois is 1 and 2 months, respectively (4). The relatively short-term persistence of hexazinone accounts for its better performance when spring applied. Even the high rate of 4 kg/ha applied in the fall failed to completely control germinating annual weeds (Table 1). These results are consistent with the author's experience with this herbicide in lowbush blueberries.

Crop injury was observed at 4 kg/ha of spring applied hexazinone on 'Jersey' (Table 1), and on other plants identified as 'Berkeley' in the trial in the mixed planting. None of the treatments injured 'Burlington'.

To investigate the differential tolerance of cultivars to hexazinone, dormant 3-year-old 'Berkeley' and 'Bluecrop' blueberries were transplanted singly into 12 liter plastic pails in a potting mixture containing 2 peat:1 loam:1 sand and grown outdoors. In early-May before the buds had opened, hexazinone was drenched onto the soil surface at rates equivalent to 1, 2 and 3 kg/ha. In mid-June, other plants received an over-the-top foliar application. The treatments were replicated six times.

When hexazinone was applied to the soil both cultivars leafed out and blossomed without any observable injury from the herbicide. However, 6 weeks after application, those plants of 'Berkeley' receiving the 3 kg/ha rate had severe foliar necrosis which in time was also evident on 'Bluecrop' (Table 2). Differential response of the 2 cultivars to hexazinone was evident by July 28. The injury observed with 'Berkeley' at 1 kg/ha and 'Bluecrop' at 2 kg/ha was primarily interveinal chlorosis with marginal necrosis which developed back to the midrib in

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Table 1. The effect of spring and fall applications of hexazinone on highbush blueberries and certain weed species.

		Foliar injury[z] (%)		Ground cover by species (%)						Annuals[y]	
Time of application	Rate (kg/ha)	'Jersey'	'Burlington'	*Agropyron repens*	*Rumex acetosella*	*Stellaria* spp.	*Solidago* spp.	*Hieraceum* spp.	*Equisetum arvense*	Grasses	Dicots
Nov. 16	1.0	0	0	8	5	6	5	4	3	12	4
Nov. 16	2.0	0	0	5	2	0	2	2	4	10	3
Nov. 16	4.0	trace	0	2	0	0	4	0	4	6	trace
April 8	1.0	0	0	2	0	trace	2	trace	3	trace	0
April 8	2.0	trace	0	0	0	0	0	0	2	0	0
April 8	4.0	40	0	0	0	0	0	0	2	0	0
Untreated	—	—	—	12	5	10	4	6	3	9	3

[z]Means of 4 replicates evaluated August 5.
[y]Annuals: grasses were primarily *Echinochloa crusgalli* (L.) Beauv.; dicots included *Ambrosia artemisiifolia* L., *Polygonum persicaria* L. and *Raphanus raphanistrum* L. Means of 8 replicates.

Table 2. Response of container grown highbush blueberries to hexazione.

Hexazinone (kg/ha)	Method of application	Foliar injury (%)	
		Berkeley	Bluecrop
1.0	soil	6	trace
2.0	soil	57	5
3.0	soil	96	37
2.0	foliar	100	100

some cases. With time, symptom development progressed at the highest rate of herbicide resulting in successive defoliations which eventually killed 'Berkeley'. Injury on 'Bluecrop' with 2 and 3 kg/ha was variable across the replications ranging from almost no effect to complete kill. The unexpected levels of injury from these treatments was attributed, in part, to confinement of the roots and herbicide within the container. In the field trials, replacement plants set out 1 and 2 years before treatment were not affected by 2 kg/ha hexazinone.

Foliarly applied hexazinone resulted in complete defoliation of both cultivars. However, new leaves emerged on 'Bluecrop' and despite being severely stunted all plants survived.

Differential tolerance between blueberries and many common perennial weed species to 1 and 2 kg/ha hexazinone was expressed under field conditions. The margin of crop safety should be greater on medium textured soils, and the herbicide should be applied before emergence of the foliage to decrease risk of drift injury. The herbicidal activity of hexazinone complements that of some presently used residual soil-applied herbicides. For example, hexazinone is active against Compositae species (Table 1) that are not controlled by terbacil. Furthermore, in lowbush blueberries excellent control of many Rosaceae species, including woody *Rosa* and *Rubus* spp., has been obtained with hexazinone (Jensen, unpublished data). Its initial control of perennial weeds coupled with its short-term persistence suggests tankmix combinations with simazine or other residual herbicides. Hexazinone has a potential use in highbush blueberries, and possibly other commerical *Vaccinium* species.

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Field Chilling vs. Cold Storage of Highbush Blueberry Cuttings[1]

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Abstract. **Hardwood cuttings from canes of highbush blueberry (*Vaccinium corymbosum* L.) collected in early dormancy and stored at 2°C until spring rooted better than cuttings collected in the latter part of the winter. Cuttings placed immediately in a greenhouse propagation structure rooted and grew poorly when collected before mid-December but if collected after mid-December produced plants up to two-fold larger than spring-rooted plants after 1 growing season due to the extended growing period.**

Highbush blueberries are commonly propagated from hardwood cuttings in outside propagation structures (7). After 1 growing season in the rooting bed, rooted cuttings are normally moved to a field nursery and grown an additional year. They are then sold as 2-year old plants for commercial field planting.

Cuttings are usually taken from the field just prior to insertion in propagation beds in early spring. Johnston (5), however, advised collecting canes in early winter and storing to avoid winter injury. Results of storing blueberry cuttings have been contradictory (3, 6, 8, 10).

Coville (1) early noted the effect of cold temperatures in stimulating blueberry plant growth. Darrow (2) determined the cold requirement for breaking rest in highbush blueberry cultivars to range from 800 to 1000 hours below 7.2°C. Following fulfillment of the cold requirement, highbush blueberries produce better vegetative growth under long photoperiods (4, 9).

This experiment was conducted to evaluate the effects of cold storage of blueberry hardwood cuttings and to compare winter rooting of cuttings in a greenhouse with traditional spring rooting in outdoor structures.

Canes from the previous season's growth were collected from 'Blueray' and 'Collins' plants from the Arkansas Agricultural Experiment Station, Fayetteville, at bi-weekly intervals from November 2, 1976 until February 22, 1977. Half the canes at each collection date were sealed in moistened polyethylene bags and stored at 2°C until March 28, 1977 at which time cuttings were made and placed in an outside propagation frame. The remaining half of the canes were immediately made into cuttings on each collection date and inserted into a greenhouse propagation bed. All cuttings were made from basal and intermediate portions of canes and were cut to a length of 10 cm (8). Cuttings were placed in a medium of 1 sphagnum peat:1 washed sand (v/v), leaving only the top bud exposed. Intermittent mist was adjusted to maintain a moist, not wet, medium. The experimental design was a randomized block with 4 replications and 12 cuttings per replicate. Air temperature was maintained at ca. 21°C and daylength was extended to 16 hr by timed incandescent lights above the propagation area. The portable frames containing the cuttings were moved from the greenhouse in May and placed alongside the cuttings inserted in March in the outside propagation area.

On March 28, 1977 the stored canes were made into cuttings as described above and inserted into an outside propagation bed in a medium of 1 sphagnum peat:1 washed sand (v/v) under intermittent mist. The same experimental design was used as in the greenhouse experiment.

After rooting was indicated by a second flush of growth the propagation beds were fertilized every 2 weeks until late August with a soluble complete fertilizer (Peter's Peat-lite Special 20N-19P-18K at 30 ppm). The cuttings were removed from the propagation beds after the onset of dormancy, the medium carefully rinsed from the roots, and each plant was evaluated for extent of rooting on a scale of 1-5 (1=no roots or callus; 2=callus, but no root; 3=callus with small root system; 4=average marketable root system; 5=extensive root system). Total stem growth was determined for each plant.

Since no significant cultivar interactions occurred in this experiment, data from the 2 cultivars were pooled.

Cuttings from canes collected in early winter and stored at 2°C until spring produced higher percent rooting and better root grade than cuttings collected from

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