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STUDY ON THE EFFECTS OF KClO3 ON THE CAPABILITY OF FLOWERING AND FRUIT-BEARING OF THE EARLY RIPENING LONGAN VARIETY THAI BINH, YEN SON DISTRICT, TUYEN QUANG PROVINCE

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Abstract

The experiment was conducted on the early ripening longan variety Thai Binh in Yen Son district, Tuyen Quang province during the period from October 2023 to May 2024 by mixing KClO3 with plain water at doses of 10, 20 and 30 grams/day. 1 m2 watered the soil around the longan canopy. Monitoring results showed that the experimental longan trees treated with KClO3 flowered and fruited, with a dose of 30 grams/1m2 of canopy having the highest rate of flowering branches, fruiting rate and yield. KClO3 treatment for early-ripening longan varieties in Thai Binh commune has resulted in harvests 45 - 60 days earlier than main crop varieties, yield reaching 22.9 - 33.9 kg/tree, economic efficiency reaching 843,400 - 1,313,400 VND/tree, each hectare gives profit from 177,114,000 - 275,814,000 VND. Meanwhile, in the main season, each longan tree only gives a profit of 201,000 VND/tree and one hectare gives an average profit of 42,210,000 VND.

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NGHIÊN CỨU ẢNH HƯỞNG CỦA $KClO_3$ ĐẾN KHẢ NĂNG RA HOA, ĐẬU QUẢ TRÁI VỤ CỦA GIỐNG NHÃN CHÍN SỚM THÁI BÌNH, HUYỆN YÊN SƠN, TỈNH TUYÊN QUANG

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Từ khóa

Chlorate kali, ra hoa trái vụ, nhãn chín sớm Thái Bình, kích thích ra hoa, cytokinin

Tóm tắt

Thí nghiệm được tiến hành trên giống nhãn chín sớm Thái Bình huyện Yên Sơn, tỉnh Tuyên Quang trong thời gian từ tháng 10 năm 2023 đến tháng 5 năm 2024 bằng cách hoà KClO3 với nước lã ở các liều lượng 10, 20 và 30 gram/1 m2 tưới vào đất xung quanh tán cây nhãn. Kết quả theo dõi cho thấy các cây nhãn thí nghiệm được xử lý KClO3 đã ra hoa đậu quả, với liều lượng 30 gram/1m2 tán cây có tỷ lệ cành ra hoa, tỷ lệ đậu quả và năng suất cao nhất. Xử lý KClO3 cho giống nhãn chín sớm xã Thái Bình đã cho thu hoạch sớm hơn từ 45 - 60 ngày so với giống chính vụ, năng suất đạt từ 22,9 - 33,9 kg/cây, hiệu quả kinh tế đạt 843.400 - 1.313.400 đồng/cây, mỗi ha cho lãi từ 177.114.000 - 275.814.000đ đồng. Trong khi đó ở chính vụ mỗi cây nhãn chỉ cho lãi 201.000đ/cây và một ha cho lãi trung bình 42.210.000 đồng.

1. Introduction

Longan (Dimocarpus longan Lour.) is a fruit tree that plays an important role in the crop structure of Tuyen Quang province. It is an easy-to-cultivate crop, suitable for the ecological conditions of Tuyen Quang province with a harvest area of 791.28 ha. However, in recent years, longan production in Tuyen Quang province has encountered many difficulties due to low prices at harvest time “Good harvest, low price”. Because longan varieties in Tuyen Quang province are mainly in-season varieties that ripen in July and early August, beside consuming fresh fruit, Tuyen Quang province only has two small-scale longan processing facilities with low capacity, so the economic efficiency of longan production is not high. The flowering of various tree types is regulated and affected by environmental factors. With the development of science and technology, it is possible to create similar environmental conditions for flowering needs or find chemicals to promote off-season flowering. Flowering induction is considered the first step from vegetative growth to reproduction. Flowering induction plays an

important role because it determines the success of commercial fruit orchards. So far, flowering induction by potassium chlorate (KClO3) has only been found to be effective for longan trees.

Therefore, the issue of off-season longan production or off-season flowering control is raised for Tuyen Quang province, which is to study the technique of spreading the crop on longan trees to find technical measures to meet the requirements for production and improve economic efficiency from longan trees is extremely necessary.

2. Materials and methods

2.1. Experimental setup

- Experimental setup method: the experiment consists of 4 formulas, each formula has 3 trees, repeated 3 times, the total number of experimented trees is 12 trees, arranged in a completely randomized design (CRDB). The experimental formulas are as follows:

+ Formula 1: watering with plain water

+ Formula 2: watering with KClO3 at a dose of 10 grams/m2 of tree canopy

+ Formula 3: watering with KClO3 at a dose of 20 grams/m2 of tree canopy

+ Formula 4: watering with KClO3 at a dose of 30 grams/m2 of tree canopy

- Experimental care: the experimented trees were arranged in the same experimental conditions and cared for and fertilized the same way according to the Technical Progress for off-season flowering treatment for longan trees in the Southern provinces.

- KClO3 irrigation technique:

+ 1st time: watering KClO3 at the beginning of October when the buds have stabilized, watering 60% of the amount of KClO3 by mixing it with warm water and stirring it around the canopy 50 cm from the base. After watering, maintain humidity by watering the base with additional clean water.

+ 2nd time: watering after the first time (10 days), watering the remaining 40% of the KClO3 fertilizer, the technique is as in the first time, after this watering, continue to maintain humidity by watering the base with additional clean water until the plant sprouts flowers.

2.2. Indicators and monitoring methods

2.2.1. Indicators for flowers

- Time of flower appearance: calculated from the day 10% of flower buds appear/plant.

- Time of flowering start: calculated from the day 10% of flowers bloom/plant.

- Time of full flowering: calculated from the day 50% of flowers bloom/plant.

- Time of flowering end: calculated from the day 80% of flowers bloom/plant.

- Ratio of flowering plants, ratio of flower-bearing branches/plant: based on the number of flowering plants/total number of experimental plants. Also based on the total number of flowering branches/total number of branches/experimental plants.

- Female flower ratio (%): Female flower ratio (%) = Number of female flowers + hermaphrodite flowers/total number of flowers x 100.

- Cluster width (cm): measured at the widest position of the cluster.

- Cluster length (cm): measured from the stem to the last end of the cluster.

2.2.2. Indicators for fruits

- Monitored 30 bunches/1 formula

- Number of fruit yielded after flowering: counted the number of fruit yielded after flowering.

- Initial fruit yielded rate: initial fruit yielded rate (%) = Total number of fruit yielded after flowering/number of female flowers + hermaphrodite flowers x 100.

- Fruit yielded rate after 15, 30, 45, 60 days and harvest.

- Efficacy and efficacy factors:

+ Number of fruit clusters/tree: based on the number of fruit clusters/tree, counted at harvest time.

+ Number of fruits/cluster: based on the number of fruits of 30 bunches at each reminder, then calculating the average value.

+ Individual fruit yield kg/tree: weighed directly per garden at harvest.

+ Theoretical yield quintal/ha: = Individual yield (kg/tree)^{x}number of trees/ha/100.

- Fruit index: measured 30 fruits/formula

+ Average fruit weight (gram): weighed 30 fruits per weighing and calculated the average value.

+ Fruit height (cm): measured from the top of the fruit to the bottom of the fruit with a Palme caliper, randomly measuring 30 fruits/1 weighing and calculating the average value.

+ Fruit diameter (cm): measured from the top of the fruit to the bottom of the fruit with a Palme caliper, randomly measuring 30 fruits/1 weighing and calculating the average value.

+ Edible portion ratio (%) = pulp weight/fruit weight^{x}100.

2.2.3. Biochemical Indicators

Biochemical indicators: Biochemical indicators were analyzed at the Institute of Life Sciences, Thai Nguyen University. The method of picking fresh fruit from the production garden for analysis was applied according to the national standard TCVN 9017. The analytical indicators include: Brix degree (%), dry matter (%), total sugar (%), total acid (%), Vitamin C (mg/100g).

2.2.4. Economic efficiency assessment

Compare the economic efficiency between longan varieties irrigated with KClO3 and longan varieties produced in the main season and evaluate the economic efficiency of the method of using KClO3 to create off-season longan with mass production. The economic efficiency of the experimental formulas was calculated according to the following formula:

Net profit: VA = GO - IE, in which: GO is the production value, IE is the total cost.

2.3. Data processing method

The data obtained from the study were processed using Excel and IRRISTAT 5.0 programs.

3. Research results and discussion

3.1. The effect of KClO3 on the flowering ability of Thai Binh early ripening longan variety

To stimulate longan trees to flower in the world and in Vietnam, many technical measures have been applied such as: bark ringing, spraying on leaves, injecting into the tree trunk and irrigating the soil. The above measures all have the effect of making longan trees flower in the main and off-season seasons. These measures have contributed to the stable flowering of longan trees and increased production value.

The measure of irrigating the soil on longan trees when using pure KClO3 was carried out in the autumn crop of 2023 in Thai Binh commune and obtained the results presented in Table 3.1, showing:

The formulas induced budding from November 4 to 15, 2023, start blooming from November 20 to 30, 2023, full blooming from December 15 to 25, 2023 and ended blooming from January 1 to 15, 2024.

The number of flowering trees reached 9/9 trees, reaching a rate of 100%, the number of flowering branches/tree ranged from 101-127.33 branches/tree, the rate of flowering branches reached from 72.8 - 79.03%. The rate of female flowers reached from 25.9 - 26.8%. The width of the flower cluster ranged from 21.1 -26.6 cm, the length of the flower cluster ranged from

31.3 - 35.8 cm, the above flower indicators were also similar to the previous study by author Vi Xuan Hoc and Cs in 2023 on the early ripening Thai Binh longan variety. The time from the appearance of flower stalks to harvest lasts 200 days, the harvest time is from May 20 to 30, 2023, compared with the annual harvest season with the harvest time of the early ripening Thai Binh longan variety when treated with KClO3, it can be harvested 45 days earlier than the main variety and 60 days earlier than the main season varieties, this is one of the advantages of the early ripening Thai Binh longan variety that needs to be applied to expand the area.

Table 3.1. Effect of KClO3 on flowering ability of early ripening longan variety Thai Binh, autumn crop 2023

Indicators	Formulas			
	1	2	3	4
Budding time (from...to...)	0	04 -15/11/2023	04-15/11/2023	04-15/11/2023
Start blooming time (from...to...)	0	20 -30/11/2023	20-30/11/2023	20-30/11/2
Full blooming time (from...to...)	0	15-25/12/2023	15-25/12/2023	15-25/12/2023
End blooming time (from...to...)	0	1/1-15/1/2024	1/1-15/1/2024	1/1-15/1/202
Number of flowering trees (trees)	0	3	3	3
Flowering rate (%)	0	100	100	100
Number of flowering branches (trees)	0	101	105	12
Flowering branch ratio (%)	0	72,8	73,3	79,03
Female flower ratio (%)	0	26,8	26,13	
Flower cluster width (cm)	0	21,1	23,4	26,
Flower cluster length (cm)	0	31,3	33,6	35,8
Time from flower spike appearance to harvest (.....days)	0	200	200	200
Harvest time	0	20-30/5/2024	20-30/5/2024	20-30/5/202

(Formula 1: control watering with plain water, formula 2: watering 10 grams/m^2 of tree canopy; formula 3: watering 20 grams/m^2 of tree canopy; formula 4: watering 30 grams/m^2 of tree canopy)

3.2. Effect of $KClO_3$ on fruit yielding ability of Thai Binh early ripening longan variety

On longan tree, there are 3 types of flowers including: male flowers, female flowers and hermaphrodite flowers. Female flowers and hermaphrodite flowers will develop into fruit after being pollinated and fertilized. Therefore, the influencing factors have a direct impact on the fruit yeilding process and maintenance of fruit yielding for longan trees. The results of monitoring the fruit yielding ability of Thai Binh early ripening longan variety are presented in Table 3.2.

The monitoring results in Table 3.2 show that: longan fruit from fruit yielding to 60 days all have 2 fruit drop processes at 15 days after flowering and 60 days total.

The indicators of flowering ability and number of flower clusters per tree were greatly affected by $KClO_3$ treatment at doses of 10, 20 and 30 grams/1 m^2 of longan canopy. However, the ability to maintain the number of fruits at the time points from 15 to 60 days of fruiting was not affected by $KClO_3$ irrigation. In the early stages of flowering longan trees, the number of fruits per bunch ranged from 87.3 - 92%. All formulas after 15 days had a gradual decrease in the number of fruits falling compared to the initial number of fruits per bunch. The highest number of fruits fell

during the 15 to 30 day period. At the 45 - 60 day period, the number of fruits per bunch fell lower than in the early stages. At the fruit harvest stage, the formulas had a number of fruits ranging from 22.3 - 25.7 fruits per bunch, the fruit retention rate reached 25.6 - 28.0%, in which the dose of 30 grams/1 m^2 of tree canopy had the highest number of fruits and fruit yielding rate.

Table 3.2. Effect of $KClO_3$ on fruit yielding rate of Thai Binh early ripening longan variety

Formulas	Indicators						
	Initial yielded fruit number (fruits)	Yielded fruit number after... days (fruits)				Harvested fruit number (fruits)	Fruit retention rate (%)
		15	30	45	60		
F1: control watering	0	0	0	0	0	0	0
F2: watering 10 grams/m^2 of tree canopy	87,3	69,3	56,7	46,3	34,7	22,3	25,6
F3: watering 20 grams/m^2 of tree canopy	88,3	67,3	54,7	43,0	32,7	24,7	28,0
F4: watering 30 grams/m^2 of tree canopy	92,0	70,7	56,3	43,7	31,7	25,7	28,0

3.3. Effect of $KClO_3$ on the mechanical composition of the fruit of the early-ripening Thai Binh longan variety

Among the factors that make up the yield, the mechanical composition index of the longan fruit is also one of the important indexes. In addition, the mechanical composition index is also an index that determines the quality of the fruit. The results of monitoring the mechanical composition of the fruit of the early-ripening Thai Binh longan variety are presented in Table 3.3.

The results in Table 3.3 show that the experimental longan varieties have fruit weights ranging from 10.59 - 10.65 g, fruit heights ranging from 2.48 - 2.65 cm, fruit diameters ranging from 3.35 - 3.97 cm and finally the pulp ratio (or edible portion ratio) ranging from 61.54 - 62.3%. The monitoring results also showed that the obtained indicators were similar to previous studies by Nguyen Thi Hien (2007) on Huong Chi longan variety, Vi Xuan Hoc and Cs (2023) on Thai Binh early ripening longan variety. The monitoring results also showed that the treatment of $KClO_3$ at different concentrations did not affect the indicators of mechanical composition of the fruit of the experimental longan varieties.

Table 3.3. Effect of $KClO_3$ on mechanical composition of Thai Binh early ripening longan fruit

Formulas	Indicators			
	Fruit weight (g)	Fruit height (cm)	Fruit diameter (cm)	Pulp ratio (%)
F1: control watering	0	0	0	0
F2: watering 10 grams/m^2 of tree canopy	10,65	2,50	3,37	62,60
F3: watering 20 grams/m^2 of tree canopy	10,59	2,49	3,38	62,30
F4: watering 30 grams/m^2 of tree canopy	10,59	2,48	3,35	61,54

3.4. Effects of $KClO_3$ on yield and yield components of Thai Binh early ripening longan variety

Monitoring yield factors and yield components of different concentrations of $KClO_3$ irrigation on longan varieties' results are shown in Table 3.4.

Table 3.4 shows that irrigation with $KClO_3$ at different concentrations has a positive effect on the number of fruit branches/tree and the number of fruits/bunch at harvest. In formula 4, the number of fruit-bearing branches and the number of fruits per bunch are the highest with the number of fruit-bearing branches being 127.33 branches/tree and the number of fruits/bunch being 25.7 fruits. In terms of fruit weight, formula 4 has the smallest fruit weight, the reason being that the number of fruits/bunch and the number of fruit-bearing branches are high, affecting the fruit weight, but the difference in fruit weight between the formulas is not large.

Table 3.4. Effect of $KClO_3$ on yield components and yield of early ripening longan variety Thai Binh

Formulas	Number of fruit branches/tree (branches)	Number of fruits/bunch (fruits)	Number of fruits/tree (fruits)	Fruit weight (g)	Individual yield (kg/tree)	Theoretical yield (tons/ha)
F1: control watering	0	0	0	0	0	0
F2: watering 10 grams/ m^2 of tree canopy	101	22,33	2.270	10,65	24,1	5.061
F3: watering 20 grams/ m^2 of tree canopy	105	24,7	2.598	10,59	27,5	5.775
F4: watering 30 grams/ m^2 of tree canopy	127,33	25,7	3.283,7	10,35	33,9	7.119

3.5. Effect of $KClO_3$ on the quality of early ripening Thai Binh longan

The ratio of basic nutrients in the fruit is one of the important indicators to evaluate the fruit quality of the experimental formulas, so the indicators of the chemical composition of the formulas need to be considered to confirm the fruit quality. The results of the analysis of the chemical composition of the experimental formulas treated with $KClO_3$ are presented in Table 3.5:

The monitoring results showed that: the dry matter content of the formulas ranged from 14.12 -14.18%, in which formula 4 had the highest ratio.

The total sugar content of the varieties ranged from 12.7 -13.2%, in which formula 4 had the highest ratio at 13.2%.

The acid content in the fruit also plays a very important role in creating the characteristic sweetness of each variety, the total acid content of the formulas ranged from 0.09 - 0.11%, in which formula 4 had the highest ratio.

The total Vitamin C content of the varieties ranges from 52.8 - 53%, in which formula 4 at the irrigation dose of 30 grams/1m2 canopy has the highest rate of 53%.

Brix is one of the most important indicators for longan fruit at harvest time, high or low Brix is related to the quality of longan fruit. The Brix measurement results show that the formulas have Brix ranging from 19.55 - 21.75%.

Evaluation of the effect of $KClO_3$ on fruit quality indicators of early-ripening longan variety Thai Binh showed that there was no significant change between the fruit quality indicators of the experimental formulas compared to the main-season variety and previous studies by authors Nguyen Thi Hien (2007), Vi Xuan Hoc and Cs (2023).

Table 3.5. Effect of $KClO_3$ on the quality of early ripening longan fruit in Thai Binh

Formulas	Indicators				
	Dry matter (%)	Total sugar (%)	Total acid (%)	C vitamin (mg%)	Brix (%)
F1: control watering	0	0	0	0	0
F2: watering 10 grams/m^2 of tree canopy	14,12	12,70	0,09	52,8	19,55
F3: watering 20 grams/m^2 of tree canopy	14,15	12,90	0,10	52,9	20,52
F4: watering 30 grams/m^2 of tree canopy	14,18	13,20	0,11	53,0	21,75

3.6. Evaluation of economic efficiency of using $KClO_3$ for early ripening longan variety in Thai Binh commune

Evaluation of economic efficiency in research is one of the important stages to determine whether the technical measure is suitable for the people and production area or not. The results of economic efficiency evaluation of experimental formulas on early ripening longan variety Thai Binh treated with $KClO_3$ are shown in Table 3.6.

Monitoring data shows that with irrigation doses of 10, 20, 30 grams of $KClO_3$/1m^2 of canopy (30m^2 of canopy/tree in the 10th year), a density of 210 trees/ha has achieved the following results:

With a selling price of 50,000 VND/kg in the off-season, the formulas treated with $KClO_3$ at doses of 10, 20 and 30 grams/m^2 of canopy have yielded profits of 843,400 - 1,313,400 VND/tree, each hectare yielded profits of 177,114,000 - 275,814,000 VND/ha. Meanwhile, in the main season, each longan tree yielded profits of only 201,000 VND/tree and an average profit of 42,210,000 VND/hectare.

Comparing the economic efficiency between longan watered with $KClO_3$ and longan in the main season shows that: longan watered with KClO3 flowering and fruiting in the off-season brings higher economic efficiency than longan in the main season from 74,904,000 - 233,604,000 VND, in which the formula of watering with $KClO_3$ at a dose of 30 grams/m^2 is the formula that brings the highest economic efficiency.

Thus, with the method of watering with KClO3 in the winter crop at different doses, Thai Binh early-ripening longan trees bear fruit in the off-season, contributing to increasing the number of flowering branches/tree, increasing the size of flower clusters, increasing productivity, raising prices, and bringing higher economic efficiency than longan in the main season.

Table 3.6. Economic efficiency of using $KClO_3$ for early ripening longan variety in Thai Binh commune

Varieties, formulas	Average yield kg/tree	Unit price VND/kg	Total amount (VND)	Total cost (VND)	Profit (VND/tree)	Profit/ha (VND)
Early Ripening Thai Binh, CT2	24,1	50.000	1.205.000	361.600	843.400	177.114.000
Early Ripening Thai Binh, CT3	27,5	50.000	1.375.000	369.600	1.005.400	211.134.000
Early Ripening Thai Binh, CT4	33,9	50.000	1.695.000	377.600	1.313.400	275.814.000
Main crop	31,4	15.000	471.000	270.000	201.000	42.210.000

4. Conclusions and recommendations

4.1. Conclusion

Irrigation with potassium chlorate ($KClO_3$) for the early-ripening Thai Binh longan variety on the autumn shoots stimulated the longan tree to flower in November 2023 and harvest in late May 2024. Longan treated with $KClO_3$ was harvested 45 days earlier than the main-season early-ripening Thai Binh variety and 60 days earlier than the main-season varieties.

Irrigation with $KClO_3$ on the early-ripening Thai Binh longan variety did not affect fruit quality, yielding 22.9 - 33.9 kg/tree and bringing economic efficiency from 843,400 - 1,313,400 VND/tree, in which the concentration of 30 grams/1m^2 of canopy gave the highest yield and economic efficiency.

4.2. Recommendation

Continue to evaluate the impact of $KClO_3$ concentrations on the ability to flower, fruit yielding, especially the growth status of Thai Binh early ripening longan variety in the next crops.

It is necessary to continue to study the flowering time of Thai Binh early ripening longan variety using $KClO_3$ and different flowering stimulants at different times to find the appropriate dosage and treatment time to recommend for propagation to apply in production.

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