



Off-season production on Durian in the Mekong delta, Vietnam

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INTRODUCTION

Natural flowering:

- Flowering depends on weather conditions.
- Flowering many times with low flowering rate; competition for nutrients between leaves–flowers, flowers–fruits, small fruits–large fruits, making management difficult, reducing yield, and increasing the physiological disorder of flesh (PDF)
- Seasonal flowering may coincide with peak harvest, leading to lower market prices

→ low yield, high the physiological disorder of flesh.

Controlled flowering:

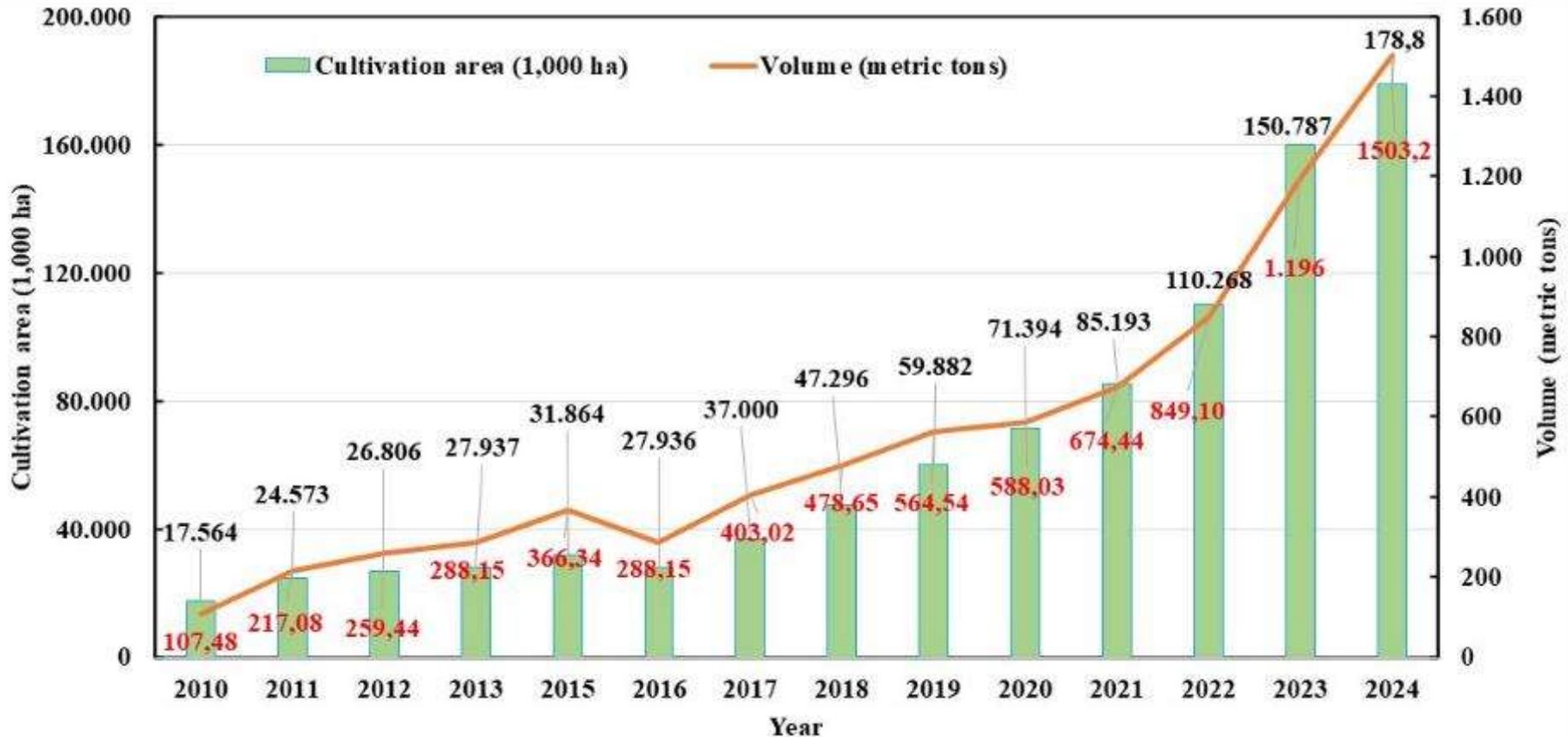
- Enables controlling of flowering season.
- Concentrated flowering, easier to manage, reduces nutrient competition that causes flower drop, fruit drop, and the physiological disorder of flesh.
- Achieves high yield, better fruit quality, less PDF.

- Higher selling prices during periods of market scarcity.



Durian cultivation area and production in Vietnam from 2010-2024

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Area increased ~ 20%/year

Production increased ~ 15%/year
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Central highland

49.3% (A); 42.16% (V)

South central Coast

4.90% (A); 2.93% (V)

South-East Area

17.3% (A); 12.94% (V)

Mekong Delta

28.50%(A); 41.96% (V)



Total country (2024):

- Area (A): 179,829 ha
- Volume (V): 1,532,690 tons

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China's fresh durian import market share in 2024

Country	Volume (tons)	Market share (%)	Value (mil. USD)	Increase compared to 2023 (%)
Thailand	833.000	52,72	3.914	-11,13
Vietnam	736.720	46,63	2.853	+38,13
Philippines	13.300	0,84	32	+353,44
Malaysia	225	0,014	4,2	
Total	1.580.000	100	6.802	



China's fresh durian import market share in the first 6-month of 2025

			
Thái Lan	Việt Nam	Malaysia	Philippines
Cultivar			
Monthong	R16	Musan King	Puyat
Volume (tons)			
549.960	157.542	433	255
Value (mil. USD)			
2.554	611	6,84	0,85
Market share (%)			
77,66	22,25	0,06	0,04
Total:708,190 tons 3,174 million USD			

Source: General Administration of Customs of China



Volume of Thai durian export to China in the first 8-month, 2024 vs 2025



	Volume (tons)	Value (mil. USD)
First 8- month 2025	893,829	4,482
First 8- month 2024	726,093	2,611



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Thai durian export to China in 2024





Durian harvest season in Southeast Asian countries

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Country	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.												
East Thailand*																								
South Thailand																								
West Malaysia																								
East Malaysia																								
Indonesia	P	P	P					S	S	S	S	S	S	S		P	P	P	P	P	P			
Philippines																								
Viet Nam	1N	1N	1N	1N	1N	1N	1N	1T	1T	1T	1T	2	2	2	2	3	3	3	3	3	1N	1N	1N	1N
Lào																								
Cambodia																								
Myanmar																								
Brunei																								
Singapore																								
North Queensland, Australia																								
Darwin, Australia																								

P: Harvest concentration; S: South Sumatra



Factors affect on durian flowering

External condition (weather)

– Water stress:

- In Thailand:

- 6-8 wks, Chanee cultivar: continuous dry in 7-14 days

- Chanthaburi: 50 days **after end of rainy season**, soil moisture $-0,1$ MPa at the depth of 15 cm (Suwanseree & Yapwattanaphun, 2017)

- **Soil moisture**: important role (30%, wilting point 19%, depend on soil type)

- **Low temperature**: daily drop from $26-33^{\circ}\text{C}$ to $20-25^{\circ}\text{C}$

Internal conditions:

Tree is qualified to induce flowering

- Healthy growth with 1-2 new shoots,

- Free from pests and diseases



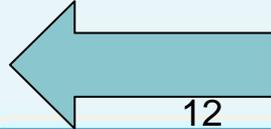
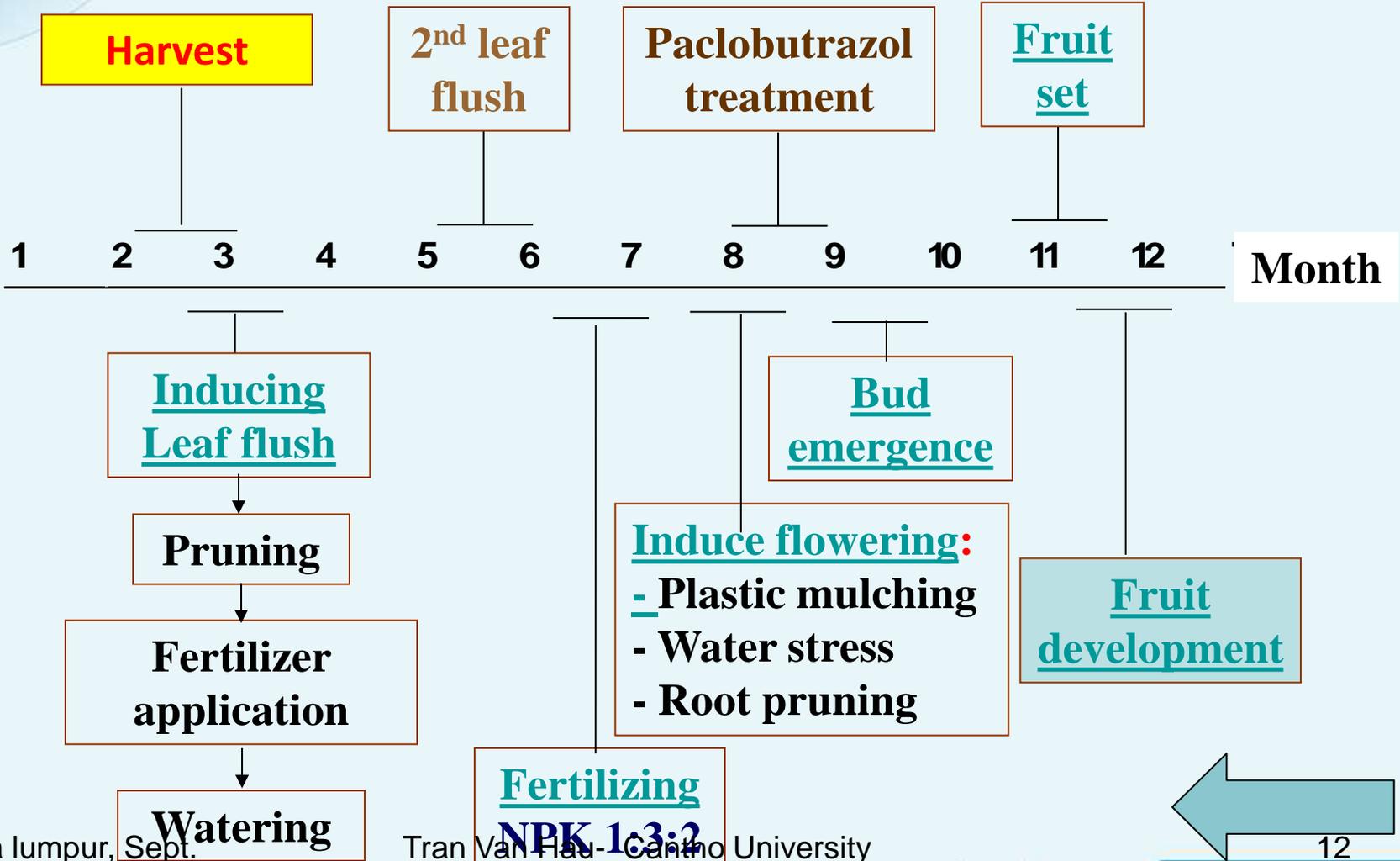
Durian harvest season in Vietnam

Area	Flowering	Harvest
Mekong delta		
- On season	12-1	4-5
- Off-Season	Year-round	(Nov. – Mar.)
South-East Area	1-3	5-7
Highland		
• 500-600 m from sea level	3-4	8-9
• 800-900 m from sea level	4-5	9-10



Off-season durian production process

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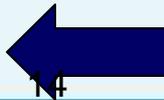
Induction of leaf flushing

- Restore the plant growth and capacity to fruit production for the coming up year
- Inducing leaf **flushing uniformly**, good growth
- Requirements for trees to response to floral induction:
 - Good growth
 - Free from pests and diseases
 - Inducing **at least 1-2 new shoots**



Post-harvest: Leaf flushing induction

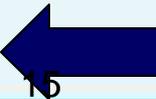
- **Fertilizing:**
 - **Organic fertilizer:** 10-20 kg organic matter per tree
 - **Chemical fertilizers:** N:P:K ratio 4:3:2, 3:1:1, 2:1:1,...
 - **Lime application:** After harvest (250-2.000 kg/ha) depending on **soil type**, **soil pH** and **organic matter**.
 - Spraying trace element when **leaves were full development** (light green)
- **Watering:** 2-3 days/time – **depend on soil humidity**
- **Leaf flushing induction:**
 - Spraying urea: 1.5-2.0% or
 - Gibberellin: 10-20 ppm (1 g a.i./50-100 litres of water)





Methods to induce flowering

- **Chemical fertilizer application:**
 - **Fertilize through the soil:** high ratio of phosphate and potassium fertilizers i.e. NPK 1:3:2, 1:3:3,..
 - Spray Phosphorous acid (H_3PO_3) 0.5-1%: 1-2 times





Techniques for floral induction

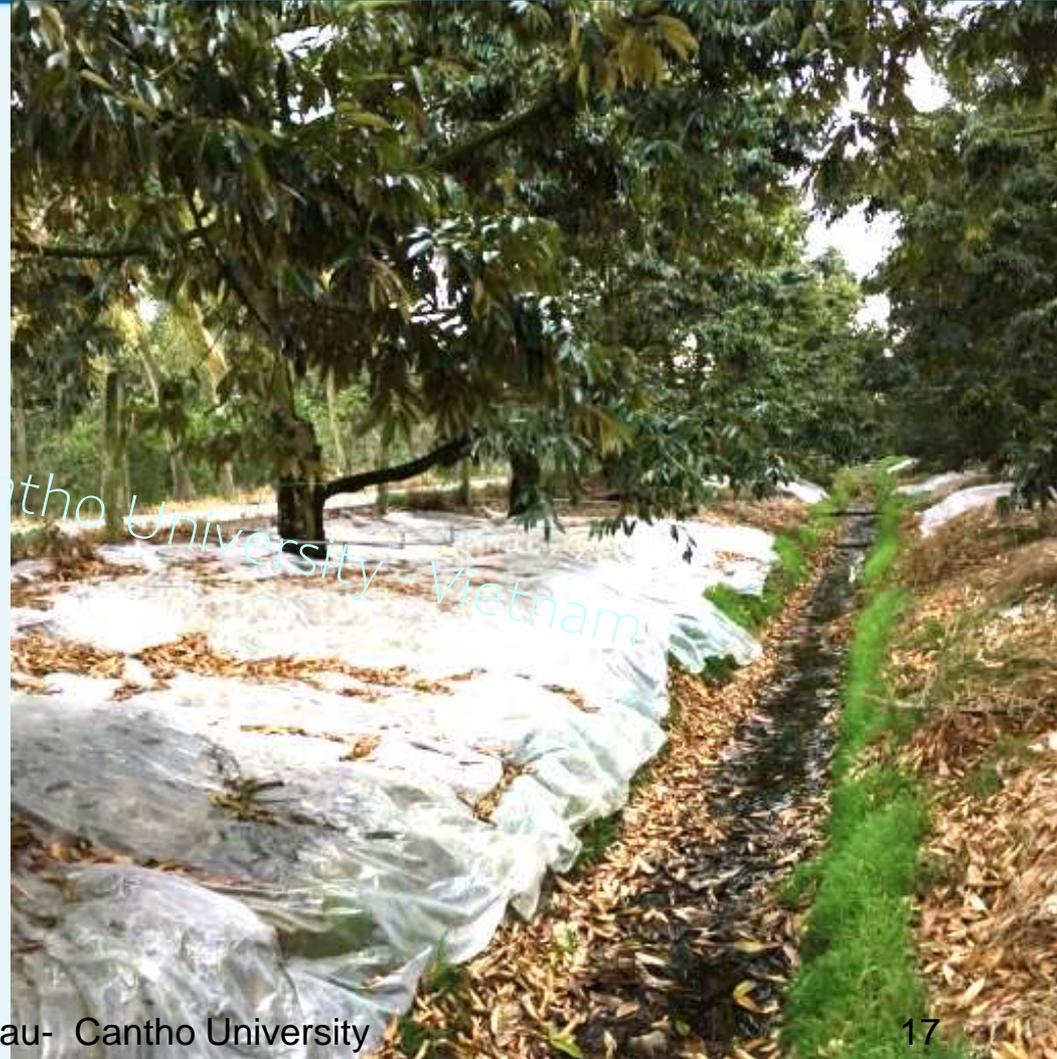
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- **Water stress:**
 - Pump water out of ditch,
 - Stop watering
 - Plastic mulching the raised bed or trunk base



Mulching the raised bed combination with draining water out of ditch

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Pump water out of ditch

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Plastic mulching of tree base in Ben Tre province

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Galaxy A13



Galaxy A13

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Techniques for floral induction

- **Root pruning:**
 - ✓ Dig up a small ditch (20-30 cm wide, 30-40 cm deep) surrounding the trunk.
 - ✓ The ditch can be located 2.5-3 m away from the trunk.
 - ✓ After fruit set, the ditch can be filled



Root pruning

(Dig up the small ditch around tree base)

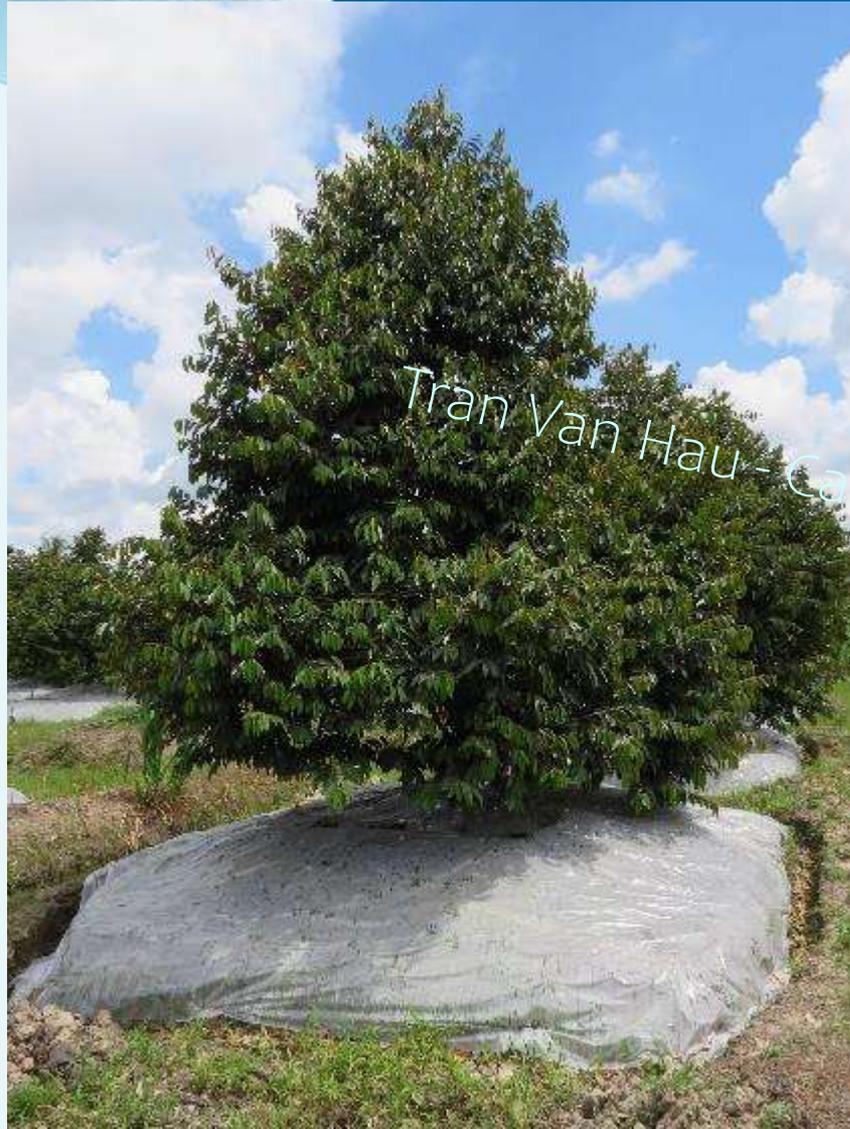


- Dig up a small ditch (20-30 cm wide, 30-40 cm deep) surrounding the trunk.
- The ditch can be located 2.5-3.0 m away from the trunk.
- After fruit set, the ditch can be filled.



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Plastic mulching of trunk base combination with root pruning



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Techniques for floral induction

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- **Spraying paclobutrazol:**

- **Concentration:**

- 1,000-1,500 ppm, (**10-15 g a.i./tree**) 8-10 years, ~ **10 litres/tree**

- **PBZ concentrations using by farmers (Dương et al., 2022)**

- in Tien Giang: **1.816 ppm** (~11,8 g a.i./cây)

- In Ben Tre: **1.240 ppm** (~10,5 g a.i./cây)

- **Method of application:** **Spray on the canopy, main branches**

- **Time of application:** Leaf age 30-40 days, light green



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Dormancy of flower bud

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1 day after appeared



- Occur when rainfall: 10 mm/day
- **Prevent:** Spraying thiourea 0.1-0.15% or KNO_3 1.0-1.5% but it does not affect if rainfall >35 mm/day

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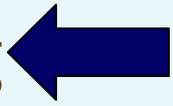
4 day after appeared

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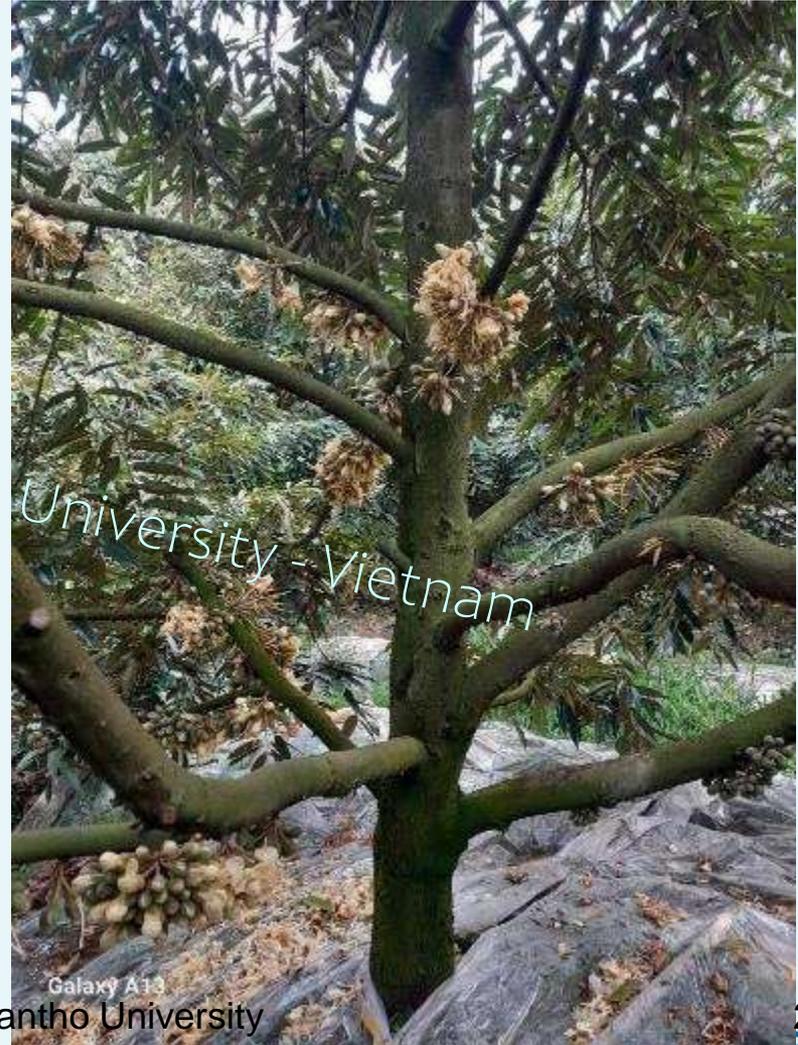
Off-season flowering of Musang King cultivar in July, 2025 in Ben Tre province



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FRUIT SET

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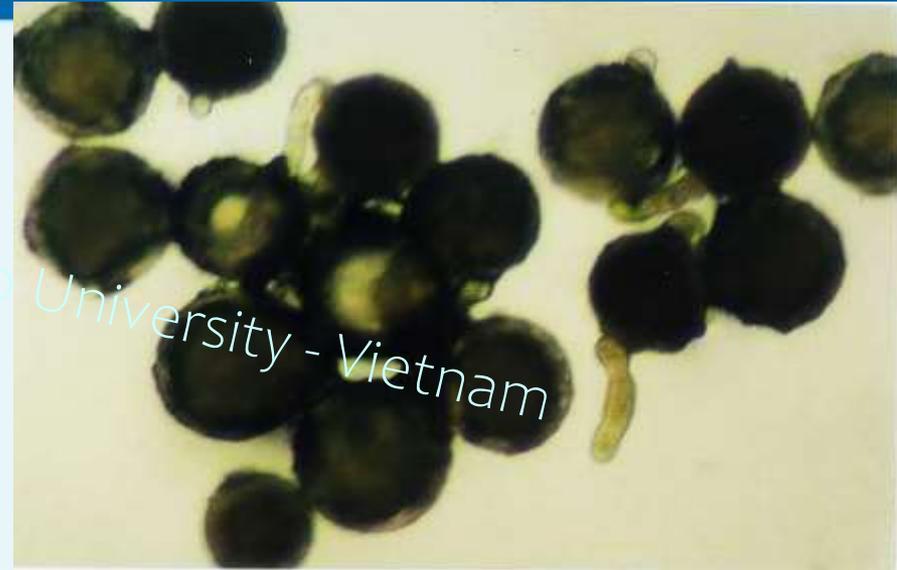
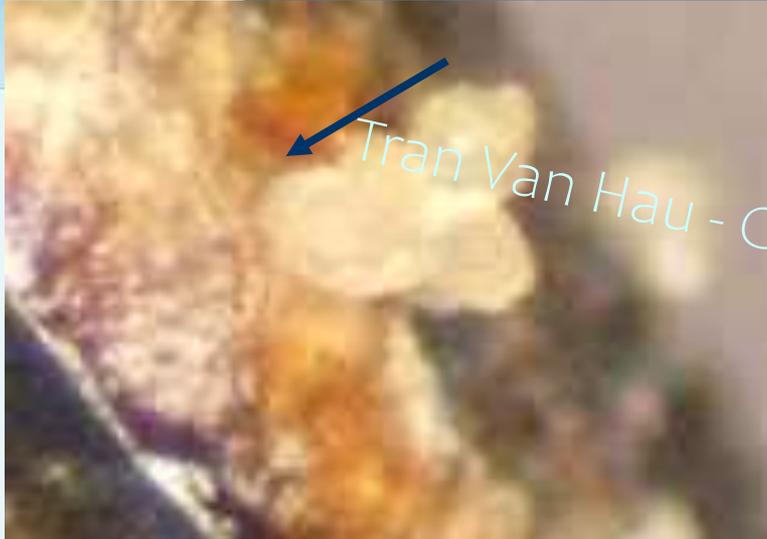
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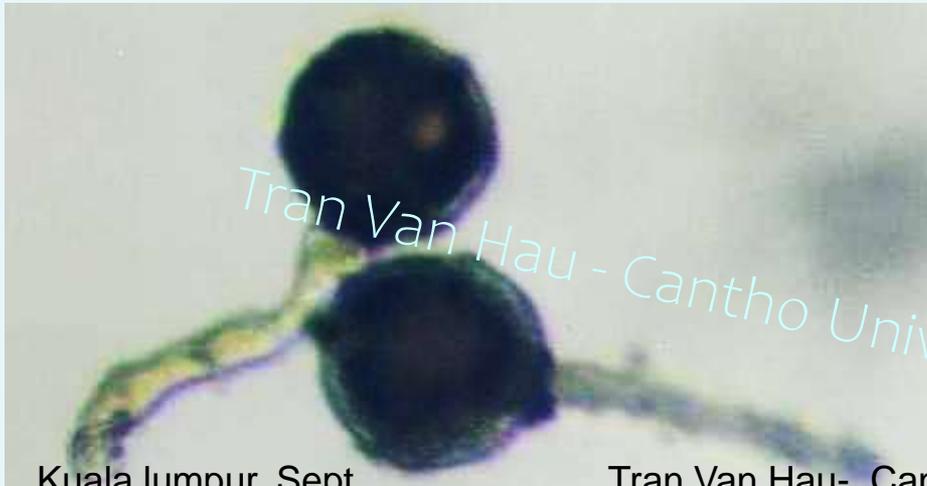


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Durian pollen grains: Round, sticky, release in clump



Pollen germination



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Development of pollen tube

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Effect of concentration of boron on ratio of pollen germination of some durian cultivar (Nguyen Thi Bich Van, 2001)

Concentration of H ₃ BO ₃ (ppm)	Source of pollen		
	Sua hat lep	Monthong	Kho qua xanh
0	23,89 ^b	12,92 ^b	19,17 ^b
50	33,89 ^b	18,37 ^b	33,11 ^b
100	65,08 ^a	58,39 ^a	66,67 ^a
150	69,97 ^a	65,88 ^a	75,83 ^a
F	**	**	**
CV (%)	20,0	29,6	29,7



Effect of Boron concentration on the length of pollen tube (μm) of some durian cultivar (Nguyen Thi Bich Van, 2001)

Concentration of H_3BO_3 (ppm)	Source of pollen		
	Sua hạt lép	Monthong	Kho qua xanh
0	132,4 ^b	147,5 ^b	218,9 ^b
50	466,0 ^b	355,1 ^b	635,4 ^b
100	1.171,1 ^a	994,9 ^a	863,7 ^{ab}
150	1.234,2 ^a	970,5 ^a	1.075,3 ^a
F	**	**	**
CV (%)	90,0	81,5	41,5



Anthesis and Fruit set

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- Hermaphrodites flower but **rarely self-pollination** due to **pistils and stamens do not open the same time.**
- **The female stigma from the pistil usually comes out first, before the anthers of the stamen appear.**
- Flower opening: from **3.00 PM to about mid-nigh.**
 - **Musang King: Anthers completely open at 17.00 p.m.**
Pollen release ~ 7.30 p.m
 - Best time for fruit set: 9.30 p.m. (Polprasid. 1969).
- Major pollinators of durian in Darwin: **Bats and the stingless Trigoma bees (beeflies)** (Lim & Luders, 2009). **Pollination by bats, little transfer by wind**
- Most durian trees have **a high degree of self-incompatibility**
needs to cross pollination



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Bats eat nectar and pollinate durian



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Bat cage near durian orchard to improve the fruit set in Hau Giang province

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Benefics of supplement pollination

- **Open pollination**
 - Low fruit set
 - High rate of immature fruit drop
 - Low yield, low No. of locule/fruit, small fruit
 - Deformed fruit
- **Supplement pollination**
 - High fruit set, decrease immature fruit drop
 - Increasing rate of good shape
 - Set fruit at suitable position on tree

Note: Male pollen have an **influence on quality of flesh** i.e. **Flesh color, flavor, taste, fruit weight, time of fruit developmet,..)**



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Supplement pollination for durian in Thailand



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Tools for supplement pollination

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Effects of assisted self and reciprocal crosses on durian fruit retention (Lim & Luder, 2009)

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Female	Male	Flowers pollinated	Percent fruit at weeks after pollination		
			3	6	Harvest
Chanee	Chanee	5	20.00	0.00	0.00
Chanee	Monthong	12	33.33	16.67	16.67
Chanee	Luang	10	30.00	20.00	10.00
Monthong	Monthong	40	12.50	0.00	0.00
Monthong	Chanee	67	25.37	7.46	4.48
Monthong	Luang	66	34.85	15.15	4.55
Luang	Luang	43	13.95	9.30	0.00
Luang	Monthong	44	18.18	11.36	6.82
Luang	Chanee	69	26.09	15.94	4.35



Effects of Different Pollination Treatments on Fruit Set of Musang King durian (Nurlisa and Mohd, 2022)

Treatment	Days after anthesis (DAA)				
	7th	14th	21st	28th	Harvest
Control	22.36 ^{ab*}	3.49 ^b	3.49 ^b	2.05 ^b	0.87 ^b
Open pollination	37.15 ^a	0 ^b	0 ^b	0 ^b	0 ^b
PST	9.27 ^b	0.85 ^b	0 ^b	0 ^b	0 ^b
D24 pollen	20.79 ^{ab}	16.28 ^a	16.28 ^a	16.28 ^a	16.28 ^a
Autogamy	5.2 ^b	0 ^b	0 ^b	0 ^b	0 ^b

Note. *Means with the same letter vertically are not significantly different at $P \leq 0.05$ using the Tukey test.

- PDT: Pollination from Different tree
- PST: Pollination from the same tree

→ **Musang King cultivar is self-incompatible**
→ **It needs to grow multi varieties instead of mono variety to achieve high fruit set**



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**Monthong durian fruit was deformed
because it is not supplemented by pollination**



Musang king durian fruits was supplemented by Ri 6 and Monthong pollen

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IMMATURE FRUIT DROP

- **Flower drop (4 days after anthesis):** no pollination, no cross pollination due to **Self-incompatibility**
- **Physiological fruit drop:**
 - Carbohydrate competition between **leaf flush and young fruit**
 - **Water stress**, nutrient deficiency
 - **Disorder of plant growth regulators** (especially in disadvantaged conditions of weather i.e. prolonged rain or high temperature - **That maybe relate to role of calcium**)
- **Damage by insect pests and diseases**

Fruit set stage of Musang king durian



after pollination

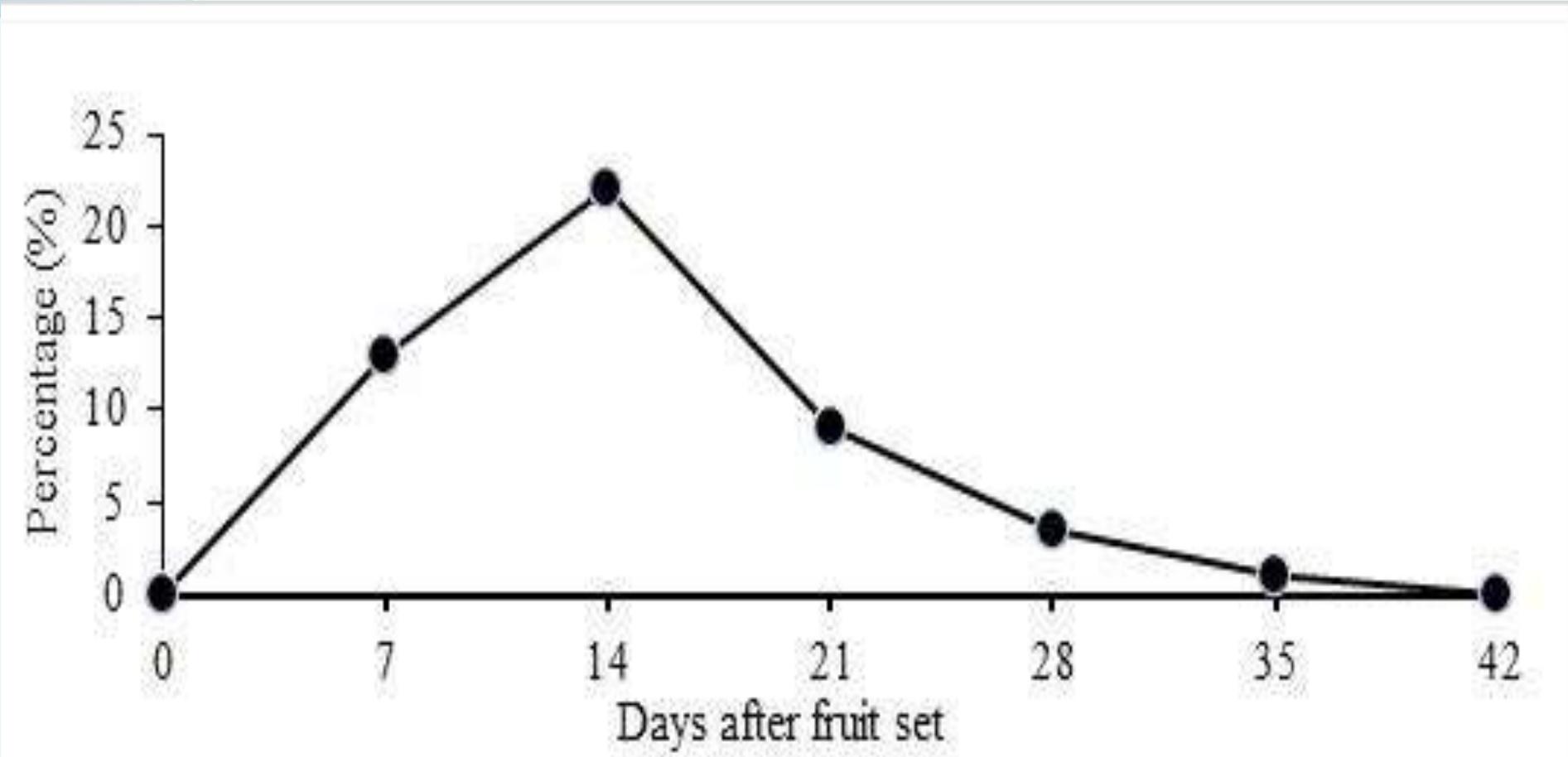


after Fertilization



Immature fruit drop (%) of Musang King durian in Can Tho City (Duong et al., 2025)

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10 days after fruit set of 'Bi ro' durian



'Ri 6' durian



7 days after fruit set of 'Sua Hai Lep' durian



'Monthong' durian

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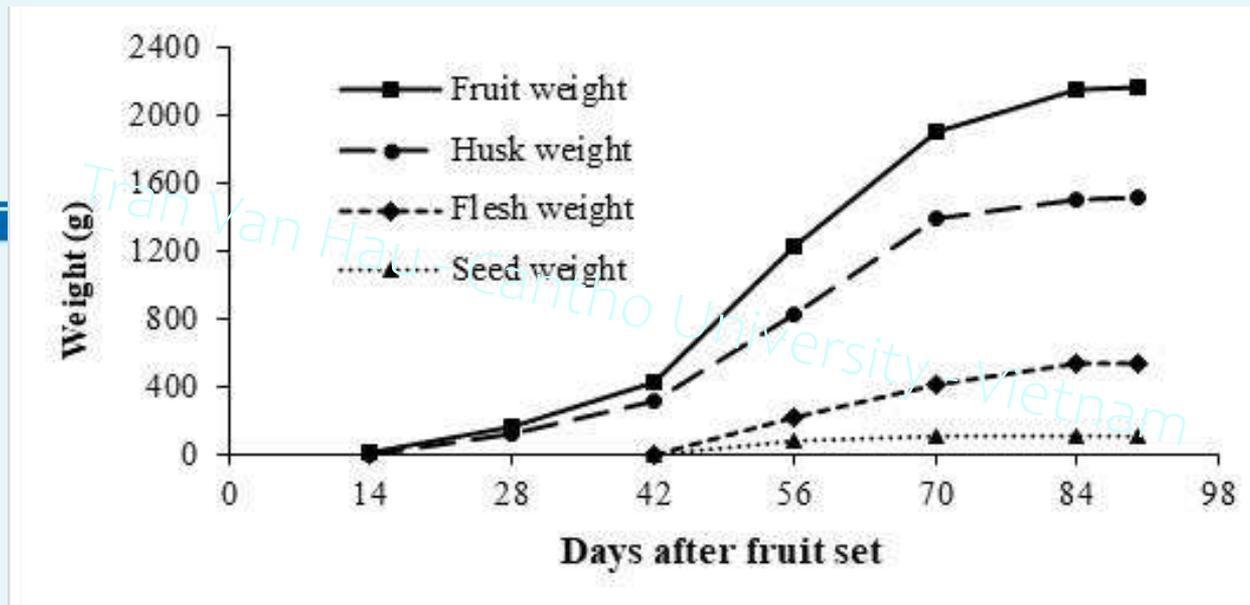
FRUIT DEVELOPMENT

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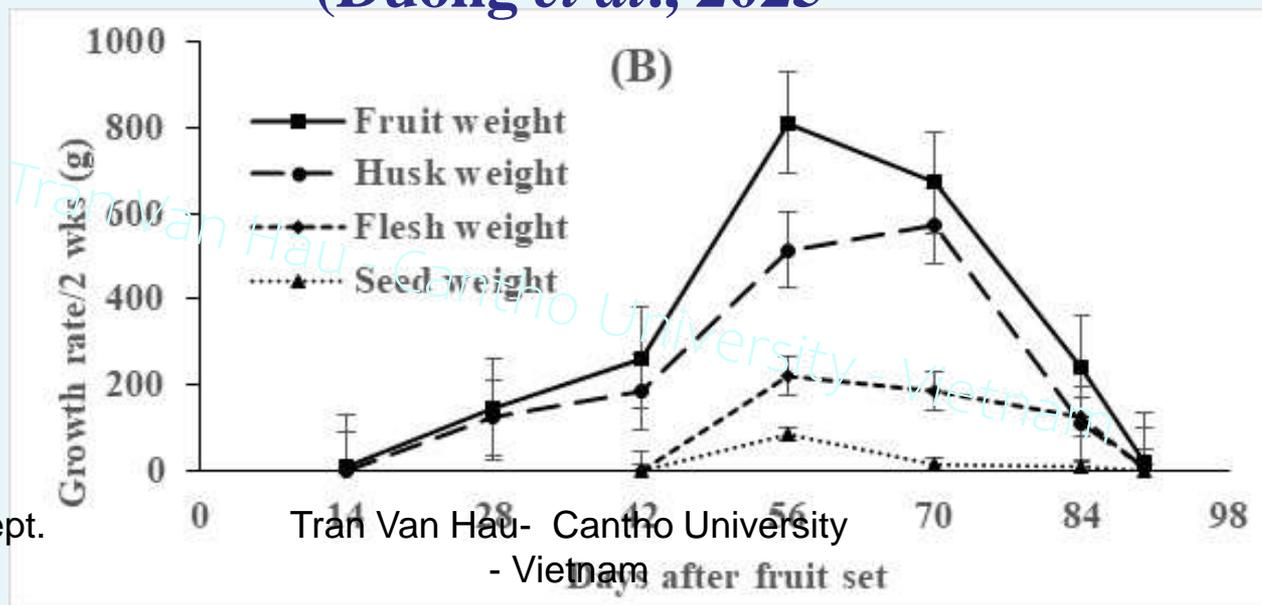
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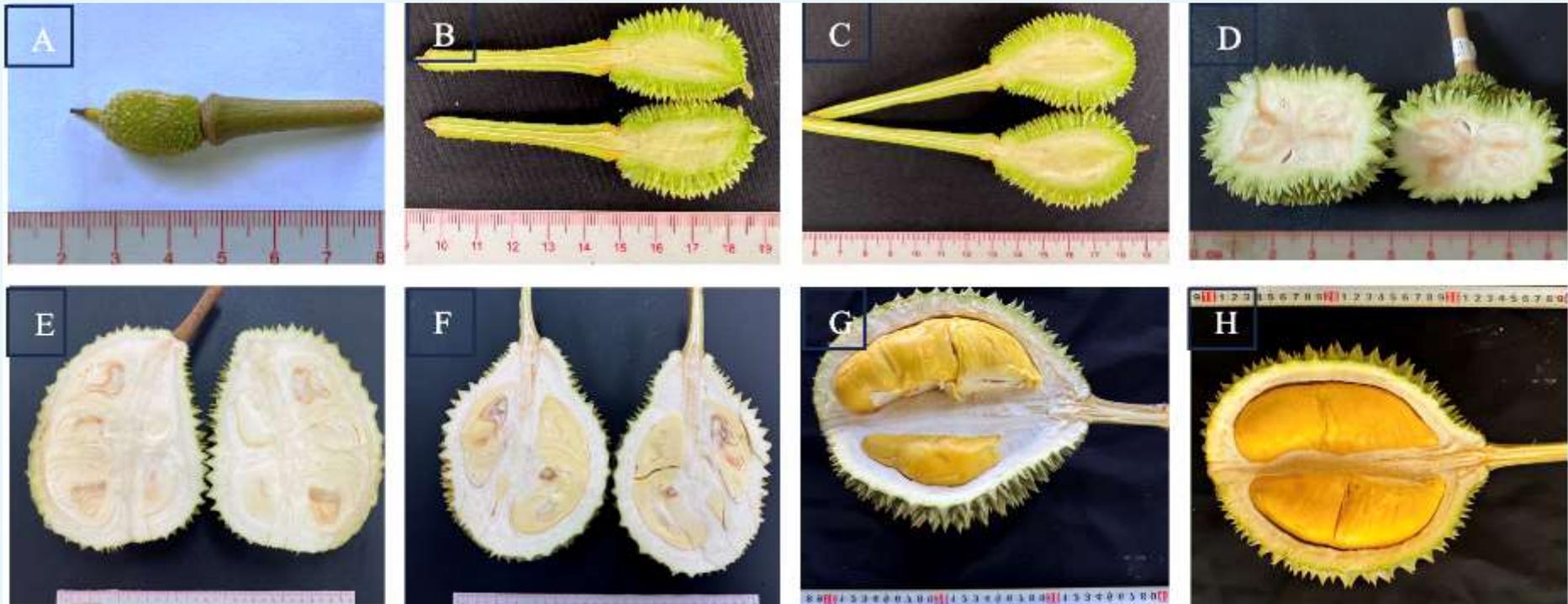


Fruit development and growth rate of Musang King durian (Duong *et al.*, 2025)





Fruit development of Musang King durian



A) After fruit set, B) 14 DAFS, C) 28 DAFS, D) 42 DAFS, E) 56 DAFS, F) 70 DAFS, G) 84 DAFS, H) 90 DAFS



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Nutrient management during fruit development

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Change of nutrients during leaves and fruit development of durian

- 1. Stage of mature leaves:** (Poovarodom *et al.*, 2002)
 - Content of N, P, K **decrease**
 - Content of **Ca, Mg, Fe và Mn increase**
- 2. Stage of fruit set to harvest:**
 - **Fruit set and development:** B & Zn **decrease**
 - Content of **N, P, K, S, Zn, Mn, Cu và Fe decrease** (Lim *et al.*, 1999)
- 3. Stage of fruit development** (Lim and Luders, 2009) :
 - **N, P and Ca** become limited from **fruit development to harvest**
 - **K** limited at stage **after fruit development to harvest**



Nutrient management during fruit development

1. Cell division and organ formations:

- Apply easily dissolved lime 2–3 times to provide calcium for cell wall formation and limit physiological disorder during the cell expanding stage
- 7-20 DAF: Spraying N:P:K 1:2:1
- 15-20 DAF: Spraying Ca-B to prevent immature fruit drop
- 20-25 DAF 1st fruit thinning

2. Enlargement stage: Achieving maximum fruit size

- 25-30 DAF : Application fertilizer NPK 1:1:1 or 2:1:1; 1.0-1.5 kg/tree for fruit enlargement, depending on tree growth
- 40-45 DAF: 2nd fruit thinning.



Nutrient management during fruit development

3. Flesh development & Mature fruit stage: Achieving good quality and reducing physiological disorder of flesh

- 55-60 DAF: Spraying $(\text{Ca}(\text{NO}_3)_2)$ 0.2%, or **Ca-B**
- 55-60 DAF: Fertilizing NPK 2:1:3, 0.5-1 kg/tree + spraying KNO_3 0.5-1.0%

cv. Monthong:

- 70-75 DAF: Foliar spraying **MgSO_4** 0.2%
- 80-85 DAF: Fertilizing 3rd + Foliar spraying KNO_3 0.5-1.0%



Effect of **Ratio of NPK Fertilizers** During the Fruit Development Stage on the Yield and **Physiological Disorder symptoms (PDS)** of Musang King Durian



Treatments	30 DAFS	45 DAFS	60 DAFS	Fruit weight (Kg)	Yield/tree (Kg/Tree)	Ratio of fruits with PDS (%)
	Ratio of N:P:K (1 kg/tree/time)					
1	3:1:1	3:1:1	2:1:3	2.288 ^a	95,5 ^a	45,0 ^a
2	1:1:1	1:1:1	1:1:1	2.006 ^c	84,3 ^b	15,0 ^{bc}
3	1:1:1	1:1:1	2:1:3	2.118 ^{bc}	88,4 ^{ab}	30,0 ^{ab}
4	2:1:1	2:1:1	2:1:3	2.307 ^a	92,3 ^a	35,0 ^{ab}
5	2:1:1	2:1:1	1:1:3	2.214 ^{ab}	89,7 ^{ab}	20,0 ^{bc}
6	2:1:1	2:1:3	1:1:3	2.207 ^{ab}	91,5 ^a	10,0 ^c

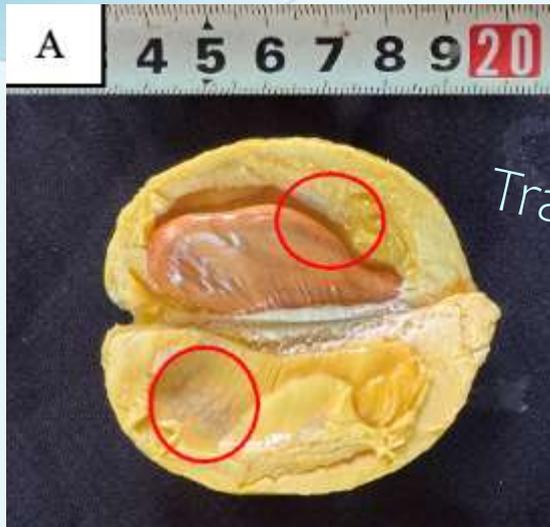
- NPK fertilizer with high ratio of nitrogen (3:1:1, 2:1:1) at 30 and 45 DAFS) then **increasing ratio of potassium (2:1:3) at 60 DAFS** helps **boost yield but also increases the incidence of PDS (23.6-29.6%)**

- High **ratio of nitrogen (2:1:1)** at 30 DAFS, then elevated ratio of potassium (**2:1:3 and 1:1:3**) at 45 and 60 DAFS, not only improves yield and fruit quality but also reduces PDS



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Types of physiological disorder as affects by fertilizer ratio of NPK



A) Cork spot or 'Tiger stripe'



B) Tiger stripe" symptoms



(C): Tip burn



Preventing leaf flush

- **The best method to control the leaf flush during fruit development is to induce concentrated flowering and fruiting.** Because **flowers and fruits** are **important sources of carbohydrate competition with young shoots.**
- Inhibition leaf flushing during stage of fruit development (**8-12 wks DAF**): To preventing the competition between young shoot and fruits
 - Spraying MKP (0-52-34): 2.0-2.5% or
 - **KNO_3 1.5% or**
 - Spraying PBZ: 250-500 ppm/Mepiquat chloride



Stimulate concentrated flowering and fruiting to prevent appearing young shoots during fruit development

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Effecting inhibition of the development of leaf sprouts during fruit development (Punachit *et al.*, 1992)

No.	Treatments	Time of delaying the development of leaf sprout (days)	Rate of fruit drop (%)	No. fruit/tree
1	Daminozide (0.25%)	21.0	33.87 ^b	39.3 ^b
2	Mepiquat Chloride (0.25%)	20.8	67.18 ^a	37.3 ^b
3	KNO₃ 1.5%	14.0	35.64^b	81.0^a
4	MKP 2.5%	14.3	53.85 ^{ab}	49.8 ^b

Spraying as soon as the leaf sprouts have sprouted:

- KNO₃ 1,5%: Killing leaf sprouts
- MKP 2,5%: Causing leaf blight, inhibition of leaf development.



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**THANK YOU VERY MUCH
FOR YOUR LISTENING!**