J. Amer. Soc. Hort. Sci. 105(1):66–67. 1980.

Onion Plant Size and Timing for Ethephon-induced Inhibition of Bolting[1]

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Additional index words. Allium cepa, (2-chloroethyl)phosphonic acid

Abstract. **Late-winter application of 5000 ppm (2-chloroethyl)phosphonic acid (ethephon) to fall-seeded short-day onions (*Allium cepa* L.) retarded leaf growth and inhibited bolting. Bolting inhibition was significantly correlated with bulb diameter at time of treatment. Bolting inhibition was greatest when bulb diameter was 0.9 to 1.6 cm at time of treatment. Bulb diameter in late February or early March was an effective criterion for the effectiveness of ethephon treatment to reduce bolting. When ethephon treatments greatly reduced bolting, the number of harvestable bulbs and yields were increased, but when bolting percentage in control plots was low, ethephon reduced yield by decreasing average bulb weight at harvest.**

The induction of flowering and subsequent seedstalk development (bolting) in onion is related to plant or bulb size, (4, 5) which for direct-seeded onions depends partly at least upon earliness of planting.

In New Mexico, fall- or winter-applied ethephon inhibits bolting in early-fall-seeded onions (2). Treated plants were smaller during the periods favoring flower induction. The treatments did not always increase yields, i.e., when bolting in control plots was low, ethephon lowered yields. Ethephon or other growth-inhibiting treatments to inhibit bolting would be more practical if treatments could be applied on the basis of predicted need. Previous work indicates the latest effective treatment date is early March (3). Since plant size determines susceptibility to flower induction and subsequent bolting, plant size at the latest effective data would appear to be a possible indicator of the need for ethephon treatment. Experiments were conducted to evaluate the effectiveness of bulb size and ethephon application dates as indices for predicting ethephon bolting inhibition.

Materials and Methods

'Yellow Grano 502 PRR' onion was seeded September 3, 1974, 1 month earlier than recommended for commercial production. Ethephon at 5000 ppm was applied as single applications on February 22, March 9, or 24. Ethephon was applied in water containing 0.5% Tween 20 surfactant at the rate of about 400 liter/ha. Control plots were sprayed with water containing 0.5% Tween 20. Treatments by date were replicated 4 times in a completely randomized design.

To relate treatment response to plant size, 10 relatively small, 10 medium and 10 large plants were selected in each of the 16 plots. Bulb diameter, neck diameter, number of visible leaves, and plant height were determined for each respectively. The 4 plant size parameters were highly correlated with each other and bulb diameter was selected as the size parameter to use in further studies. A term *"quantitative bolting inhibition"* (QBI) was defined as the difference in bolting percentage between treated and control plots and was used to describe bolting inhibition response to treatment. Bolting percentage is defined as the percentage of total plants with visible seedstalks one week before harvest. QBI was plotted against bulb diameter at time of treatment.

In 1975-76, differences in plant sizes at treatment time were obtained by varying planting dates. Consecutive blocks were seeded on each September 5 and 19 and October 3. Cultural management was similar to that in 1974-75. Ethephon at 5000 ppm was applied to single beds 6 m long on January 23, February 7 or 22, or March 8 or 25. Treatments were replicated 4 times in randomized complete blocks within each planting date block. Bulb diameters of 15 randomly selected plants in each treated and control plot were determined at time of treatment. QBI was plotted against average bulb diameter at time of treatment Regression lines were calculated separately by treatment date.

Bulbs from non-bolting plants were harvested when about 80% of the tops in the control plots had fallen, May 21 in 1975, and May 23 or 30, or June 4 for each planting date, respectively, in 1976. Bulbs were harvested, counted, cured 2 days in burlap sacks, weighed, and reported as total yield. Multiple regression analysis was used to calculate second order regression equations.

Results and Discussion

When bolting percentage was high in the control plots, ethephon treatments from January 23 through March 8 significantly reduced bolting percentages (Table 1). This was associated, in some instances, with greater bulb yield. Average bulb weight was not affected significantly by treatment. Yield increases by treatments resulted from higher percentages of harvestable bulbs. When bolting in the control plots was only 1%, ethephon treatments resulted in smaller bulbs and lower yields. If bolting percentages were very high (73 to 78%), the most effective treatment reduced bolting only to about 50%; but with 27% bolting, control to as low as 7% was achieved. Such control is promising for commercial use if it can be accomplished consistently. These data are generally in agreement with those previously reported (1, 2, 3).

In 1974-75, maximum bolting inhibition was obtained on plants with bulb diameter of 1.1 to 1.2 cm at time of treatment (Fig. 1). Data were insufficient to plot separate regression lines for each treatment date. Bulb diameter differences were by size class within treatment date and by size differences between treatment dates. Bulbs were larger for the later treatments, which confounded the effects of treatment date with effects of bulb diameter at time of treatment.

In 1975-76 regressions were plotted separately by treatment date (Fig. 2), and bulb diameter was determined by the average of a random sample of plants in a plot instead of by size classes within plots as in 1974-75. The earliest and latest treatment dates were less effective than intermediate dates; greatest response was obtained when plant populations averaged 0.9 to 1.6

[1]Received for publication July 20, 1977. Part of a thesis presented by Juan Izquierdo to the Faculty of the Graduate School of New Mexico State University in partial fulfillment of requirements for the MS degree. Journal Article 634 of the Agricultural Experiment Station, NMSU, Las Cruces, New Mexico, 88003.

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Table 1. Bolting, total yield and average bulb weight of 'Yellow Grano 502 PRR' onion, as affected by 5000 ppm ethephon.

Ethephon application date	Bolting (%)	Total yield (MT/ha)	Avg bulb wt (g/bulb)
Planted Sept. 3, 1974, Harvested May 21, 1975			
Feb. 22	66.1 BC[z]	13.4 A	94 A
March 9	63.5 C	14.7 A	98 A
March 24	85.1 A	5.3 B	71 A
Control	78.1 AB	7.7 B	78 A
Planted Sept. 5, 1975, Harvested May 23, 1976			
Jan. 23	66.2 B[z]	10.2 B	110 A
Feb. 7	54.2 C	12.3 AB	95 A
Feb. 22	51.7 C	15.1 A	110 A
March 8	64.8 B	11.2 AB	109 A
March 23	74.2 A	8.3 B	116 A
Control	73.3 A	8.7 B	114 A
Planted Sept. 19, 1975, Harvested May 30, 1976			
Jan. 23	11.8 B[z]	29.0 B	104 A
Feb. 7	9.3 BC	31.9 AB	88 A
Feb. 22	6.9 C	37.4 A	102 A
March 8	7.5 BC	24.9 B	110 A
March 23	26.5 A	25.8 B	116 A
Control	26.6 A	27.2 B	110 A
Planted Oct. 3, 1975, Harvested June 4, 1976			
Jan. 23	0.3 A[z]	28.3 A	113 A
Feb. 7	0.0 A	19.3 B	85 AB
Feb. 22	0.0 A	19.9 B	88 AB
March 8	0.0 A	17.6 B	78 B
March 23	0.0 A	14.7 B	78 B
Control	1.0 A	27.3 A	116 A

[z]Mean separation within columns, within planting dates by Duncan's multiple range test, 1% level.

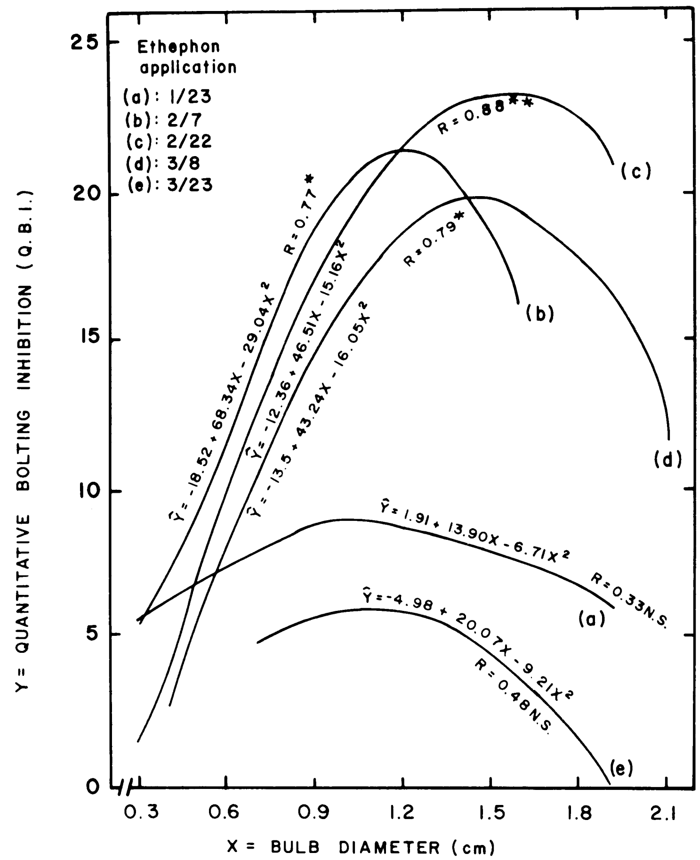

Fig. 2. Relationships and second order regression equations between *Q.B.I. (% Bolting, control – % Bolting, treated)* by 5,000 ppm ethephon and bulb diameter at 5 times of application to 'Yellow Grano 502 PRR' onion planted at 3 dates. 1975-1976). Multiple regression coefficient significant at 5% (*) and 1% (**) level of probability, or nonsignificant (NS).

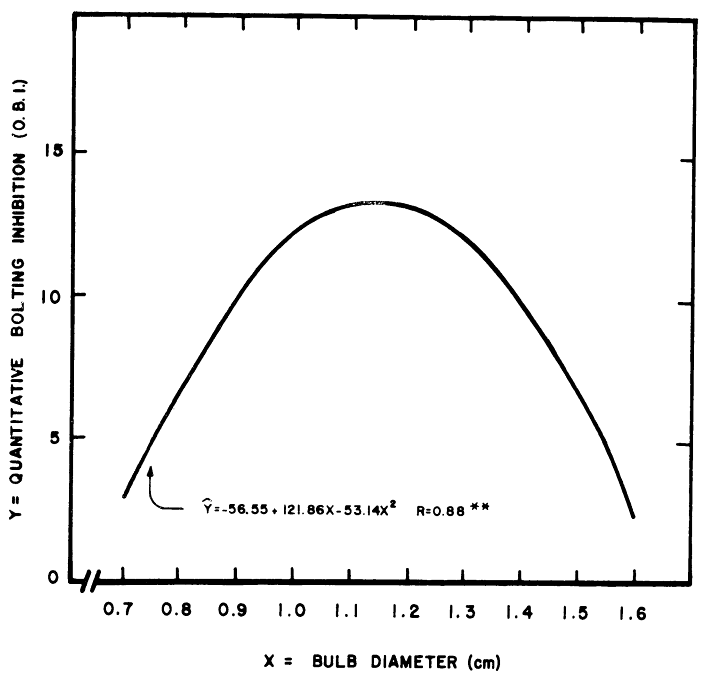

Fig. 1. Relationship and second order regression equation between *Q.B.I. (% Bolting, control – % Bolting, treated)* by 5,000 ppm ethephon and bulb diameter of 'Yellow Grano 502 PRR' onion at 3 times of application (1974-1975). Multiple regression coefficient significant at 1% level (**) of probability.

cm bulb diameter at time of treatment. For the three treatment dates with greatest response, the range was smaller (1.2 to 1.6 cm).

In both years, very large or very small plants were less responsive to ethephon induced inhibition than intermediate sizes. Bulb diameter (or other plant size measurements) could be used to predict the effectiveness of growth inhibition treatments to prevent bolting. For example, if it were determined that a minimum economic response to treatment would be a reduction of 10%, treatment could be recommended for fields having average bulb diameter greater than 0.7 cm by March 8 (Fig. 2). In practice, however, such recommendations would be specific by climate zone and would require multi-year data.

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