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Effects of Glyphosate on Highbush Blueberry (*Vaccinium corymbosum* L.)¹

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Abstract. Five-year-old 'Collins' highbush blueberries were treated in August with glyphosate (N-phosphonomethyl glycine) at 0.36, 3.6 and 7.2 g/liter acid equivalent as a spot treatment alone or with pruning or applying paraquat (1, 1'-dimethyl-4, 4'-bipyridinium ion) at 1.2 g/liter to remove green tissue prior to glyphosate application. Initial response was terminal dieback of young canes. Symptoms the following spring included additional terminal dieback, leaf and cane morphological aberrations, and elongation of the flower corolla. One year after treatment, regrowth was normal. There was no effect on blueberry yield the season following treatment.

Glyphosate has potential for use as a postemergence systemic herbicide against weeds such as bermudagrass [*Cynodon dactylon* (L.) Pers.] and johnsongrass [*Sorghum halepense* (L.) Pers.] in perennial fruit crops. Its properties and mode of action have been described by Baird et al. (1) and Jaworski (3), respectively. Glyphosate metabolism and degradation in soil and water were described by Rueppel et al. (6). Rom and Talbert (4) and Rom et al. (5) suggested that rates sufficient for controlling weeds in apple and peach orchards were phytotoxic to foliage and green bark of young trees. Abnormal leaf development and inhibition of leaf and flower formation were observed when the glyphosate was applied the previous autumn before leaves were shed. Tucker (7) also reported morphological aberrations on citrus plants as a result of using glyphosate, but he found the herbicide to be effective in the control of weeds. We evaluated glyphosate to determine

its phytotoxic effect on highbush blueberries.

The test was conducted at the Main Experiment Station, University of Arkansas at Fayetteville on a Captina silt loam soil with 1% organic matter and 10% clay. The 1% Roundup³ solution (containing 3.6 g/liter acid equivalent to glyphosate plus surfactant) was the standard rate used (2). Each treatment consisted of one 5-year-old plant per replication. The experimental design was a randomized complete block design with four replications. Plots were kept weed-free by hand hoeing.

Paraquat and glyphosate treatments were applied August 12 and 19, 1976 respectively, with a hand sprayer to the point of spray runoff. Treatments included: a) a control; b) paraquat alone at 1.2 g/liter (0.5% solution) applied to the lower one-third of the

plant; c) glyphosate at 0.36 g/liter (0.1% solution) applied to all leaves and canes to simulate a drift rate; d) glyphosate at 3.6 g/liter (1% solution) applied to the lower one-third of the plant; e) glyphosate at 7.2 g/liter (2% solution) applied to the lower one-third of the plant; f) paraquat at 1.2 g/liter (0.5% solution) applied to the lower one-third of the plant to remove green tissue, followed 1 week later by glyphosate at 3.6 g/liter applied to the lower one-third of the plant; and g) pruning of all leaves and green canes from the lower one-third of the plant 1 week prior to application of glyphosate at 3.6 g/liter applied to the lower one-third of the plant. Percent injury was determined by visual ratings based on plant vigor, growth abnormalities, chlorosis, and necrosis. A scale of 0 (no injury) to 100 (total kill) was used. Plants were not pruned in the winter of 1976.

Three weeks after the August treatment, all glyphosate-treated plants exhibited some terminal dieback, but injury was greatest where green tissue was exposed to either 3.6 or 7.2 g/liter (Table 1).

The next spring, injury symptoms included small, strap-shaped leaves with some chlorosis, elongated flower corolla, delay in flowering, additional terminal dieback of canes, dead canes, and proliferation of lateral shoots to form "witches brooms." Although younger, more succulent growth showed the most injury, old wood was also damaged, especially where glyphosate was applied

Table 1. Effect of glyphosate applied in August on mature highbush blueberries.

Treatment	Rate (g/liter)	Injury (%)			Yield 1977 (kg/plant)	Avg wt (g/25 berries)	Avg growth (cm) (Sept. 1976-Sept. 1977)	New canes/plant (Sept. 1976-Sept. 1977)
		3 weeks after treatment (Sept. 1976)	At bloom (April 1977)	1 yr. after treatment (Sept. 1977)				
Check	--	0	9	4	2.1	33.4	18	6
Paraquat	1.2	2	12	6	1.8	33.7	30	4
Glyphosate	0.36	22	17	23	2.6	34.5	22	2
Glyphosate	3.6	28	24	20	2.7	33.9	21	1
Glyphosate	7.2	44	40	46	2.4	32.8	22	0
Paraquat & glyphosate	1.2 & 3.6	19	16	14	2.8	34.0	36	3
Pruning & glyphosate	3.6	6	19	13	2.7	31.6	26	5
	LSD _{5%}	20	NS	19	NS	NS	NS	NS

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at 7.2 g/liter. The type and severity of injury varied within the 4 individual plants for each treatment. The season following application no significant differences were found in the 1977 total yield per plant or in the average weight of 25 berries.

Eleven months after treatment only those plants treated with the 2× rate of glyphosate applied to green tissue showed significant injury. Minor symptoms remained on all glyphosate-treated plants, but injury symptoms were less apparent where contact with green tissue was avoided by either pruning or applying paraquat prior to glyphosate treatment (Table 1).

One year after treatment there was no effect on plant height (Table 1). Glyphosate tended to reduce the growth of new canes, but this growth measurement was highly variable among the plants and no significance was indicated. New growth developing in the summer of 1977 was normal on all glyphosate-

treated plants. However, vigorous lateral branching was characteristic of some canes where terminal dieback had occurred earlier.

Severe morphological aberrations may result from application of glyphosate to mature highbush blueberries, particularly when green tissue is sprayed, but this injury is not permanent to the mature plant when rates equivalent to those for control of bermudagrass are applied. Mature highbush blueberries were able to recover to a normal growth pattern within 1 year after exposure to low concentrations or basal sprays. Yields the year following treatment were not affected. Thus, careful application of glyphosate at 3.6 g/liter as a spot treatment to control persistent perennial weeds may be acceptable to the blueberry grower.

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