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MANAGEMENT INTERVENTIONS FOR IMPROVED YIELD IN MANGO CV JULIE

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ABSTRACT: Management protocols to enhance flowering and fruit set of Julie mango were investigated at two locations in Trinidad over two seasons. The protocols tested represented the positive results of previous studies on flowering or yield of Julie mango conducted within the region over the past ten years. Treatments included potassium nitrate for flower induction, and the use of microelements, fungicide and insecticide for improved fruit set and post fruit-set protection. Potassium nitrate application resulted in significant increase of flowering in the second trial only. In the first trial, a combination of all treatments resulted in increased yield, as assessed at 14 weeks. In the second trial increased yield was found to be due to fungicide only. Despite the applications, the yield in the second trial was very poor. This leads to the conclusion that there were limitations other than nutrition, pests or disease that affected final yield.

INTRODUCTION

Julie is the most popular and major export mango in the southern Caribbean. It is a dwarf cultivar that shows readiness-to-flower throughout most of the year. This leads to sporadic flowering that may result in little or no set except for the main crop. The main crop occurs around June and there may be continuous light cropping thereafter. The demand for Julie by exporters has fueled work in making the cultivar more productive.

The approach that has received most attention is the concentration of flowering and improvements in fruit set using growth regulators such as potassium nitrate (KNO_3) and paclobutrazol (Andrews and LeeFook, 1990; James, 1993; Andrews, 1994, Shongwe and Roberts-Nkrumah, 1996; Mossak, 1997). The need for control of pests (Daisley et al., 1994) and the major disease anthracnose (Fortune et al., 1994) has also been reported.

Whitwell (1993) demonstrated the potential losses at fruit set due to pests in Dominica, including the gall midge *Erosomyia mangiferae* Felt, larvae of geometrid moths, thrips *Frankliniella sp.,* and the mirid bugs *Dagbertus* sp. and *Rhinacloa antennalis* (Reuter). Of these the mango gall midge was the most serious followed by the geometrid larvae. Daisley et al. (1994) also reported on gall midge damage and the use of traps for control of fruit fly *Anastrepha obliqua* (Macq.).

The integration of these factors into a single orchard management program has not been tested locally as it has been in Dominca (Robin et al., 1997). To this end, an attempt was made to demonstrate increased yield of Julie through flower induction, enhancement of nutrition, and pest and disease control in two trials at separate locations in Trinidad.

MATERIALS AND METHODS

Two trials were conducted during the period February to May 1998 and June to July 1999, the first at Todds Road Estate and the second at La Gloria estate. Trees were 12 years of age and single tree plots were used.

All spray applications were made with a Stihl™ mistblower. Trees were sprayed to dripping, each tree receiving about 1.5 L of mixture. Trees treated for flower induction were sprayed with an 8% solution of potassium nitrate.

Trial 1: This trial was performed during the dry season of 1998, on the L'Ebranche Soil series. Thirty-nine July mango trees, with relatively few or no panicles, were selected from a single row of fifty trees bordering a trace. On each tree a branch supporting 30-100 terminal shoots was selected to serve as the sample unit. Three treatments were applied to the trees in a completely randomized experimental design with thirteen replicates. The treatments were as follows: Treatment I - control, no intervention; Treatment II, one application of potassium nitrate at day one; Treatment III, one application of potassium nitrate at day 1, followed one week later by an application of microelements, fungicide and insecticide, and applications of fungicide and insecticide after week three and week seven. Microelements were applied as a 0.5% solution of Microzit. Fungicide was applied as a 1.0 % a.i. emulsion of Chlorothalonil as Daconil for the first application, and as Daconex thereafter. Insecticide was applied as a 0.1% emulsion of lambda cyhalothrin as KARATE 2.5 EC™; concentration of active ingredient was 25 ppm.

Three weeks following the initial application of KNO_3, ten panicles were labeled within each sample unit. In two units ten panicles were unavailable within the plot, so the nearest adjacent panicles were labeled to make up the required number.

The number of terminal shoots in each plot was recorded at the start of the trial. The number of panicles per plot was determined 21 days after the KNO_3 application. The number of fruit per labeled panicle, fruit per plot, and fruit per tree was recorded at fourteen weeks. At this time, fruits were of two distinct sizes. Fruit, which had set during the initial four weeks of the trial, were roughly 8-12 cm long whereas a subsequent period of fruit set resulted in fruit 2-4 cm in length. Canopy diameter was measured in two directions at fourteen weeks after treatment. Panicle counts of treatments II and III combined were compared to the control using a t-test (Statgraphics 6). Fruit per shoot, fruit per panicle, and fruit per tree of the three treatments were analyzed by ANOVA (Minitab, 1991). Data for the latter (fruit per tree) were standardized by the surface area of the canopy assuming a hemispherical shape.

Trial 2. This trail was conducted on a 5-ha block of Julie on Tarouba clay soil at the La Gloria estate in south Trinidad. For this trial uniform management of the trees began one year prior to the study and included pruning branches close to the ground. The pruning served to minimize variability within blocks. A factorial experimental design was adopted in order to determine which of the treatments, in which combinations, were responsible for the increased fruit set. This trial was laid out as a factorial (3 factors, 2 levels) in a randomized block design with 11 blocks.

Treatments were as follows:

1. Microelement x 1
2. Insecticide x 2
3. Fungicide x 3
4. Microelement x 1, Insecticide x 2
5. Microelement x 1, Fungicide x 3
6. Insecticide x 2, Fungicide x 3,
7. Microelement x 1, Insecticide x 2, Fungicide x 3
8. No applications.

The insecticide used was alpha cypermethrin as Pestac 5EC™ at a rate of 50 ppm, and the fungicide was Daconex™ as in Trial 1 at a rate of 13.3 g/L. Microelement rate was 2.1 g/L using Microcomplex Foglaire™. All trees were fertilized with NPK (26:0:26) at a rate of 500 g/tree on 23rd July and 500 g/tree 19th November 1998. Potassium nitrate was applied on three occasions - 2nd and 10th March, the second because of rainfall during the first application. The final application was on 28th April 1999 after removal of young fruit. Fungicide treatments began on 19th February 1999 and were repeated at monthly intervals. Insecticide was applied on 24th March 1999 and repeated after three weeks.

Flower count was done as a percentage of canopy covered on 26th February 99 and 24th March 99. This data was expressed as high (>60%), medium (30-60%) and low (0-29%). Total fruit set per tree was recorded 7 weeks after potassium nitrate treatment by harvesting off all fruit and doing a count. Results were analyzed by ANOVA (Minitab, 1991).

RESULTS

Flower induction

The effect of KNO_3 on flower induction was not demonstrated (Table 1).

Table 1. Effect of KNO_3 application on flower induction.

Treatment	Mean percentage of shoots with panicles (SEM)
KNO3	38.0 (5.0 %)
Control	22.9 (7.4 %)

Computed t statistic = 1.61, $\alpha = 0.05$ P 0.116

Fruit set

Trees treated with KNO_3 followed by microelements, fungicide and pesticide showed increased fruit set (Table 2).

Table 2. Effect of management practices on fruit set per shoot, per panicle and per tree (Todds Road, 1998).

Treatment	Mean fruit set			
	per 100 shoots * P = .036	per 10 panicles P = 0.1	per m^2 canopy Large fruit P= 0.08	per m^2 canopy Small fruit P = 0.008
Control	1.37 (0.24) {0.87}	0.62 (0.57)	3.35 (1.84)	3.66 (0.76)
KNO_3 only	1.57 (0.24) {1.47}	1.30 (0.51)	4.49 (1.84)	1.23 (0.76)
Full works	2.26 (0.24) {4.11}	2.30 (0.51)	9.06 (1.84)	0.13 (0.76)

* Data transformed $y = \sqrt{(x + 1)}$, {Back-Transformed Mean} (SEM)

Flowering

Most trees were observed to be flowering on 26th February 1999 after undergoing uniform vegetative flushing in August 1998. Flowering response to the March applications of potassium nitrate was observed to be very good on 1st April 1999, three weeks after the second application. More than 95% of trees flowered heavily whereas non-trial trees had only 45% of trees flowering heavily ($P<0.001$). Flowering of trees after the last application of potassium nitrate was neither heavy nor uniform, and the trial was subsequently discontinued.

Fruit set

Fruit set was poor resulting in a mean of just 12 fruits per tree (SEM= 0.75). Yield data as count gave a skewed curve and were therefore transformed (√) before analysis. Analysis of Variance showed significant effect due to fungicide treatment ($P<0.002$).

Table 3. Means table of fruit set, Trial 2 La Gloria Estate.

Factor	Mean Yield/tree (Transformed)	SEM	Back Transformed mean
Fungicide	3.355	0.300	11.3
No Fungicide	1.983	0.300	3.9
Insecticide	2.526	0.304	6.4
No Insecticide	2.813	0.296	7.9
Microelements	2.448	0.300	6.0
No Microelements	2.891	0.300	8.4

Table 4. ANOVA table, transformed fruit set data for Trial 2.

Source of Variation	Degrees of freedom	Seq SS	Adj MS	F	P
Block	10	102.817	10.303	2.68	0.008
Fungicide	1	41.224	40.253	10.47	0.002
Insecticide	1	1.920	1.761	0.46	0.501
Microelement	1	4.143	4.202	1.09	0.300
Fungicide*Insecticide	1	13.148	12.542	3.26	0.075
Fungicide*microelement	1	0.285	0.213	0.06	0.815
Insecticide*microelement	1	8.706	8.706	2.26	0.137
Fungicide*Insecticide *microelement	1	6.903	6.903	1.80	0.185
Error	68	261.465	3.845		
Total	85	440.630			

DISCUSSION

Trial 1 was successful in demonstrating an increase in fruit set with full management, but was unsuccessful at demonstrating whether the increase was due to panicle initiation or protection of panicles plus nutrition. Both these factors may be operating but against a background of high variability. This variability may be inherent, in which case a larger sample size may be necessary, or may be due to differences in location or prior management. It was observed that one stretch of trees, from tree 16 to tree 30, produced very few fruits. It is possible that these trees had experienced competition for light from either adjacent trees or vine cover.

The results of Trial 2 indicate that at the La Gloria site only fungicide treatment was instrumental in increasing yield despite the low set that occurred overall. The reason for poor set is unknown but is thought to be unrelated to pollinator activity since houseflies were seen in the field and two non-Julie trees there fruited well. Few female flowers were evident from a cursory examination of Julie inflorescences in April 1999. It is proposed that the sex ratio of Julie be monitored over time together with the flowering pattern of possible pollinizer cultivars in a follow up exercise. Van Hau (1997) reported that potassium nitrate did not affect sex ratio of seedling mango inflorescences, however, Shongwe and Roberts-N'Krumah (1996) reported increased maleness in panicles of Julie but no data were provided. Trial 2 also confirmed the action of potassium nitrate in increasing flowering in Julie.

Examination of insects on a few panicles at the time of insecticide application showed that some pests were present including geometrid larvae, thrips, mirid bugs, and gall midges. Whitwell (1993) demonstrated the potential losses due to these pests in Dominica, especially the gall midge. The populations that he referred to, however, were higher than those observed in these trials. In addition, the concentration of flowering due to the potassium nitrate should have resulted in relatively low pest densities. Although it is possible that these insects could have resulted in the loss of developing fruit, we are confident that if pests were an important limiting factor in this trial, this would have been picked up in the analysis for insecticide treatment.

Despite the ample flowering and the opportunities presented in the trial to control pests and disease and to satisfy nutritional requirements, fruit set was uniformly very poor. Whereas this finding may be generally indicative of an off-year production, the poor set was not due to physiological fruit drop as there was very little fruit set in the first place. Also discounted was the possibility that blossom blight prevented fruit set. This did not appear to be the case, nor was there a shortage of pollinators in the field.

This leads to the conclusion that the problem is one of poor initial set probably due to low percentage of bisexual flowers, unavailability of pollenizer pollen or abnormal flower development. Abnormal flower development may be reflected as poor stigmatic receptivity, low viability of pollen, or poor ovule or style development. The clarification of these issues is the next logical step in elucidating and solving the problem of the sometime poor yield despite adequate induced flowering in Julie mango.

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