Evergreen Blackberry Potassium and Nitrogen Fertilization Trial: North Willamette Experiment Station

Special Report 774
June 1986

Agricultural Experiment Station
Oregon State University, Corvallis

ABSTRACT

Three treatments of combined N and K (0, 60, and 120 pounds per acre of each element were applied to 'Thornless Evergreen' blackberries, *Rubus laciniatus* (West.) Willd. Fruit was harvested in 1981-1984 with a Littau self-propelled harvester; yield, fruit size, soluble solids, and firmness were measured. Fruit pH, acidity, and anthocyanin content were measured in 1983 and 1984.

Treatments affected yield, fruit characteristics, and leaf mineral composition; the intermediate treatment level was the most desirable. There was not a consistent relationship of N and K levels of primocane leaves or soil K level with yield, fruit size, soluble solids, or firmness of the fruit, regardless of whether the fruit samples were taken the same year as the leaf and soil samples or the year following.

'Thornless Evergreen' blackberry, *Rubus laciniatus* (West.) Willd., grown primarily in Oregon's Willamette Valley, is often fertilized exclusively with nitrogen (N). However, relatively large amounts of potassium (K) are recommended for 'Thornless Evergreen' blackberry, and fertilizer recommendations for other blackberries, trailing and erect, suggest complete fertilizers with balanced N and K. Increasing N supply is known to induce a need for increased K in red raspberry and has been implicated in improving yields and quality of other fruits. This experiment was designed to test the effects of graduated combination rates of N and K on 'Evergreen' yield and quality.

Materials and Methods

In October 1979, plots were established on sandy loam soil at the North Willamette Experiment Station, Aurora, OR, with plants produced by tip layering into gallon pots of sterilized soil. Plots were 100 feet long and 10 feet apart with plants spaced 10 feet apart in the row. Applications of 0, 60, and 120 pounds per acre of both N and K were made in March of each year, 1980-1984. Soil phosphorus (P) was adequate (102 ppm) in the test area, precluding the need for additional P. Soil K was inadequate (225 ppm) according to standards. The recommended preplant application rate for K was 98 pounds per acre. N was supplied alternately as urea or ammonium nitrate (NH_4NO_3); K was supplied as potassium sulfate (K_2SO_4). Each combination K and N treatment was replicated four times.

Leaf samples from each plot, taken annually in mid-August, were the most recently fully-expanded compound leaves from 25 primocanes. In each year, 1981-1984, fruit was harvested with a Littau self-propelled harvester. Yield, fruit size, soluble solids, and fruit firmness were measured each year. In 1983 and 1984, fruit samples were frozen and stored for analysis of pH, acidity, and anthocyanin content.

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Results

The level of applied N and K showed stronger relationship with yield and fruit characteristics than it did with leaf N, leaf K, and soil K. Applied N and K were significantly correlated with yield ($r = .81$), the highest yields produced with 60 pounds per acre N and K (Table 1), The 60 pounds per acre application was also associated with the largest fruit and lowest percent soluble solids in two years and in four-year means. Fruit pH, titratable acidity, and pigment concentration were not affected by N and K treatments.

Treatments consistently affected the concentrations of several elements in leaf tissue. With higher levels of applied N and K, leaf N and manganese (Mn) increased and leaf Ca decreased (Table 2). Variations in leaf K, P, boron (B), and magnesium (Mg) were not attributable to N and K applications although four-year means show the highest leaf P and B with the lowest level of applied N and K.

The nutrient status of primocane leaves is thought to bear on crop characteristics the following (fruiting) year. However, there was not a consistent relationship of N or K levels of primocane leaves with yield, fruit size, soluble solids, or fruit firmness in the following year. Nor did N or K levels of primocane leaves relate to crop characteristics of the current year.

The effect of N and K applications on soil K was consistent in both years statistically analyzed (Table 3), K increasing with higher levels of applied N and K. Composite soil samples taken 1980 through 1982 were not appropriate for statistical analysis, but indicate the same trend. However, soil K was not related to yield, fruit size, soluble solids, firmness, leaf K, or leaf N. Application of N and K depressed soil pH (Table 3), but pH for all treatments remained within a range considered acceptable.

Discussion

Recommended for K for commercial plantings suggest annual applications of 67 pounds per acre K for soil such as that in the test area with 225 ppm soil K at the time of planting. The level of soil K increased with repeated N and K application to more than the 350 ppm recommended maximum. However, soil K had no relationship to yield, berry size, firmness, or leaf K, confirming that soil K alone is not a good indicator of crop response.

After a planting is established, leaf sampling is considered the best indicator of plant nutrient status for most elements and the best basis for fertilizer recommendations. Leaf sampling in August from caneberry primocanes is considered an indicator of plant needs for cropping in the following year. Leaf samples from plots treated with the three N and K rates all fell in the range from "low normal" to "normal" for N and K. On the basis of leaf samples with N and K in the normal range, growers are advised to continue their current level of N application rate and apply K at a rate of 59-71 pounds per acre. On the basis of soil analysis alone, a grower would have been advised to apply 80-120 pounds per acre of N and 66 pounds per acre of K until soil K exceeded 350 ppm, a level reached after three years of K application in treatment plots.

Table 1. Effect of N and K applications on 'Thorniess Evergreen' Blackberry Yield and Fruit Characteristics

Applied N and K[z]	1981-1984[y] Yield T/A	Weight (g/fruit)	Soluble solids (%)	Firmness (Newtons)	1983-1984[y] pH	Titratable acidity	Absorbance at 535 nm
0	2.50	3.2	13.4	3.98	3.76	.72	.744
60	3.53	3.5	12.4	4.06	3.77	.76	.744
120	3.06	3.3	12.9	3.82	3.83	.71	.789
Least significant difference	0.32	0.1	0.35	0.10	.....	.....	.....
Significance[x]	**	**	*	**	NS	NS	NS

[z]Lb of each element/acre.
[y]Mean values of 4 replications.
[x]Nonsignificant (NS) or significant at 5% (*) or 1% (**) level.

Table 2. Effect of Applied N and K on Elemental Composition of 'Thornless Evergreen' Primocane Leaf Tissue

Applied N and K[z]	1981-1984[y] N (%)	K (%)	P (%)	Ca (%)	Mg (%)	B (ppm)	Mn (ppm)
0	2.78	1.29	0.39	0.65	0.46	27.0	76
60	2.94	1.35	0.35	0.62	0.46	23.6	108
120	2.97	1.37	0.34	0.56	0.44	21.3	143
Least significant difference	0.07	.....	.....	0.04	.....	.....	14
Significance[x]	*	NS	NS	**	NS	NS	**

[z]Lb of each element/acre.
[y]Mean values of 4 replications.
[x]Nonsignificant (NS) or significant at 5% (*) or 1% (**) level.

Table 3. Variation Among Years in Soil K and Soil pH Following Annual Soil Applications of N and K

Applied N and K[z]	Soil K (ppm) 1980[y]	1981[y]	1982[y]	1983[x]	1984[x]	Soil pH 1980[y]	1982[y]	1984[x]
0	105	254	281	275	289	6.2	6.4	6.4
60	99	320	363	557	513	6.2	6.1	5.9
120	102	417	526	712	651	6.2	5.9	5.5
Least significant difference	.....	.....	.....	82	96	.....	.....	0.1
Significance[w]	.....	.....	.....	**	**	.....	.....	**

[z]Lb of each element/acre.
[y]Values are from analysis of composite samples.
[x]Mean values of 4 replications.
[w]Significantly different at 1% (**) level.

The greatest average yield, fruit size, and fruit firmness occurred in plots treated with 60 pounds per acre of both N and K. The fertilizer recommendation for K based on leaf or soil samples (59-71 pounds per acre or 66 pounds per acre, respectively) is very close to the rate which produced the most desirable results in the experiment (60 pounds per acre). The fertilizer recommendation for N based on leaf samples (continue current level) does not mean

that 0 pounds per acre and 120 pounds per acre are equally desirable; it may reflect that N was always applied with K and may have been balanced appropriately and utilized with K, producing "normal" levels of both elements in leaf tissue from all treatments. The N application based on soil samples (80-120 pounds per acre) seems generally high. The maximum yield per unit of applied N is probably achieved with N between the the 60 and 120 pounds per acre rates tested. According to the theoretical curve generated with data from this experiment, the "ideal" rate for this planting would fall at about 75 pounds per acre at the lower end of the range. In summary, the results suggest that moderate rates of both N and K produce the most desirable results and that high rates may actually be counterproductive.

Despite significant changes in elemental composition of leaves, N, P, K, Ca, and Mg levels all remained within "normal" ranges. Boron was below normal in leaves from all treatments in all years. A trend of decreasing B with increasing N and K developed. Low B may have limited potential yield responses to increases in N and K. Mn increased with increasing N and K, probably an indirect response to soil pH, but did not exceed acceptable levels.

The results of such trials have led to refinements in interpreting both leaf and soil samples and have historically led to significant savings in fertilizer in several crops.