CHAPTER 3

EFFECT OF FRUIT THINNING ON 'SENSATION' MANGO (*MANGIFERA INDICA*) TREES WITH RESPECT TO FRUIT QUALITY, QUANTITY AND TREE PHENOLOGY.

3.1 ABSTRACT

Different fruit thinning methods (various intensities in manual fruit thinning as well as a chemical thinner) were tested on 'Sensation' mango trees both as initial and cumulative effects during two seasons (2001/2002 and 2002/2003). The trial was conducted at Bavaria Estate, in the Hoedspruit area, Northern Province of South Africa. The thinning treatments were carried out in October before the occurrence of excessive natural fruit drop. The objective of the study was to select the best thinning intensity or method, based on their impacts on different parameters. Where fruit on 'Sensation' were thinned to one and two fruit per panicle, a significant increase was obtained for most of the fruit quantitative yield parameters. With the treatments where one fruit and two fruit per panicle were retained and 50% of the panicles removed, a significant increase in fruit size was noted. The same trees also produced higher figures for most of the fruit qualitative parameters as well as fruit retention percentage. However, the trend showed that bigger sized fruit were prone to a higher incidence of physiological problems, especially jelly seed. Chemical fruit thinning with Corasil.E produced very small sized fruit with a considerable percentage of "mules" (fruit without seed). Trees subjected to severe thinning intensities showed earlier revival of starch reserves and better vegetative growth.

Key words: fruit per panicle, fruit quantity, fruit quality

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3.2 INTRODUCTION

Within a reproductive cycle, it is apparent that many plants produce far more flowers than they could possibly support as fruit. Many mango cultivars in general, and 'Sensation' in particular, set a huge number of fruit of which more than half are abscised from the tree prior to harvest. Consequently, with no human interference, a tree that has set a large crop will tend to abscise far more fruit, than if the fruit on the trees were thinned beforehand, thus reducing the yield to below levels the tree is capable of supporting (Davie & Stassen, 1997b). Therefore, the delay in ridding itself of the excess fruit results in wastage of carbohydrate, which is eventually reflected in the smaller size of the remaining fruit. Commercially, it is frequently desirable to have a smaller number of large fruits rather than a large number of small ones (Jackson, 1989). Janse Van Vuuren *et al.* (1997) indicated that as much as 65% of the starch of plants in an "on" year is finally channelled to the fruit. Hence, heavy fruiting in one-year, leads to poor flower initiation and light fruiting the following year (Wright, 1989). Generally, the tree size and its carbohydrate storage capacity is one of the most important factors that determine the number of fruit the tree can nurture to maturity (Davie *et al.*, 1995). Fruit thinning may therefore be the answer for starch conservation and regular bearing.

Manual or chemical thinning of blossoms or fruit to enhance fruit size is practiced in a number of fruit crops. Knight (1980) working with 'Cox's Orange Pippin' apple found that 'part tree' fruit thinning was not as effective as selective 'whole tree' thinning. The best results were obtained by thinning within fruit clusters, suggesting that the competitive effects are rather localised. This indicates that, if accurate fruit thinning is required, the number of individual fruit per cluster should be reduced rather than removing all the fruit on a portion of the cluster (Knight & Jackson, 1980). Corasil.E is an emulsifiable concentrate plant growth regulator basically used for improving the fruit size of mandarin and orange. Its effect on mango fruit size was studied in the current study. It is generally recognised that the effect of thinning is most pronounced when performed early, i.e., at or soon after full bloom or at or soon after initial fruit set (Richardson & Dawson, 1994). In an experiment to determine the effect of fruit thinning on fruit drop and fruit size, Davie *et al.* (1995) found that the timely reduction in the number of mango fruits on the tree, to a quantity the tree can cope with, greatly reduced further fruit drop and at the same time resulted in a 15% increase in fruit size. Fruit thinning, by reducing competition for carbohydrates between fruits (Horscroft & Sharples, 1987), also improves fruit quality in terms of firmness, soluble solids content and anthocyanin formation, hence red skin colour. The effects of fruit thinning on market quality appear to result from reducing competition for assimilates. Its effect on biennial bearing seems to result from reducing the supply of seed-produced hormones which inhibit fruit bud formation (Jackson, 1989). Even if the effect of thinning has been evaluated, there was no investigation as to how and how many fruit to be thinned. Mango cultivars like Sensation produces small and poor export quality fruit that can be improved by applying suitable fruit thinning intensity. Nevertheless, there is no information about the effects of specific thinning intensities on mango production and fruit quality. Thinning spontaneously may affect tree reserves as well as may lead to unnecessary loss of crop. This necessitated conducting an experiment on different fruit thinning methods and intensities. This study reports on fruit thinning experiments done on 'Sensation' mango trees from which South Africa is getting considerable export income.

3.3 MATERIALS AND METHODS

3.3.1 Area description

The trial was conducted at Bavaria Estate, in Hoedspruit area, Northern Province of South Africa (latitude: 24^0 25'S; longitude: 30^0 54'E; elevation: 600 m.a.s.l.) during 2001/2002 and 2002/2003 seasons.

3.3.2 Plant material

After flowering, seventy-two (8-year-old) and sixty-three (9-year-old) 'Sensation' mango trees of uniform size and vigour were selected to study the initial as well as cumulative effects of treatments. All treatment trees were subjected to the standard orchard management practices as applied at the Fruit Estate.

3.3.3 Treatments applied

The total number of fruit on each tree was counted during early October 2001 and 2002 before applying the treatments. The average number of fruit per tree at that time was more than 250 fruit of varying size (each fruit being approximately 15 mm. in diameter). Various treatments were applied in different seasons and experimental groups (1a, 1b and 2) (Table 3.1). Since experiment 1b was the continuation of 1a during the subsequent season, the results of only experiments 1b and 2 were compared with each other in order to determine season-by-treatment interactions in the result and discussion. The details of the three separate experiments are presented in Table 3.1 below.

Table 3.1 Details of treatments applied and their treatment codes according to the seasons and various experiments conducted

Treatments	Experiments/Seasons		
	1a (2001-2002)	1b (2002-2003)	2 (2002-2003)
1	†Removing all fruit (No result for first harvest)	‡All fruit retained	Spraying trees with Corasil.E as a chemical fruit thinner
2	Thinning fruit to one fruit per panicle	Thinning fruit to one fruit per panicle	Thinning fruit to one fruit per panicle
3	Thinning fruit to one fruit per panicle and removing 50% of the panicles	Thinning fruit to one fruit per panicle and removing 50% of the panicles	Thinning fruit to one fruit per panicle and removing 50% of the panicles
4	Thinning fruit to two fruit per panicle	Thinning fruit to two fruit per panicle	Thinning fruit to two fruit per panicle
5	Thinning fruit to two fruit per panicle and removing 50% of the panicles	Thinning fruit to two fruit per panicle and removing 50% of the panicles	Thinning fruit to two fruit per panicle and removing 50% of the panicles
6	Control (No thinning)	Control (No thinning)	Retain average sized fruit
7	----------------------	----------------------	Control (No hand or chemical thinning)

† There was no result for treatment 1 in 2001-2002 season due to removal of all fruit

‡ A continuation of experiment 1a where all fruit in treatment 1 was retained to evaluate effects for treatment 1 of experiment 1a

NB: During launching experiment 2, trees were sprayed with Corasil.E as one treatment that has an active ingredient of Dichlorprop (as 2-butoxyethyl ester) 50g/l.

3.3.4 Parameters studied and design used

In experiment 2, the trees were sprayed with Corasil.E (treatment 1). It has Dichlorprop (as 2-butoxyethyl ester) as an active ingredient. Quantitative as well as qualitative parameters were measured in all the three trials, but due to cost implications, only experiment 1a was considered for starch analysis and measurement of vegetative growth parameters. Accordingly, the following parameters were evaluated:

Yield

The fruit left on each tree was counted after applying the treatments. During harvesting, on 6 February 2002 and 1 February 2003, for the first and second season experiments respectively, the number of fruit retained on each of the trial trees were counted to calculate fruit retention percentage and then weighed to calculate yield based on tree spacing, and was finally presented as t ha^{-1}.

Fruit quality

Different fruit quality parameters were also measured after shipping simulation by storing the fruit for 28 days at 10 ^{0}C and ripening them at room temperature for two days. All the sampled fruit passed through the commercial pack house procedures. For this purpose, two representative fruit from three size groups (small≈30mm, medium≈50mm, large≈70mm in diameter) of each tree were taken for recording specific parameters: The total soluble solids (TSS) was measured using a EUROMEX handheld digital refractometer. The titratable acid (TA) was measured after preparing the sample by mixing the pulp of the six sampled fruits per tree and mixing them together with a juicer. The samples were centrifuged for ten minutes at 1000-rpm intensity. The floating fluid on top of the sedimented pulp from the centrifuge was then diluted to 1:4 with deionised water and titrated using a METTLER TOLEDO DL 25 (Mettler-Toledo Inc., USA) Titrator, using 0.1 N sodium hydroxide solution. The titratable acid is expressed in m eq l^{-1}. The fruit firmness was measured using 8 mm diameter Penetrometer probe, after peeling a portion of the exocarp and expressed as kg cm^{-2}. Presence of any physiological defects in the fruit, particularly jelly seed, was assessed using Fivas's (1997) guidelines.

Vegetative growth

Vegetative growth data was taken on May 2002, once new shoot development had ceased. The total number of new flushes developed, the length of twenty randomly selected new flushes, number of leaves per new flush and the length as well as width of forty newly developed leaves randomly selected from the whole tree canopy was measured. The leaf area of each of the forty leaves measured was calculated using the formula:

$$Y= -0.146+0.706X \ (r^2=0.995)$$

where Y= leaf area (cm^2) and X = leaf length (cm) × leaf width (cm) (Nii *et al*., 1995). It is expressed in cm^2.

3.3.5 Starch analysis

Wood, bark, leaf and fruit samples were also taken from each of the trial trees for starch analysis. Wood samples for analysis were collected immediately before applying the treatments (24 October 2001), during peak fruit development stage (10 January 2002), soon after harvest (8 March 2002), during rest period (3 May 2002) as well as during bud maturation and burst period (10 July 2002). Due to cost implications, bark, leaf and fruit samples for analysis were collected during October 24-2001 and January 10-2002 representing starch status of the samples before treatment application and during peak fruit development stage, respectively. In all stages, fresh and disease free samples were collected. The sampled plant parts were oven dried at 70 ^{o}C before the starch analysis. The starch analysis was conducted according to the AOAC (1980) procedure, but the enzyme chromogen reagent was prepared with 4-amino-antipyrine instead of orthodianisidine as recommended by Karkalas (1985). In addition a further modification was introduced in order to remove any interfering substances (phenolics) as per the method used by Davie & Stassen (1997a). The periods when samples were collected represent different tree phenological phases and the reason for this was to identify possible relationships between starch content and tree phenological phases as influenced by the treatments. The starch results are expressed as mg g^{-1} dry matter.

A randomised complete block design was used with three blocks and four trees (experiment 1a and 1b) and three trees (experiment 2) per plot. The trees on the outermost rows of all the blocks were not used as treatment trees to avoid border effects. Besides, a movable canvas shield was used to cover a tree when it was being sprayed with Corasil.E, to prevent spray drift contamination to other trees.

3.3.6 Statistical analysis

Analysis of variance (ANOVA) was used for the two cultivars separately to test differences among thinning treatments in each season separately and combined. The test for the data distribution proved to be normal with homogeneous treatment variances. The data was analysed using GenStat (2000). Treatment means were separated using Fishers' protected t-test least significant difference (LSD) at the 5% level of significance (Snedecor & Cochran, 1980).

3.4 RESULTS

3.4.1 Quantitative parameters

The results of the quantitative parameters of the different experiments are summarised in Tables 3.2 and 3.3. As expected with no thinning, the control trees bore a significantly higher number of fruit when counted immediately after treatment application (Table 3.2). Treatments 2 and 4 (1fr/pan and 2fr/pan) had a significantly higher number of fruit at harvest for experiments 1a (179 and 182) and 1b (181 and 186) respectively (Tables 3.2 and 3.3). Treatment 1 (Corasil.E) showed the highest number of fruit (191) for experiment 2 (Table 3.3).

In the current experiment, trees treated with Corasil.E, in spite of producing smaller sized fruit, retained more fruit per tree. As would be expected, it was observed that, when a higher number of fruit was left on the tree (no thinning or less thinning intensity) the lower was the fruit retention percentage (Tables 3.2 and 3.3). Consequently, treatment 3---1fr/pan+50%pan had 26.5% increment in the percentages of fruit retained as compared to the control. The same trend was followed for fruit mass and hence there was a relationship between thinning intensity and the individual as well as average fruit weight at harvest. The treatment with the highest thinning intensity (treatment 3---1fr/pan+50%pan) produced a significantly higher average fruit weight (346 g) as compared to the control (331 g) in experiment 1a (Table 3.2).

The result was also significantly higher than all the other treatments. In experiments 1b and 2, the same trend as above was seen except that treatment 2 (1fr/pan) showed a better average fruit weight (340 and 338 g respectively) equivalent to treatment 3 (1fr/pan+50%pan) (347 and 337 g respectively) (Table 3.3). The lowest fruit mass was recorded for the control trees of experiment 1a (331 g) and treatment 1 (all fruits thinned and Corasil.E sprayed) of experiments 1b and 2 (327 and 245 g) respectively (Tables 3.2 and 3.3). Fruit size variations and distribution of fruit in different counts (number of fruit per box) due to the treatments are shown in Fig. 3.1, 3.2 and 3.3.

In these experiments, leaving one or two fruit per panicle proved to increase the yield significantly higher than all the other treatments for all the three trials (Tables 3.2 and 3.3). There was a 6.5 and 7% yield increment after application of treatment 2 (1fr/pan) and treatment 4 (2fr/pan) respectively, as compared to the control in experiment 1a. In experiment 1b and 2, the two treatments had 8.4/8.2 and 8.7/7 % yield increment over the control.

Table 3.2 Mean fruit quantitative and qualitative data of 'Sensation' for experiment 1a

Thinning treatments	FNAT	FNAH	FRP	AFWAH	Y	FIRM	TSS	pH	TA	PP
2(1fr/pan)	213b	179cd	83.9bc	340bc	27.8cd	0.71a	16.2bc	4.2abc	65.9a	13.9a
3(1fr/pan+50%pan)	189c	163b	86.9d	346d	25.8a	1.02c	16.3c	4.1ab	63.7a	15.3a
4(2fr/pan)	225d	182d	81.1b	335ab	27.9d	0.80ab	15.1ab	4.4bcd	67.9a	11.1a
5(2fr/pan+50%pan)	201e	170a	84.5cd	340c	26.4ab	1.13c	16.2bc	4.0a	66.7a	13.9a
6(control)	251a	173ac	68.7a	331a	26.1ab	0.82ab	13.7a	4.4bcd	69.7a	11.1a

Means followed by different letters in the same column are significantly different by LSD test at P<0.05

Keys

FNAT: Fruit number after treatment

FRP: Fruit retention percentage (%)

AFWAH: Average fruit weight at harvest (g)

Y: Yield (t ha^{-1})

FIRM: Firmness (kg cm^{-2})

TSS: Total soluble solids (^{o}Brix)

TA: Titratable acids (m eq l^{-1})

PP: Physiological problem (%)

'mule' and small sized fruit

Figure 3.1 Fruits harvested from the treatments of all fruits thinned (A) and Corasil. E chemical fruit thinning (B) in experiments 1b and 2 during 2002-2003 season.

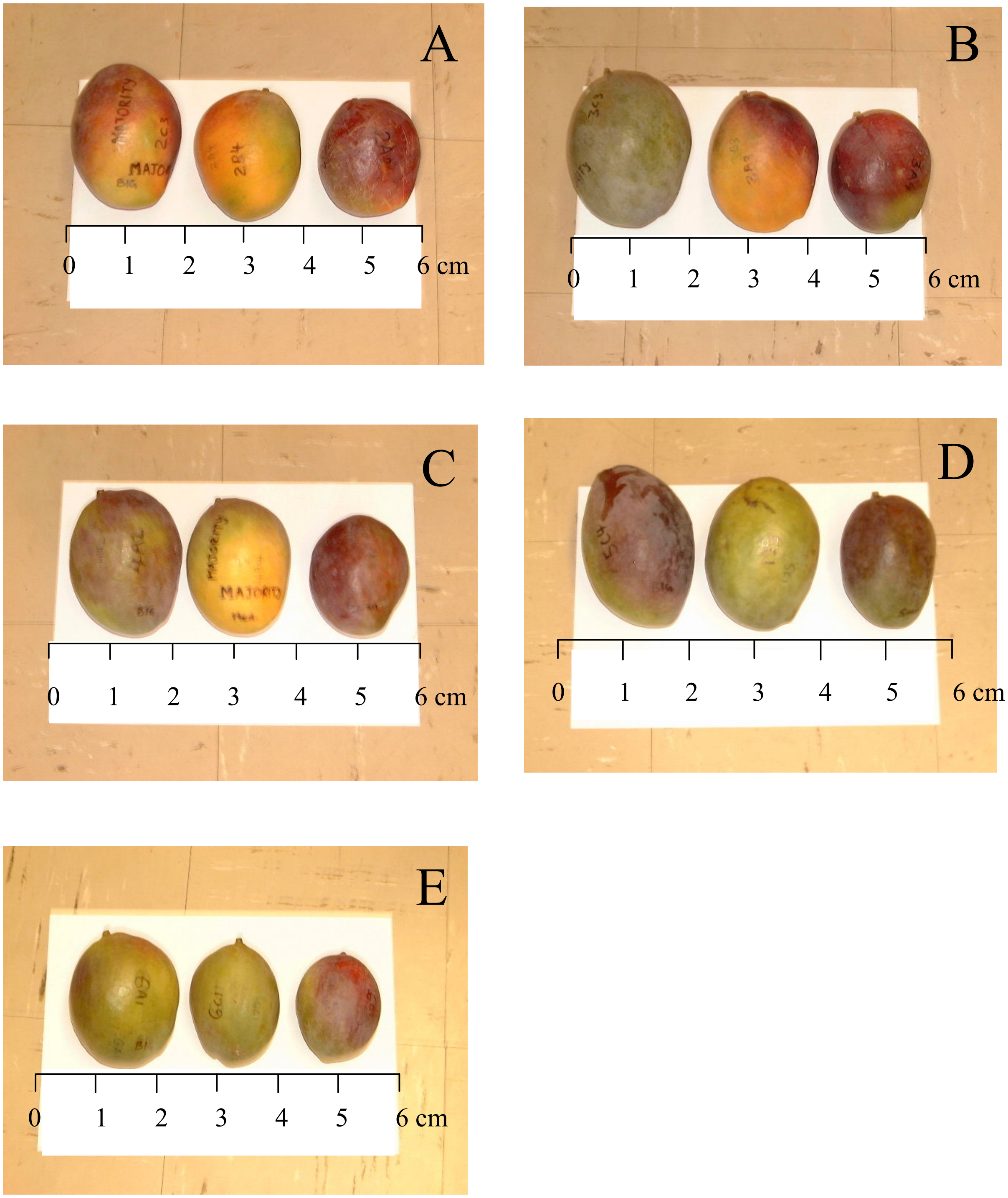

Figure 3.2 **Fruit size groups among treatments and their majority category for experiment 1a: (A) 1fruit per panicle; Majority, big. (B) 1fruit per panicle and 50% panicles removed; Majority, big. (C) 2 fruits per panicle; Majority, medium. (D) 2 fruits per panicle and 50% panicles removed; Majority, big. (E) No thinning (control); Majority, small.**

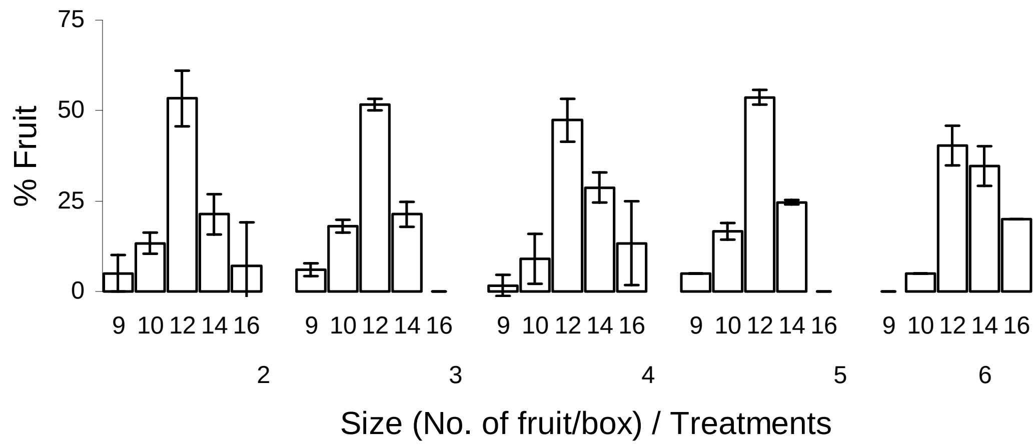

Figure 3.3 Size group (fruit/box) distribution of fruits due to treatments during February 6 2002 harvest. Line bars indicate standard deviations with in the size groups.

Keys for Fig. 3.3

Grade	9	10	12	14	16
Wt. (g)	439-472	350-438	295-349	241-294	220-240

Treatments:

2-One fruit per panicle

3-One fruit per panicle & 50% of panicles removed

4-Two fruits per panicle

5-Two fruits per panicle & 50% of panicles removed

6-Control

Table 3.3 Mean quantitative yield data of 'Sensation' fruit for experiments 1b and 2

Thinning treatments	No. of fruit per tree at harvest		Fruit retention (%)		Average fruit weight (g)		Yield (t ha^{-1})	
	Exp. 1b	Exp. 2	Exp. 1b	Exp. 2	Exp. 1b	Exp. 2	Exp. 1b	Exp. 2
1(all thinned (exp.1b)/ Corasil.E (exp. 2))	179a	191a	83.0a	78.0bc	327a	245a	27.1a	21.6a
2(1fr/pan)	181ab	177bc	80.0ab	76.0ab	340bc	338c	28.5b	27.8c
3(1fr/pan+50%pan)	167d	160e	85.0a	82.0c	347c	337c	26.7a	24.8b
4(2fr/pan)	186b	179b	76.0b	72.0a	333ab	331bc	28.6b	27.5c
5(2fr/pan+50%pan)	172c	167de	79.0ab	77.0b	339b	336c	26.9a	26.1b
6(control/av. fr.)	173c	166de	60.0c	80.0bc	328a	334bc	26.3a	25.7b
7(control)	--------	170e	--------	62.0d	--------	328b	--------	25.7b

Means followed by different letters in the same column are significantly different by LSD test at P<0.05

3.4.2 Qualitative parameters

The results for the qualitative parameters for the different experiments are summarised in Tables 3.2 and 3.4. There was a slight difference in the pH of the fruit juice among the treatments, where the lowest acidity (high pH) was recorded for treatment 5 (2fr/pan+50%pan) in experiments 1b (5.06) and 2 (5.03) (Table 3.4). The result was not significantly different between all treatments except treatment 4 (2fr/pan) and the control. Thinning treatments did not affect the titratable acids of the fruits in experiments 1a and 2. However, a significantly higher TA was recorded for treatments 4 (2fr/pan) (72 m eq/l) and the control (73.8 m eq/l) in experiment 1b (Table 3.4). There was a significantly higher TSS (16.3 ^{o}Brix) for treatment 3 (1fr/pan+50%pan) in experiment 1a, which was not significantly different from treatments 2 (1fr/pan) (16.2 ^{o}Brix) and 5 (2fr/pan+50%pan) (16.2 ^{o}Brix) (Table 3.2). In experiments 1b and 2, fruit from the control trees recorded a significantly lower TSS (15 and 15.07 ^{o}Brix respectively) as compared to all treatments except treatment 4 (2fr/pan) (15.8 ^{o}Brix) in experiment 2 (Table 3.4). In experiment 2, fruit were significantly firm from trees sprayed with Corasil.E and where treatment 5 (2fr/pan+50%pan) was applied. In experiment 1a fruit from trees where treatment 3 and 5 were applied had firm fruit. There was no significant difference in fruit firmness among treatments in experiment 1b. On the other hand, even if there was no significant difference, the highest incidence of the physiological problem (jelly seed) was observed for treatment 3 (1fr/pan+50%pan) while the lowest for treatment 1 (Corasil.E) (Table 3.4).

Table 3.4 Mean fruit qualitative data of 'Sensation' fruit for experiments 1b & 2

Thinning treatments	TSS (^{o}Brix)		pH		Titratable acids (m eq/l)		Firmness (kg/cm^2)		Physiological problems (%fruits)	
	Exp.1b	Exp.2	Exp.1b	Exp.2	Exp.1b	Exp.2	Exp.1b	Exp.2	Exp.1b	Exp.2
1(all thinned/Corasil.E)	17.1a	17.0ac	5.96a	4.88bc	56.4a	62.0a	1.38a	2.13c	11.8a	10.1a
2(1fr/pan)	16.9a	17.0ac	4.95a	4.83ab	60.0a	64.0a	1.43a	1.64a	12.4a	11.8a
3(1fr/pan+50%pan)	17.8a	17.4ac	5.00a	4.97bc	53.0a	56.0a	1.83a	1.82ab	13.1a	12.9a
4(2fr/pan)	16.5a	15.8ab	4.65b	4.67a	72.0b	70.0a	1.75a	1.78ab	12.0a	11.4a
5(2fr/pan+50%pan)	17.8a	18.2c	5.06a	5.03bc	52.2a	50.0a	1.55a	2.02bc	12.1a	12.0a
6(control/av. fr.)	15.0b	17.1ac	4.63b	4.94bc	73.8b	60.0a	1.42a	1.80ab	12.5a	12.4a
7(control)	--------	15.07b	--------	4.67a	--------	71.6a	--------	1.64a	--------	12.0a

Means followed by different letters in the same column are significantly different by LSD test at P<0.05

3.4.3 Tree phenology and starch reserve

During October, when the first samples were collected to do the analysis right before treatment application, the wood starch concentration for all treatment trees was high especially when compared to the months of January, March and May (Fig. 3.4). Treatment 1 (all fruit thinned) had a significantly lower wood starch reserve than all the other treatments (18.31 mg/g). The overall wood starch status of the trees in January was low as compared to all the other months except being relatively better than that of March, especially for the control (1.83 mg/g) and treatment 1 (all fruit thinned) (2.92 mg/g) (Fig. 3.4). Wood starch status during early March was even lower than that of January (lower than all other periods) and there was no clear variation among the treatments (Fig. 3.4). There was a substantial build-up of wood reserve for all treatments towards May and more especially, a significantly higher wood reserve (24.2 mg/g) was recorded for treatment 1 (all fruit thinned) (Fig. 3.4). There was a clear increasing trend of wood reserve for treatment 1 (all fruit thinned) in July even if the value was not significant from the other treatments (Fig. 3.4).

The general bark starch status of the trees during January was very low as compared to October and the various treatments did not cause a significant variation on the bark starch status of the trees during both months (Table 3.5). The same trend as that of wood reserve was observed for bark starch status of the trees. Since the fruit were small in size and still had to develop further, their starch concentration during October was low (Table 3.5). After attaining the full-grown size (elapsing the different fruit developmental phases), the starch concentration of the fruit in January was higher than other months. Of all the periods and the plant parts for which starch analyses were done, starch concentration in the fruit during January was the highest. Nevertheless, no significant differences were observed among the treatments during both analyses periods (Table 3.5). The starch analyses results for the fruit of treatment 1 (all fruits thinned) were from the second (2003) harvest. The reason for this being that, there was no fruit for the 2002 harvest as to the nature of the treatment. Leaf starch followed the same trend as that of bark and wood starch and there were no significant differences among the treatments in both analyses periods (Table 3.5).

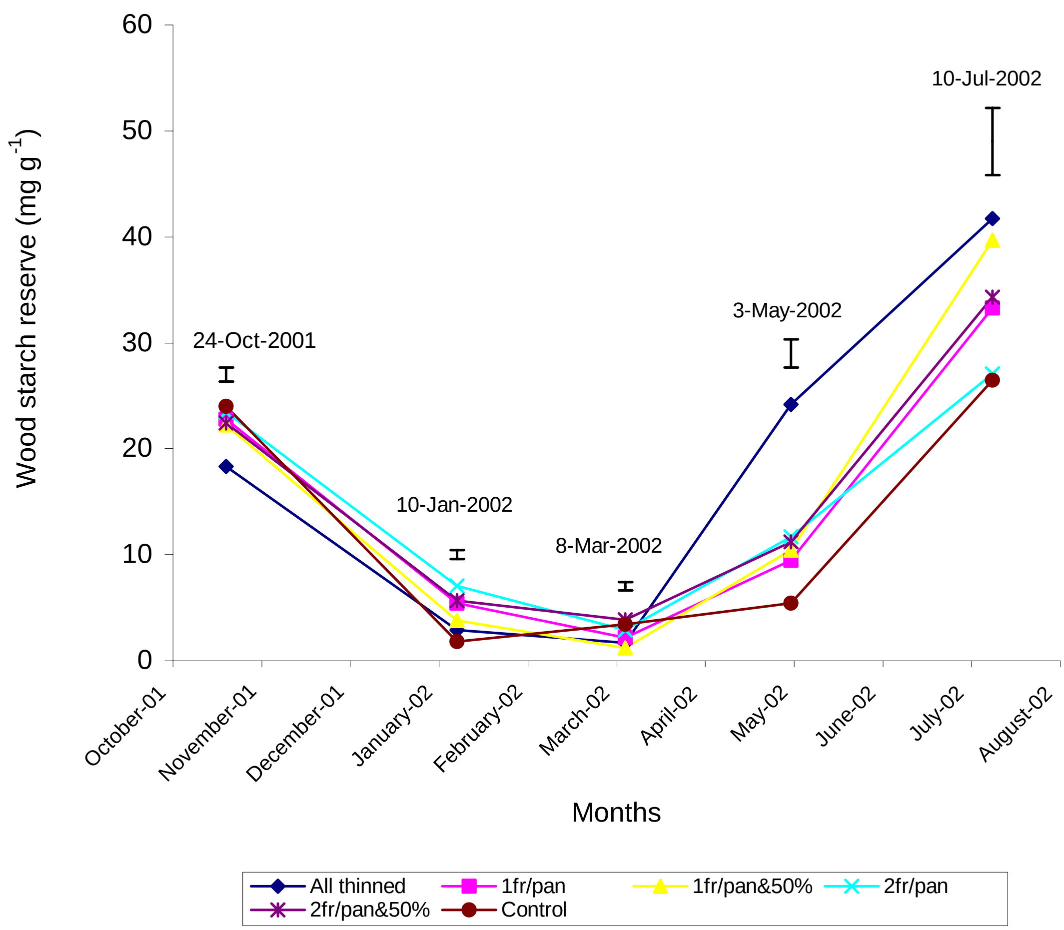

Figure 3.4 Wood starch reserve of 'Sensation' mango as influenced by treatments at various tree phenological periods. The vertical line bars indicate LSD between means at P<0.05 level.

Table 3.5 Bark, fruit and leaf starch status of the trees as affected by the treatments during October 2001 and January 2002

Thinning treatments	Bark starch (mg/g)		Fruit starch (mg/g)		Leaf starch (mg/g)	
	October	January	October	January	October	January
1(all thinned)	15.43a	1.43a	6.33a	138.4a	4.84a	1.62a
2(1fr/pan)	18.16a	3.27a	8.56a	135.5a	5.96a	1.38a
3(1fr/pan+50%pan)	17.47a	3.90a	9.12a	111.2a	5.10a	3.20a
4(2fr/pan)	17.08a	3.89a	8.40a	128.3a	5.18a	2.32a
5(2fr/pan+50%pan)	17.62a	5.32a	6.85a	141.2a	6.01a	4.01a
6(control)	20.00a	4.47a	7.20a	164.4a	4.58a	3.55a

Means followed by different letters in the same column are significantly different by LSD test at $P<0.05$

3.4.4 Vegetative growth parameters

Significantly higher numbers (185.69) and the longest new flushes (23.32 cm) were seen in treatment 1 (all fruits thinned) (Fig. 3.5 and 3.6). The control as well as treatment 4 (2fr/pan) had the lowest numbers (65.32 and 58.46 respectively) and shortest new flushes (14.31 and 11.74 cm respectively). The significantly higher number of new leaves per new flush (14.57) was observed for trees that received treatment 1 (all fruit thinned) and the lowest for the control trees (8.78) (Fig 3.5). The average leaf area of the forty sample leaves proved not to be affected by the treatments (data not shown).

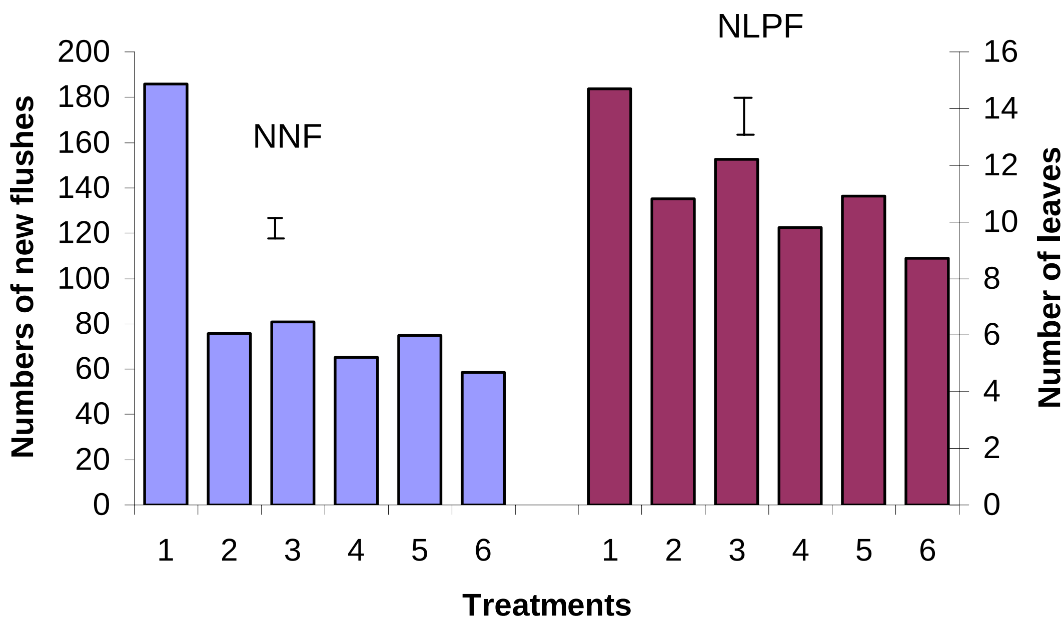

Figure 3.5 **Number of new flush growth and leaves per new flushes on 'Sensation' mango trees as affected by thinning treatments. The vertical line bars indicate LSD between means at P<0.05 level.**

Treatments

1. All fruit thinned
2. One fruit per panicle
3. One fruit per panicle and 50% panicles removed
4. Two fruit per panicle
5. Two fruit per panicle and 50% panicles removed
6. Control

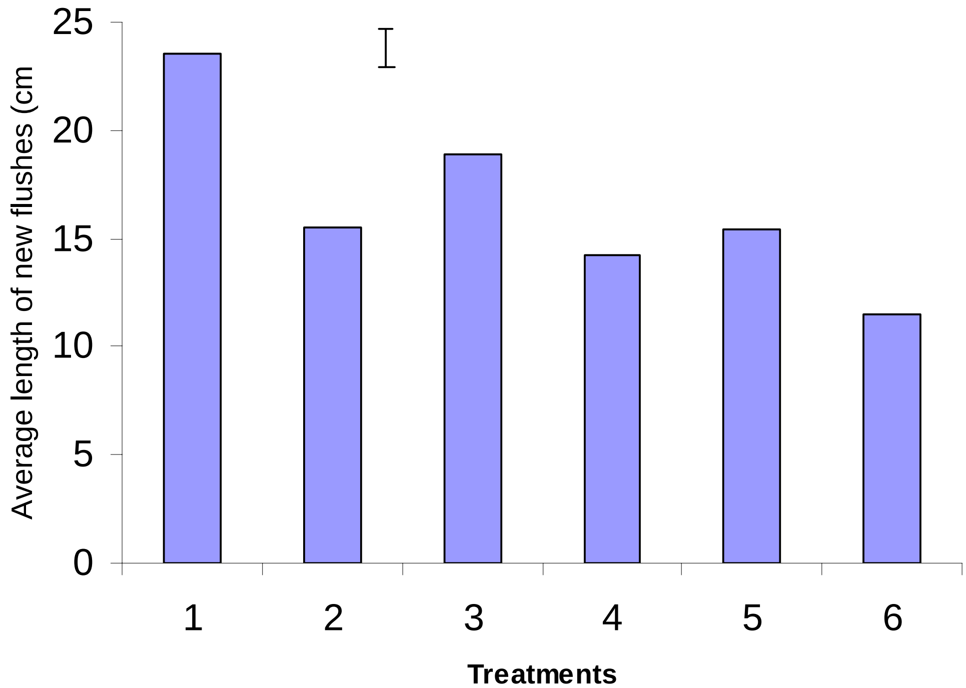

Figure 3.6 **Average length of new flush growth on 'Sensation' mango trees as affected by thinning treatments. The vertical line bars indicate LSD between means at P<0.05 level.**

Treatments

1. All fruit thinned
2. One fruit per panicle
3. One fruit per panicle and 50% panicles removed
4. Two fruit per panicle
5. Two fruit per panicle and 50% panicles removed
6. Control

3.5 DISCUSSION

The higher fruit number at harvest of treatments 2 and 4 (1fr/pan and 2fr/pan) were achieved by leaving one or two fruit per panicle, which minimised fruit abscission unlike with the control trees. At the same time the thinning intensity was lower compared to other treatments, which ended up with higher fruit numbers at harvest. On the control trees, with the initial high fruit number, more fruit abscised and less fruit of smaller size were harvested. Hence, a significant negative correlation (*r* = -0.949*) was found between lower fruit thinning intensity (higher number of fruit after treatment) and fruit retention percentage. The regression graph for the relationships of the two parameters is presented in Fig. 3.7.

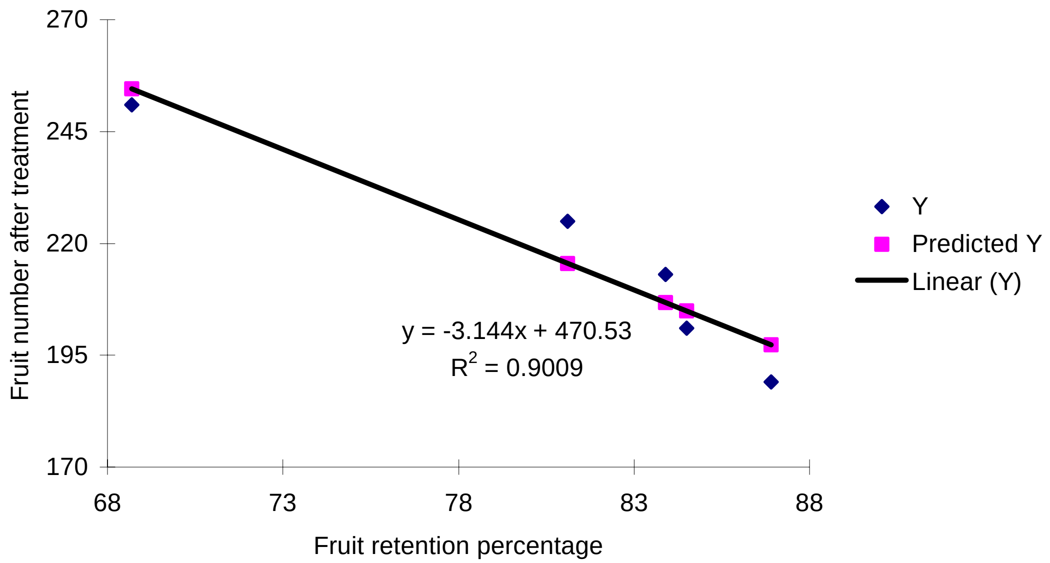

Figure 3.7 Regression between fruit number after treatment (indication of fruit thinning severity) and fruit retention percentage.

Davie *et al.* (1995) explained that, early reduction of the number of mango fruit on the tree, to a quantity the tree can nurture up to harvest, greatly reduced further fruit drop. Subsequently, trees from treatment 3 (1fr/pan+50%pan) retained a significantly higher percentage of fruit. Fruit retention percentage was calculated considering fruit number directly after treatment application and fruit number at harvest. The actual numbers of fruit at harvest for treatment 3 (1fr/pan+50%pan), however, were lower than that of the control in all the experiments due to the intensity of the fruit thinning treatment. In these experiments, very high intensity of thinning (like in the case of treatment 3---1fr/pan+50%pan) caused a reduction in yield. That was due to a very high thinning intensity, where the trees had very low number of fruits directly after treatment application. That is why thinning intensities that do not leave excess or very low numbers of fruit on the tree should be selected.

Corasil.E is a chemical fruit thinner normally used for oranges and mandarins in order to increase fruit size. Hence, reduction in fruit size by Corasil.E treatment was not expected. In addition, of the very small sized fruit attained, about 12% of the sampled fruit from Corasil.E treated trees were 'mules' (without seed). The mechanism causing the seed degeneration or abortion, however, was not clear. Fruit without seeds were not observed in any of the manual thinning treatments. Hence, it may be one research area to test the chemical for reducing fruit size on cultivars with excess fruit size like 'Keitt' and where fruit without seeds are needed.

It was also observed that, when the number of fruit per tree gets lower, the higher would be the accumulation of assimilates (like TSS) per fruit. This is compared to treatments with high initial fruit number per tree as for the control. Horscroft & Sharples (1987) found that fruit thinning, by reducing competition for carbohydrates between fruit, also improves fruit quality in terms of soluble solids content, firmness and anthocyanin formation, hence red skin colour on apples. Jackson (1989) also stated that the effects of fruit thinning on market quality appear to result from reducing competition for assimilates between fruit.

A significant negative correlation (*r* =-0.902*) was observed between the total soluble solids and the titratable acids in experiment 1a . The correlation indicated that, the increase in the other soluble solids content of the fruit reduced the proportion of titratable acids. There was no clear trend of fruit firmness with the thinning intensities since both small (fruit from Corasil.E treated trees) and big sized fruit (fruit from treatments 3 and 5) were firm in the different sets of experiments.

Jelly seed (soft-nose) is the breakdown of the fruit flesh at the fruit apex as evidenced by marked cell separation and cell wall degeneration (Burdon *et al.*, 1991). Jelly seed was given emphasis since it is one of the main physiological problems affecting South African mango produced for export and is usually associated with fruit size. Cull (1991) indicated that there is evidence for fruit physiological problems such as jelly seed to be associated (in susceptible cultivars) with excess growth vigour (as observed for treatment 3---1fr/pan+50%pan). Excess growth vigour may be associated with light crop loads due to severe thinning treatments.

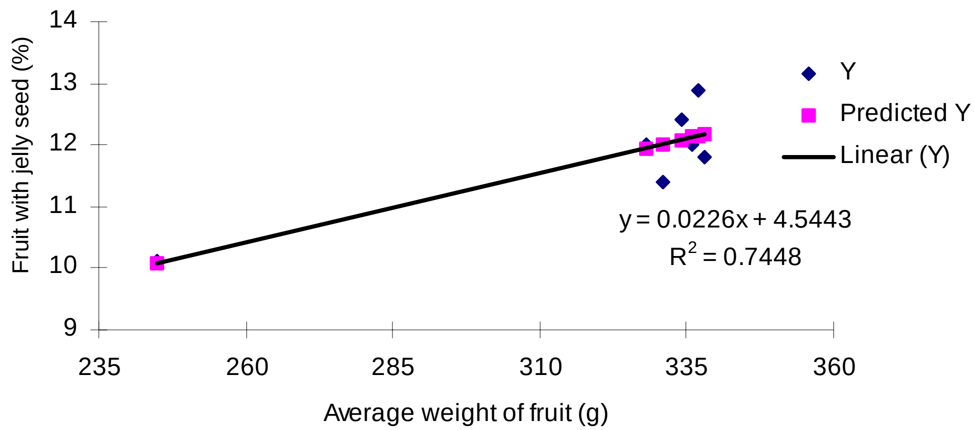

Figure 3.8 **Regression between average weight of fruit and the occurrence of jelly seed in the fruit.**

There was a lower wood starch concentration especially for the control trees in January. That was due to excess fruit production beyond the trees capacity and the period coincided with active fruit growth stage. The starch content in March was even lower than that of January because it was a period directly after fruit harvest and the trees did not recover the assimilates they lost due to fruiting, and therefore, fruit is already known to be a heavy sink. In general, Heim *et al.* (1979) reported severe effects of fruiting on stem dry matter accumulation, accounting for over 40% of the dry matter fixed in non-fruiting apple tree stems compared with over 10% for heavily fruiting tree stems. A reduction in dry matter partitioning to shoots, leaves and roots due to fruiting has been demonstrated in a wide range of species (Wright, 1989). He also explained that it is perhaps not surprising that fruiting commands such a large proportion of a plant's resources since it usually leads to the production of seeds for the continuation of the species. In general, it was observed that, if trees are thinned at earlier fruit developmental stages, to have fruit numbers which the tree can nurture up to harvest, there will be no wastage of reserves due to fruit that would ultimately abscise being over the tree's capacity. Consequently the phenomenon of alternate bearing can be alleviated. Fruit thinning may therefore be the answer for starch conservation, and alleviating alternate bearing.

A positive relationship was observed between fruit thinning intensity and the vegetative growth parameters considered. Sufficient vegetative growth will have its own implication on the amount of assimilates to be produced by the new and young leaves and finally complement the reserve replenishment process. Consequently, the reserve and currently produced assimilates play their role on the number, size and qualitative aspects of fruit to be produced in the coming season. On the other hand, a significant positive correlation (r = 0.863*) was observed between fruit size and the occurrence of jelly seed. The regression graph indicating their positive relationship is presented in Fig. 3.8.

3.6 CONCLUSION

There was a yield reduction after severe thinning intensity treatments. However, fruit from intense fruit thinning treatments had a higher quality and the trees a more intensive vegetative growth. With low intensity thinning (like that of the control trees), a higher degree of assimilate wastage due to the high number of fruit that were abscised at an advanced developmental stage was noted. These trees were more liable to alternate bearing, which is a common phenomenon in many fruit trees. Spraying of Corasil.E, which increased fruit size in oranges and mandarins through fruit thinning (J. Fivas, personal communication), had a reverse effect on mangoes. The treated trees produced small sized mule fruit.

The principle of chemical or manual fruit thinning is to conserve tree carbohydrate reserves by reducing fruit number during early growth stage. The aim of the current experiment was to determine the intensity of fruit thinning. With this two-season experiment, thinning 'Sensation' mango to one and two fruit per panicle produced a significantly larger yield compared to the control while fruit quality, vegetative growth as well as tree reserve status parameters were within acceptable limits. In addition, no alternate bearing was observed on trees where thinning fruit to one and two fruit per panicle treatments were applied. Monitoring the carry-over effects of the applied treatments will give additional information. An acceptable practice, however, would be to apply moderate fruit thinning every season.