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Canopy Management for Sustainable Passion Fruit Production

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Yellow passion fruit (*Passiflora edulis var. Flavicarpa*) is gaining a wide adoption in Kenya, emerging as an important high market value horticultural crop. However, its current yields levels are low due to poor agronomic practices. This study aimed at evaluating the orchard management practices for sweet yellow passion fruits by farmers, with a special focus on canopy management. A survey was conducted on sweet yellow passion fruit in Embu East sub- county, Kenya from June 2016 to august 2016. The sweet yellow passion fruit farmers were randomly sampled using a stratified sampling procedure. Personal interviews with the farmers were conducted in each household using structured and semi- structured questionnaires. The data was analysed using SPSS version 20. Correlation between pruning intensity and dieback disease incidence was analysed using Pearson's correlation model. Findings from the study showed that pruning intensity among farmers varied from very low, moderate to very high. The results showed that 9.8% of farmers pruned moderately, 58.8% of farmers pruned with a low pruning intensity and 29.4% of farmers pruned with a very low pruning intensity. Pruning intensity was negatively correlated (-0.265) to dieback incidence at 0.05% level of significance at a p value of 0.040 the results imply that most farmers pruned the vines at low intensity with the aim of retaining more vines. However,

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this resulted to more incidence of the dieback disease. The farmers require effective training skills on vine pruning to provide an appropriate canopy size which would improve the productivity of sweet yellow passion fruits.

Keywords: Sweet yellow passion fruit; canopy management; pruning intensity; dieback incidence.

1. INTRODUCTION

Passion fruit is grown mostly in tropical and sub-tropical parts of the world [1]. Today, passion fruit is grown nearly everywhere in the tropical belt of South America to Australia, Asia and Africa [2]. South America is currently the largest producer of passion fruit [3]. The passion fruit is one of an estimated 500 *Passiflora* species from the family Passifloraceae [4]. Within this species, there are two distinct forms, the standard purple (*Passiflora edulis)* and the yellow (*Passiflora edulis var. flavicarpa*). Passion fruit stands out not only for its exotic and unique flavour and aroma but also for its amazing nutritional and medicinal properties [4].

In Kenya, passion fruit is produced mostly by smallholder farmers on orchards measuring from 0.10 to 0.81 hectares [5,6]. Although passion fruit's life span is 5 to 7 years, in Kenya it has reduced to an average of 2 to 3 years due to numerous biotic and abiotic constraints [7]. Currently, production of passion fruits has declined due to various factors, namely; prolonged drought, decline in soil fertility, pests and diseases incidence, scarcity of high quality planting materials, inadequate production skill by farmers and poor markets [8].

Kenya Agricultural and Livestock Research Organisation (KALRO), previously known as KARI, developed three new passion fruit varieties, Kenya passion fruit number 4 (KPF 4), KPF 11 and KPF 12. The KPF4 is popularly referred to as sweet yellow passion fruit [9]. Sweet yellow passion fruit grows best at an altitude of 1200-2000 meters above sea level, and at a soil pH of 5.5 to 7 [1]. One carefully tended sweet yellow passion fruit vine will grow to a length of over 20 meters, after the first 4-5 months of transplanting [1] and yield of 30 kg of fruit per vine can be achieved. Good plant nutrition and orchard management practices for vigorous growth of passion vine are the key to achieving high yields [10].

Farmers in Embu County prefer sweet yellow passion fruit because of its ability to tolerate drought, and high volume and quality of juice content [7]. However, most farmers own relatively small pieces of land, lack adequate production skills and face numerous challenges that constrain passion production. Farmers incur high cost of production through fertiliser application, irrigation and control of pests and diseases [11].

Plant canopy is managed through vine pruning and training [12]. Beside, it is an important factor in production of passion fruits. Passion fruit vine has a vigorous growth habit and it is a fast consumer of water and nutrients [1]. Since the Second World War, technological advances, particularly in vine nutrition and pest control and the planting of vines on fertile soils have increased problems of vine vigour leading to poor canopy management [11]. Canopy size determines how effectively the plant can access light, water and nutrients [13]. Thus proper canopy management is important as it helps to maximise the quality of the plant's micro-climate, hence proper growth [14].

2. MATERIALS AND METHODS

2.1 Study Description

The study was conducted in Embu East Sub-County, covering the two Divisions of Runyenjes and Kyeni. Embu East covers an area of 253.8 Km^2 and lies at an altitude of 1280-1770 m above sea level. This area receives an annual rainfall of 750-2400 mm and an average temperature that ranges between 18°C and 20.6°C. Embu East Sub- County has a bimodal pattern of rainfall with the long rains falling between April and June while the short rains fall between October and December [15]. The area consists of a wide range of ecological zones, namely, Upper Midland zone 2 (UM2), Upper Midland Zone 3 (UM3), Upper Midland zone 4 (UM4) and Upper Midland zone 5 (UM5) [15].

2.2 Sampling and Data Collection

A household level survey covering Runyenjes and Kyeni Divisions was conducted. The area was stratified in terms of geographical distance to cover the approximate ecological range of

yellow passion fruit farmers. The sampling units were determined using a stratified sampling procedure in which three locations from each Division were randomly selected for the survey. Consultation with agricultural officers and key informants knowledgeable with the area enabled accurate identification of the farmers growing sweet yellow passion fruits. Personal interviews in each household were conducted using structured and semi- structured questionnaires. Assessment of yellow passion fruit orchards in each household was carried out and results were recorded on the questionnaire.

The sample size was determined by sampling method according to Nassiuma [16] as in equation.

$$n = \frac{NC^2}{C^2 + (N-1)e^2}$$

Where n = sample size; N = population; C = covariance; *e* = standard error

In most surveys and experiments, a coefficient of variation in the range of 21% ≤ C ≤ 30% and a standard error in the range of 2% ≤ e ≤ 5% is usually acceptable [16]. Therefore taking a coefficient of variation of 23% and a standard error of 0.02 (2%) out of a target population of 103, a sample of 57 respondents was obtained.

The data collected on assessment of vine training and pruning include; vine training extent, pruning intensity, vine spacing extent, height of support poles, source of support poles, treatment of support poles, pruning tools used and disinfection state of pruning tools.

2.3 Data Analysis

Descriptive statistics was performed using SPSS version 20 and results were presented as tables and figures. The data analysed include, vine training extent, pruning intensity, pruning used. Correlation between pruning intensity and dieback disease incidence was analysed using Pearson's Correlation model.

3. RESULTS AND DISCUSSION

3.1 Pruning Intensity

The pruning intensity was determined by the number of secondary vines retained after pruning. It varied from very high (below 35), high (35-44), moderate (45-50), low (51-65) to very low (above 65). The results showed that only 9.8% of farmers pruned moderately, 58.8% of farmers pruned with a low pruning intensity, 29.4% of farmers pruned with a very low pruning intensity, no farmer (0%) pruned with a high intensity and 2% of farmers practised very high pruning intensity (Fig. 1).

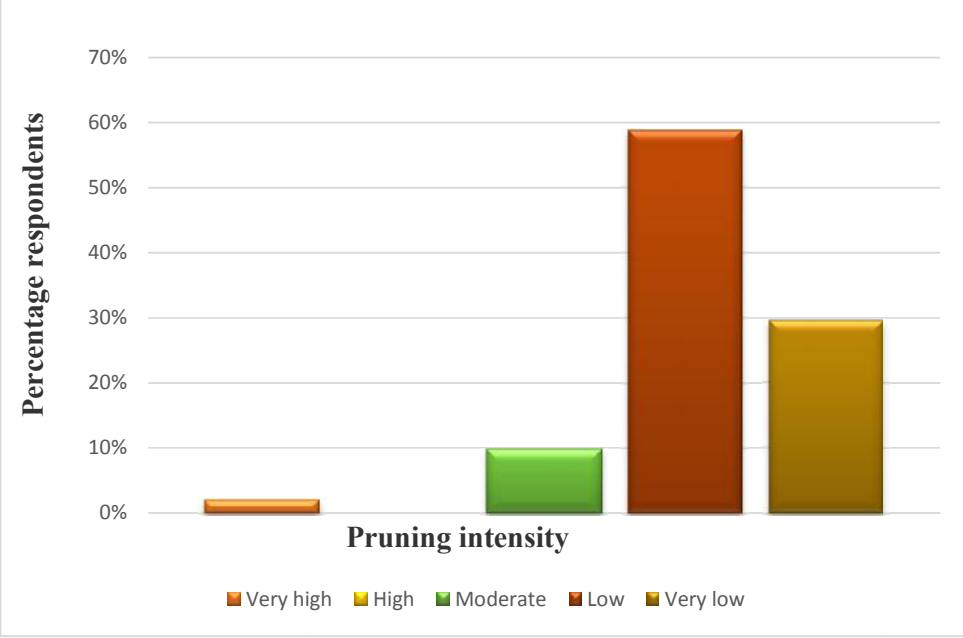

Fig. 1. Pruning intensity for sweet yellow passion fruit practised by farmers (N=57)

These results show that most farmers (58.8%) in Embu East pruned with a low pruning intensity (Fig. 1). The farmers minimised on pruning vines in order to retain as many vines as possible accordingly to get high number of fruits, whereas the size of the fruits, an important quality determinant in the market, was not considered as a priority. A conventionally trained vine (3 m primary vine length) should have 50 secondary vines [9], which requires moderate pruning. Low pruning intensity retains many vines which results to overcropping and excessive canopy density [17]. According to Skinkis [18], overcropping leads to the reduction of vine vigour (rate of shoot growth) and vine size (pruning weight). Although the vine might appear to be mature, stored starch reserves in vines stressed by overcropping can be so low that the next year's vegetative growth and fruit yield will be severely reduced [19].

On the other hand, with high pruning intensity, the crop will be needlessly reduced if too few vines remain [18]. Furthermore, severely pruned vines are apt to produce excessively vigorous shoots because all of the stored energy in the parent vine and roots is available to relatively few growing points [20]. Excessive shoot vigour can reduce fruit set and delay shoot maturation in the next season [19].

3.2 Pruning Intensity and Dieback Incidence

The pruning intensity was negatively correlated (-0.265) to dieback incidence at 0.05% level of significance at a P value of 0.040 (Table 1).

Table 1. Pearson correlation for pruning intensity and dieback incidence

		Pruning intensity	Dieback incidence
Pruning intensity	Pearson correlation	1	-.265
	Sig. (2-tailed)		.060
	N	57	57
Dieback incidence	Pearson correlation	-.265	1
	Sig. (2-tailed)	.060	
	N	57	57

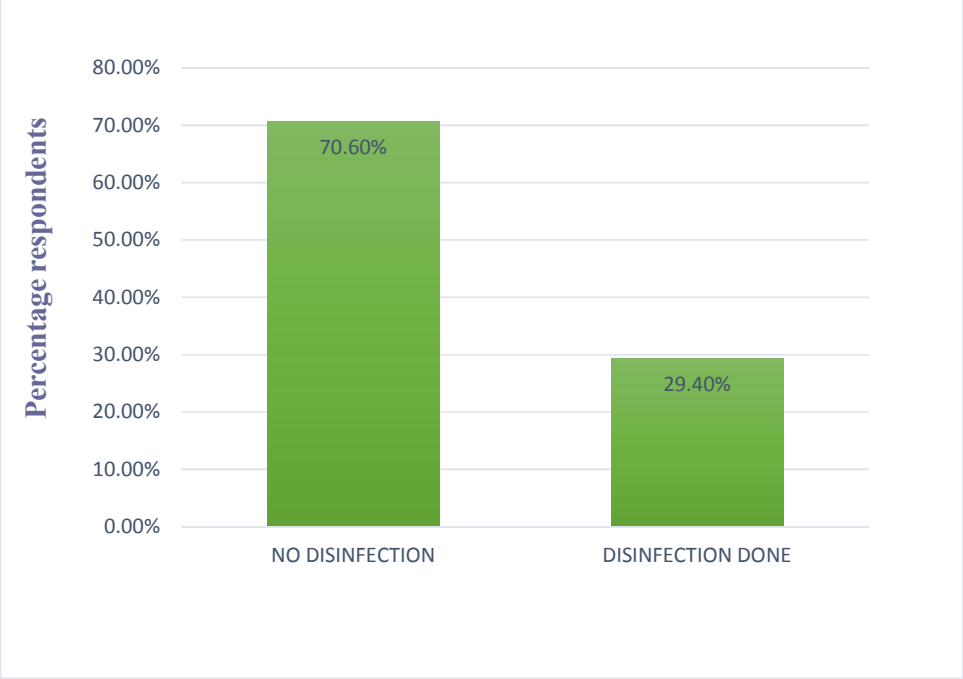

Fig. 2. Phytosanitary practices for sweet yellow passion fruit farmers (N=57)

The results of the study revealed that pruning intensity was negatively correlated to dieback incidence at 0.05% level of significance (Table 1). This shows that where higher pruning intensity was practised, less incidence of dieback was observed, whereas in lower pruning intensity, higher incidence of dieback disease occurred. Dieback is a disease complex involving fungal pathogens such as *Fusarium* (*F. oxysporum, F. semitectum, F. pseudoanthophilum, F. subglutinans and F. solani*), *Phytophthora* (P. *nicotianae*) and possibly others [21]. Dieback disease is the most important constraint to Kenya's passion fruit industry and causes over 70% of total fruit loss in the country [22]. Low pruning intensity allows a high canopy density which promotes a favourable environment for diseases [18]. This explains why lower pruning intensity was related to higher incidence of dieback disease in this study. According to Cushnie [23], moderate pruning provides an appropriate canopy density which allows adequate aeration creating an unfavourable environment for occurrence of dieback [18]. High pruning intensity creates an open canopy which discourages the occurrence of dieback [24]. However, high pruning intensity increases vine vigour reducing yield quantity which would render its practice unfavourable [25]. Hence, moderate pruning might be the most appropriate as it lowers dieback incidence and promotes optimum yield.

3.3 Hygiene State during Pruning

Majority (70.6%) of farmers in Embu East Sub-County reported that they did not disinfect the pruning tools before and after pruning (Fig. 2).

Passion fruit vines are subject to infection by a variety of diseases throughout the year and minimising inoculum sources by proper orchard hygiene is essential for effective control [26]. Use of non- disinfected pruning tools results to spreading of pathogens from vine to vine resulting to reduced longevity of passion fruit orchards [27]. Disinfection of tools before and after pruning minimises spread of pathogens from vine to vine [28]. The tools should be disinfected by dipping in methylated spirits or household bleach and wiping dry with a clean cloth before use [27].

4. CONCLUSION

Most farmers did not carry out proper pruning as they minimised on pruning vines in order to retain as many vines as possible accordingly to get a high number of fruits. On the other hand, the size of the fruits, an important quality determinant in the market, was not considered as a priority. Majority of farmers do not practise field hygiene during pruning which results to spreading of pathogens from vine to vine reducing the longevity of passion fruit orchards. Therefore, effective training on orchard management with emphasis on pruning is required. This has the potential to minimise the incidence of dieback disease and improve productivity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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