Effect of Soil-Injected Ethylene on the Yield of Sugarbeets

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Abstract

The effect of ethylene on the yield components of sugarbeets was investigated over a two-year period in experiments conducted in production fields.

Ethylene was soil injected at a depth of 8 in. in three fields of sugarbeets in 1974 and in five fields in 1975. Beets were harvested from rows 1, 5, 10 and 50 (30 in. spacing) from the place of application. A general decline in sugar yield with distance from application was noted, but there were no significant differences in any of the yield parameters measured due to high variability.

Review of Literature

Ethylene is a simple, unsaturated hydrocarbon, with a boiling point of 219 F and a solubility in water of 130 ppm at 68 F. It is a natural product of plant processes.

Much has been reported concerning the effect of ethylene on plants. Illuminating gas was first observed to defoliate plants, about 75 years ago and ethylene was later identified as the active ingredient of this gas.

Gane isolated ethylene from gaseous products produced by apples in storage thereby proving production of ethylene by plants. This observation was confirmed by Burg and Thinmann using gas chromatography.

Ethrel is an ethylene releasing chemical used to ripen fruit post harvest. Ethylene has been shown to stimulate abscission, retard growth, cause epinasty and stem swelling, stimulate root hair development and adventitious rooting and induce flowering.

Ethylene applications have been used to increase the germination rate of wheat, lettuce, peanuts, clover and sugarbeets and old seed of several species. Egley and Dale discovered that ethylene could be used to stimulate germination of witchweed. Ethylene has also been shown to occur naturally in the soil and to accumulate under anaerobic conditions.

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Freytag obtained increased yields of cotton, sorghum and sugarbeets when ethylene was injected into the soil. He found above normal amounts of ethylene of 0.1 to 8 ppm remained in the soil eight or more days after soil injection.

Commercially, ethylene is a product of the petroleum industry. Natural gas or petroleum is passed through a high temperature chamber yielding several kinds of short-chain molecules. These are then separated by fractional distillation. Ethylene is a gas at normal physiological temperatures.

Materials and Methods

A cylinder containing technical grade ethylene was mounted on a tool bar attached to a tractor. Ethylene was delivered through a gas flow regulator and meter. Plastic hose was used to connect the gas outlet to an anhydrous ammonia shank. The place of ethylene emission was about 8 in. below the soil surface. If one assumes a horizontal movement of 25 ft. in each direction from the place of injection, the application rate of ethylene was 1.1 lb./A.

The field plot layout was based upon injection furrows extending the length of the field. Application of ethylene was made when the leaf span of plants averaged 10 to 12 in. Rows in each test field were 30 in. apart.

Beets were harvested from four 100 ft. lengths of row located in the first, fifth, tenth and 50th rows from the injection furrow. The 50th row was considered to be the untreated check. Soil samples were taken to monitor nitrate nitrogen.

Results and Discussion

The soil at all test sites was alkaline, with pH ranging from 7.4 to 8.2. Nitrate nitrogen was higher than desirable at Willcox, averaging about 40 ppm. Nitrate nitrogen was very high in the soil at one site near Sacaton at the time of ethylene application, averaging 140 ppm. Phosphorus levels were satisfactory at all locations.

Table 1. Mean sugarbeet root weight, per cent sugar, and sugar yield of plants in three field experiments near Willcox, Arizona.

Yield Parameter	Distance from ethylene injection (ft.) 1.25	11.25	23.75	123.75
Beet weight (t/a)	23.84 a[1/]	22.01 a	22.55 a	21.58 a
Sugar (%)	11.6 a	11.8 a	11.8 a	10.7 a
Sugar (lbs./a)	5530 a	5195 a	5322 a	4619 a

1/ Means within rows followed by the same letter are not significantly different at the 5% level according to the Student-Newman-Keuls test.

Table 2. Mean sugarbeet root weight, per cent sugar, and sugar yield of plants in three field experiments near Sacaton, Arizona

Yield Parameter	Distance from ethylene injection (ft.) 1.25	11.25	23.75	123.75
Beet weight (t/a)	15.72 a[1/]	15.30 a	14.62 a	15,89 a
Sugar (%)	16.0 a	15.9 a	15.5 a	15.6 a
Sugar (lbs./a)	5030 a	4864 a	4533 a	4959 a

1/ Means within rows followed by the same letter are not significantly different at the 5% level according to the Student-Newman-Keuls test.

Table 3. Mean sugarbeet root weight, per cent sugar, and sugar yield of plant in experiment near Chandler, Arizona.

Yield Parameter	Distance from ethylene injection (ft.) 1.25	11.25	23.75	123.75
Beet weight (t/a)	27.26 a[1/]	25.07 a	23.69 a	24.94 a
Sugar (%)	13.8 a	14.1 a	14.1 a	13.5 a
Sugar (lbs./a)	7524 a	7069 a	6681 a	6735 a

1/ Means within rows followed by the same letter are not significantly different at the 5% level according to the Student-Newman-Keuls test.

Table 4. Mean sugarbeet root weight, per cent sugar, and sugar yield of plants in experiment on the Douglas Mellon farm near Yuma, Arizona.

Yield Parameter	Distance from ethylene injection (ft.) 1.25	11.25	23.75	123.75
Beets (t/a)	31.20 a[1/]	30.39 a	28.93 a	29.50 a
Sugar (%)	15.8 a	16.1 a	16.5 a	16.5 a
Sugar (lbs./a)	9859 a	9786 a	9547 a	9735 a

1/ Means within rows followed by the same letter are not significantly different at the 5% level according to the Student-Newman-Keuls test.

Table 5. Mean sugarbeet root weight, per cent sugar, and sugar yield from eight field experiments.

Yield Parameter	Distance from ethylene injection (ft.) 1.25	11.25	23.75	123.75
Beet weight (t/a)	26.81	25.63	24.76	25.83
Sugar %	14.1	14.2	14.1	13.6
Sugar (lbs./a)	7561	7278	6983	7025

Summary

Beets in the 1974 field experiments were mechanically harvested, weighed, and sampled to determine sugar content. The production of sugar was 20% higher in the rows nearest the applied ethylene than in the rows located 123.75 ft. from the place of application. Although not significantly different, this finding prompted further field experiments.

In March of 1975, field experiments at Sacaton, Chandler and Yuma were initiated. The methodology used for these experiments closely followed that of the first field experiment. There were no significant differences at the 5% level among the ethylene treatments on beet weight, sugar percentage, or sugar yield. Results indicate that soil injection of ethylene can not be recommended at this time as a method for increasing sugar yield of beets in Arizona. The trends as noted in Table 5 are encouraging, however, and suggest basic studies under laboratory conditions where variability, as usually encountered under field conditions, may be reduced.

References

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