Effect of Aqueous Application of GA3 on Flowering of Mango Trees: Why in Certain Instances is Flowering Prevented, and in Others Flowering is Only Delayed?

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ABSTRACT

Sensation mango trees were sprayed with GA3 (ProGibb,® Abbott Laboratories, USA) at 200 ppm in mid-June, when the apical buds were at varying stages of floral differentiation. Budbreak was either inhibited, or 'pure' inflorescences, leafy inflorescences, inflorescence/shoot-like structures (intermediary inflorescences), or shoots developed shortly after treatment. When differing concentrations of GA3 (25 to 200 ppm) were applied, the extent of the repression in inflorescence character was positively related to the GA3 concentration. When Sensation, Tommy Atkins, Kent, Zill and Keitt mango trees sprayed with GA3 (100 ppm) at 14 day intervals from April 20 until Aug. 24 (one spray per tree), the number of inflorescences and intermediary inflorescences developing per tree showed considerable variation in relation to both application date and cultivar. However, application in late July or early August, which was accompanied by pruning to remove the apical buds and any inflorescences present at the time of spraying, resulted in the prevention of further flowering. These results suggest that GA3 inhibits budbreak of still dormant buds and represses continued inflorescence differentiation when applied to differentiating floral buds. Furthermore, it would appear that GA3 is generally effective in preventing flowering if it delays budbreak to a period when environmental conditions are less inductive for flowering, otherwise GA3 may act to delay flowering.

UITTREKSEL

Sensation mangobome is gespuit met GA3 (ProGibb,® Abbott Laboratoriums, VSA) teen 200dpm gedurende middel Junie toe apikale botsels by variërende stadia van blom differensiasie. Boselontwikkeling is geïnhibeer of 'suier' bloeiwyses, blaaragtige bloeiwyses, bloeiwysestingelagtige strukture (intermediêre bloeiwyses), of lote het ontwikkel kort na behandeling. Toe verskillende konsentrasies GA3 (25 tot 200 dpm) toegediende is, is die graad van onderdrukking van die bloeiwysse karakter positief verwant aan die GA3 konsentrasie. Toe Sensation, Tommy Atkins, Kent, Zill en Keitt mango bome met 14 dae intervalle gespuit is met GA3 (100 dpm) vanaf 20 April tot 24 Aug. (een bespuiting per boom), het die hoeveelheid bloeiwyses en intermediêre bloeiwyses 'n redelijke mate van variasie getoon wat beide toedienings datum en kultivar betref. Toediening gedurende laat Junie van vroeë Augustus teame met snoei om die apikale botsels en enige blomme reeds teenwoordig, het verhoed dat verdere bloemvorming voorkom. Uit die resultate kan afgelei word dat GA3 die dormansie periode van nie-ontwikkelende botsels verleng en dit onderdruk bloeiwysse differensiasie wanneer dit toegediende word aan ontwikkelende bloemknoppe. Verder wil dit voorkom dat GA3 oor die algemeen effektief is in die voorkoming van bloemvorming indien dit botsel ontwikkeling vertraag tot 'n periode wanneer omgewingstoestande minder gunstig is vir bloemontwikkeling, andersins kan GA3 bloemontwikkeling vertraag.

INTRODUCTION

During the first few years after planting mango trees, it is desirable to encourage rapid canopy development by pruning, by preventing flowering, by supplying adequate water and fertilizer, and by controlling diseases and insect pests. In South Africa, GA3 spray application at 100 ppm during April, May or June is often found to be effective in preventing flowering. However, inconsistent results have been reported by growers, and questions remain, specifically concerning the time of application for successful flower prevention with respect to a particular cultivar.

The inhibition of flowering in mango by GA3 application has been reported by a number of researchers (Kachru et al., 1971; Sigler et al., 1981; Rawash et al., 1983; Tomer, 1984). Inconsistent effects have however been encountered, which appear to relate to the time of application relative to that of floral bud differentiation, the concentration of GA3, and the cultivar treated (Kachru et al., 1971; Tomer, 1984; Nunez-Elisea and Davenport, 1991).

GA3 delays budbreak in mango (Kachru et al., 1971; Nunez-Elisea and Davenport, 1991). Kachru et al. (1971) found that budbreak was delayed and flowering prevented after application at 10⁻¹ M to undifferentiated Dashehari apical buds. Application at 10⁻³ M resulted in a lesser delay in budbreak, and flowering generally occurred. In Keitt, Nunez-Elisea and Davenport (1991) found that the development of axillary buds on deblossomed terminal shoots treated with GA3 shortly after deblossoming was delayed in direct relation to the concentration of GA3 applied (10 to 250 ppm).
Flowering always occurred, but was slightly suppressed following application at the highest concentration.

The aim of the present study was to ascertain the effect on flowering of GA3 sprayed on mango trees whose apical buds are at differing stages of floral differentiation (Expt. I), to determine whether differences in the response of buds undergoing floral differentiation depend on the concentration of GA3 applied (Expt. II), and to ascertain the effect on flowering of the time of GA3 application relative to that of normal flowering (Expt. III).

MATERIALS AND METHODS

Expt. I

In early June 1992, 10 adjacent, two-year-old Sensation mango trees were selected at Constantia Estate (latitude: 23°40'S; longitude: 30°40'E; elevation: 457 m). On June 12 1992, when signs of apical budbreak were apparent, the trees were sprayed to run-off with 200 ppm GA3 (ProGibb,® Abbott Laboratories, USA). It is noteworthy that Sensation flowers unevenly in the Northern Province of South Africa, and hence, it was expected that variation in the stage of floral differentiation of the apical buds existed at the time of spraying. The responses of the trees were closely observed after spraying.

Expt. II

In early June 1992, 40 two-year-old Sensation mango trees of uniform size were selected at Constantia Estate. On June 12 1992, when signs of apical budbreak were apparent, 32 of the trees were sprayed to run-off with GA3 (ProGibb®) at 25, 50, 100 or 200 ppm. Single trees served as plots in a randomized complete blocks design comprising eight blocks with five trees in each. Eight unsprayed trees served as controls.

On Aug. 12 1992, after the flowering period, two terminal 'structures' [inflorescences, inflorescence/shoot-like structures (intermediary inflorescences) or shoots] having grown as a result of immediate development of the apical bud, were randomly removed from each tree, and the fresh weight of the primary axis, secondary and higher order axes, bracts/leaves, and flowers comprising each structure were separately determined. The data (tree averages) were subjected to analysis of variance.

Expt. III

In early April 1993, 55 two- to three-year-old mango trees in each of six separate cultivar blocks were selected at Mariepiskop Estate (latitude: 24°25'S; longitude: 30°52'E; elevation: 550 m). The cultivars used were Sensation, Tommy Atkins, Heidi, Kent, Zill and Keitt. GA3 (ProGibb®) at 100 ppm was sprayed on the trees every 14 days from April 20 until Aug. 24 1993 (10 spraying dates). One spray was administered per tree, and five trees of each cultivar were sprayed to run-off on each date. If the trees due to be sprayed were flowering or starting to flower at spraying, the apical buds and any inflorescences present were removed by pruning just prior to spraying. Five unsprayed trees per cultivar served as controls. In each cultivar block, single trees served as plots in a com-
New shoots developing from buds whose dormancy was prolonged by GA3.

After spraying, the trees were inspected weekly, and the growth responses were noted. In mid-October, the number of inflorescences and intermediary inflorescences on each tree were counted. The data were subjected to analysis of variance.

RESULTS AND DISCUSSION

Expt. I

Budbreak was either inhibited, or 'pure' inflorescences, leafy inflorescences, intermediary inflorescences, or shoots developed after spraying. Elongation of the primary axis and higher order axes of the 'pure' and leafy inflorescences was accentuated, and as a result, the flowers were widely spaced (Figs. 1 and 2). The intermediary inflorescences were characterized by well developed leaves (bracts), and shortened inflorescence branches which bore reduced numbers of flowers (Fig. 3). The primary axis, although elongated and often having the reddish colouring of an inflorescence axis, resembled the stem of a terminal shoot. In extreme cases, the inflorescence branches were very poorly developed, in which instance these structures strongly resembled terminal shoots. The 'pure' shoots that developed had some inflorescence features in that the stems were often reddish and elongated, and the leaves were of a lighter green than normal leaves (Fig. 4). In a number of instances stunted shoots arose (Fig. 5). Most of the apical buds not breaking showed some swelling. Swelling of the adjacent axillary buds was also noted (Fig. 6). Some weeks after flowering, the swollen apical and axillary buds developed as shoots (Fig. 7).
Fig. 10 Number of inflorescences or intermediary inflorescences developing per tree in relation to GA3 application date, for each cultivar. Treatment differences significant at $P = 0.001$ (***)
The foregoing observations suggest that the GA3 applied inhibited break of still dormant buds, but repressed or inhibited continued inflorescence differentiation in differentiating floral buds (reversion to shoot differentiation). It would appear that 'pure' or leafy inflorescences developed if floral differentiation was advanced at the time of application, whereas inflorescences which resembled shoots (intermediary inflorescences) developed if floral differentiation was in its early stages at the time of spraying. Shoot development would appear to indicate application when floral differentiation had just been initiated or was about to be initiated. The occurrence of stunted shoots may indicate partial dormancy re-imposition by GA3 in buds that were about to grow at the time of spraying. The swelling response of the apical and axillary buds seems to indicate some form of bud development despite the re-imposition of dormancy by GA3.

**Expt. II**

The degree of inflorescence-character repression in relation to the concentration of GA3 applied is shown in Fig. 8. As the concentration increased, the weight of the primary axis and leaves (bracts) increased, and that of the inflorescence branches (secondary and higher order axes) and flowers decreased. A reduction in the number of secondary inflorescence axes initiated was also associated with the increase in GA3 concentration (Fig. 9). The increase in weight of the primary axis was partly due to increased elongation of this axis (data not shown).

These results signify that GA3 represses rather than inhibits continued floral differentiation when applied to differentiating floral buds, and that the degree of repression is positively related to the concentration of GA3 applied.

**Expt. III**

Flowering of the unsprayed trees (normal flowering) commenced in mid-May in Zill, in mid-July in Keitt, Kent and Tommy Atkins, and in late July in Sensation and Heidi. GA3 had the general effect of delaying budbreak. However, budbreak was not always delayed, particularly in the trees that were sprayed two or four weeks prior to normal flowering. GA3 delayed budbreak in the trees that were pruned.

The average number of inflorescences and intermediary inflorescences developing per tree in relation to application date is shown for each cultivar in Fig. 10. Prior to the times of pruning, a reduction followed by an increase in inflorescence number generally occurred with application date. The latter increase was mainly due to the development of intermediary inflorescences, presumably as a result of floral bud differentiation at the time of spraying. In every cultivar, the number of inflorescences and intermediary inflorescences developing after pruning and spraying declined with application date. Very few inflorescences developed when these treatments were carried out in late July or during the second week of August.

It was interesting to observe that GA3 was sometimes effective in enhancing flowering (Heidi, Zill). Moreover, the degree to which flowering was prevented, and the flowering 'intensity' pattern in relation to application date differed to a large extent between the cultivars.

The results of this experiment suggest that GA3 is generally effective in preventing flowering if it delays budbreak to a period when environmental conditions are less inductive for flowering, otherwise GA3 may act to delay flowering.

**CONCLUSION**

The results of the present study are generally consistent with the studies cited previously. They support the view that GA3 prevents flowering by delaying budbreak until after the flowering period. However, in the case of GA3 application to differentiating floral buds, a repression of continued floral differentiation as opposed to its inhibition by GA3 is indicated (Experiment II), which has not been considered before.

It is desirable to prevent young mango trees from setting fruit for the purpose of hastening canopy development. In South Africa, it is currently recommended that young mango trees be sprayed with 100 ppm GA3 (ProGibb®).

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**LITERATURE CITED**


