Effects of Gibberellic Acid and Nitrogen on the Strawberry cv. 'Redcoat'[1]

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Abstract. **Field grown plants receiving gibberellic acid (GA) 4 weeks or 4 and 8 weeks after planting produced significantly more runners than the control. Compared with the controls, there were no significant vegetative or cropping differences due to rate of GA application. Increasing the rate of applied nitrogen increased runner, runner plant, and % leaf N values in greenhouse grown plants and a GA spray of 50 ppm combined with 120 ppm N gave the highest runner plant yield. Time of GA application was the significant factor in the vegetative response of this cultivar; however, compared with the control the increases were relatively small.**

Several studies have been conducted concerning the effect of rates and dates of application of GA on strawberry fruit yields, (5, 6, 9) runner development and flowering (2, 4, 8). Other investigators (1, 3) were primarily concerned with deflowering and GA as possible means of increasing the production of marketable runner plants in commercial nurseries. They obtained a beneficial effect from the use of GA either alone or in combination with deflowering and also found that time of GA application appeared to be more critical than rate. Some inconclusive results from the use of GA may be due to plant age or varietal variations (7). There have been no reports on the effect of GA on fruit yield or on the GA x N interaction when this chemical was applied during the vegetative stage. The present study was designed to assess the effect of GA on runner and runner plant production, and fruit yield of the strawberry cultivar 'Redcoat', a mid-season July bearer.

Field Experiment 1. Plants were planted in the field on May 23, 1967. The experimental design was a randomized block with 4 replicates, 12 plots per replicate, 4 of which were untreated controls, and 5 plants per plot. Treatments consisted of 3 rates (0, 25 and 50 ppm) of GA (80%, Eastman Organic Chemicals, Rochester, N. Y.) applied as an aqueous spray. Single applications were made 2, 4 and 8 weeks after planting at both 4 and 8 weeks. Plants used in this (and other experiments) were manually deflowered in the year of planting to enhance vegetative growth (3). During the growing season, plants received fertilizer and the recommended pesticides. Runner counts were taken 9 weeks after planting and crop yields were recorded in July, 1968.

GA applications 4 weeks or 4 and 8 weeks after planting were the only treatments that significantly increased runner growth compared with the control (Table 1). Irrespective of time of application, GA did not significantly increase early or total fruit yields over the control. In some instances, time of GA application apparently had a detrimental effect on runner growth and fruit yield. There were no significant effects due to rate of GA application (8.6, 8.8 and 9.2 runners per plant at 0, 25 and 50 ppm) or to the rate x time interaction. The later applications (4 and 8, and 8 weeks) did not appear to enhance the late summer runner growth so as to increase the fruit yield compared with the control.

Field Experiment 2. The design of this trial, planted on May 15, 1968, was similar to that of Experiment 1 except there were 4 plants per plot and only 2 untreated control plots per replicate. Treatments consisted of 3 rates of GA (0, 50, and 100 ppm) applied as follows: single applications at 5 or 10 weeks, at both 5 and 10 weeks and at both 10 and 15 weeks after planting. During the growing season, plants received fertilizer and the recommended pesticides. Runner counts were taken 6, 9, and 14 weeks after planting, runner plant counts were taken 14 weeks after planting and marketable runner plants were dug on May, 1969. Samples of fully expanded recently matured leaves were harvested in September, 1968. The leaves were dried at 80°C, ground in a Wiley mill and total N determined by a micro-Kjeldahl procedure.

GA application did not significantly increase the no. of runners, runner plants, or marketable runner plants when compared with the control (Table 2). Marketable runner plant production following double applications was higher than that following single applications, indicating a probable additive response. There were no significant effects due to rate of GA application (61.9, 65.9 and 61.8 marketable runner plants per plant at 0, 50 and 100 ppm) or to the rate x time interaction.

Greenhouse Experiment. In May, 1968, plants were set in acid-washed 8-mesh silica grits in glazed gallon crocks 6 inches in diam. Four plants were used for each of the 12 treatments. Nutrient solutions, renewed twice weekly, were applied by the use of a continuous drop automatic recycling technique. Nutrient N levels were 2, 20, 70, and 120 ppm and constant nutrient concn in ppm were: P, 5; K, 39; CA, 80;

Table 1. Effect of time of GA application on runners per mother plant, and crop yields (field experiment 1)

GA applications (weeks after planting)	No. runners[a] per plant	Fruit yields (lb./rep) First 3 harvests	Fruit yields (lb./rep) Total harvest
Control	8.6	4.96	9.10
2	8.4	4.60	7.74
4	9.8	5.60	10.45
4 and 8	9.7	5.26	9.58
8	8.1	4.43	8.45
LSD 5%	0.9	NS	1.55

[a]Runner count taken 9 weeks after planting.
NS=not significant

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Mg, 12; S, 16; Fe (as Fe-DTPA), 5; B, 0.37; Mn, 0.55; Zn, 0.065; Cu, 0.064; and Mo, 0.02. A single application of GA at 0, 50, and 100 ppm was applied 3 weeks after planting. Runner and runner plant counts were recorded in September, 1968. Leaf disk samples were taken from the laminae of fully expanded recently matured leaves in September and were prepared and analyzed for total N as described in Field Experiment 2.

Nitrogen at 120 ppm gave the highest runner and runner plant production (Table 3). The analysis of variance showed a significant interaction between rates of applied N and GA on runner plants and leaf N. Consequently, the interaction mean square was used to test main effects. Nitrogen at 120 ppm x GA at 50 ppm gave the highest no. of runner plants per mother plant. Results indicate that N had a greater effect than GA on number of runners and runner plants produced. There were no significant effects due to rate of GA application on runners, runner plants and leaf N. The % leaf N was influenced mainly by rate of applied N (Table 4). Nitrogen applied at 120 ppm resulted in the highest leaf N level. Increasing GA at the 120 ppm N level resulted in a consistent decrease in leaf N values.

Discussion. The 2 field experiments showed that time of GA application, but not rate, was a factor in the vegetative growth of the 'Redcoat' cultivar. However, in only 2 instances did treatment values differ significantly from the control (Table 1). Smith *et al.* (6) studied the effects of concn, no. and timing of potassium gibberellate sprays applied to the 'Sparkle' cultivar during the flower bud initation period. They found a significant increase in fruit yields in the first several harvests but no reduction in total yields when 3 applications of 20 ppm GA were applied at weekly intervals starting on September 10 or 17. Their results indicate that the mode of action of GA was primarily centered on the flowering response, these findings being similar to those of Singh *et al.* (5) and Turner (9). Our studies indicate no beneficial effects of GA upon the first 3 harvests or the total fruit yield, compared with the control, when GA applications were made during the vegetative stage of growth.

The greenhouse study, in which plant competition was not as severe as in the field, showed that the highest level of nitrogen (120 ppm) could produce a larger no. of runners and runner plants compared with the other N levels. A single GA application of 50 ppm combined with 120 ppm N gave the highest runner plant production at a % leaf N value comparable to field values.

The highest total fruit yield in Experiment 1 was only 15% higher than the control and the 5 and 10 week application schedule produced only 9% more marketable runner plants than the control in Experiment 2. These responses suggest that the 'Redcoat' strawberry approaches self-suffiency in endogenous gibberellins and there may be certain periods during the vegetative stage of growth when small increases in plant stand may be obtained from sprays of gibberellin-type hormones. The natural vegetative vigor of this cultivar may also have nullified the applied GA effect, and resultant crowding could possibly have been the strongest growth regulating factor.

Table 2. Effect of time of GA application on runner, runner plant and marketable runner plant yields per mother plant (field experiment 2)

GA application (weeks after planting)	No. runners per plant[a]	No. runner plants per plant[a]	No. marketable plants per plant[b]
Control	19.0	27.2	61.9
5	18.8	27.9	59.5
10	20.6	24.5	58.0
5 and 10	18.4	28.0	67.4
10 and 15	20.1	26.4	64.7
LSD 5%	NS	NS	5.8

[a]Counts taken 14 weeks after planting.
[b]Runner plants dug on May 5-9, 1969.
NS=not significant.

Table 3. Effect of application rates of nitrogen and GA on runner and runner plant yields per mother plant (greenhouse experiment).

Rate of N applied (ppm)	Runners[a] per plant	Runner plants per plant GA(ppm) 0	50	100	Avg
2	3.2	8.8	8.8	5.3	7.6
20	9.1	31.3	29.8	24.8	28.6
70	9.4	31.5	19.3	33.5	28.1
120	11.6	31.0	39.3	31.5	33.9
	Avg.	25.7	24.3	23.8	
LSD 5%	1.0		13.2		4.4

[a]Counts taken at termination of experiment in September, 1968.

Table 4. Effect of application rates of nitrogen and GA on % leaf nitrogen (greenhouse experiment)

Rate of N applied (ppm)	% leaf nitrogen GA (ppm) 0	50	100	Avg
2	1.17	1.49	1.51	1.39
20	1.64	1.68	1.67	1.66
70	2.20	2.29	2.08	2.19
120	2.46	2.30	2.18	2.31
Avg	1.87	1.94	1.86	
LSD 5%		0.34		0.10

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