Hydrogel as a Field Medium Amendment for Blueberry Plants

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Abstract. Three field experiments were conducted to determine short- and long-term effects of hydrogel mixed with peatmoss, milled pine bark, or soil on growth and yield of blueberry. Rabbiteye blueberry cultivars (*Vaccinium ashei* Reade) Delite, Tifblue, and Climax, and southern highbush cultivar (*V. corymbosum* L.) Georgiagem were used as test plants. Hydrogel mixed with soil was detrimental to plant survival. Hydrogel with or without peatmoss or pine bark did not influence yield or berry weight of 3- to 4-year-old 'Delite' and 2- to 3-year-old 'Tifblue' plants. The southern highbush, 'Georgiagem', grown in peatmoss + hydrogel, produced plants of larger volume than those grown in peatmoss alone. Yield or berry weight was not affected significantly by soil amendments. Genetic differences between cultivars affected growth, yield, and berry weight, but the cultivar x soil treatment interaction was not significant.

Young blueberry plants have a shallow and limited root system; thus, water stress symptoms commonly develop on newly planted, nonirrigated fields (Spiers, 1983). Amending compacted soil with peatmoss increases water-holding capacity and available soil water (Ohu et al., 1985). Incorporating peatmoss into the soil before planting is reported to be the most effective soil amendment for rabbiteye blueberry plants (Brightwell, 1971; Spiers, 1983). Spiers (1986) found that incorporated peatmoss tended to concentrate roots near the crown area and at depths of 30 to 45 cm. Also, highbush blueberry plants grew better when soil was amended with peatmoss (Haynes and Swift, 1986).

Hydrogel granules were introduced by Agricultural Systems, Union Carbide Corp., in the late 1970s. These water-absorbing polymers or soil conditioners seem well suited for water stress studies, because they can absorb up to 130 to 150 times their dry weight in water (Union Carbide Corp., 1977). Super slurper, a hydrolyzed polyacrylonitrile graft copolymer, has decreased crust strength and infiltration and increased water retention of several soils (Hemyari and Nofziger, 1981).

Bedding plants (Gehring and Lewis, 1980) and tomato (*Lycopersicon esculentum* Mill.) transplants (Willingham and Coffey, 1981)

grew better in media mixed with hydrophilic polymers than in media alone. Less irrigation was required for *Ligustrum lucidum* Ait. grown in hydrophilic polymer-amended medium than for plants in nonamended medium (Taylor and Halfacre, 1986). Stomatal conductance and leaf water potential of young grapefruit (*Citrus paradisi* Macfad.) trees were higher 2 months after planting for trees in hydrogel-amended soil than for control trees, but no differences existed 1 month later (Swietlik, 1989).

Conversely, one study (Gupton, 1985) showed that when four *Vaccinium* genotypes and the *V. ashei* cv. Tifblue were treated with hydrogel either alone or in combination with peatmoss, ~ 25% of the plants died during the first year after transplanting. The present study was undertaken to compare the effects of hydrogel alone and in a mixture with peatmoss and pine bark on yield, berry weight, and growth of several blueberry cultivars. Effects of plant age, cultivar, and their interactions with soil treatments on plant performance also were investigated.

Three experiments were conducted to evaluate short-term (Expts. I and II) and long-term (Expt. III) effects of hydrogel on blueberry growth, berry weight, and yield.

Short-term, amendments, and soil (Expt. I). Bare-rooted, 2-year-old nursery plants of 'Delite' rabbiteye blueberry were planted in Mar. 1978 in a Leefield loamy sand (loamy, siliceous, thermic, Arenic, Plinthaquic Paleudults). Furrows were opened with a middle buster, and treatments consisting of 3 liters of various moist soil amendments were applied at each plant location. Plants were spaced 1.5 m in rows with 3.0 m between rows. Treatments were six soil amendments: 1) 3 liters of peatmoss (PM); 2) 3 liters of peatmoss mixed with Viterra 2 Hydrogel

(Union Carbide Corp., Tuxedo, N.Y.) (PM + Gel) at the rate of 3.2 g-liter⁻¹; 3) 3 liters of milled pine bark (PB); 4) 3 liters of pine bark mixed with 10 g of hydrogel (PB + Gel); 5) 20 g of hydrogel mixed with 3 liters of soil, incorporated into the soil 2 days before planting; and 6) 20 g of hydrogel incorporated into the soil at planting. The volume of hydrogel we used per plant was 42% less than recommended by the manufacturer (Union Carbide Corp., 1977), but hydrogel with soil alone was applied at the recommended rate. Experiment I, consisting of four replications and three plants/plot, was continued for two harvest years (1979 and 1980). In addition to total yield and berry weight, plant growth of 'Delite' was rated (0 = dead to 5 = excellent growth) in Jan. 1979 and Feb. 1980.

Short-term, amendments, no soil (Expt. II). A similar experiment with four replications and five plants per treated plot was initiated in Mar. 1979 using 2-year-old 'Tifblue' rabbiteye blueberry plants. Treatments were the same as in Expt. I, except the hydrogel-soil treatments (Treatments 5 and 6 in Expt. I) were omitted. The experiment was for two harvest years (1980 and 1981), but plant growth was rated only in Feb. 1980.

In Expts. I and II, plants were harvested with a hand-held vibrator and catching assembly. Berries were weighed and graded and percent marketable yield calculated. In all studies, berry weight was determined from the number of berries in a 100-g sample.

Long-term (Expt. III). An experiment to determine the long-term effect of hydrogel on yield, growth, and fruit size was initiated in Mar. 1979. There were four replicates of two plants for each soil amendment. The soil was a Tifton loamy sand (fine-loamy, siliceous, thermic Plinthic Paleudults). The cultivars were rabbiteye 'Climax' and southern highbush 'Georgiagem'. Only two soil amendments (Treatments 1 and 2 of Expt. I), peatmoss and peatmoss with hydrogel at the same rate described in Expts. I and II, were included in this experiment.

Plants were grown under uniform cultural conditions for 11 years, and growth data (height, width, and breadth in centimeters) were then obtained from each plant in June 1989. Plant volume was computed as cubic meters from height x width x breadth. Stem length (average of eight terminal stems) was measured, and the number of leaf nodes was counted. Berries were hand-harvested in 1990.

Statistical analysis. Data were first analyzed for each experiment separately as complete randomized block designs with subsampling. For Expt. III, data were first analyzed for each cultivar separately, and then data from both cultivars were combined to analyze for cultivar comparisons. The experimental error was tested over the sampling (residual) error. In the absence of a significant experimental error, the sum of squares for the two error terms was pooled

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Table 1. Effect of soil amendment treatments on plant growth of 'Tifblue' blueberry (Expt. II).

	Treatment ¹					Effect ²
	PM	PM + Gel	PB	PB + Gel	SE	
Growth ³	4.0 a	3.2 b	2.9 b	3.1 b	0.2	*

¹Gel = hydrogel before planting; PM = peatmoss; PB = pine bark.

²Plant growth was rated at plant age = 2 years (0 = dead to 5 = excellent growth). Mean separation at $P = 0.05$.

for the test of significance. Otherwise, the experimental error mean square was used to test the significance of the treatment effect.

All analyses of variance were conducted using the GLM procedure of SAS (1985). Type III sum of squares were determined in all analyses, and least square means are reported. Transformation of scale was used for some measurements before variance analysis (e.g., log transformation was used for plant volume), but all means reported are transformed back to the original scale. Since Treatments 5 and 6 were included in Expt. I only, and since all plants in Treatment 6 died, data from four treatments common to Expts. I and II were pooled to test cultivar and cultivar $\times$ treatment interaction effect using a standard split-plot model.

In Expt. I, 'Delite' plants in soil amended only with hydrogel at planting (Treatment 6) were dead by the time of the first harvest in July 1980. Similar results were reported by Gupton (1985) using 'Tifblue'. Hydrogel, being a hydrophilic polymer that was not buffered with organic matter, probably drew water from the blueberry plant roots. Thus, even the small amount of hydrogel used in this study, when not mixed with organic matter, could be detrimental to young blueberry plants. These results indicate that blueberry roots are very sensitive to water availability and may not survive the competition by weeds or other water-absorbing materials in the soil. Similar observations were made by Welker and Brogdon (1968).

After omitting Treatment 6 from Expt. I due to plant death, analysis of variance showed no significant treatment effect for any of the traits studied, and, thus, means are not presented for each treatment. Averages were: growth, rating of 3.5; total yield, 1.3 kg/plant; marketable yield, 83.4%; berry weight, 1.76 g/berry. Plant age influenced growth, yield, and berry weight of 'Delite', but no significant treatment $\times$ plant age interaction was observed.

In Expt. II, excellent growth was obtained from 'Tifblue' plants with peatmoss alone; these plants grew significantly better than plants with any other soil amendments, none of which differed from each other (Table 1). However, total yield (0.8 to 1.1 kg/plant), percent marketable yield (85% to 88%), and berry weight (1.29 to 1.36 g) were not af-

ected by soil treatments. These data were in accordance with the results of Expt. I and confirm that, in the short-term, hydrogel mixed with organic matter does not enhance growth or improve yield of rabbiteye blueberries. Also, no significant cultivar $\times$ soil treatment effect was discovered when data from Expts. I and II were combined.

In Expt. III cultivar $\times$ soil amendment interaction was significant for plant breadth and volume. The breadth and plant volume of 'Georgiagem' increased when hydrogel was added, but very little change was observed for 'Climax' (data not shown). Long term, hydrogel had no significant effect on yield or other plant growth attributes (plant width, stem length, number of leaves, internode length) of either 'Climax' or 'Georgiagem' but significantly ($P = 0.05$) increased breadth (101 vs. 131 cm) and volume (1.39 vs. 2.21 m³) in 'Georgiagem'.

According to Johnson (1984) and James and Richards (1986), deterioration of hydrogel was accelerated when placed in solutions containing Ca, Mg, or Fe salts. Such deterioration might also be expected in soils fertilized annually with complete fertilizers, as was the case with these three experiments. Swietlik (1989) reported that water storage properties of hydrogel deteriorated after 2 months, and, thus, hydrogel was not beneficial in the establishment of young grapefruit under field conditions. His study did not report on possible effects of hydrogel beyond 2 months. On the contrary, our study shows hydrogel had no effect on growth attributes or yield of blueberry plants after 11 years in the field.

Cultivar differences and the significance of the cultivar $\times$ soil treatment interaction indicate that genetic differences between rabbiteye and highbush blueberry could cause differential responses to soil amendment treatments. These two species are known to require different climatic conditions and soil types.

In conclusion, in the short term (based on 2 years of harvest), adding hydrogel to either peatmoss, pine bark, or soil did not improve plant growth, yield, or berry weight. The long-term effect (after 11 years of initial application) of adding hydrogel to peatmoss was not significant on any attribute of 'Climax' plants, but it did increase breadth and vol-

ume of 'Georgiagem' plants. Since total or percent marketable yield was not increased by hydrogel amendments in any of the three experiments, blueberry growers should expect little or no economic benefit from adding hydrogel to organic matter for soil amendments. Caution should be exercised in the use of hydrogel not mixed with organic matter, as this could create a potential lethal situation for young blueberry plants.

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