

**LEMBAR
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU PEER REVIEW
KARYA ILMIAH : PROSIDING**

Judul Karya Ilmiah : **Strangulation Improves Flowering and Fruiting of 'Nambangan' Pummelo Trees**
 Jumlah Penulis : 3 Orang
 Status Pengusul : Penulis Pertama
 Identitas Prosiding : a. Nama Prosiding : International Symposium on Tropical and Subtropical Fruit
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STRANGULATION IMPROVES FLOWERING AND FRUITING OF 'NAMBANGAN' PUMMELO TREES

Pilih Bahasa | ▼

Authors

A. Rahayu, S. Susanto, Setyono

Abstract

'Nambangan' Pummelo has a good taste, sweet, a slightly sour and fresh, pink-red color flesh, and long shelf life, i.e., 3-4 months. Fruit production of this cultivar is fluctuated due to irregular flowering. A series of experiments was conducted to study the effect of strangulation on flowering and fruiting of 'Nambangan' pummelo trees. Three experiments were conducted at Cikabayan Research Station IPB from October 2000 to July 2007. In experiment 1 strangulation was applied using wire size 1.6 and 2.0 mm with a period of strangulation 1, 2, and 3 months. In experiment 2, the pummelo trees were strangulated using 2.0 and 3.0 mm wire size for three months period. In experiment 3, the pummelo trees were subjected to 3, 5, and 7 months period of strangulation. The result of experiment 1 showed that strangulation significantly improved flowering; 89-100% of the treated trees produced flowers, whereas all control trees were not flowered. The flower and fruit numbers, and leaf-carbohydrate contents were significantly higher on the trees treated with wire size of 2.0 mm for 3 months duration. Strangulation using 3.0 mm wire size produced slightly more flowers as compared with 2.0 mm. Different duration of strangulation produced no significant difference in the flower numbers and carbohydrate content in leaves. Meanwhile, it was noted that application of seven-month strangulation duration caused severe damage on the phloem tissues. It is recommended that to improve flowering and fruiting of pummelo trees without significant damages, the strangulation should be applied using 2.0-3.0 mm of wire for not more than 3 months duration.

Citation

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975_10 CHARACTERIZATION OF INDONESIAN TANGERINE CULTIVAR BY MORPHOLOGICAL AND ISSR MARKERS

975_11 TISSUE CULTURE, ANATOMICAL AND MORPHOLOGICAL STUDIES OF TRIPHASIA TRIFOLIA (BURM. F.) P. WILSON

975_12 CHARACTERIZATION OF LEAF MORPHOGENESIS IN MULBERRY MUTANTS (MORUS SPP.)

975_13 PERFORMANCE OF A DURIAN GERMPLASM COLLECTION IN A PENINSULAR MALAYSIAN FRUIT ORCHARD

975_14 ALTERATION OF LEAF ANATOMY STRUCTURE IN MANGOSTEEN REGENERANTS IN VITRO CAUSED BY GAMMA RAY IRRADIATION

975_15 THE ADVANCEMENT OF RESEARCH ON BANANA GERMPLASM RESOURCES IN CHINA

975_16 GENETIC VARIABILITY OF MANGOSTEEN, AN APOMICTIC GARCINIA

975_17 INTEGRATED DISEASE CONTROL STRATEGIES FOR LENGTHENING THE STORAGE LIFE OF PAPAYA CULTIVARS 'RED LADY' AND 'RATHNA'

975_18 CONTROL OF FUSARIUM WILT OF BANANA BY USING TRICHODERMA HARZIANUM AND RESISTANT BANANA CULTIVARS

975_19 SCREENING OF BANANA CULTIVARS TO BIOTIC STRESSES

975_20 THE OCCURRENCE OF ANTHRACNOSE DISEASE CAUSED BY COLLETOTRICHUM GLOEOSPORIOIDES ON DRAGON FRUIT (HYLOCEREUS SPP.) IN PENINSULAR MALAYSIA

975_21 IN VITRO ANTIFUNGAL ACTIVITY OF NEEM OIL AGAINST BANANA PATHOGENS

975_22 COLLETOTRICHUM: HOST SPECIFICITY AND PATHOGENICITY ON SELECTED TROPICAL AND SUBTROPICAL CROPS

975_23 ALK(EN)YLRESORCINOL CONCENTRATIONS IN 'KENSINGTON PRIDE' MANGO PEEL AND ANTIFUNGAL ACTIVITY AGAINST COLLETOTRICHUM GLOEOSPORIOIDES

975_24 MYCOBIOTA OF APPLE FRUIT: EFFECTS ON BITTER ROT CAUSED BY COLLETOTRICHUM ACUTATUM

975_25 ENHANCING SOIL SUPPRESSIVENESS USING FORMULATED GLIOCLADIUM TO CONTROL BANANA FUSARIUM WILT DISEASE

975_26 HIGH DENSITY ORCHARD SYSTEMS FOR 'HIMSAGAR' MANGO IN THE NEW ALLUVIAL ZONE OF WEST BENGAL

975_27 EFFECTS OF ETHYLENE ON RUDIMENTARY LEAF AND PANICLE PRIMORDIUM IN LITCHI: ANTIOXIDANT ENZYMES, HYDROGEN PEROXIDE AND NITRIC OXIDE

975_28 EVALUATION OF COCONUT CULTIVARS FOR TENDER NUT WATER

975_29 FLOWERING PATTERN AND FRUITFUL CAPACITY OF 'FINO DE JETE' CHERIMOYA SHOOTS

975_30 FOLIAR APPLICATION OF UREA ADVANCES BUD BREAK, BLOOM AND HARVEST IN CHERIMOYA (ANNONA CHERIMOLA MILL.)

975_31 THE COMBINATION OF PRE- AND POST-HARVEST DEFICIT IRRIGATION IMPROVES LOQUAT FRUITS EARLINESS AND PERFORMANCE AT PACKING HOUSES

975_32 CONDITIONS FOR SEED GERMINATION IN PITAYA

975_33 EFFECTS OF WATER STRESS ON QUANTITATIVE AND QUALITATIVE FRUIT CHARACTERISTICS OF DATE PALM (PHOENIX DACTYLIFERA L.)

975_34 SALINITY AND PHYSIOLOGY OF PASSIFLORA EDULIS

975_35 DELAYING THE RIPENING OF 'BOMBAI' LITCHI

975_36 ORGANIC TROPICAL AND SUBTROPICAL FRUIT PRODUCTION IN INDIA - PROSPECTS AND CHALLENGES

975_37 TROPICAL AND SUBTROPICAL FRUIT PRODUCTION IN WEST BENGAL, INDIA

975_38 TISSUE CULTURE STUDIES ON FORTUNELLA POLYANDRA 'NAGAMI' AND 'MEIWA'

975_39 FLOWER AND FRUIT ABA, IAA AND CARBOHYDRATE CONTENTS IN RELATION TO FLOWER AND FRUIT DROP ON MANGOSTEEN TREES

975_40 FACTORS AFFECTING UNEVEN FRUIT RIPENING IN 'MON-THONG' DURIAN

975_41 FRUIT DEVELOPMENT AND MATURATION PHENOLOGY OF 'FINO DE JETE' CHERIMOYA

975_42 INFLUENCE OF SAN JULIAN GF 655/2, MRS 2/5 JULIOR FERDOR AND CUARES MILLO ROOTSTOCKS ON THE PLUM CULTIVAR 'OZARK PREMIER'

975_43 EFFECT OF ROOTSTOCK AGE AND TIME OF SOFTWOOD GRAFTING ON GRAFTING SUCCESS IN AONLA (EMBLICA OFFICINALIS)

975_44 PHYSICO-CHEMICAL ANALYSIS OF POLYEMBRYONIC MANGO CULTIVARS UNDER NORTH INDIA CONDITIONS

975_45 STUDY OF THE ESTABLISHMENT, PRODUCTIVITY AND QUALITY OF 'DEGLET NOOR' DATE PALM IN SOUTHWEST IRAN

975_46 ASSOCIATIONSHIP OF WEATHER PARAMETERS ON THE FLORAL CHARACTERISTICS OF COCONUT

975_47 THE IMPACT OF SUMMER RAINFALL ON ALTERNATE BEARING OF MANGOSTEEN (*GARCINIA MANGOSTANA* L.) IN SOUTHERN THAILAND

975_48 CHERIMOYA DORMANCY AND BASE TEMPERATURE DETERMINATION IN EXCISED 'FINO DE JETE' SHOOTS

975_49 PRELIMINARY ASSESSMENT OF A RAPID LEAF NITROGEN TEST IN MANGO

975_50 EFFECTS OF NIGHT-HEATING OF FRUIT ON CELL SIZE REGULATION AND SUCROSE ACCUMULATION IN THE OUTER PORTION OF WATERMELON (*CITRULLUS LANATUS* MATSUM. ET NAKAI)

975_51 EFFECT OF INTERMITTENT METHOD OF DEEP SEA WATER TREATMENT ON FRUIT PROPERTIES IN MULTI-TRUSSES CULTIVATION OF TOMATO

975_52 PINEAPPLE SUGAR METABOLISM AND ACCUMULATION DURING FRUIT DEVELOPMENT

975_53 LEAF PHOTOSYNTHESIS AND FRUIT QUALITY OF MANGO GROWING UNDER FIELD OR PLASTIC ROOF CONDITION

975_54 GROWTH AND POSTHARVEST QUALITY OF MANDARIN (*CITRUS RETICULATE* 'FREMONT') FRUIT HARVESTED FROM DIFFERENT ALTITUDES

975_55 STRANGULATION IMPROVES FLOWERING AND FRUITING OF 'NAMBANGAN' PUMMELO TREES

975_56 CHANGES IN CARBOHYDRATE IN BRANCHES AND ITS RELATION TO FLOWERING IN *AVERRHOA CARAMBOLA*

975_57 FEASIBILITY STUDY TO ALLEVIATE THE TRANSLUCENT FLESH AND GAMBOGE DISORDERS OF MANGOSTEEN (*GARCINIA MANGOSTANA* L.) BY SPRAYING WITH CALCIUM CHLORIDE

975_58 THE CONTROL OF YELLOW LATEX IN MANGOSTEEN FRUIT THROUGH IRRIGATION AND FERTILIZER APPLICATION

975_59 CITRIC ACID INHIBITS THE PHYSICO-CHEMICAL CHANGES OF UNPASTEURIZED DUKU PUREE

975_60 CHANGES IN ANTIOXIDANT ACTIVITY OF CITRUS TANKAN RIND AND EXTRACTED JUICE DURING STORAGE

975_61 POSTHARVEST STORAGE OF CITRUS TANKAN FRUIT UNDER NORMAL CONDITION AND COLD STORAGE

975_62 CURRENT POSTHARVEST HANDLING PRACTICES OF SALAK AND MANGO FRUITS IN INDONESIA

975_63 EFFECT OF HOT WATER TREATMENT ON THE INHIBITION OF ANTHRACNOSE, PG, PME ACTIVITY AND PGIP GENE EXPRESSION IN HARVESTED PAPAYA FRUITS

975_64 PRELIMINARY STUDY ON MICROBIAL QUALITY OF FRESH-CUT HONEYDEW STORED AT REFRIGERATED TEMPERATURE

975_65 EFFECT OF TIME AND TEMPERATURE ON QUALITY AND STABILITY OF ASCORBIC ACID IN PROCESSED KINNOW MANDARIN JUICE

975_66 NON-DESTRUCTIVE TECHNIQUE FOR DETERMINING MANGO MATURITY

975_67 PROCESSING THE INDONESIAN TANGERINE (*CITRUS NOBILIS* LOUR.)

975_68 EFFECT OF WAX TREATMENT ON THE QUALITY AND POSTHARVEST PHYSIOLOGY OF PINEAPPLE FRUITS

975_69 FEASIBILITY STUDY ON EVALUATION OF INTERNAL QUALITY OF RED PITAYA USING NEAR INFRARED SPECTROSCOPY

975_70 ACTIVITY AND GENE EXPRESSION OF ETHYLENE BIOSYNTHETIC ENZYMES OF 'IRWIN' MANGO DURING FRUIT RIPENING

975_71 TEMPERATURE MANAGEMENT OF TROPICAL AND SUBTROPICAL FRUITS IN JAPAN

975_72 NON-DESTRUCTIVE QUALITY AND MATURITY EVALUATION OF THE PAPAYA FRUIT CULTIVAR 'IPB 1' (*CARICA PAPAYA* L.)

975_73 TRENDS IN PRODUCTION AND TRADE OF TROPICAL FRUITS IN ASEAN COUNTRIES

975_74 POTENTIAL OF MINOR TROPICAL FRUITS TO BECOME IMPORTANT FRUIT CROPS

975_75 PRODUCTIVITY AND EFFICIENCY OF WATERMELON FARMS IN MALAYSIA

975_76 HIGH DENSITY LOQUAT ORCHARDS INCREASE PROFITS AND SHORTEN THE TIME FOR INVESTMENT RETURNS

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975_78 EUROPEAN MARKET ENVIRONMENT FOR SELECTED LATIN AMERICAN TROPICAL FRUIT SPECIES

975_79 RESEARCH ON PREPARATION OF 'DODOL' DURIAN TO INCREASE ADDED VALUE OF DURIAN FRUIT AND COW'S MILK IN THE TUTUR DISTRICT, PASURUAN REGENCY

[975_80 THE ASSESSMENT OF SUPPLY CHAIN MANAGEMENT ON 'PONTIANAK' TANGERINE IN WEST KALIMANTAN, INDONESIA](#)

[975_81 FARMER EXTENSION APPROACH TO REHABILITATE SMALLHOLDER FRUIT AGROFORESTRY SYSTEMS: THE "NURSERIES OF EXCELLENCE \(NOEL\)" PROGRAM IN ACEH, INDONESIA](#)

[975_82 FRUIT GERMLASM RESOURCES AND DEMANDS FOR SMALL SCALE FARMERS POST-TSUNAMI AND CONFLICTS IN NANGGROE ACEH DARUSSALAM PROVINCE, INDONESIA](#)

[975_83 VILLAGE-AGROINDUSTRY CHARACTERISTICS OF BANANA CHIPS \('AGUNG SEMERU'\) IN LUMAJANG REGENCY, EAST JAVA](#)

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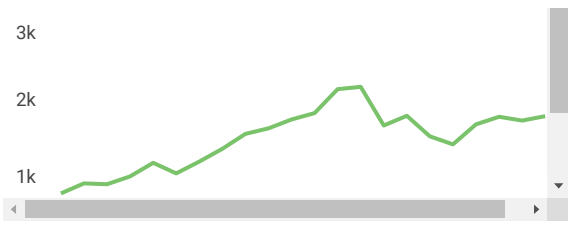
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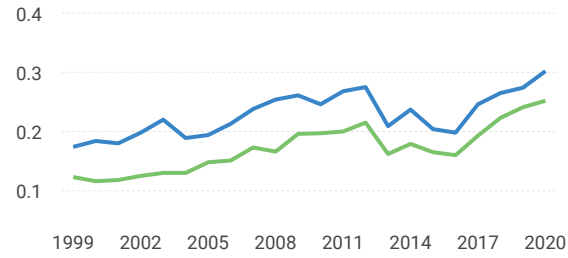
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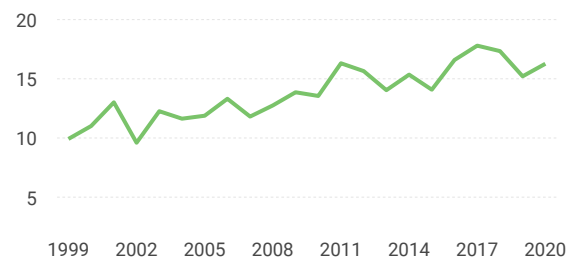
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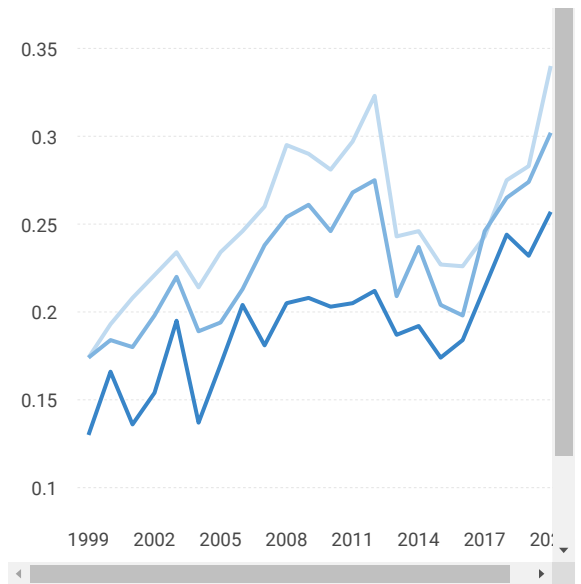
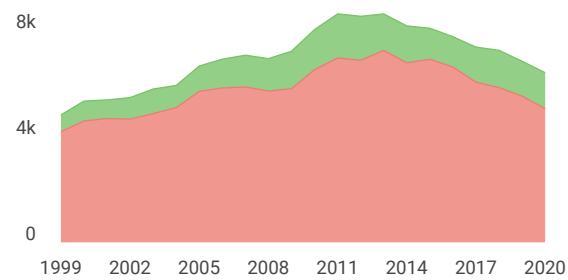
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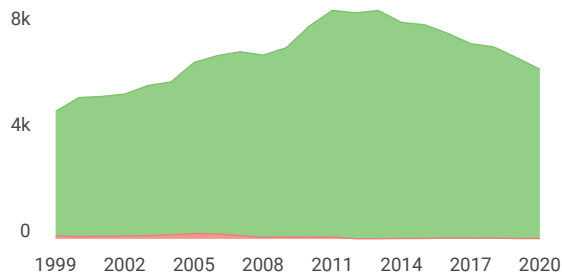
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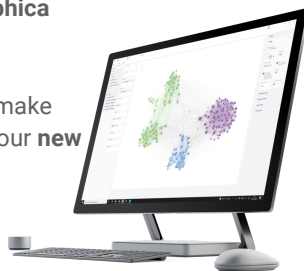
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Key words: strangulation, flowering, fruiting, pummelo

Abstract

A series experiment was conducted to study the effect of strangulation on flowering and fruiting of 'Nambangan' pummelo trees. Three experiments were conducted at Cikabayan Research Station IPB from October 2000 to July 2007. In the experiment 1 strangulation was applied using wire size 1.6 and 2.0 mm with a period of strangulation 1, 2, and 3 months. In the experiment 2, the pummelo trees were strangulated using 2.0 and 3.0 mm wire size for three months period. In experiment 3, the pummelo trees were subjected to 3, 5, and 7 months period of strangulation. The result of the experiment 1 showed that strangulation significantly improved flowering. About 89-100% of the treated trees produced flower, meanwhile all control trees were not flowered. The flower and fruit numbers and carbohydrate content in leaves produced were significantly higher on the trees treated with wire size of 2.0 mm in 3 months duration. From experiment 2, the result showed that strangulation application using 3.0 mm wire size produced slightly more flower as compared with 2.0 mm. The result of experiment 3 showed that different duration of strangulation produced no significant different in the flower number and carbohydrate content in leaves. Meanwhile, it was noted that application of seven month strangulation duration caused severe damage on the phloem tissues. It is recommended that to improve flowering and fruiting of pummelo trees without significant damages, the strangulation should be applied using 2.0 – 3.0 mm of wire for not more than 3 months duration.

INTRODUCTION

Pummelo (*Citrus grandis* (L.) Osbeck) is a species of citrus that has a good prospect to be more developed in Indonesia. National Biology Institute noted 15 pummelo cultivars in Indonesia, one of them is 'Nambangan' (Sarwono, 1991). This cultivar has a good taste, sweet, a slightly sour and fresh, pink-red color flesh, and long shelf life, 3-4 months (Pusat Penelitian dan Pengembangan Hortikultura, 2004). 'Nambangan' doesn't have bitter taste, with relatively thin peel and specific aroma. These leading of 'Nambangan' make it competitively with other imported fruits in supermarket.

'Nambangan' pummelo bears seasonally. Trees flowering on September-October will be fruiting on April-June in the following year. This phenomenon causes over production in the on season that makes the prices down. On the other season the production is limited.

To prevent the fluctuations of pummelo fruit production, regulation of flowering is needed. Some of methods that generally applied to improve and regulate flowering were application of plant growth regulator (Susanto and Poerwanto, 1999), low temperature (Susanto et al., 1991), water stress (Nakajima et al., 1993) and strangulation (Susanto et al., 2002). Strangulation is relatively easier and more simple to apply as compare with other methods.

The best-known effect of strangulation is presumably brought about by accumulation of assimilates above the strangulated parts. On the other hand, the side beneath the strangulated area suffers from shortage of assimilates. High accumulation of carbohydrate positively correlated with flowering (Garcia-Luis et al., 1995; Yamanishi and Hasegawa, 1995).

Strangulation proved effectively increasing flowering on the previous researches (Yamanishi and Hasegawa, 1995; Yamanishi et al., 1993), but not appropriate treatment of strangulation could decrease and delay growth, that made trees suffer after the treatments.

The objective of the research was to investigate the appropriate wire size and length of period of strangulation to improve flowering without damaged of the 'Nambangan' pummelo trees.

MATERIALS AND METHODS

A series of experiments were conducted at Cikabayan Research Station of IPB and the Center for Biotechnology of Food Crops Bogor, from October 2000 to July 2007.

Trials were conducted on two years old 'Nambangan' pummelo trees at experiment 1, seven and eight years old on experiment 2 and 3. Trees were spaced at 5 m x 5 m. Strangulation was carried out by tightening wire on primary branch, then pulled it as depth as wire diameter.

All experiments used Randomized Complete Block Design. In the experiment 1, strangulation was applied using wire size 1.6 mm and 2.0 mm with period of strangulation 1, 2 and 3 months. In the experiment 2, the pummelo branch strangulated using 2.0 mm and 3.0 mm wire size for three months. In the experiment 3, strangulation was done for 3, 5 and 7 months. There was control treatment (unstrangulated branches) in each experiment.

Fertilizers were applied a week before the experiments started, with 0.38 kg N, 0.20 kg P₂O₅, 0.51 kg K₂O, and 20 kg organic fertilizers per tree. Insects and disease were controlled according to the recommendation of the local agricultural development.

Measurements were carried out on the number of vegetative shoots, reproductive shoots, flower buds, open flowers and fruits. Nitrogen and carbohydrate leaves content were analyzed before the trees starts flowering. Analyzed leaves samples were taken in the morning. Each sample for different treatments were put in different plastic bags. Nitrogen analysis used Kjeldahl method. The analysis of carbohydrate leaves content followed a procedure adapted from Nelson-Somogy method, which used HCl 0.7 N solution for carbohydrate hydrolysis. The result of hydrolysis was read by spectrophotometer at 500 nm wave length.

Differences between treatments at each experiment were tested for significance by ANOVA. Variables that shown significant then were analyzed by Duncan Multiple Range Test ($p \leq 0.05$) on experiment 1 and 2, and by Tukey Test ($p \leq 0.05$) on experiment 3. In experiment 1, it was also used a Contrasts Test to show different level between strangulation and control treatment.

RESULT

Experiment 1. Strangulation significantly decreased the number of vegetative shoots (16 WAS= weeks after strangulation) and leaves N content. On the other hand strangulated plants have more reproductive shoots (19 WAS), flower buds (19 WAS), open flowers (19 WAS), and leaves carbohydrate content. All control trees were not flowering. Wire size did not significantly influence the number of vegetative shoots and nitrogen and carbohydrate content. Plants strangulated with 2.0 mm wire size had more reproductive shoots, flower buds and open flower than 1.6 mm wire size. Plants strangulated for 2 and 3 months have less vegetative shoots and leaves N content, but more leaves carbohydrate content (Table 1).

Table 1. The average number of vegetative shoots, reproductive shoots, flower buds, open flowers, leaves carbohydrate and nitrogen content.

Treatment	Vegetative shoots ^z	Reproductive shoots ^y	Flower buds ^y	Open flowers ^y	Carbohydrate content (%)	N content (%)
Control	71.0	-	-	-	11.2	2.8
Wire Size						
1.6 mm	43.0 ^a	2.7^a	8.5^a	8.3^a	14.1 ^a	2.4 ^a
2.0 mm	40.7 ^a	5.9^b	20.2^b	17.5^b	16.6 ^a	2.3 ^a
Length of strangulation						
1 month	51.1^b	3.3 ^a	12.2 ^a	11.1 ^a	13.4^a	2.6^b
2 months	37.3^a	3.6 ^a	14.0 ^a	12.4 ^a	15.8^a	2.4^a
3 months	37.2^a	6.1 ^a	16.9 ^a	15.1 ^a	16.9^b	2.4^a
Contras Test						
Control vs. Treatment	**	*	**	**	**	**
Interaction	NS	NS	NS	NS	NS	NS

* Significant at $P \leq 0.05$, ** significant at $P \leq 0.01$, NS: non significant

^z Data from 16 WAS (weeks after strangulation)

^y Data from 19 WAS

Experiment 2. There was no significant difference between strangulated branches with the 2.0 mm and 3.0 mm wire size, in the number of vegetative and reproductive shoots, flower buds, open flowers, fruits and leaves nitrogen and carbohydrate content. But the strangulated branches tended to have more reproductive shoots, flower buds, open flowers and fruits than unstrangulated branches (Figure 1).

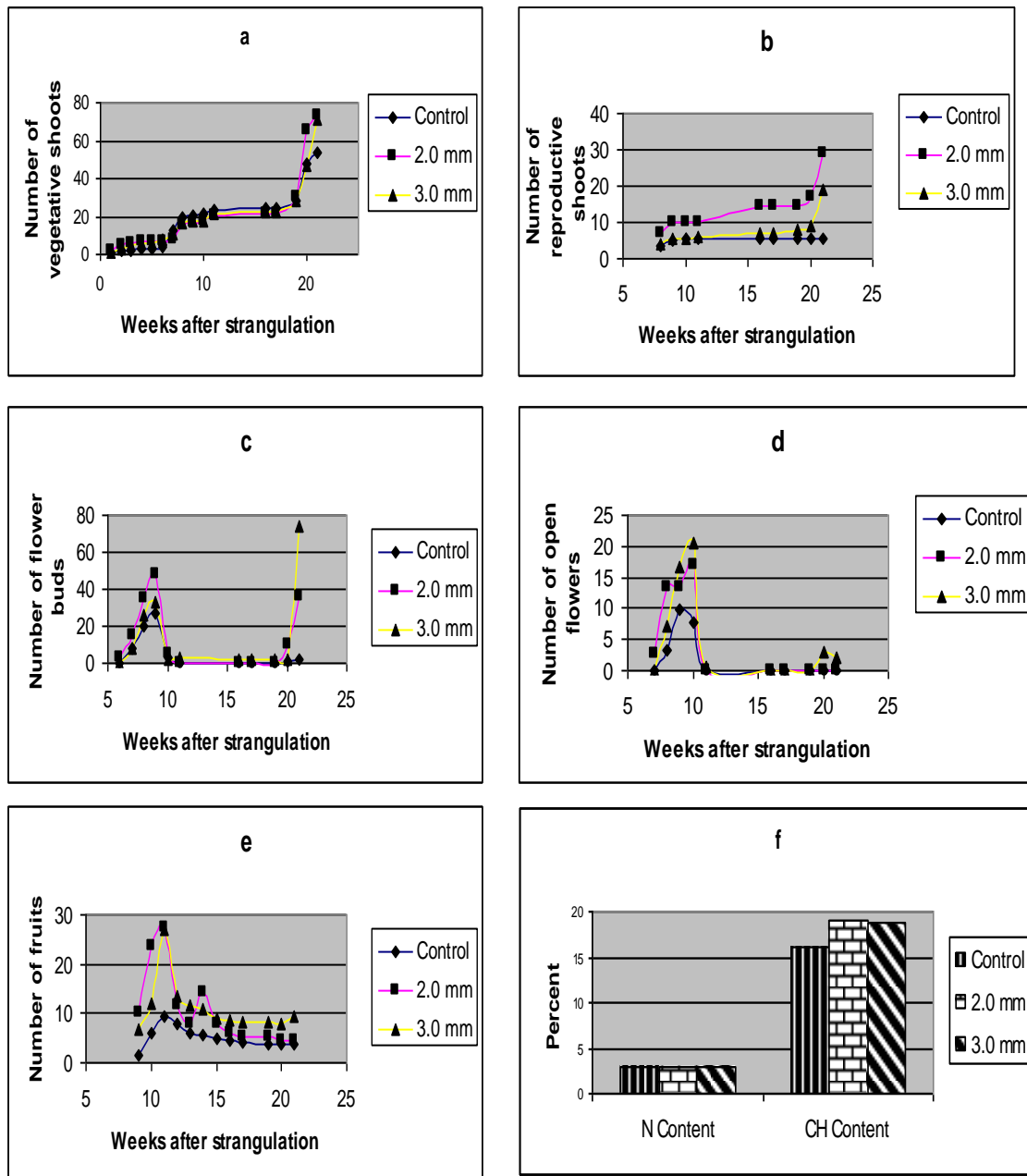


Fig. 1. (a) Development of the number of vegetative shoots; (b) Development of the number of reproductive shoots; (c) Development of the number of flower buds; (d) Development of the number of open flowers; (e) Development of the number of fruits; (g) Leaves nitrogen and carbohydrate content on experiment 2.

Experiment 3. The number of vegetative shoots, flower, leaves N and carbohydrate content were not significantly different among various period of strangulation. Meanwhile the number of reproductive shoots and fruits on branches strangulated for 5 months higher than not strangulated branches (Figure 2.). Almost all control trees were not flowering.

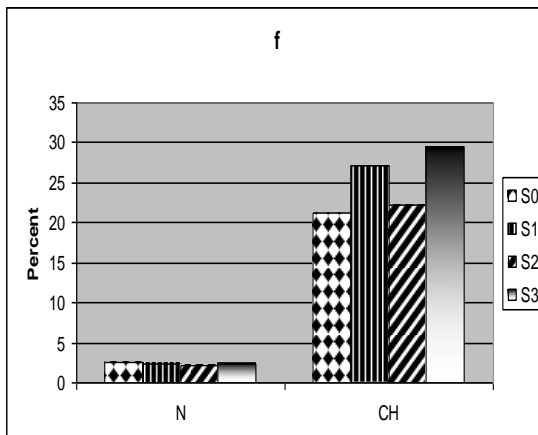
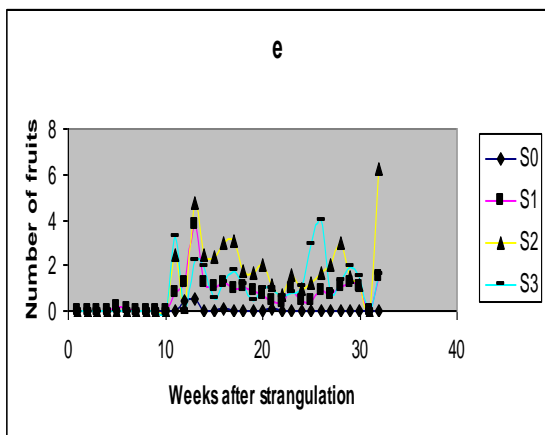
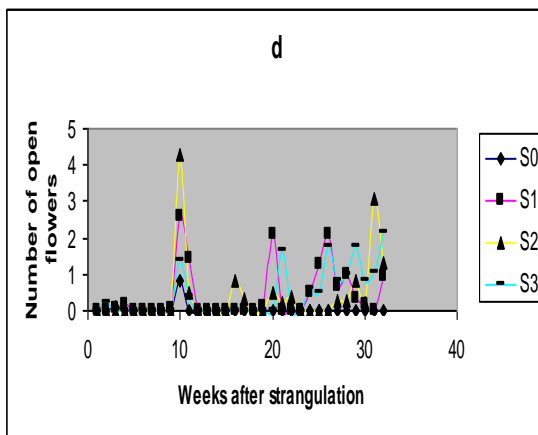
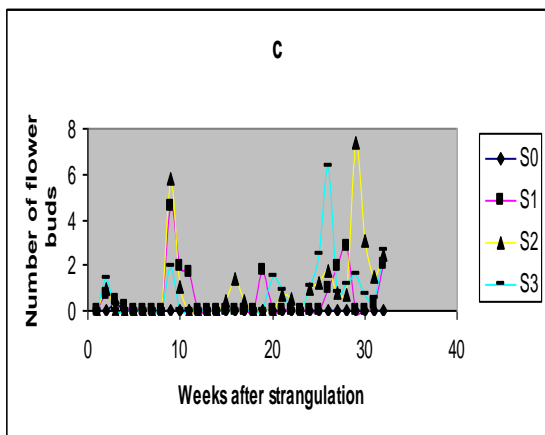
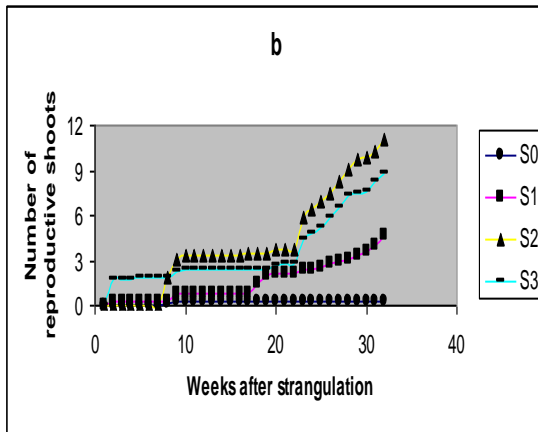
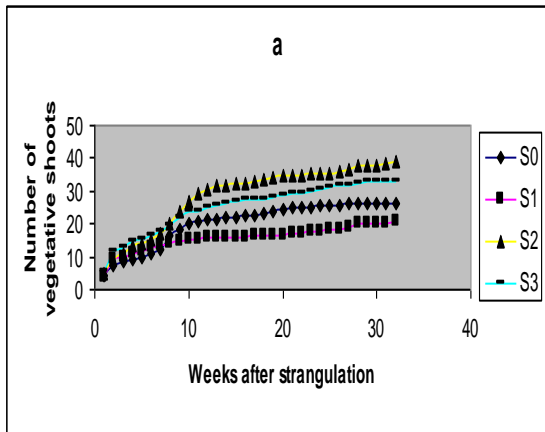


Fig. 2. (a) Development of the number of vegetative shoots; (b) Development of the number of reproductive shoots; (c) Development of the number of flower buds; (d) Development of the number of open flowers; (e) Development of the number of fruits; (g) Leaves nitrogen and carbohydrate content on experiment 3. (S0: control, S1: 3 months, S2: 5 months, and S3: 7 months period of strangulation).

DISCUSSION

Based on the results of the experiment 1, 2 and 3, indicated that strangulation improved flowering and fruiting. The tightening of phloem from the main trunk by wire actually blocks the transport of sugars to the roots; large amounts of carbohydrate produce by photosynthesis will accumulate in vegetative organs above the part of strangulated branches or to be utilized for flowering. This condition related to leaves carbohydrate and nitrogen contents. The strangulated branches have higher carbohydrate and lower nitrogen than control, which would induce trees to flowering and fruiting (Yamanishi and Hasegawa, 1995). The similar results reported by Mustafa and Saleh (2006) on girdled 'Balady' mandarin, and Yahata et al. (2004) on girdled 'Satsuma' mandarin. Reduces in leaves nitrogen concentration on strangulated branches could be attributed to nitrogen dilution in growing leaves or to the remobilization of nitrogen from leaves to developing fruits (Rufat and DeJong, 2001).

According to the results on experiment 1 and 2, the 2.0 mm wire size seems more suitable used for strangulation of pummelo branches, compared with 1.6 mm and 3 mm wire size. Presumably the 1.6 mm wire size is not strong enough to inhibit translocation of assimilates downward, so less effective than the 2.00 mm wire size. While, the 3.0 mm wire size didn't induce flowering better than the 2.0 mm wire size, but made greater damaged at the bark of the tree. This disorder need more time to recovery.

Prolonged of period of strangulation from one to two and three months on Experiment 1, increased leaves carbohydrate content, so enhanced flowering. Meanwhile in experiment 3, lengthened period of strangulation from three to five and seven months, was not significantly increasing the number of reproductive shoots. Possibly accumulation of carbohydrate in long time would decrease photosynthetic capacity, because it would affect proteins of the Calvin cycle activity on thylakoids. A decrease of photosynthetic capacity, resulting from reduced sink activity and carbohydrate accumulation, associated with a decrease on nitrogen content per leaf area unit (Urban et al., 2004).

In conclusion, it has been demonstrated that to improve flowering and fruiting of pummelo trees without significant damages, strangulation should be applied using 2.0 mm of wire size for 3 months period.

ACKNOWLEDGEMENTS

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