later-maturing fruit (Table 1). Parthenocarpic peaches were somewhat smaller than nonparthenocarpic peaches sprayed with GA, but the lack of ovule development had little effect on fruit shape or firmness. The GA-treated fruit, both parthenocarpic and nonparthenocarpic, were smaller and more elongated than control fruits harvested on the same date (Table 1). The maturation of 'Cardinal' peaches was not accelerated by GA.

'Ranger'. About half of the 'Ranger' peaches sprayed with GA were parthenocarpic, and this percentage varied only slightly with maturity date (Table 2). As with the 'Cardinal' variety, nonparthenocarpic 'Ranger' peaches harvested from trees sprayed with GA were similar in shape and firmness to the parthenocarpic peaches from the same trees. The GA-treated fruits were more elongated than unsprayed control fruits, and matured about 10 days earlier, as indicated by the date of first harvest (Table 2).

In both varieties the applied GA tended to increase both titratable acids and soluble solids in the mature fruit. Comparisons of parthenocarpic and nonparthenocarpic fruits given the same GA application indicate that the lack of ovule development had relatively little effect on fruit shape or maturity in either variety (Tables 1 and 2). The failure of the early harvests to have a higher proportion of parthenocarpic fruits than the later harvests also indicates that maturity was not accelerated by a lack of developing ovules.

These results indicate that the advanced maturity and elongated shape previously noted in parthenocarpic peaches (2, 3, 4) should not be ascribed to the absence of developing ovules, but rather to the applied GA. The increase in length-diameter ratio of nonparthenocarpic peaches as a result of GA treatment parallels a similar response in apples (6, 7).

The varietal difference in the effect of GA on fruit maturation may be related to the season of ripening. A preliminary experiment indicated that the maturation of late-season varieties was accelerated by GA to a greater extent than that of early-season varieties, such as 'Cardinal'.

Our data also suggest varietal differences in the extent of alteration of fruit shape by GA, since the shape of 'Cardinal' fruit was affected much less than that of 'Ranger'. This difference could, however, be due to the stage of development at the time of GA application.

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Effects of Gibberellin and Alar Sprays upon Fruit Set, Seed Development, and Flowering of 'Bartlett' Pear[1]

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Abstract. **Spray applications of gibberellic acid (GA_3) were tested for their effects in increasing fruit set when applied during bloom in two commercial pear orchards in which cross-pollination was limited. No beneficial effects were obtained, and flower bud formation was inhibited at concentrations of 20 to 100 ppm. In one year, the inhibitory effect of GA_3 upon flowering was partially offset by spraying with 500 or 1000 ppm of succinic acid, 2,2-dimethylhydrazide (Alar) at petal fall.**

In most pear producing districts of California, 'Bartlett' sets commercial crops of parthenocarpic fruits, making cross-pollination unnecessary (3); in New York, other varieties are required as pollen sources. Cross-pollination is a potential source of infection by fire-blight bacteria (*Erwinia amylovora*) in the eastern United States, thus the growing of solid blocks of 'Bartlett' might reduce the spread of this important disease.

Gibberellin sprays have been used successfully in Europe to increase fruit-set of pears when the developing ovules were killed by frosts or when pollinating conditions were unsatisfactory (6,8,9,11,12,13). Tests of gibberellin on 'Bartlett' in California indicated limited commercial benefit, coupled with severe inhibition of flowering (4). In this case, however, controls set good crops of fruit.

Our objectives were to: (a) determine the effects of gibberellin on fruit set and development of 'Bartlett' pears under conditions of limited cross-pollination; and (b) determine if sprays of succinic acid 2,2-dimethylhydrazide (Alar) applied at petal fall would counteract the inhibitory effects of GA upon flower bud formation. The promotive effects of Alar on flowering of 'Bartlett' and 'Anjou' pears had previously been reported (1,5).

A solid block of 'Bartlett' pears planted in 1957 was used in 1964, 1965 and 1968 (Orchard A). The trees were growing in sod near Hamlin, New York, and had produced very few fruits prior to 1964, despite heavy blooms. In 1964, the trees bore an average of 28 lb. of fruit. No other pear varieties were present within a radius of 200 yards, and no bees were introduced for pollination. A second block of mature 'Bartlett' trees near Oswego, New York, also in sod, was used in 1965 (Orchard B), and bloom was light to moderate. 'Bosc' trees were interplanted as pollenizers, but they had fruited heavily in 1964, and bore very few flowers in 1965. Bouquets of 'Clapp's Favorite' and colonies of bees were placed in the

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orchard during bloom to favor cross-pollination.

Sprays were applied either with a high pressure sprayer (Orchard A, 1964; Orchard B, 1965) or with a knapsack sprayer (Orchard A, 1965, 1968). 'Tween 20' surfactant (0.1%) was included in all solutions, and control trees were either left untreated or sprayed with the wetting agent alone. Gibberellin concentrations are expressed in acid equivalents. Two or 3 branches were tagged on each tree, and data recorded as to the original numbers of flower clusters, numbers of fruit developing, and flower bud formation. Samples of 5 mature fruits from each branch were taken for determination of fruit characteristics. Mean values for each tree were analyzed by analysis of variance, and significant differences were determined either with Tukey's test (10) according to the methods of May (7), or with Duncan's multiple range test (2).

Effects of KGA_3 and insect pollination upon fruit set. In 1964, one branch bearing 50 to 100 flower clusters was enclosed in a cheesecloth bag prior to flower opening on each of four trees in Orchard A. A second branch on each tree served as an open-pollinated control. Two of these trees were sprayed at full bloom (May 11) with 50 ppm KGA_3; the remaining 2 were not sprayed. In 1965, styles were cut with scissors prior to flower opening on 1 limb on each of 4 trees in lieu of bagging, and 1 tree was sprayed with 50 ppm KGA_3 at pink (May 11), another at full bloom (May 18), the 2 remaining trees being left unsprayed. The numbers of fruits harvested per 100 flower clusters (Table 1) indicate that preventing insect pollination markedly reduced fruit set, and that treatment with GA replaced the effect of pollination, but did not increase set consistently in open-pollinated flowers.

Effects of concentration and timing of KGA_3 upon response of open-pollinated flowers. To determine if timing of gibberellin application were an important factor in response, KGA_3 was applied at 0, 25, 50, and 100 ppm at pink (May 11), at full bloom (May 18), and at petal fall (May 24) in Orchard A in 1965. Four trees were used for each concentration X time combination, or 48 trees in all. Main effects are given in Table 2, all interactions being non-significant. Gibberellin did not affect fruit set, but increased the percentage of seedless fruits and inhibited flowering. The only significant effects of timing were higher proportions of seedless fruits and less inhibition of flowering with early sprays.

Effects of Alar in counteracting inhibition of flower bud formation by gibberellin. In order to test the effects of Alar in counteracting inhibition of flowering by GA, the following treatments were applied in Orchard A in 1964: (a) wetting agent alone; (b) KGA_3, 100 ppm; (c) KGA_3, 100 ppm plus Alar, 1000 ppm. Five trees were used for each treatment, 3 being sprayed at full bloom and 2 at petal fall with wetting agent or KGA_3. (Effects of timing were factored out by using a randomized complete block design, and analysis of variance indicated no effect of blocks.) Alar was applied at petal fall. In Orchard B, KGA_3 was used at 0, 25, and 50 ppm, and a fourth treatment consisted of 50 ppm KGA_3 plus 500 ppm Alar. Each treatment was applied to 4 trees at petal fall.

In Orchard A, application of Alar partially offset the inhibitory effects of GA upon flowering (Table 3). Maximum flowering of trees sprayed with 100 ppm KGA_3 was 9%, while only 1 of the 5 trees sprayed with both KGA_3 and Alar formed less than 26% flower buds. Fruit set in Orchard B was heavy, and the only effects of a petal fall application of gibberellin were reductions in fruit set and in flower bud formation at both levels of KGA_3 (Table 3). Application of Alar again offset the effect of GA in reducing flower bud formation.

Effects of GA_3 and Alar in a factorial combination. In 1968, sprays of GA_3 (acid, rather than K salt) at 20 and 40 ppm, and Alar at 500 and 1000 ppm were applied in a factorial design in Orchard A, using 4 trees per treatment. The gibberellins were applied on May 7, when approximately 30% of the flowers were open, Alar at petal fall (May 19). Rain which fell approximately 3 hr after the trees were dry on May 19 may have reduced the effectiveness of the Alar.

Weather during bloom was cool and rainy, and fruit set was extremely light (Table 4). Only main effects are shown, as all interactions were non-significant. Gibberellin increased yields, but the effects were small and variable. Trees not sprayed with GA bore 0 to 4 fruits per 100 flower clusters (2 to 24 fruits per tree) at harvest, while those sprayed with 20 or 40 ppm GA_3 yielded 1 to 38 fruits per 100 clusters (23 to 470 fruits per tree). GA_3 increased the percentage of seedless fruits. Flowering of check trees was very heavy in 1969, and inhibition of flowering by GA_3 was non-significant. The combination of a light crop and high rainfall in 1968 led to very vigorous shoot growth, which apparently offset any inhibiting influence of the GA applied. Alar had no effect on fruit yield or seed content at any level of GA_3. The inhibitory effect of GA_3 on flowering appeared to be offset by 1000 ppm Alar, but neither main effects nor interaction were significant.

GA_{4+7} and GA_{13} were tested in parallel experiments. The effects of GA_{4+7} (20 and 40 ppm) were similar to those of GA_3 (increased percentage of seedless fruits, inhibited flowering), while GA_{13} (15 ppm) produced no observable effects.

In view of the absence of both pollenizers and colonies of bees in Orchard A, the sets of fruit in both 1964 and 1965 were remarkably high.

Table 1. Effects of pollination and potassium gibberellate (KGA_3) upon fruit set of 'Bartlett' pear. Numbers of fruits harvested per 100 flower clusters.[x]

Treatment	Year 1964 Tree 1	1964 Tree 2	1965 Tree 1	1965 Tree 2
Not pollinated	2	2	5	0
Not pollinated + KGA_3	55	35	104	42
Open-pollinated	33	18	45	18
Open-pollinated + KGA_3	35	46	60	20

[x]Values for single branches. KGA_3 (50 ppm) applied May 11, 1964 (full bloom) and May 11 (pink - tree 1) or May 18 (full bloom - tree 2), 1965.

Table 2. Effects of potassium gibberellate (KGA_3) on fruit set, seed development, and flowering. Orchard A, 1965-66.

	KGA_3 (ppm) 0	25	50	100	Date[x] 5/11	5/18	5/24
Fruits per 100 flower clusters	26	25	28	36	32	24	31
% Seedless fruits	38	57*	72**	68**	68[b]	68[b]	41[a]
% Buds flowering,	53	19**	7**	5**	26[b]	18[a]	19[a]

[x]Pink, full bloom, and petal fall, respectively.
Within rows, means not followed by the same letters are significantly different from one another at the 5% level.
*Significantly different from no KGA_3 at the 5 (*) or the 1 (**) % level.

The high proportion of seedless fruits reflects the limited amount of cross-pollination occurring, yet preventing insect pollination greatly reduced set. This indicates that a limited amount of pollen of other varieties was available for cross-pollination by bees. The effects of GA_3 on blossoms which were bagged or whose styles were cut confirm the responses obtained by previous workers. However, GA appears to have limited use in commercial pear growing under New York conditions, even in the absence of adequate cross-pollination. An increase in yield was observed only when the controls set very few fruits (Orchard A, 1968), while a reduction in yield occurred when fruit set was heavy (Orchard B, 1965). In areas where spring frosts are a hazard, its use might be beneficial, especially if inhibition of flowering can be limited by petal fall application of Alar as suggested by the data in Table 3.

Table 3. Effects of potassium gibberellate (KGA_3) and Alar upon fruit set and flower bud formation, 1965-66.

Treatment 1965[x]	Fruits/100 flower clusters[y] 1965	% Spurs flowering[y] 1966
Orchard A		
Tween 20 only	–	50[b]
KGA_3, 100 ppm	–	5[a]
KGA_3, 100 ppm plus Alar, 1000 ppm	–	26[b]
Orchard B		
Tween 20 only	78[b]	16[b]
KGA_3, 25 ppm	19[a]	8[ab]
KGA_3, 50 ppm	52[ab]	3[a]
KGA_3, 50 ppm plus Alar, 500 ppm	35[a]	13[b]

[x]KGA_3 applied at petal fall (Orchard B) or at full bloom or petal fall (Orchard A); Alar applied at petal fall.

[y]Within sets, means not followed by the same letter are significantly different from one another at the 5% level.

Table 4. Effects of gibberellic acid (GA_3) and Alar upon fruit set, seed development, and flowering. Orchard A, 1968-69.

	GA_3 (ppm)			Alar (ppm)		
	0	20	40	0	500	1000
Fruits/100 flower clusters	1.1	9.6**	7.8**	4.2	7.6	6.2
% Seedless fruits	25	76**	82**	57	58	68
% Spurs flowering	86	76	74	77	73	87

**Significantly different from no GA_3 at the 1% level.

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Effect of Succinic Acid 2, 2-Dimethyl Hydrazide on Carotene Development in 'Alphonso' Mango[1]

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Abstract. **Five minute dips in aqueous solutions of 2,500 ppm Alar at 25C had no consistent effect on carotene content of the flesh of 'Alphonso' mangoes. A similar dip at 53C caused an increase in both total carotenoids and in β-carotene. This was associated with increased respiratory rate and advance of the respiratory climacteric.**

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Succinic acid 2,2-dimethyl hydrazide (Alar) has been extensively used in recent years by horticulturists for the stimulation of external fruit color (1, 2). Many other chemicals and auxins are also used as pre- or post-harvest treatments to enhance color and improve the market quality of fresh produce (3, 4).

Earlier investigations in this laboratory indicated accelerated ripening and advanced respiratory climacteric maximum when mango fruit was treated with Alar as a post-harvest, momentary dip (5). It was thought desirable to examine the effect of this treatment on the development of carotenoids in the mango fruit.

Mature 'Alphonso' mangoes harvested from a nearby orchard were used in this investigation. The fruits were dip-treated within 24 hours after harvest as follows: 1) cold water at 25C; b) hot water at 53 ± 1C; c) cold water at 25C containing Alar 85, 2500 ppm; and d) hot water at 53 ± 1C containing Alar