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Fertilizing and Pruning Application for the Flowering and Fruiting of Conjoined Citrus

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Abstract

This study aims to examine the application of fertilizing and pruning for the flowering and fruiting of conjoined citrus plants and their interactions. This study used a randomized-group design, arranged factorially with two factors, namely Fertilizing (F) and Pruning (P). The first factor that was experimented was fertilization (F) consisting of 3 levels, namely P0 (fertilization following the farmers' way only with manure), F1 (fertilizing with manure, N, P, K and Ca), F2 (fertilizing with manure N , P, K, Ca + Cu and Zn), while the second factor that was experimented was pruning (F) consisting of 3 levels, namely F0 (without pruning), F1 (young shoots trimmed), F2 (young shoots, twigs and leaves that were stricken with disease and were shaded, trimmed). Fertilizing and pruning treatments have a very significant effect on the number of fruits formed per tree. The results show that obtaining highest number of fruits formed per tree in fertilizing treatment with manure N, P, K, Ca + Cu and Zn was 256.00 pieces, increased by 95.79% compared with that of the lowest number in fertilizing treatment carried out only by manure, which was 130.75 pieces. The conclusion that obtained highest number of fruit per tree in the treatment of pruning the young shoots, twigs and leaves that were stricken with disease and were shaded was as many as 222.42 pieces, an increase of 25.71% compared with that of the lowest number in the treatment without pruning, which was only 176.92 fruit.

Keywords: fruit quality, fertilizer, pruning, conjoined citrus

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1. Introduction

Orange is one of the horticultural fruit plants that has high economic value because it is much sought after by the community. It is the most widely cultivated plant in Bali, especially the species of conjoined citrus (1). Conjoined citrus are widely developed in Bali due to the environmental conditions which are very suitable for planting conjoined citrus, especially in the regencies of Bangli and Gianyar. Citrus-producing centers in Gianyar Regency are located two districts, namely Payangan and Tegalalang. Between the two sub-districts, Payangan Sub-district is the largest orange producer known in Gianyar, especially in the villages of Kerta, Puhu and Buahan.

A cultivation technique that can bring oranges out of season can be realized by engineering several factors that affect the growth and development of plants using chemicals and by physical treatment. The chemical method utilizes substances inhibiting the growth which then can stimulate flowering. Fertilization outside the season can also be done by physical and mechanical means, namely, strangulation, pruning and water stress.

Physical arrangement in the form of pruning aims to control the size, shape, diversity, regulation of flower production, and the amount and quality. The physiological response of plants undergoing physical regulation by pruning can be seen in the rate of growth as well as the response to generative organ formation (2).

In plants that are pruning, a decrease in vegetative growth that can store C will occur, so that with the existence of a larger amount of C, this condition will spur generative growth. Pruning will increase the C/N ratio in the body of the plant. A high C/N ratio results in a buildup of carbohydrates, which ultimately stimulates the formation of flowers and fruit, as well as more efficient use of solar radiation by plants. Thus a net photosynthesis yield per unit area of leaves greater than uncropped plants will be obtained. Pruning also aims to reduce competition in the struggle for assimilation between productive leaves and twigs and unproductive leaves, shoots and twigs (3).

Fertilization is an effort to sufficient nutrients in the soil so that the genetic potential of plants can be reached to the maximum or in other words as an effort to create a condition where nutrients are balanced and available, in accordance with plant needs. One effort that can be done to overcome nutrient deficiencies, especially N, P and K is by applying fertilizers such as Urea, TSP and KCl. These three elements have a very important role in the growth and production of plants where these elements interact with each other in support. In addition to using N, P, K fertilizers to increase plant growth and production, it is also necessary to provide micro fertilizer and organic fertilizer (manure) (4). It was further claimed that the application of manure was intended to improve the physical, chemical and biological properties of the soil so that its productivity could be increased.

In addition to fertilization with N, P and K, fruits also need to be fertilized with Ca fertilizer and micro fertilizer containing Zinc (Zn) and Copper (Cu). The quality of citrus fruits is improved by fertilizing with ZnSO4 and CuSo4 with a concentration of 0.5%. (5). The quality of guava fruit improves after being fertilized with Calcium Nitrate and micro fertilizer containing copper sulfate. Applying the Ca in the form of gypsum and micro fertilizer can maintain quality during storage and shelf life becomes longer. The lowest fallen fruit and the best fruit quality can be obtained from the administration of copper sulfate with a concentration of 0.5% through the leaves (6).

Grounded by the limited number of studies on fertilization and pruning for conjoined citrus plants, the present researcher tries to study the fertilization combined with pruning in the plants in question. The purpose of this study is to determine the effect of fertilization and pruning on flowering and fruiting of conjoined citrus plants and their interactions. The hypothesis proposed is by administering manure, N, P, K, Ca + Zn and Cu micro elements with pruning of young shoots, twigs and leaves that are stricken with disease and are shaded can stimulate a best flowering and fruiting of the conjoined citrus plants.

2. Materials and methods

Time and Location of the Research

This study was conducted at the conjoined citrus plantation, owned by one of the farmers in Br. Seming, Kerta Village, Payangan Sub-district, Gianyar Regency. Altitude is between 925-1000 m above sea level. In addition this study was conducted from March to July 2017.

Materials and Instruments of the Research

The materials used in this research are conjoined citrus from farmers, manure, N, P, K, Ca fertilizer (in the form of gypsum), Zn and Cu micro elements, water and chemical solution materials needed for analysis in laboratory.

The tools used in this study are nylon ropes, zinc (plates), permanent markers, paper, hoes, pruning shears, scales, writing instruments, ovens, spray sprayers, cameras, plastics, 40 watt fluorescent lamps, plates, small ice flask, aluminum foil, special round shape tool with 1 cm diameter to print leaves and the Chlorophyll Meter SPAD-502.

Research design

This study made use of a Randomized-group Design, which was arranged factorially, with 2 factors: fertilization (F) and pruning (P). The first factor that was experimented was fertilization (F) consisting of 3 levels, namely: P0 = fertilization following the way of farmers who only use manure, F1 = fertilization with manure, N, P, K and Ca, F2 = fertilization with manure N, P, K, Ca + Cu and Zn. Meanwhile, the second factor that was experimented on was pruning (P) consisting of 3 levels, namely: P0 (without pruning), P1 (young shoots pruned) and P2 (young shoots, twigs and leaves that have disease and shaded were trimmed). Thus there are 9 combination treatments, each of which was repeated 4 times, so that in total there are 36 tree plants needed.

The variables observed in this study were conditions when new shoots appeared per tree (hsp), number of new shoots formed per tree (stalk), conditions when flowers began to grow (hsp), number of flowers formed per tree (florets), percentage of flowers which changed into young fruit (Fruit set), the number of fruits formed per tree (fruit), the percentage of young fruits that fell per tree, leaf chlorophyll content (SPAD), nutrient content of N, P, and K Leaves, Relative Water content of leaf (%).

Data Analysis

Data obtained from observations were tabulated, and then analyzed statistically using analysis of variance in accordance with the design used. Firstly, diversity testing was carried out so that diversity is then obtained. If the treatment had a significant effect, proceeded with analysis to look for a single effect of each of the nested factors with a LSD test of 5% and 1%.

3. Results and Discussion

Findings

Based on statistical results the significance of the effect of fertilization (F) and pruning (P) on all variables and their interactions (FXP) on the observed variables is presented in Table 1.

Table 1.

The significance of the effect of fertilization (F) and pruning (P) and their interactions (FXP) on the observed variables

Variable	Fertilization (P)	Pruning (M)	Interaction (FXP)
1. The time when new shoots per tree appear (hsp)	**	*	ns
2. Number of new shoots per tree (stalk)	**	**	ns
3. The time when flowers begin to grow (hsp)	**	**	ns
4. Number of flowers per tree (florets)	**	*	ns
5. The percentage of tree flowers turn into fruit	*	ns	ns
6. Number of fruits produced per tree (piece)	**	**	ns
7. Persentase buah muda gugur per pohon(%)	**	**	ns
8. Chlorophyll content of leaves (*SPAD*)	**	ns	ns
9. Nutrient content in N leaves (%)	**	ns	ns
10. Nutrient content P leaves (%)	**	ns	ns
11. Nutrient content K leaves (%)	**	ns	ns
12. Relative Water content of leaves (%)	**	*	ns

Notes:

*	= having a significant effect (P<0,05)
**	= having a very significant effect (P<0,01)
ns	= having no significant effect (P ≥0,05)

As shown by Table 1, the fertilization treatment (F) has a significant effect (F<0.05) to very significant effect (F<0.01) on all observed variables. Pruning (P) has no significant effect (F≥0.05) on most of the observed variables, except when new shoots per tree (hsp) appear; the number of flowers per tree (bud) and relative water content of leaves (%) have a significant effect (P <0.05), while the number of new shoots per tree (stalk), when flowers begin to grow (hsp), number of fruits per tree (fruit) and the percentage of fallen fruit per tree (%) have a very significant effect (F<0.01). The interaction between fertilization and pruning (FXP) have no significant effect (P≥0.05) on all observed variables.

Discussion

The interaction between fertilization and pruning has no significant effect on the variable number of fruit formed per tree but fertilization and pruning treatments have. F2 fertilizer treatment (manure N, P, K, Ca + Cu and Zn) produced the highest number of fruit formed, that is 256.00 fruits per tree, and in this case an increase occurred by 95.79% compared to that of F0 treatment (fertilization by means of farmers' method which is only with manure), which is only 130.75 pieces (Table 2). The increasing number of fruits formed per tree after applying F2 (manure N, P, K, Ca + Cu and Zn) is also supported by the increasing number of shoots formed per tree (r = 91 **) and also by the number of flowers formed per tree (r = 1.00 **).

The number of shoots increased (28%) in the treatment of F2 (manure N, P, K, Ca + Cu and Zn), namely 91.25 stalks compared to that of F0 treatment (fertilization by farmers' method who only apply manure), which is only 304.25 stalks. The increasing number of shoots in F2 treatment (manure N, P, K, Ca + Cu and Zn) supports an increase in the number of flowers per tree (r = 0.94 **), the highest number of flowers per tree obtained in treatment of F2 (N manure , P, K, Ca + Cu and Zn) is 304.08 buds, with an increase of 68.80%, compared to that of the lowest number in the F0 treatment (fertilization by farmers who only use manure) which is only 180.08 buds . The increasing number of fruits per tree, besides being affected by an increase in the number of shoots and the number of flowers, is also influenced by the percentage of fruit-set (r = 0, 95 **) (Table 4). In the fertilization treatment, the highest percentage (83.83%) fruit-set per tree is obtained in the F2 treatment (manure N, P, K, Ca + Cu and Zn) compared to that of F0 treatment (fertilization by farmers who only use manure) that is only 74.31% (Table 2).

This shows that the application of manure N, P, K, Ca + Cu and Zn (P2) has a rapid effect on the development of flowers into fruit thus increasing the percentage of fruit-set. The percentage of fruit-set is higher in the P2 treatment (manure N, P, K, Ca + Cu and Zn) compared to that in P0 treatment (fertilization by farmers who only use manure). As a result it increases the number of fruits per tree (r = 0.95 **) (Table 4), and is associated with a higher value of leaf KAR (Table 3) and leaf chlorophyll content (Table 3).

In Table 3 shown the highest value of leaf KAR in treatment F2 (manure N, P, K, Ca + Cu and Zn) is 0.99%, higher than that of F0 treatment (fertilization by farmers who only use manure) 0.92%. The data show that the application of a more complete fertilizer is capable of improving the status of plant tissue water which is shown by the increase in leaf KAR, can also be caused by the increased ability of plants to absorb ground water or reduce transpiration (7). These conditions cause the process of plant metabolism to increase so that the leaf chlorophyll content in plants that are given a complete fertilizer will increase (Table 3). Table 3 shows that the chlorophyll content in the F2 treatment (manure N, P, K, Ca + Cu and Zn) is significantly higher by 12.53%, with a value of 54.28 SPAD, compared to the one with no fertilization which is only 48.24 SPAD. The chlorophyll content which is significantly higher in the F2 treatment (manure N, P, K, Ca + Cu and Zn) compared with that in P0 treatment (fertilization by farmers who only use manure) causes a higher photosynthesis process. This is evidenced by the lower percentage of fallen fruit per tree (4.23%) in the F2 treatment (manure N, P, K, Ca + Cu and Zn) compared with that in F0 treatment (fertilization by farmers who only use manure) which reaches 16.07%. The low percentage of fruit fallen per tree is due to the better photosynthesis process in F2 treatment (manure N, P, K, Ca + Cu and Zn). In addition, this condition is also caused by increased leaf chlorophyll and leaf KAR content and increased leaf, N and P nutrient content in plant tissue (leaves), which are 1.81%, 0.20% and 3.22%, respectively. This condition is higher than the F0 treatment (fertilization by farmers who only use manure), which is only 1.45%, 0.14% and 2.33% with a respective correlation of r = 0.98 **, r = 0.86 ** and r = 0.99 **.

The increase in chlorophyll content in leaves causes a higher photosynthesis process so that the development in fruit faster. The increase in the number of fruit supported by the increase in fruit-set and at the same time by the higher value of leaf chlorophyll content and leaf N, P and K nutrient content in F2 treatment (manure N, P, K, Ca + Cu and Zn), will cause photosynthetic activity more optimal.

At the level of fertilization at the emergence of shoots, the most immediate is on the treatment of F2 (manure N, P, K, Ca + Cu and Zn) which is 7.67 hsp and the slowest is on treatment of F0 (fertilization by farmers only by manure), which is only 11.17 hsp. The faster emergence of shoots in F2 treatment (manure N, P, K, Ca + Cu and Zn) compared to that in F0 treatment (fertilization by farmers who only use manure) causes flower growth also faster in the F2 treatment (N, P, K manure, Ca + Cu and Zn), which is 7.75 hsp, compared with that in the F0 treatment (fertilization by farmers who only use manure) which is only 12.58 hsp with r = 1.00 **.

P2 (young shoots, twigs, and leaves that are attacked by diseases and shaded and pruned) has a significant effect on photosynthesis thereby increasing the number of shoots and flowers formed. Table 2 shows that the number of shoots, flowers per tree, and the percentage of flowers that become fruit (set-fruit) is higher, which respectively are 387.92 stems, 272.92 buds, and 85.05% compared to the unpruned ones (P0), which respectively are 303.75 stems, 215.42 buds and 76.25%.

A higher percentage of fruit-sets in citrus plants whose young shoots, branches, stricken and shaded are pruned (P2) causes a higher number of fruits per tree to be produced, which is 222.42 fruits or an increase by 25.71% compared with that which are unpruned ones (P0), which is only 176.92 (Table 2) with r = 1.00 **. The results of this study indicate that pruning of young shoots, twigs and leaves that are attacked by disease and are shaded (P2) is very important to do, more than what is usually done by farmers, where young shoots, twigs and shaded and disease-attacked are left in such a way that be a competitor for nutrients, water and photosynthesis results on the development of flowers and fruit of the parent plants (8).

Table 2.

Effects of fertilization and pruning on the average of all observed variables in conjoined citrus plants

Treatment.	Shoots Appear (hsp)	Number of Shoots (stalk)	Start Flowering (hsp)	Number of Flowers (florets)	*Fruit-Set* *(%)*	Amount of Fruit Per Tree (Piece)
F						
F0	11,17 a	304,25 c	12,58 a	180,08 c	74,31 b	130,75 c
F1	8,92 b	322,25 b	9,75 b	244,33 b	82,77 a	203,33 b
F2	7,67 c	391,25 a	7,75 c	304,08 a	83,83 a	256,00 a
BNT 5%	0,66	37,70	0,76	36,18	7,75	27,86
P						
P0	9,75 a	303,75 c	11,00 a	215,42 c	76,25 b	176,92 b
P1	9,00 b	326,08 b	10,17 b	240,17 b	79,61 b	190,75 b
P2	9,00 b	387,92 a	8,92 c	272,92 a	85,05 a	222,42 a
BNT 5%	0,66	37,70	0,76	36,18	7,75	27,86

Notes: The average value followed by the same letter in the same treatment and column means that the difference is insignificant at the BNT test level of 5%

The increasing number of fruits per tree in P2 pruning was supported by higher leaf KAR, leaf chlorophyll content and nutrient content of N and K with values of r = 0.89 **, r = 0.94 **, r = 1, 00 ** and r = 0.96 **, thus causing more optimal photosynthetic activity. The low photosynthesis received by flowers on uncut pruned (P0) conjoined plants is related to the higher competition for the results of photosynthesis between various organs. The young shoots, twigs, and attacked and shaded leaves, if immediately unremoved or unpruned, they will become a competing competitor making them physiologically reduce the ability of flowers or fruit to obtain photosynthetic (8).

In P2 treatment (young shoots, twigs and shaded and disease-attacked leaves are trimmed), the values of leaf KAR and leaf chlorophyll obtained are 0.97% and 51.98 SPAD. This is higher than those of unpruned ones (P0), which are 0.95% and 49.88 SPAD (Table 3) and 4.5 respectively. The nutrient content of N, P and K leaves is also obtained higher at P2 pruning, which are 1.68%, 0.18% and 2.96%, compared to those which are unpruned (P0), which are only 1.61 %, 0.17% and 2.64% (Table 3).

Table 3

Effects of fertilization and pruning on the average of all observed variables in conjoined citrus plants

Treatment	Percentage of Fallen Fruit (%)	Content Chlorophyll (*SPAD*)	Content N Leaves (%)	Content P Leaves (%)	Content K Leaves (%)	KAR (%)
F						
F0	16,07 a	48,24 c	1,45 b	0,14 b	2,33 c	0,92 c
F1	9,31 b	50,51 b	1,65 ab	0,16 b	2,87 b	0,97 b
F2	4,23 c	54,28 a	1,81 a	0,20 a	3,22 a	0,99 a
BNT 5%	1,94	1,82	0,21	0,03	0,34	0,02
P						
P0	11,71 a	49,88 b	1,61 a	0,17 a	2,64 a	0,95 b
P1	10,22 a	51,18 b	1,63 a	0,15 a	2,82 a	0,97 a
2	7,68 b	51,98 a	1,68 a	0,18 a	2,96 a	0,97 a
BNT 5%	1,94	1,82	0,21	0,03	0,34	0,02

Notes: The average value followed by the same letter in the same treatment and column means that the difference is insignificant at the BNT test level of 5%

The increase in chlorophyll content of leaves and KAR leaves makes the metabolic process better. Inadequate photosynthate supply causes the fruit to fall off and it is caused by limited photosynthate production or low photosynthate allocation in the fruit. The low photosynthesis received by flowers and fruit in the unpruned citrus conjoined plants causes young shoots, twigs and shaded and disease-attacked leaves are still sinking (9). As a result, it enlarges the competition to obtain photosynthates produced by the plants, so that in the treatment of unpruning (P0) the highest percentage of fallen fruit per tree is obtained, which is 11.71% compared to pruning the young shoots (P1) and young shoots, twigs and shaded and disease-attacked leaves (P2), which respectively are 10.22% and 7.68% (Table 3).

At the stage of pruning, the fastest emergence of shoots is in the treatment of P2 (young shoots (P1) and young shoots, twigs and shaded and disease-attacked leaves are pruned) with a value of 9.00 hsp and the slowest is in the treatment without pruning (P0) with a value of only 9.75 hsp. The emergence of shoots faster in P2 compared to P0 treatment causes flower growth to also be faster in P2 treatment, which is 8.92 hsp compared to that in the P0 treatment which is only 11.00 hsp (Table 2). Pruning will increase the C/N ratio in the body of the plant. A high C/N ratio results in a buildup of carbohydrates, which ultimately stimulates the formation of flowers and fruit, and the use of solar radiation by plants is more efficiently, so that the net photosynthesis yield per unit area of leaf is obtained greater than of the unpruned plants. Pruning also aims to reduce competition in the struggle for assimilation between productive leaves and twigs with unproductive leaves, shoots and twigs (3).

4. Conclusion

Based on the results of this study, several points are made as conclusions, that is to say, the interaction between fertilization (F) and pruning (P) does not significantly affect all observed variables. The highest number of fruits formed per tree is obtained in fertilizing treatment with manure N, P, K, Ca + Cu and Zn, which is 256.00 fruits per tree, or with an increase of 95.79%. This is greater than the lowest amount obtained in fertilization with ordinary manure, which is only 130.75 fruits. The highest number of fruits formed per tree in the treatment of pruning the young shoots, twigs and shaded and disease-attacked leaves, obtained as many as 222.42 fruits per tree with an increase of 25.71%. It is also greater than the lowest amount obtained in plants without pruning, which is only 176.92 units.

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