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Effect of different fruit growing position and cultivation altitude on unjuicy fruit in Tejakula Tangerines (*Citrus reticulata* cv. Tejakula)

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Abstract

Tejakula tangerine (*Citrus reticulata* cv. Tejakula) is one of the citrus with a characteristic bright yellow fruit. This type of citrus is favored by many people because of its fresh and sweet taste compared to other oranges. Tejakula tangerines experience problems at this time, namely the decline in the quality of the fruit produced. The declining fruit quality is caused by several obstacles, one of which is unjuicy fruit. Unjuicy fruit or the tip of the upper fruit, near the fruit stalk is white like cotton, low water content and bland taste. The purpose of this study was to determine the effect of cultivation altitude and fruit growing position on unjuicy fruit in Tejakula tangerines. This study used a randomized group split plot design with two factors. The first factor is the cultivation altitude with two levels, namely the height of the cultivation site 0-150 meters above sea level (m asl) (K_1), the height of the cultivation site >150-300 m asl (K_2). The second factor is fruit growth position with two levels: fruit growth position on the outer crown (P_l), fruit growth position on the inner crown (P_d). The results of the K_2 treatment gave the best results on the percentage of unjuicy fruit weight (11.11%), the Percentage of the of Unjuicy Fruit (11.11%), the percentage of the number and weight of unjuicy fruits at lightly level (9.52%), the percentage of the number and weight of unjuicy fruits at medium level (0.79%). P_d treatment gave the best results on the percentage of unjuicy fruit weight (11.11%), the Percentage of the of Unjuicy Fruit (11.11%), the percentage of the number and weight of medium unjuicy fruits (0.79%). K_2P_d interaction gave better results for the variables of percentage of unjuicy fruit weight (9.52%), percentage of unjuicy number (9.52%) and percentage of number and weight of medium unjuicy fruits (0%).

Keyword: Tejakula tangerine; Cultivation altitude; Unjuicy; Growing position

1. Introduction

Tejakula tangerines (*Citrus reticulata* cv. Tejakula) are a fruit commodity with great potential to replace imported oranges in Indonesia, especially in the Bali market. This citrus has a characteristic bright yellow color and sweet taste that is favored by the community. Tejakula tangerine production is currently experiencing a decline in quality and quantity, caused by several factors such as inappropriate planting locations, unhealthy seedlings, and high light intensity. Farmers revealed that citrus groves in this area need shade to produce good quality fruit, due to the increase in temperature caused by global climate change [1]. One of the main problems that reduce fruit quality is the unjuicy fruit phenomenon, where the fruit has a low moisture content. This phenomenon is mainly found in fruits growing at the end of twigs that are more exposed to direct sunlight. Intense sunlight causes increased transpiration rates that reduce fruit moisture content, which results in poor fruit quality [2]. Increased transpiration can reduce water supply to the fruit, which in turn affects photosynthate transport [3]. In addition to fruit growing position, altitude also affects the quality of Tejakula tangerine fruit. Low altitudes with high temperatures and low humidity lead to higher transpiration, potentially causing water content loss in the fruit [2]. Based on the above description, further research is needed to determine the effect of different altitudes of cultivation and fruit growing position on unjuicy fruit in Tejakula tangerine.

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2. Materials and methods

2.1. Time and Place of Research

The research took place from April to June 2024. Sampling was conducted in citrus plantations in Tejakula Village, Buleleng Regency, Bali Province with an altitude of 15,3 m asl and Penuktukan Village, Buleleng Regency, Bali Province with an altitude of 236,9 m asl. Variable observations were carried out at the Agronomy and Horticulture Laboratory, Faculty of Agriculture, Udayana University.

2.2. Tools and Materials

The materials used in this study were Tejakula tangerine plants, pure water (distilled water), coolbox, plastic bags, label paper, envelopes. The tools used are scales, cups, knives, Chlorophyll Meter SPAD-502 and other observation support tools.

2.3. Research Design

This study used a randomized group split plot design with two factors and seven replications. The first factor is the altitude of the cultivation site with two levels: 0-150 m asl (K_1), >150-300 m asl (K_2). The second factor is the fruit growth position on the crown with two levels: fruit growth position on the outer crown (P_l), fruit growth position on the inner crown (P_d).

2.4. Fruit Sampling

Tejakula tangerine fruit samples used are oranges with different harvest times, namely when the fruit is almost mature (shiny dark green rind), physiologically mature fruit (yellowish green rind), mature fruit (greenish yellow rind). Fruit sampling was carried out by dividing the crown into two parts, then the outer part was taken for fruit samples with growth position factors on the outer crown and the inner part was taken for fruit samples with growth position factors on the inner crown. Samples that have been taken are grouped according to treatment and replication in plastic and then put into a coolbox.

2.5. Observation Variable

2.5.1. Percentage of light entering the base of the tree

Light intensity measured using the Lux Meter application on a Smartphone was calculated at harvest time. Measurements were made by directing the Lux Meter application on the Smartphone at three measurement points, namely by dividing three parts on the crown, namely on the outside of the crown, the outer crown and the inner crown. Measurement of light intensity in each crown is done by taking three points, namely the base of the tree, the middle of the tree and the top of the tree on the fruit that is still on the tree according to the position of each fruit growth in each crown location then averaged and get the value of light intensity received by the fruit with lux units, after averaging the results in each part of the crown divided by the results on the outside of the crown and multiplied by 100%.

2.5.2. Leaf chlorophyll content

Leaf chlorophyll content was measured using Chlorophyll Meter SPAD-502. Measurements are made by taking leaves on twigs that support the harvested fruit and then attached to the measuring device until the numbers appear on the screen and to get the average value by pressing the average button on the tool.

2.5.3. The percentage of unjuicy fruit weight

Fruit at each growing location were harvested at near maturity (dark green shiny skin), physiologically ripe fruit (yellowish green skin), mature fruit (greenish yellow skin). A number of fruits harvested at each maturity level were observed and the weight of unjuicy fruits was measured at lightly, medium, heavy levels. The lightly level was characterized by the upper fruit juncture close to the fruit stalk being less juicy and white like cotton. At the medium level, unjuicy fruit is characterized by the upper fruit ring up to half of the fruit being less juicy and white like cotton. Unjuicy fruit at the heavy level is characterized by the entire top to bottom fruit ring in the vertical direction being less juicy and white like cotton. Unjuicy fruit weight is calculated by dividing the weight of unjuicy fruit at each level by the harvested fruit weight multiplied by 100%.

Figure 1 The Difference Between Non Unjuicy Fruit Curves, Lightly Level Unjuicy, Medium Level Unjuicy, Heavy Level Unjuicy[1]

2.5.4. The Percentage of the of Unjuicy Fruit

A number of fruits were harvested at each growing location when the fruits were nearly mature (shiny dark green rind), physiologically mature fruits (yellowish green rind), mature fruits (greenish yellow rind). From the number of fruits harvested at each maturity level, the number of unjuicy fruits was observed and measured. Unjuicy fruits were divided into 3 levels: light, medium, and heavy. The Percentage of the of Unjuicy Fruit was calculated by dividing the number of unjuicy fruit at each level by the total number of harvested fruit multiplied by 100%.

2.5.5. Calcium (Ca) and boron (B) concentration

Nutrient content was analyzed using a mixture of samples of near-ripe mature fruit (shiny dark green rind), physiologically mature fruit (yellowish green rind), ripe fruit (greenish yellow rind) separated between unjuicy and unjuicy and then baked and crushed using a blender. Ca and B concentrations were measured by Atomic Absorption Spectroscopy (AAS) method.

2.6. Statistical Analysis

Statistical Analysis The data obtained was analyzed using one-way ANOVA and if there was a significant difference ($P<0.05$) between treatments, it was continued with BNT 5% test.

3. Results

3.1. Percentage of Light Entering the Base of the Tree

The results of statistical analysis showed that the treatment of altitude was not significantly different from the variable percentage of light entering the base of the tree. The highest percentage of light entering the base of the tree was obtained in the treatment of cultivation altitude >150-300 meters above sea level (m asl) (K_2) at 79,58% and the lowest percentage of light entering the base of the tree was obtained in the treatment of cultivation altitude 0-150 m asl (K_1) at 70,27%. The treatment of fruit growing position was significantly different from the variable of the percentage of light entering the base of the tree. The highest percentage of light entering the base of the tree was obtained by the treatment of growth position on the outer crown (P_l) at 89,21% and the lowest percentage of light entering the base of the tree was obtained by the treatment of growth position on the inner crown (P_d) at 60,65% (Table 1).

Table 1 Single Factor Results of Altitude Cultivation (K) and Fruit Growing Position (P) on the Variable Percentage of Light Entering the Base of the Tree (%), Leaf chlorophyll content (unit)

Treatment	Percentage of Light Entering the Base of the Tree (%)	Leaf chlorophyll content (unit)
Cultivation Altitude		
K_1	70.27 a	53.14 b
K_2	79.58 a	58.76 a
BNT 5%	10.96	4.94
Fruit Growing Position		

P_l	89.21 a	53.14 b
P_d	60.65 b	58.76 a
BNT 5%	5.46	4.94

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test.

3.2. Leaf chlorophyll content

The results of statistical analysis showed that the treatment of altitude was significantly different on the variable of leaf chlorophyll content. The highest leaf chlorophyll content was obtained in the treatment of cultivation altitude >150-300 m asl (K_2) at 58,76 unit and the lowest leaf chlorophyll content was obtained in the treatment of cultivation altitude 0-150 m asl (K_1) at 53,14 unit. The treatment of fruit growing position was significantly different from the variable of leaf chlorophyll content. The highest leaf chlorophyll content was obtained by the treatment of growth position on the outer crown (P_l) at 58,34 unit and the lowest leaf chlorophyll content was obtained by the treatment of growth position on the inner crown (P_d) at 53,37 unit (Table 1).

3.3. The percentage of unjuicy fruit weight

The results of statistical analysis showed that the treatment of altitude was not significantly different from the variable percentage of unjuicy fruit weight. The highest percentage of unjuicy fruit weight was obtained in the treatment of cultivation altitude 0-150 meters above sea level (K_1) at 12,70% and the lowest percentage of unjuicy fruit weight was obtained in the treatment of cultivation altitude >150-300 meters above sea level (K_2) at 11,11%. The treatment of fruit growth position was not significantly different from the variable percentage of unjuicy fruit weight. The highest percentage of unjuicy fruit weight was obtained by the treatment of growth position on the outer crown (P_l) at 12,70% and the lowest percentage of unjuicy fruit weight was obtained by the treatment of growth position on the inner crown (P_d) at 11,11% (Table 2).

Table 2 Single Factor Results of Altitude (K) and Fruit Growing Position (P) on Unjuicy Fruit Weight (%), Lightly Unjuicy Fruit Weight (%), Medium Unjuicy Fruit Weight (%), Heavy Unjuicy Fruit Weight (%) and Interaction between Altitude (K) and Fruit Growing Position (P) on Unjuicy Fruit Weight (%).

Treatment	**Percentage of unjuicy fruit weight (%)**	**Percentage of Lightly Unjuicy Fruit Weight (%)**	**Percentage of Medium Unjuicy Fruit Weight (%)**	**Percentage of Heavy Unjuicy Fruit Weight (%)**
Cultivation Altitude				
K_1	12.70 a	11.51 a	1.59 a	0
K_2	11.11 a	9.52 a	0.79 a	0
BNT 5%	13.09	10.67	3.55	0
Fruit Growing Position				
P_l	12.70 a	10.32 a	1.59 a	0
P_d	11.11 a	10.71 a	0.79 a	0
BNT 5%	6.17	5.19	3.16	0

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test.

Interaction between Altitude (K) and Fruit Growing Position (P) on Unjuicy Fruit Weight (%).

Treatment	**K_1**	**K_2**
P_l	12.70 a	12.70 a
P_d	12.70 a	9.52 a

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test.

3.4. The Percentage of the of Unjuicy Fruit

The results of statistical analysis showed that the treatment of altitude was not significantly different from the variable percentage of unjuicy fruit . The highest percentage of unjuicy fruit was obtained in the treatment of cultivation altitude 0-150 m asl (K_1) at 12,70% and the lowest percentage of unjuicy fruit was obtained in the treatment of cultivation altitude >150-300 m asl (K_2) at 11,11%. The treatment of fruit growth position was not significantly different from the variable percentage of unjuicy fruit. The highest percentage of unjuicy fruit was obtained by the treatment of growth position on the outer crown (P_l) at 12,70% and the lowest percentage of unjuicy fruit was obtained by the treatment of growth position on the inner crown (P_d) at 11,11% (Table 3).

Table 3 Single Factor Results of Altitude (K) and Fruit Growing Position (P) on the Variables Percentage of Unjuicy Fruit (%), Percentage of Lightly Unjuicy Fruit (%), Percentage of Medium Unjuicy Fruit (%), Percentage of Heavy Unjuicy Fruit (%) and Interaction between Altitude (K) and Fruit Growing Position (P) on the Variables of Unjuicy Fruit (%), Medium Unjuicy Fruit (%).

Treatment	Percentage of Unjuicy Fruit (%),	Percentage of Lightly Unjuicy Fruit (%)	Percentage of Medium Unjuicy Fruit (%)	Percentage of Heavy Unjuicy Fruit (%)
Cultivation Altitude				
K_1	12.70 a	11.51 a	1.59 a	0
K_2	11.11 a	9.52 a	0.79 a	0
BNT 5%	13.09	10.67	3.55	0
Fruit Growing Position				
P_l	12.70 a	10.32 a	1.59 a	0
P_d	11.11 a	10.71 a	0.79 a	0
BNT 5%	6.17	5.19	3.16	0

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test.

Interaction between Altitude (K) and Fruit Growing Position (P) on Variable of Unjuicy Fruit (%)

Treatment	K_1	K_2
P_l	12.70 a	12.70 a
P_d	12.70 a	9.52 a

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test.

Interaction between Altitude (K) and Fruit Growing Position (P) on Variable of Medium Unjuicy Fruit (%)

Treatment	K_1	K_2
P_l	1.59 a	1.59 a
P_d	1.59 a	0 a

Note: Numbers followed by the same letter indicate that they are not significantly different in the 5% BNT test.

3.5. Boron Concentration (B)

The results of laboratory analysis, the average boron concentration in unjuicy fruit is 1,835 mm/kg higher than the boron concentration in unjuicy fruit is 1,111 mg/kg based on the average fruit samples from the cultivation altitude of 0-150 m asl, >150-200 m asl and also the position of fruit growth on the outer and inner crowns (Table 4). The average boron concentration at the cultivation altitude of >150-250 m asl (K_2) of 2,024 mg/kg gave higher results than at the cultivation altitude of 0-150 m asl of 1,845 mg/kg (K_1) based on samples taken from the fruit growth position on the outer and inner crowns (Table 4). Boron concentration in the treatment of fruit growing position on the inner crown (P_d) gave the highest average of 1,492 mg/kg compared to the treatment of fruit growing position on the outer crown (P_l) which was 1,455 mg/kg based on samples taken from the cultivation altitude of 0-150 m asl and >150-300 m asl (Table 5).

Table 4 Labarotorium Analysis Results Boron (B) concentration (mg/kg**)**

	K_1		**K_2**		**Total**	**Average**
	P_l	P_d	P_l	P_d		
No Unjuicy	0.363	0.002	0.437	3.643	4,445	1,111
Unjuicy	2.224	1.100	2.794	1.222	7,340	1,835
Average	1.845		2.024			

Note: Test device detection limit = 0,002 mg/kg

Table 5 Labarotorium Analysis Results Boron (B) concentration (mg/kg)

	P_l		**P_d**		**Total**	**Average**
	K_1	K_2	K_1	K_2		
No Unjuicy	0.363	0.437	0.002	3.643	4.445	1.111
Unjuicy	2.224	2.794	1.100	1.222	7.340	1.835
Average	1.455		1.492			

Note: Test device detection limit = 0,002 mg/kg

3.6. Calcium (Ca) Concentration

The results of laboratory analysis, the average calcium concentration in unjuicy fruit, 862,706 mm/kg, was higher than the calcium concentration in unjuicy fruit, 583,131 mg/kg, based on the average fruit samples from the cultivation altitude of 0-150 m asl, >150-200 m asl and also the position of fruit growth on the outer and inner crowns (Table 6). The average calcium concentration at cultivation altitudes >150-250 m asl (K_2) 760,346 mg/kg gave higher results than at cultivation altitudes 0-150 m asl of 685,491 mg/kg (K_1) based on samples taken from the position of fruit growth on the outer and inner crowns (Table 6). Calcium concentration in the treatment of fruit growth position on the inner crown (P_d) gave the highest average of 829,839 mg/kg compared to the treatment of fruit growth position on the outer crown (P_l) which was 615,998 mg/kg based on samples taken from the cultivation altitude of 0-150 m asl and >150-300 m asl (Table 7).

Table 6 Labarotorium Analysis Results Calcium (Ca) concentration (mg/kg)

	K_1		**K_2**		**Total**	**Average**
	P_l	P_d	P_l	P_d		
No Unjuicy	225.556	183.516	497.018	1426.434	2332.524	583.131
Unjuicy	1262.853	1070.039	478.564	639.367	3450.823	862.706
Average	685.491		760.346			

Table 7 Labarotorium Analysis Results Calcium (Ca) concentration (mg/kg)

	P_l		**P_d**		**Total**	**Average**
	K_1	K_2	K_1	K_2		
No Unjuicy	225.556	497.018	183.516	1426.434	2332.524	583.131
Unjuicy	1262.583	478.564	1070.039	639.367	3450.823	862.706
Average	615.998		829.839			

4. Discussion

The fruit growth position on the inner crown (P_d) gave a lower percentage of unjuicy fruit at 11,11% compared to the fruit growth position on the outer crown (P_l) at 12,70% (Table 3). This is indicated by the percentage of light entering the Pd treatment which is lower at 60,65% compared to the Pl treatment which is 89,21% (Table 1) in line with the statement [4] that the growing position of the fruit on the outer crown receives more sunlight. The transportation of mineral nutrients depends on the transpiration rate of leaves and fruits, and it was found that fruits exposed to sunlight with higher transpiration rates accumulated more minerals than fruits in shaded conditions. Too high light conditions can cause physiological disorders such as sunburn damage or fruit rot. The results showed that the treatment of fruit growth position on the inner canopy resulted in greater calcium and boron concentrations compared to the outer canopy position, namely calcium concentration of 829,839 mg/kg (Table 7) and boron concentration of 1,492 mg/kg (Table 5). This is in line with research [5] on mandarin orange plants the concentration of minerals in the fruit, including boron and calcium, is higher in fruits growing on the inside of the crown than the outside, due to better microclimate distribution and reduced environmental stress. Boron and calcium are transported through xylem tissue to various parts of the plant. The position of the fruit on the outside of the canopy, which is more exposed to light and high transpiration rates, can cause disruption of water and mineral transport into the fruit. High transpiration in the outer part of the canopy can cause boron and calcium to be absorbed more quickly by nearby leaves, resulting in lower accumulation in the fruit [6]. Fruit on the inside of the canopy that are protected from direct sunlight have lower transpiration rates, allowing for more efficient accumulation of boron and calcium into the fruit tissue. Boron plays an important role in cell wall formation and carbohydrate transportation, while calcium is responsible for cell wall strengthening through the formation of pectin bonds in the middle lamella [7] [8]. Fruits growing in the inner part of the crown, with higher boron and calcium content, have stronger cell walls, which help to retain moisture content and prevent unjuicy. Suboptimal calcium (Ca) nutrient uptake is the cause of citrus fruit bursting, bland taste, and less intense fruit aroma [9].

The results of the analysis showed that the cultivation altitude of >150-300 m asl (K_2) gave a percentage of unjuicy fruit weight of 11.11%, while at an altitude of 0-150 m asl (K_1) it was recorded at 12,70% (Table 2). These results show that the two treatments were not significantly different although the results of K_2 gave a lower percentage of unjuicy fruit weight than K_1, which means that the altitude had no significant effect on the weight of unjuicy fruit produced. The percentage of unjuicy fruit weight that was not significantly different from the K2 treatment was influenced by the lower percentage of the number of unjuicy fruits at 11.11% compared to the K_1 treatment at 12,70% (Table 3). The number of unjuicy fruits was also influenced by the lower number of fruits at the light (9,52%), medium (0,79%), and heavy (0%) unjuicy levels which were not significantly different from the K_1 treatment (Table 3). Chlorophyll content is a factor of growth and production, therefore this parameter is closely related to the rate of photosynthesis [10]. The results of chlorophyll content in the K_2 treatment gave the highest results of leaf chlorophyll content of 58,76 units which was significantly different from the K_1 treatment (Table 1). The altitude of the place affects the production of citrus. The research location in the K_2 treatment is at an altitude of 236.9 m asl. This is in accordance with research [1], Tejakula tangerines are very well planted at an altitude of 0-700 m asl. Chlorophyll plays an important role in the process of photosynthesis, which produces organic compounds as assimilates from inorganic compounds with the help of sunlight. The intensity of light absorbed by the leaves determines the activity of photosynthesis, which in turn will affect the amount of assimilate (carbohydrates) produced. These organic compounds will be utilized by plants for their survival, including to grow, develop, and produce fruit [11]. The percentage of light entering the tree in the K_2 treatment (79,58%) was greater than the K_1 treatment (70,27%) (Table 1). Optimal light intensity can increase the rate of photosynthesis. This is supported by the statement [1] that Tejakula tangerines that receive sufficient irradiation will produce more and good quality leaves so that the photosynthesis process is optimal, where the energy from photosynthesis will be used by plants to form stems, roots and fruit efficiently. The growth and development of horticultural commodities (fruits, vegetables, and ornamental plants), and their quality, are strongly influenced by the process of photosynthesis [12]. Boron concentration in K_2 treatment gave the highest result of 2,024 mg/kg compared to K_1 treatment of 1,845 mg/kg (Table 4). The results of this study are in accordance with the statement [13] that if boron translocation is influenced by the air temperature around the plant, it determines the concentration of boron in the leaves. Boron contributes to the formation of strong and stable cell walls, transports sugars, develops hormones and balances nutrients with others such as nitrogen, phosphorus, calcium and potassium. Suboptimal boron concentration causes the cell wall to become brittle, which can cause damage to the fruit and increase water loss. Fruit that do not have good cell structure are more susceptible to physical damage and moisture loss [14].

Boron content also affects calcium metabolism and its deficiency lowers calcium associated with pectin constituents [15], this is in line with the results of the study of calcium concentration in K_2 gave higher results of 760,346 mg/kg compared to K_1 treatment of 685,491mg/kg (Table 6). Ca^{2+} ions help maintain cell wall integrity due to their role in boron-diester bonds in the pectate layer [16]. Calcium and boron, both elements play an important role in cell wall metabolism and are required for auxin transport [17]. Calcium is necessary for cell wall stability, while boron contributes to the formation and maintenance of cell wall structures, especially in pectin. When plants are exposed to non-optimal calcium concentrations, growth inhibition is based on the prevention of cell wall expansion, cell membrane rigidity and an increase in insoluble deposits in walls and vacuoles [18].

The interaction between the cultivation altitude >150 -300 m asl and the position of fruit growth on the inner crown (K_2P_d) gave better results than the other treatment combinations for the lowest percentage of unjuicy fruit weight (9,52%), the lowest percentage of unjuicy fruit (9,52%) and the lowest percentage of medium unjuicy fruit (0%). This is due to the fact that at an altitude of 150-300 m asl, the temperature is lower and the relative humidity is higher compared to the lowlands (0-150 m asl). This condition reduces the transpiration rate, so the plant can maintain the water content in the fruit in line with the statement [2] that too high temperatures in the lowlands increase the water vapor pressure in the leaves and fruit, which triggers faster water loss. Fruits on the inside of the crown are protected from direct sunlight. This helps to reduce excessive transpiration rates, maintain water content in the fruit, and reduce the risk of unjuicy. [19] mentioned that direct light increases stomatal opening, which accelerates water loss through transpiration. Shadier inner canopy helps reduce transpiration rate.

5. Conclusion

The growing position of the fruit on the inner crown (P_d) gives better results than the growing position of the fruit on the outer crown. This is indicated by the lowest percentage of unjuicy fruit weight (11,11%), the lowest percentage of unjuicy fruits number (11,11%), the lowest percentage of the number and weight of medium unjuicy fruits (0,79%). Cultivation altitude >150-300 m asl (K_2) gave better results than cultivation altitude 0-150 m asl. This is indicated by the lowest percentage of unjuicy fruit (11,11%), the lowest percentage of unjuicy fruit weight (11,11%), the lowest percentage of light unjuicy fruit (9,52%), the lowest percentage of unjuicy medium fruit (0,79%). The interaction between the cultivation altitude >150 -300 m asl and the position of fruit growth on the inner crown (K_2P_d) gave better results than the other treatment combinations for the lowest percentage of unjuicy fruit weight (9,52%), the lowest percentage of unjuicy fruit (9,52%) and the lowest percentage of medium unjuicy fruit (0%).

Compliance with ethical standards

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Disclosure of conflict of interest

The study was carried out without conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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