Yield and fruit quality of tomato as affected by rates and ratios of K and Ca in water culture

B. Nzanza , D. Marais & A.S. Claassens

University of Pretoria

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Introduction

- Fruit quality: crucial in greenhouse tomato production
- Quality factors driving consumer choice:
  - Fruit size
  - Fruit color
  - Fruit shape
  - Shelf life
  - Etc.
- Fruit quality is often affected by mineral nutrition mainly K and Ca

Introduction…

- K plays a key role in fruit quality:
  - Involved in metabolic and transport processes
  - Generating turgor pressure
  - Relates to fruit shape
  - Increases fruit acid concentration
  - Reduces ripening disorders
  - Increases carotenoid concentrations
  - Etc.

Introduction…

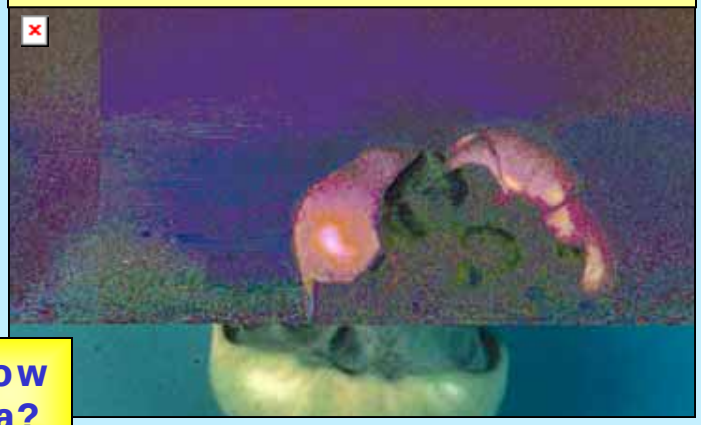
- Ca is also important in:
  - Maintaining cell wall integrity
  - Maintaining membrane permeability
  - Enhancing pollen germination
  - Activating numerous enzymes
  - Affecting fruit quality and health of conductive tissue
  - Reduces physiological disorders
  - Etc.

Introduction…

- K deficiencies lead to:
  - Reduction of plant growth and dry matter production
  - Effect fruit taste negatively
  - Low fruit quality
- Ca deficiencies cause:
  - Reduced leaf size
  - Necrosis of young leaves
  - Yield loss
  - Etc.

Physiological disorders → yield loss and low fruit quality

Cat Facing

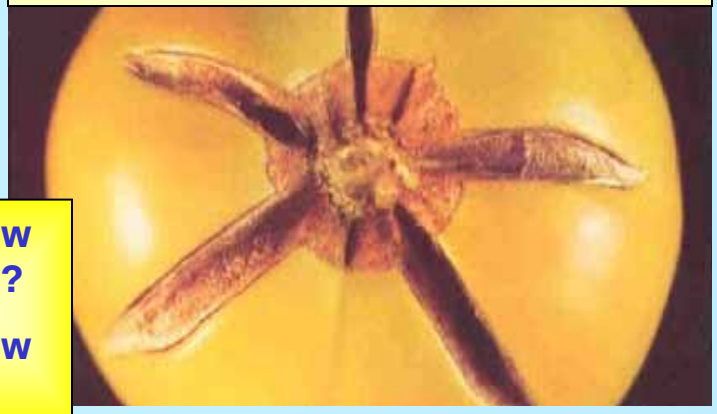


Low Ca?

Blotchy Ripening

Low K?

Fruit Cracking



Low Ca?

Low K?

Blossom End Rot

Low Ca & Ca:K ratios ?

Problem statement

- Sufficient K and Ca are needed for high yield and quality
- Unfortunately K and Ca strongly interact during uptake
- High Ca decreases K uptake and vice versa
- As result:
  - Induced deficiencies are found
  - yield loss and low fruit quality
  - Physiological disorders = nutritional effects?

Aim

Investigate the effects of K and Ca rates and ratios on yield and quality of tomato

Material and Methods

- Experimental Farm (UP): Glasshouse
- Tomato " Money maker":test crop
- Treatments consisted of:
  - Two K concentrations (6 and 10 mmolc/l) combined
  - With two Ca concentrations (12 and 16 mmolc/l)
  - Giving four K:Ca ratios (6/12; 6/16; 10/12; & 10/16 mmolc/l)
- Replication: 4 times
- Experimental design: Completely Random Design

Material and Methods…

- Water culture system
- 10 liter pots on a rotating table Renewal of solution (Tables 1 and 2): every fortnight
- Water supplemented daily
- Number of trusses allowed: 5
- Pruning of lateral shoots

Table 2. Hoagland no 2 solution

Compound	Volume
$Ca(NO_3)_2$	8 $mmol_c.l^{-1}$
$MgSO_4$	4 $mmol_c.l^{-1}$
KNO_3	6 $mmol_c.l^{-1}$
$NH_4H_2PO_4$	1 $mmol_c.l^{-1}$
Fe	1 $mg.l^{-1}$
Mn	0.5 $mg.l^{-1}$
Zn	0.05 $mg.l^{-1}$
Mo	0.01 $mg.l^{-1}$
B	0.5 $mg.l^{-1}$
Cl	0.5 $mg.l^{-1}$

Results and Discussion

Figure 1. Effect of K:Ca ratios on fruit pH

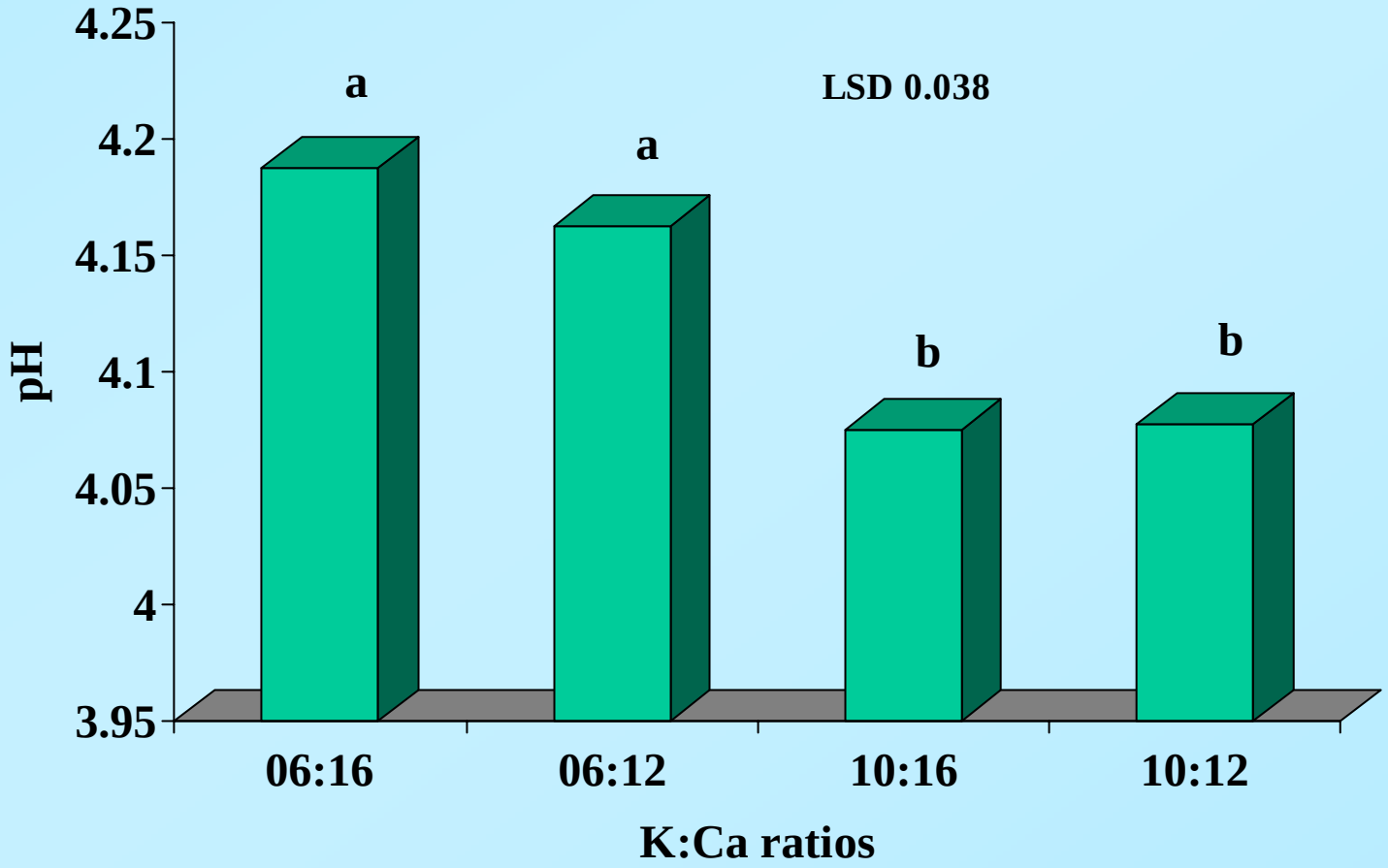


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Figure 2. Effect of K:Ca ratios on Titratable Acidity (TA) of tomato fruits

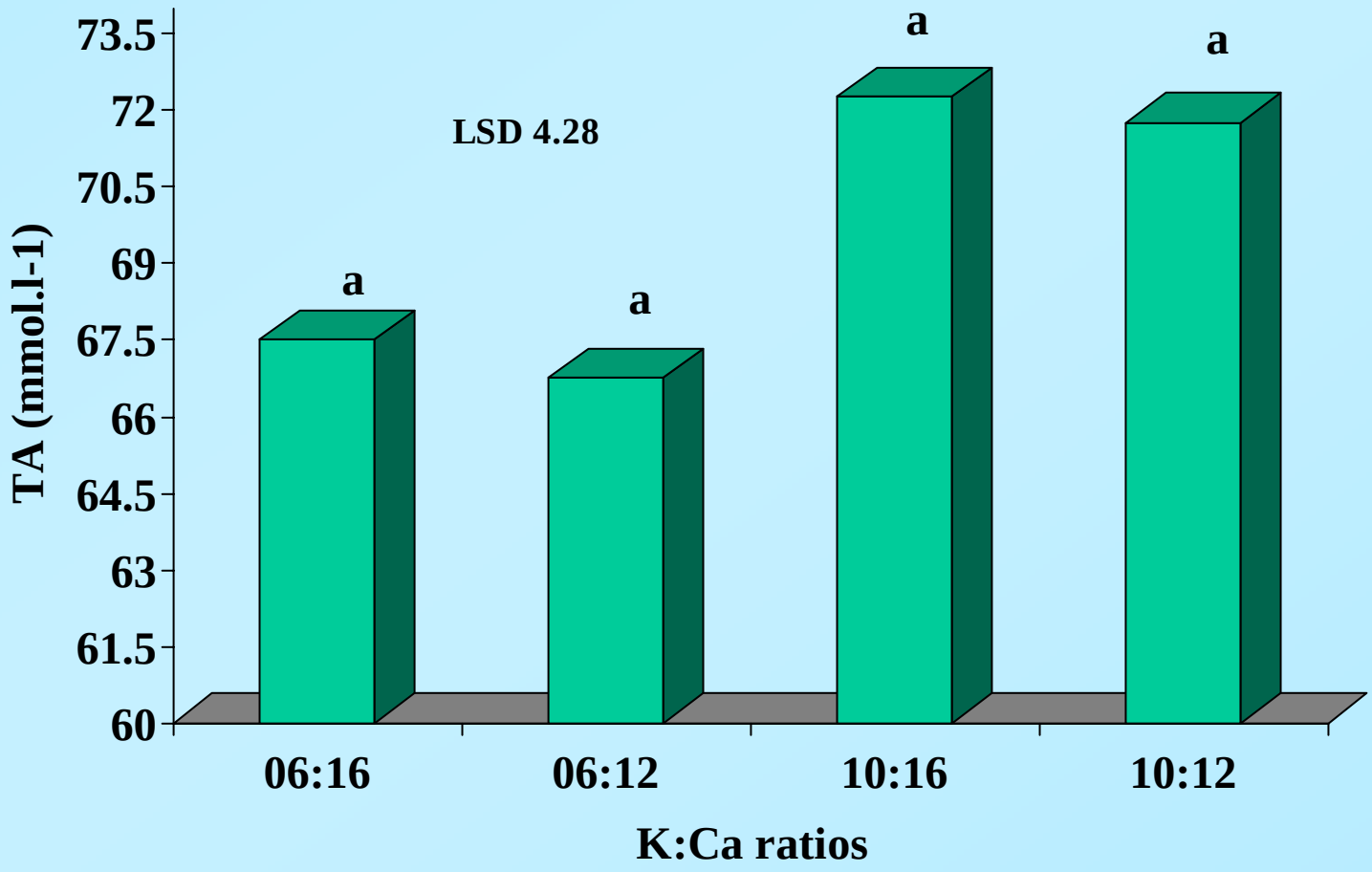

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Figure 3. Effect of K:Ca ratios on Total Soluble Solids of tomato fruits

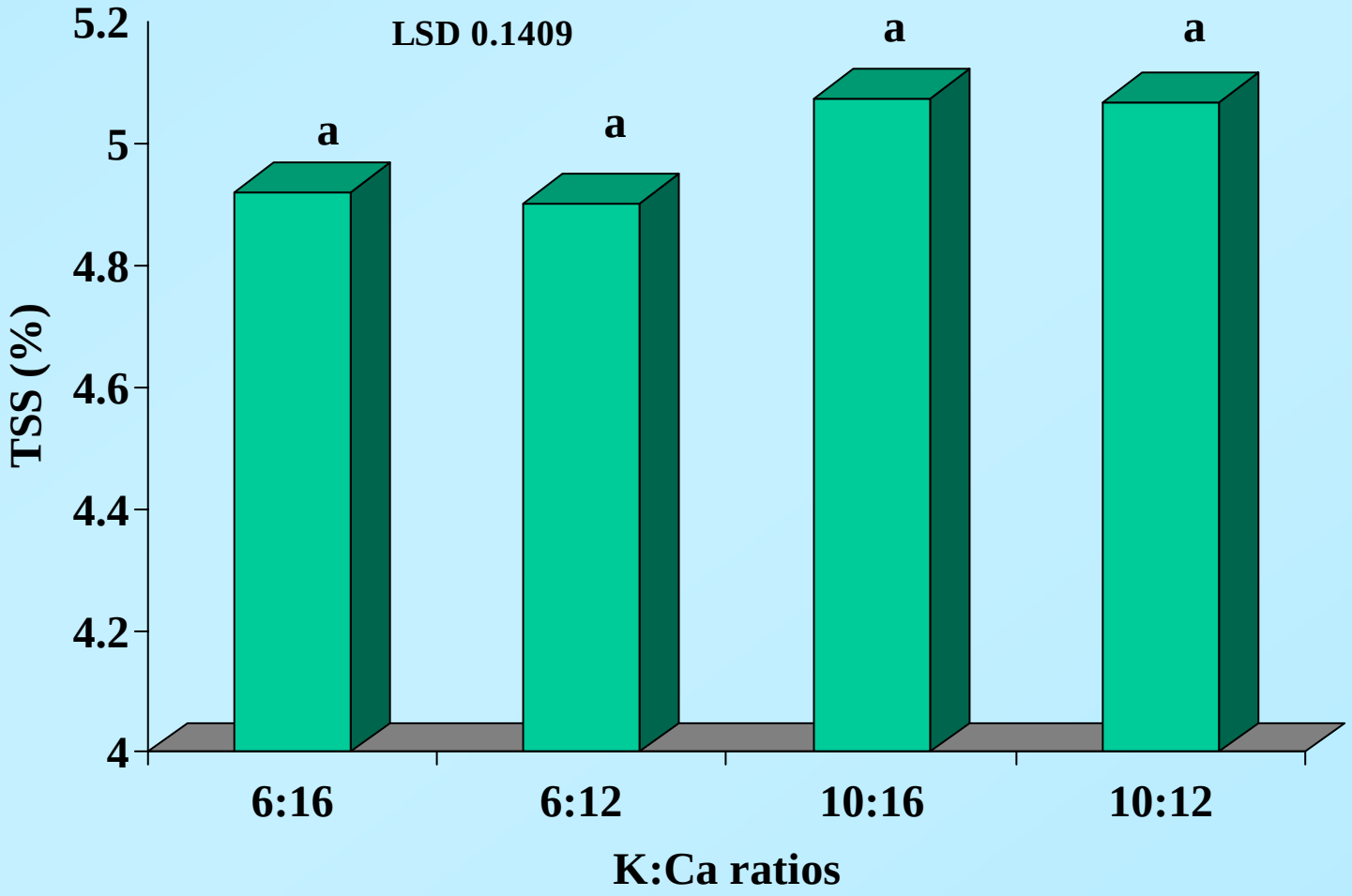

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Figure 5. Effect of K:Ca ratios on fruit dry matter(%)

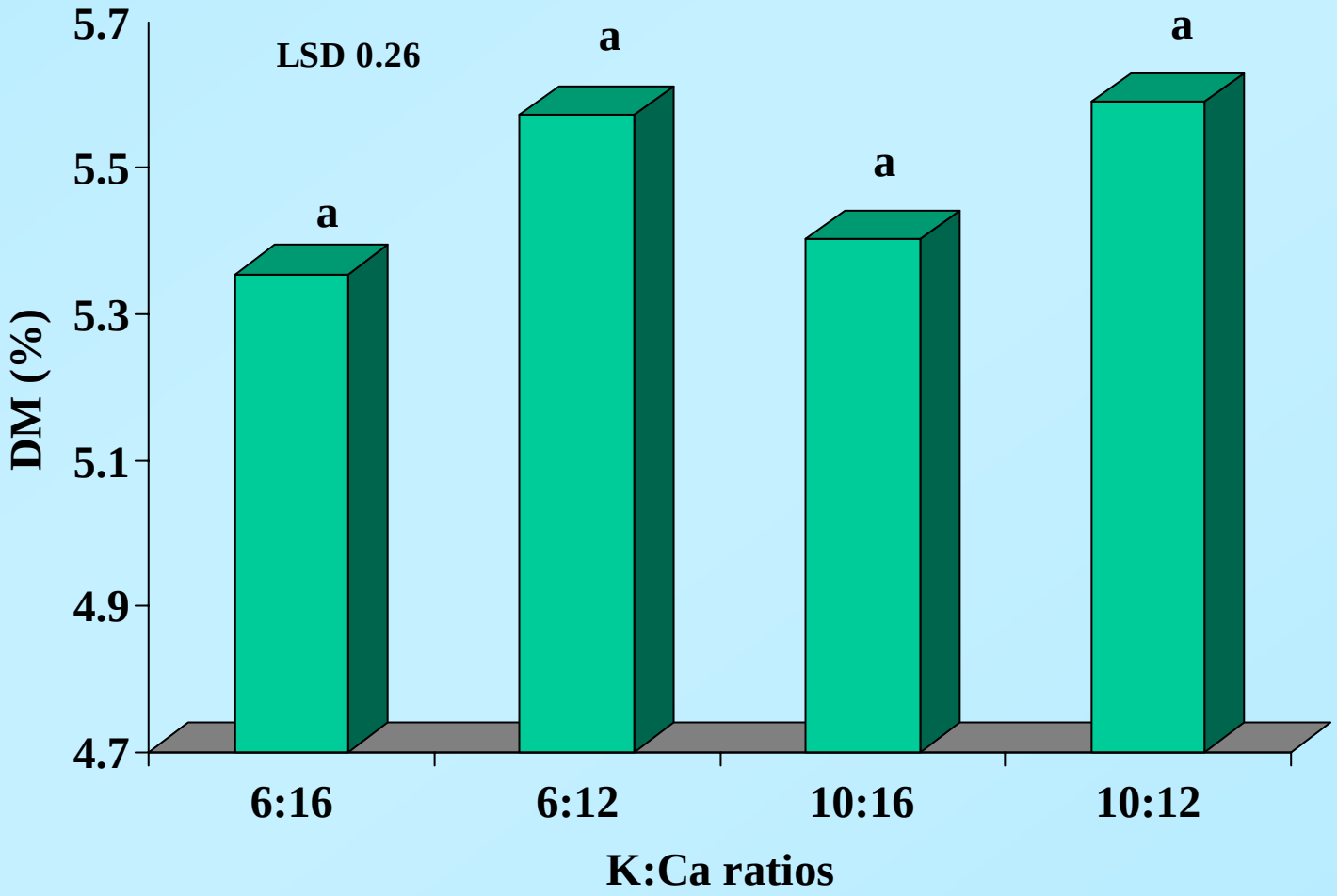

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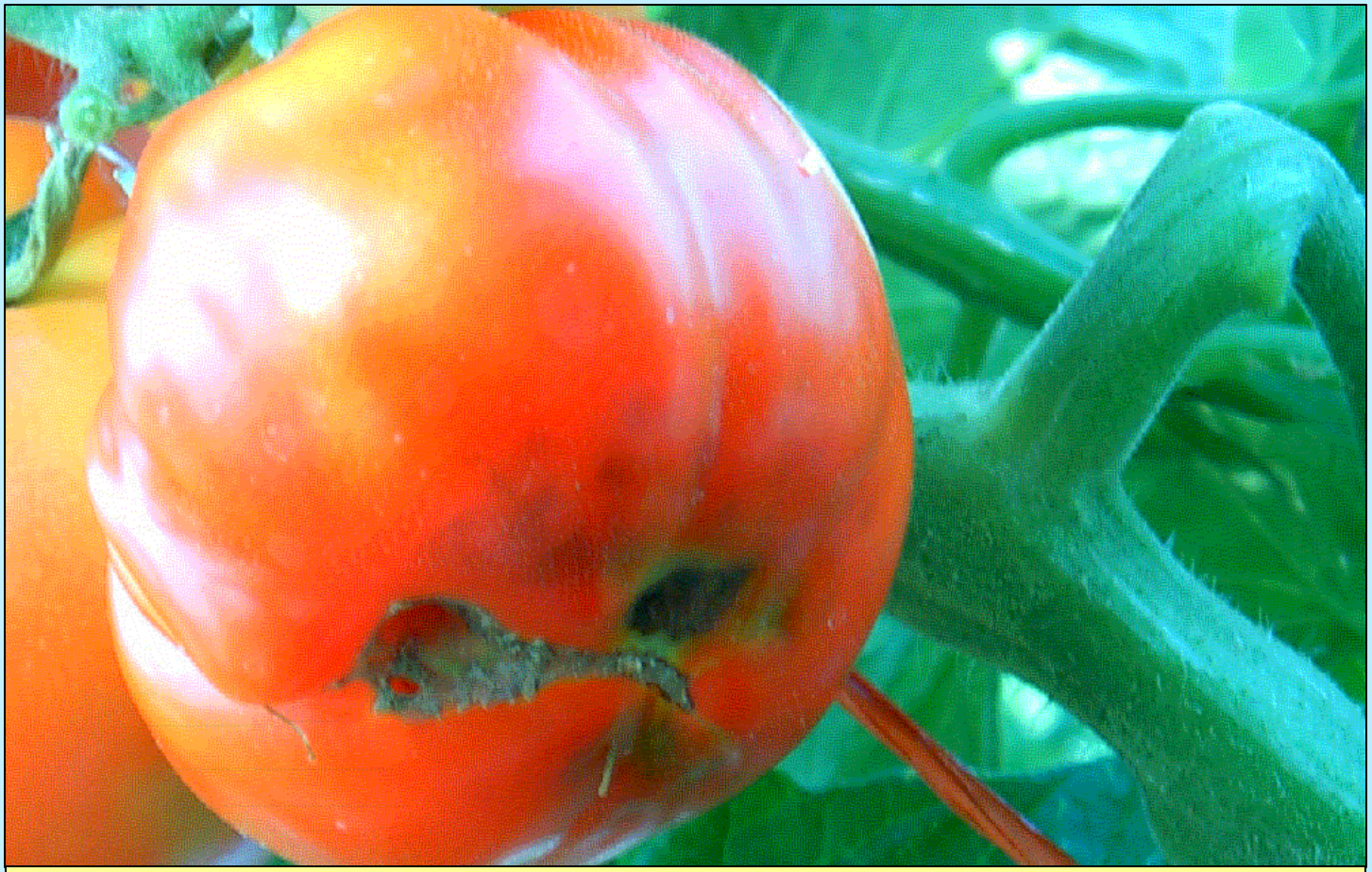
Figure 6. Blossom-End Rot (BER) of tomato



High incidence on treatments with low Ca

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Figure 7. Effect of K:Ca ratios on BER incidence in greenhouse tomatoes

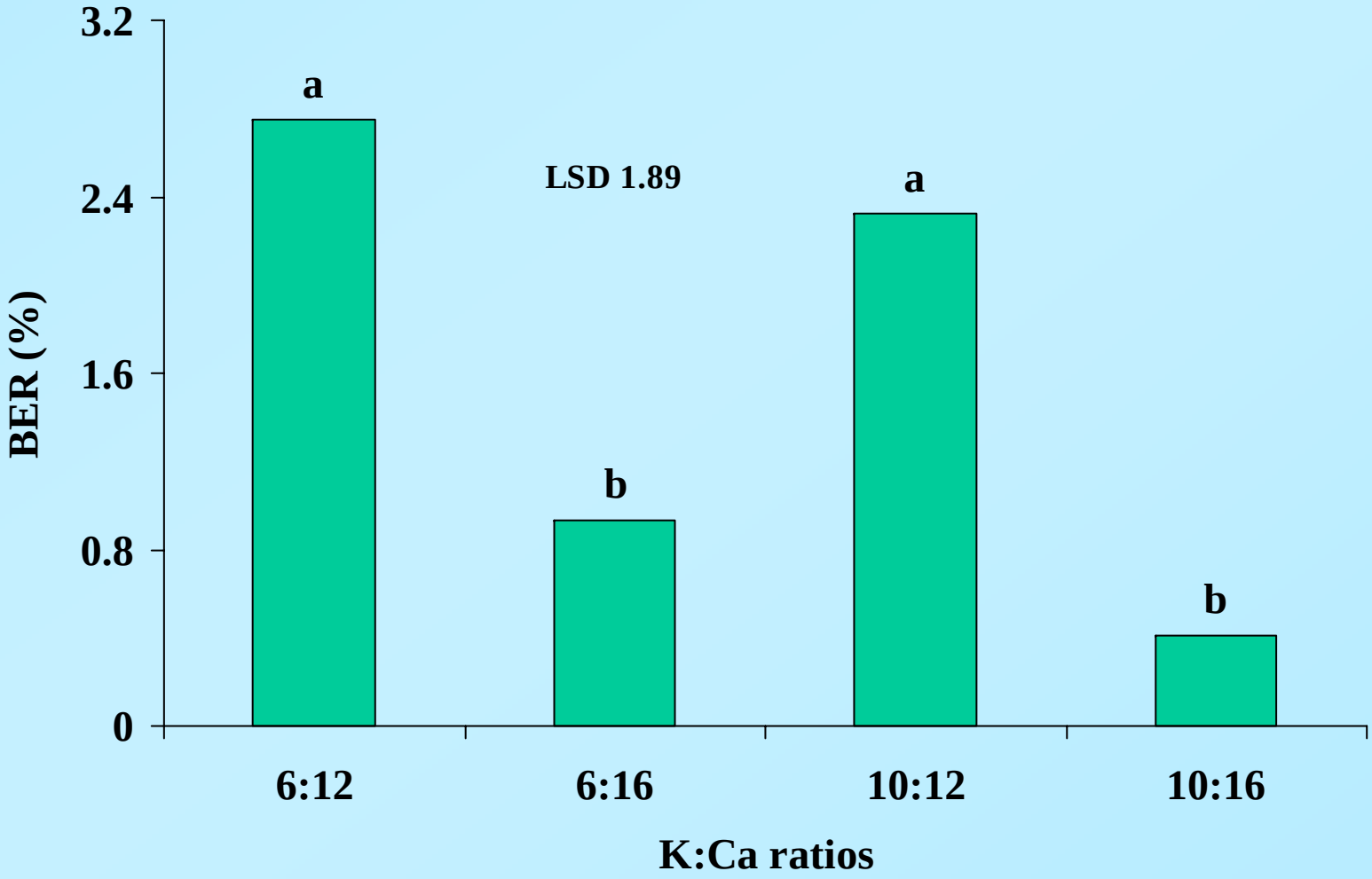

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Figure 8. Incidence of Blotchy Ripening in greenhouse tomatoes

- Disorder appear only in treatments with low K, however, the incidence was very low
  - 0.42 % for K:Ca 6:12
  - 0.96 % for K:Ca 6:16

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Figure 9. Incidence of Fruit Cracking in greenhouse tomatoes

- No relationships between Fruit Cracking and K:Ca
- Disorder appears in all treatments (up to 2.59 %)

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Figure 10. Incidence of Cat Facing in greenhouse tomatoes

- No relationships between Cat Facing and K:Ca ratios
- Disorder appears in all treatments (up to 0.91 %)

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Figure 11. Effect of K:Ca ratios on tomato yield (kg plant^{-1})

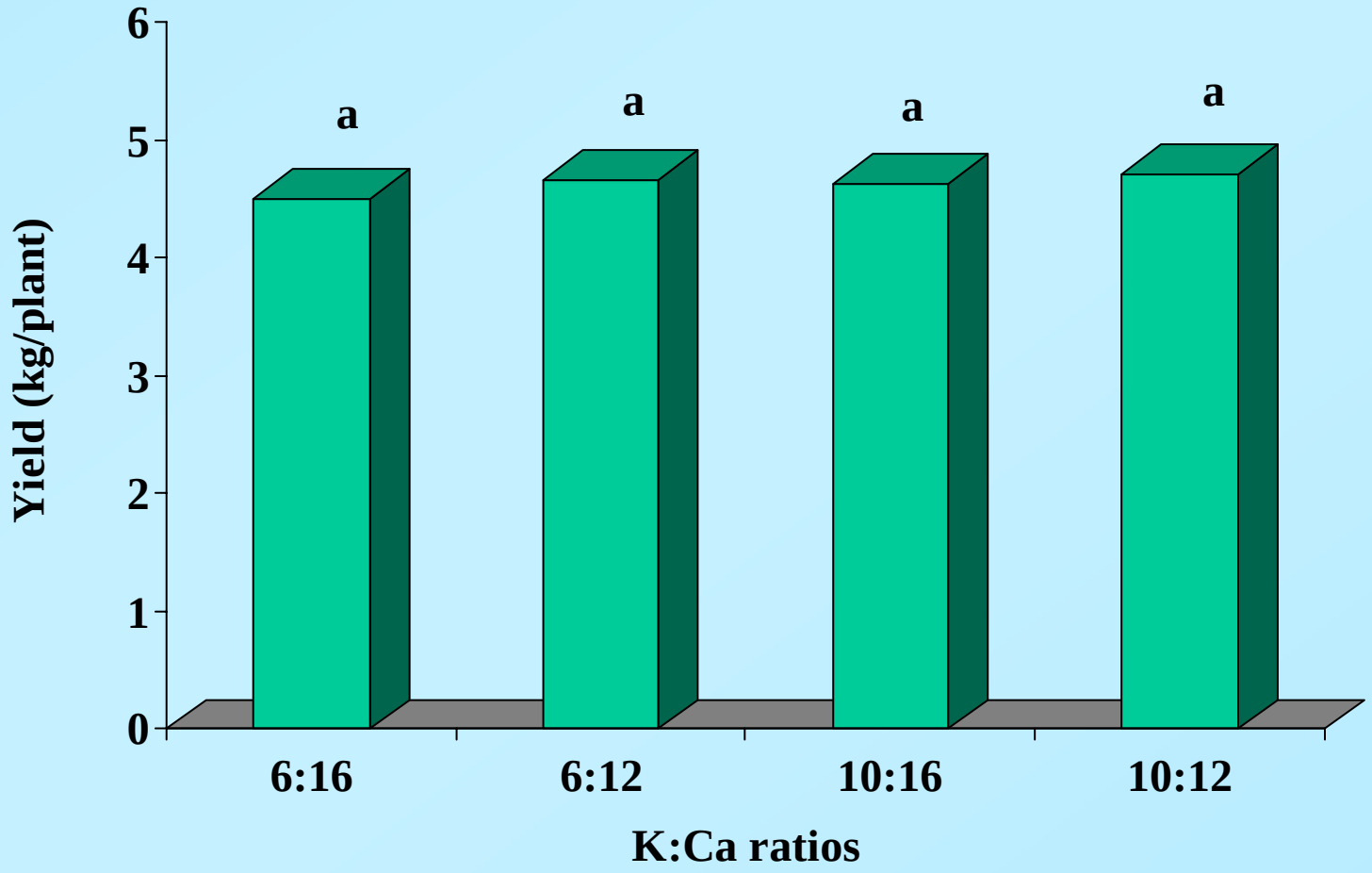

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Figure 12. Effect of K:Ca ratios on marketable tomato yield

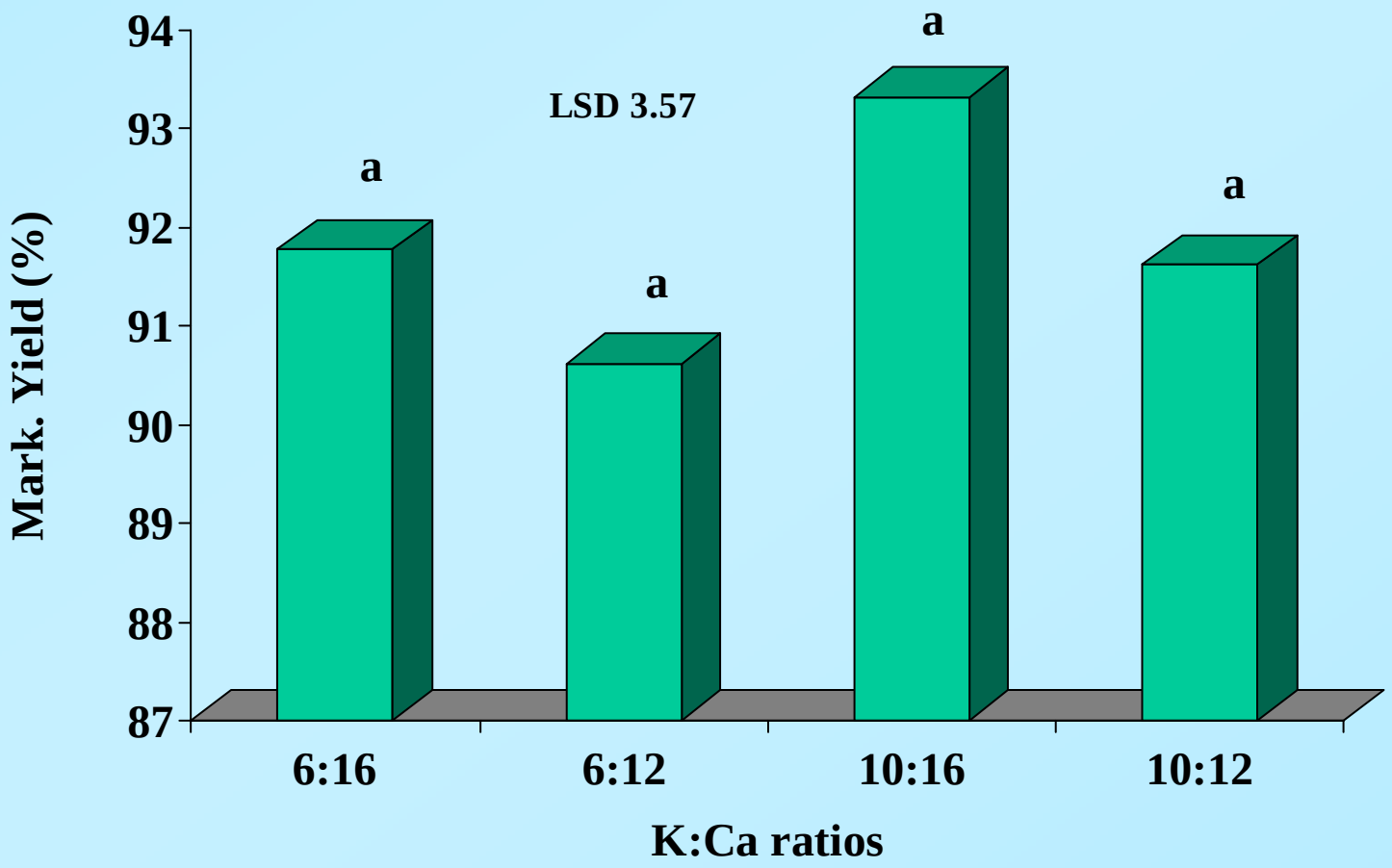

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Figure 13. Effect of K:Ca ratios on fruit N

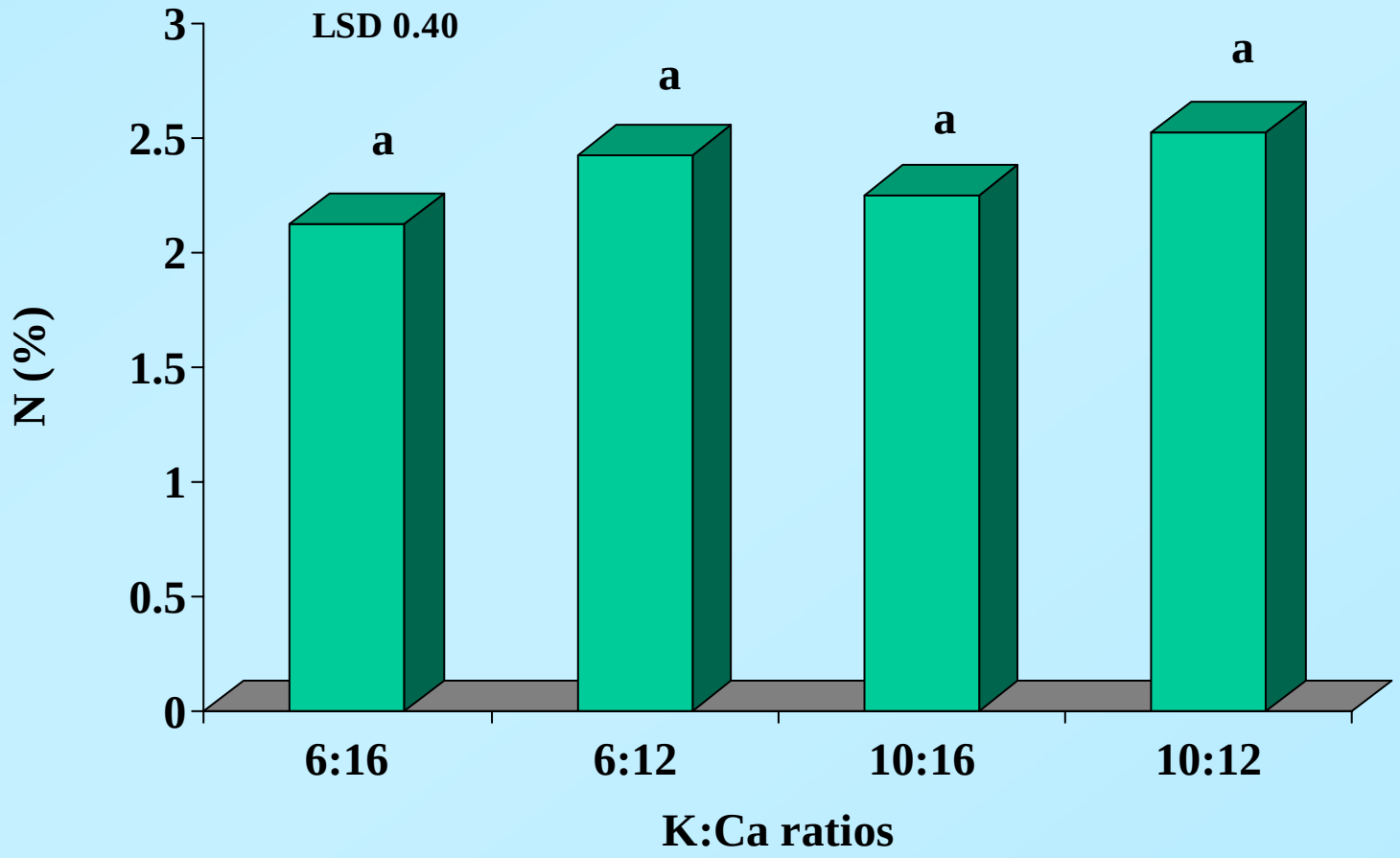

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Figure 14. Effect of K:Ca ratios on fruit-P

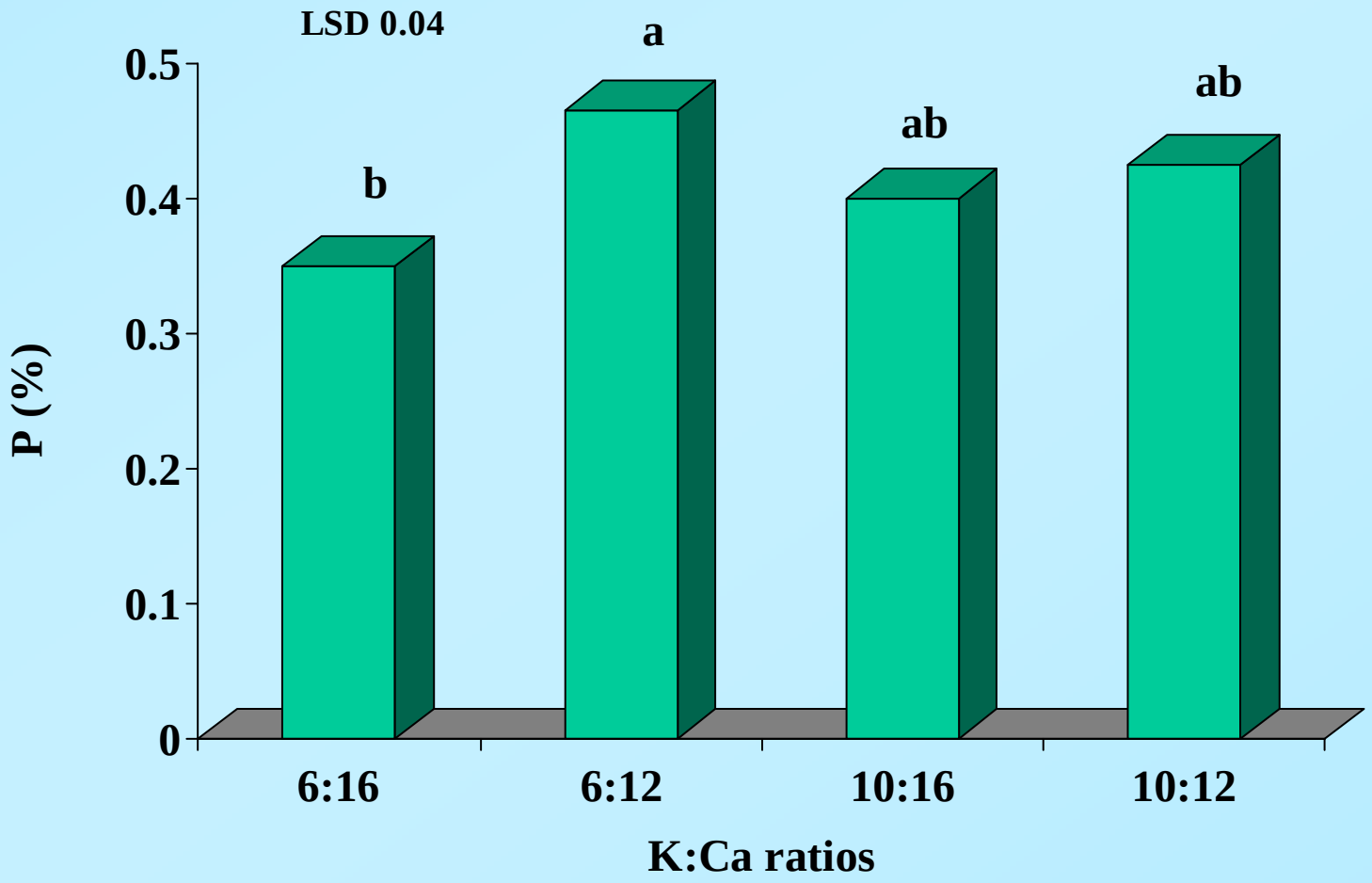

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Figure 15. Effect of K:Ca ratios on fruit-Ca

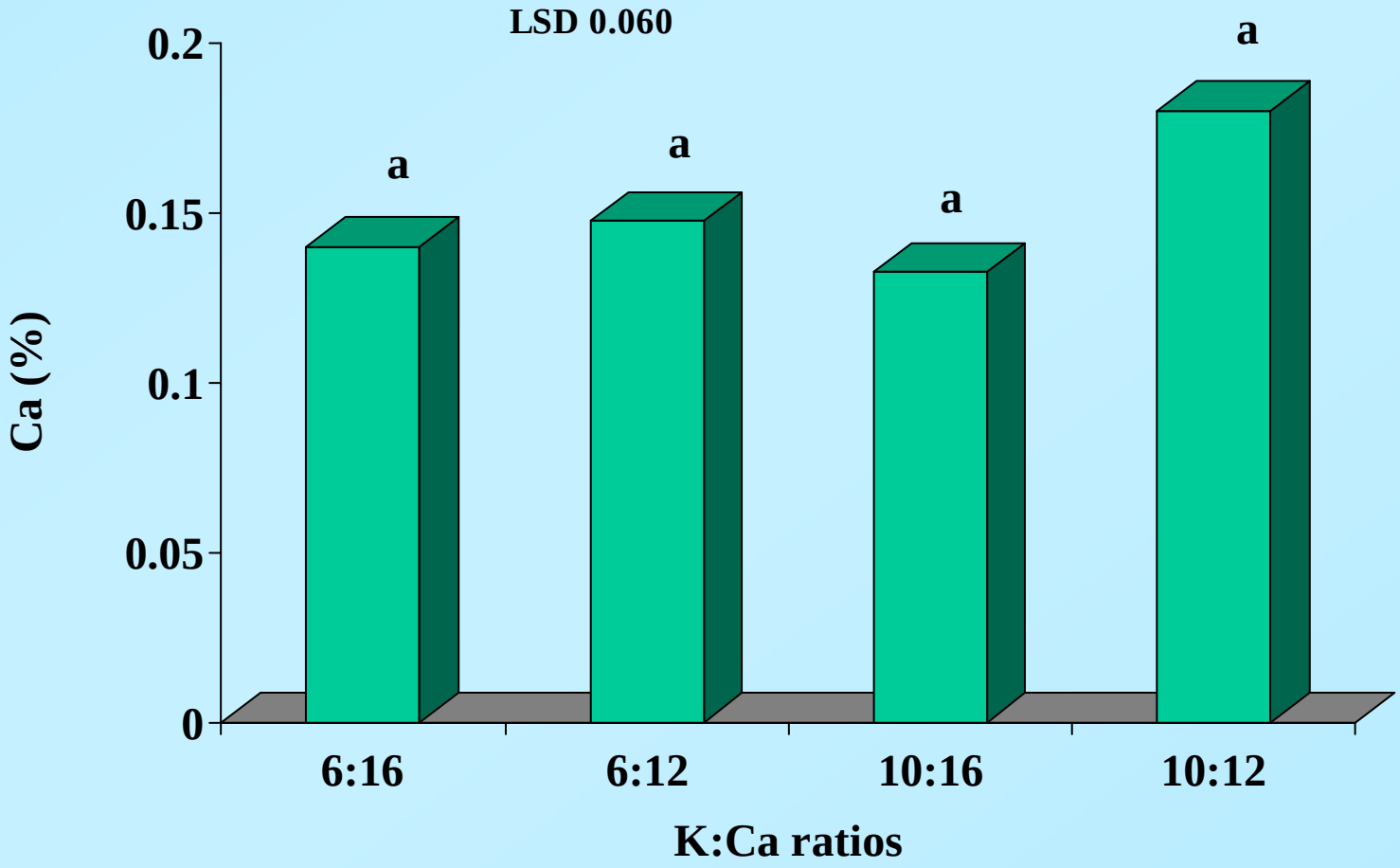

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Figure 16. Effect of K:Ca ratios on fruit-K

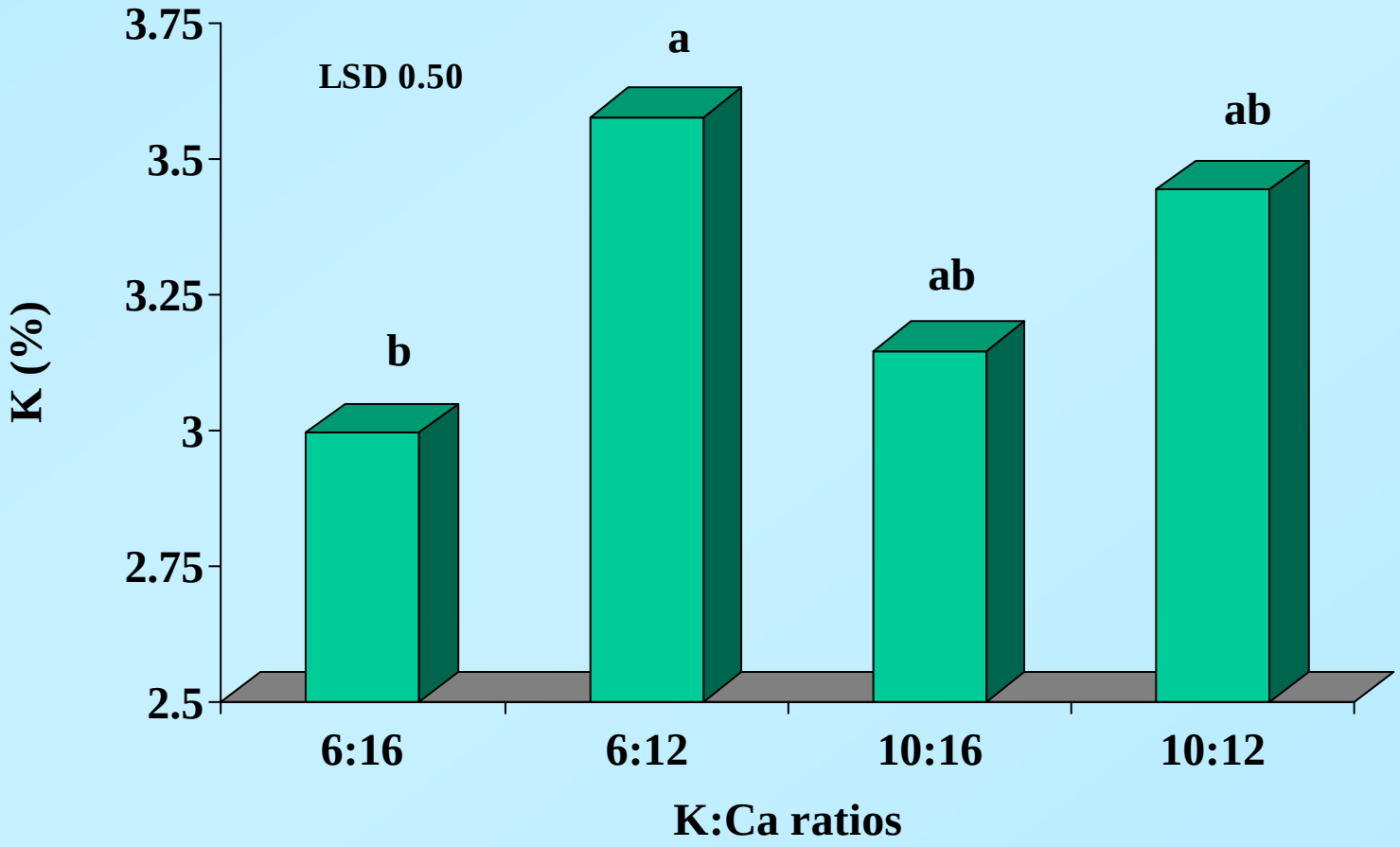

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Figure 17. Effect of K:Ca ratios on fruit-Mg

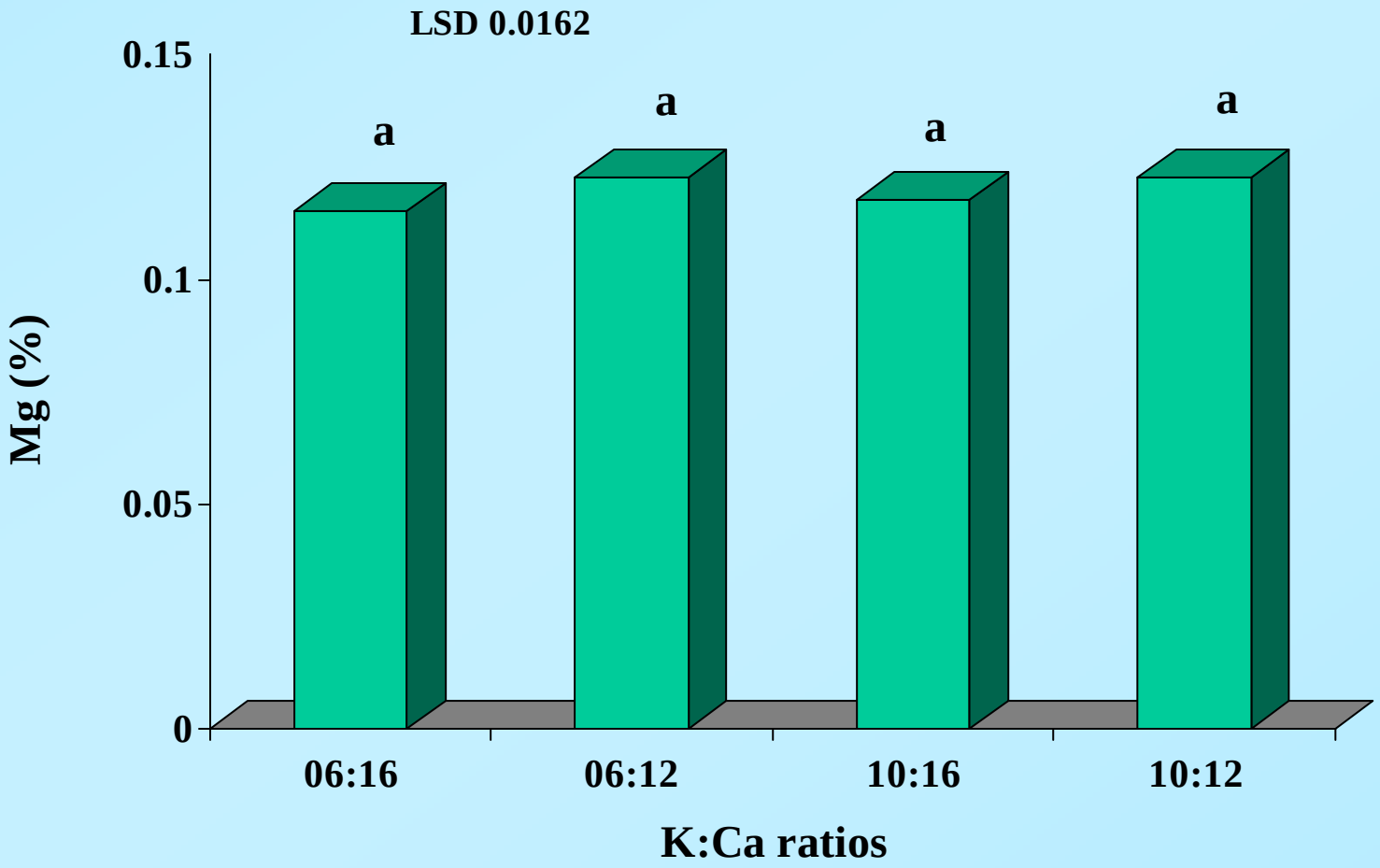

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Figure 18. Effect of K:Ca ratios on leaf-N

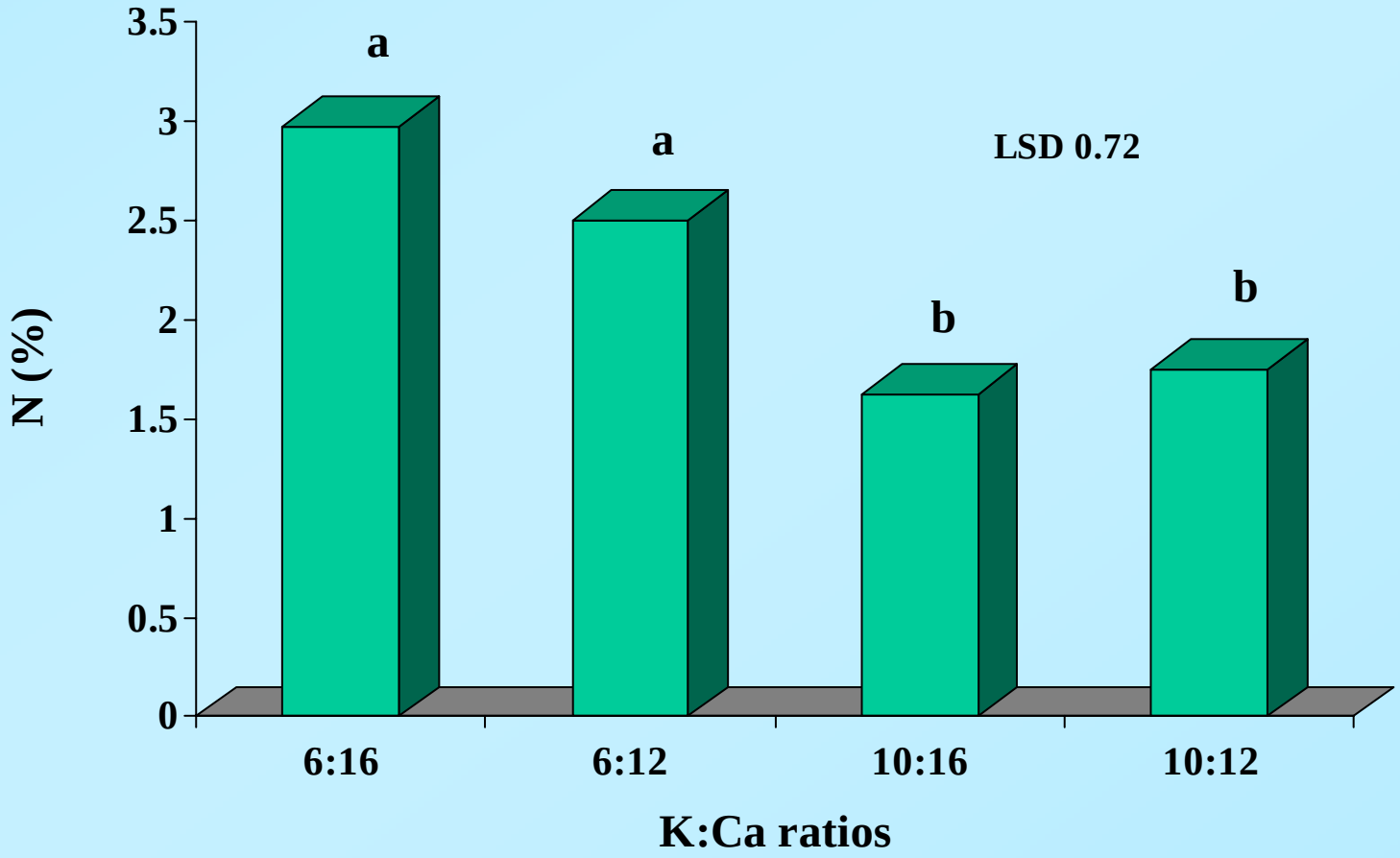

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Figure 19. Effect of K:Ca ratios on leaf-P

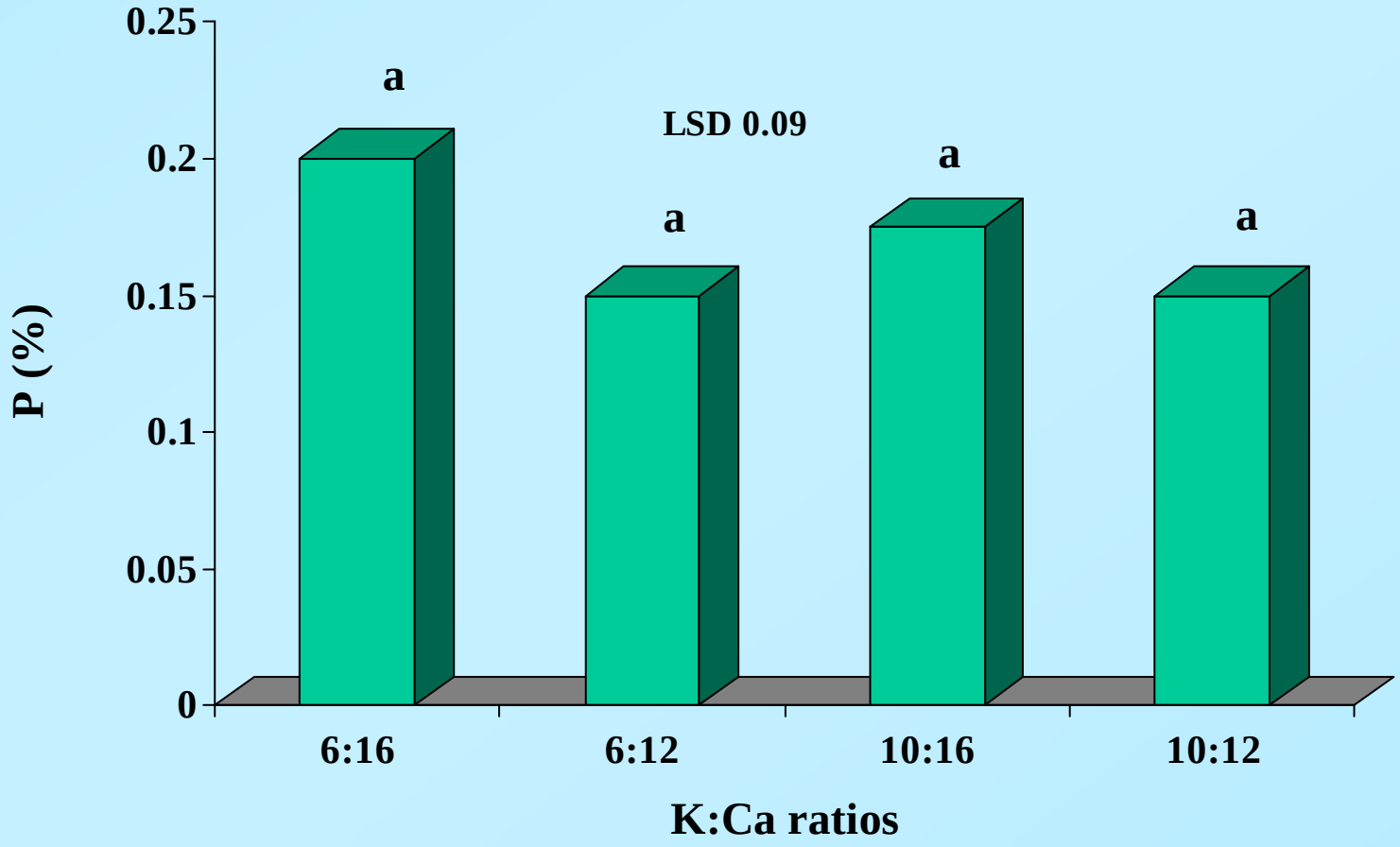

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Figure 20. Effect of K:Ca ratios on leaf-Ca

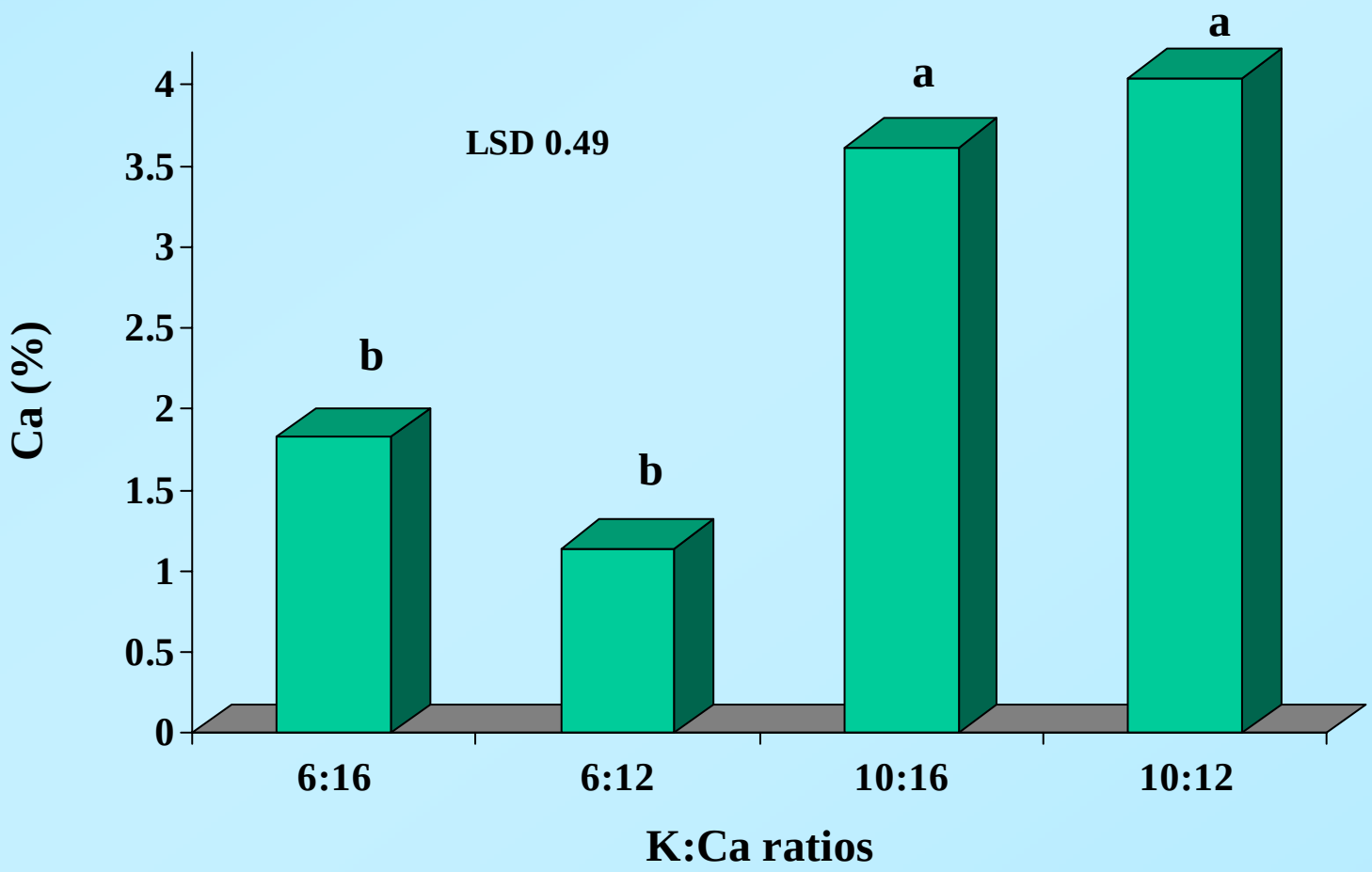

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Figure 21. Effect of K:Ca ratios on leaf-K

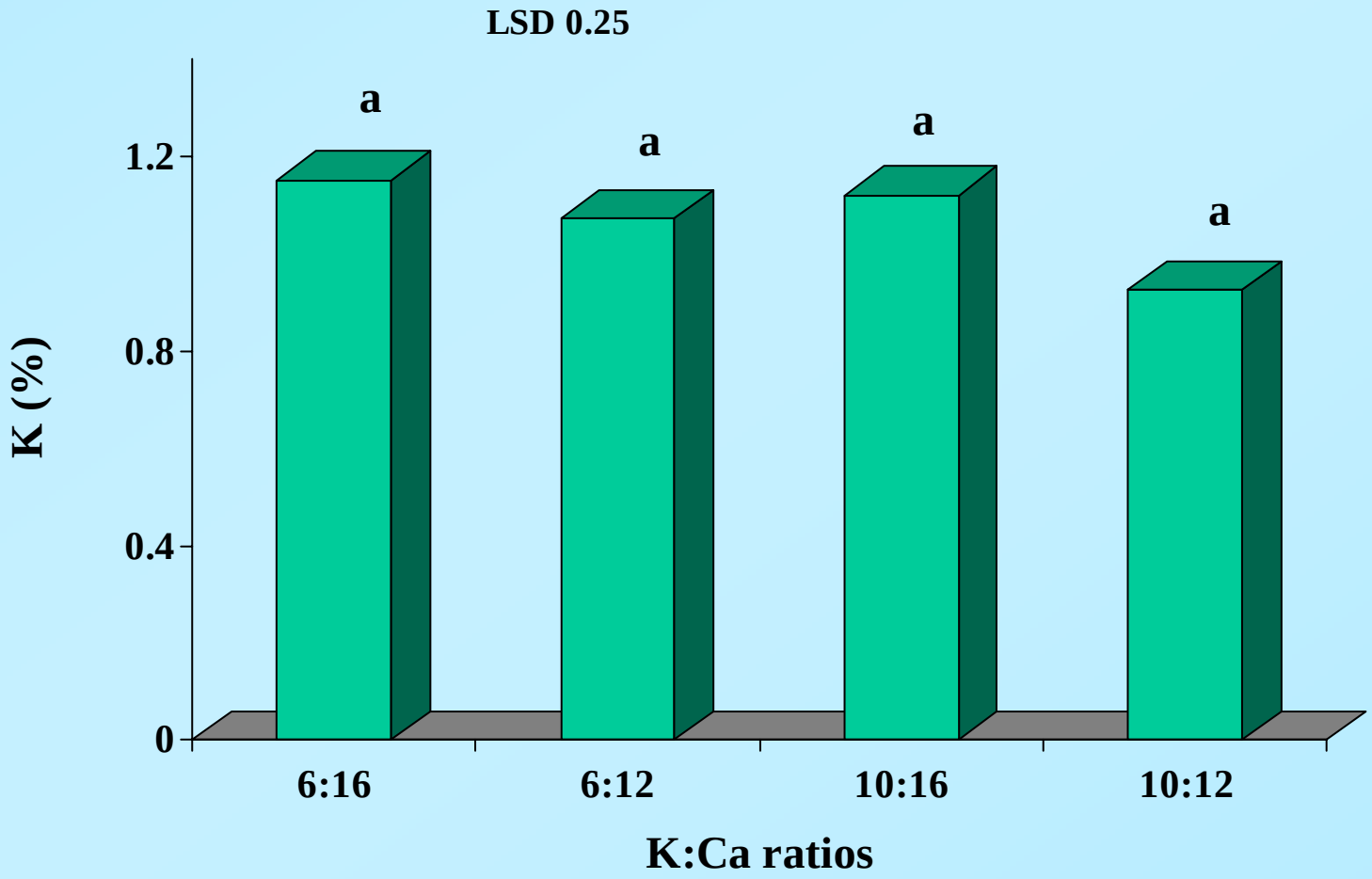

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Figure 22. Effect of K:Ca ratios on leaf-Mg

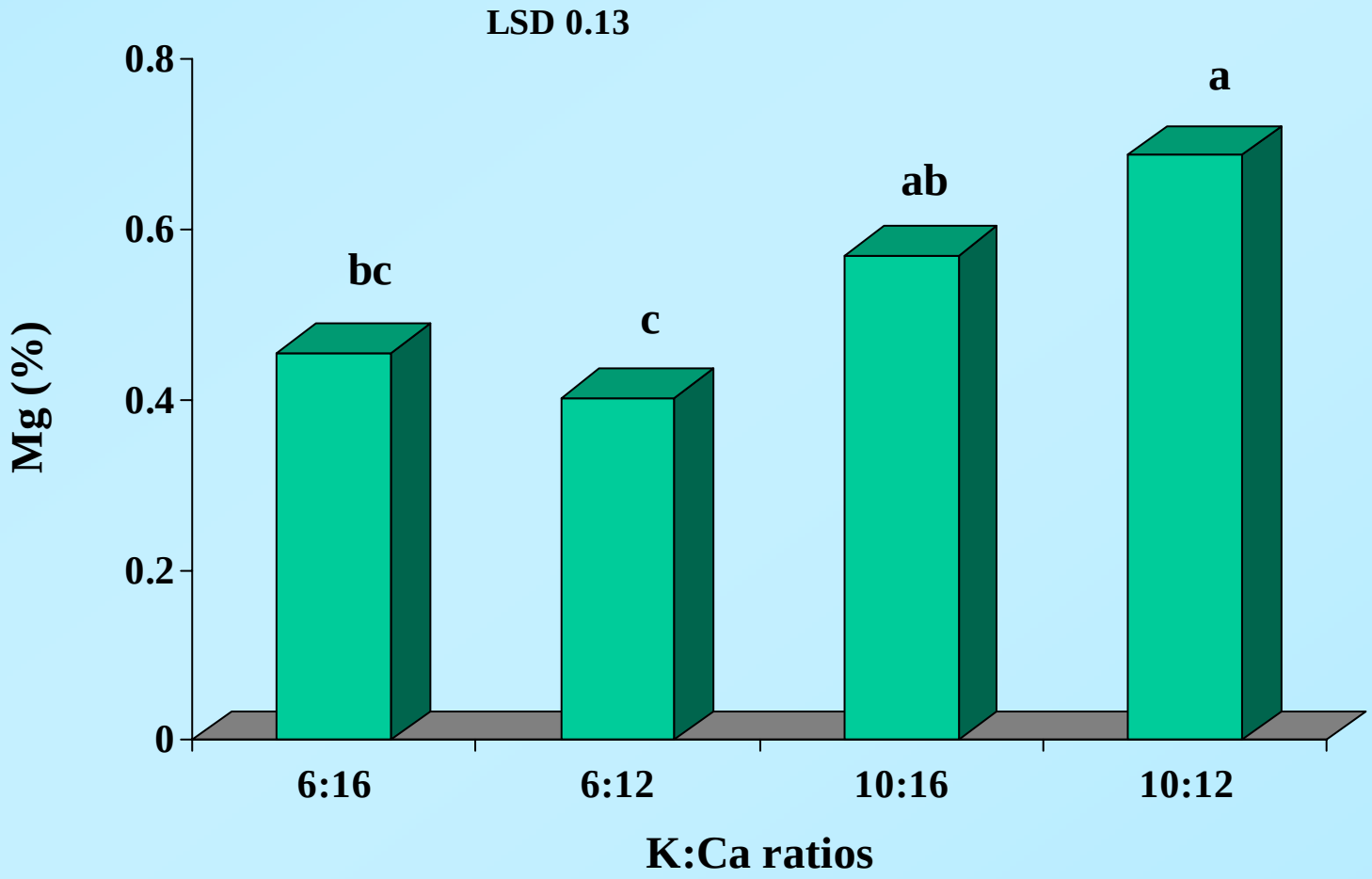

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Table 3. Effect of K:Ca ratios on mineral content of greenhouse tomatoes

K:Ca ratios	N (%)	P (%)	Ca (%)	K (%)	Mg (%)
6:16	2.125 a	0.35 b	0.14 a	2.995 b	0.115 a
6:12	2.425 a	0.475 a	0.1475 a	3.575 a	0.1225 a
10:16	2.25 a	0.4 ab	0.1325 a	3.145 ab	0.1175 a
10:12	2.525 a	0.425 ab	0.18 a	3.4425 ab	0.1225 a
LSD	0.40009	0.0943	0.06092	0.5003	0.0162
CV	11.161	14.875	26.352	9.948	8.802

Means followed by the same letter in a column are not significantly different according to Turkey test at $P<0.05$

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Conclusions

- Increased K from 6 to 10 mmolc/l resulted in:
  - Decreased fruit pH (good)
  - Increased Titratable Acidity (good)
  - Increased Total Soluble Solids (good)
  - Reduced incidence of Blotchy Ripening
- Thus, High K improves fruit quality

Conclusions…

- High Ca reduced the incidence of Blossom-End Rot of tomato fruit
- K:Ca ratio (6:16 mmol.l-1) decreased the K percentage in the fruit
- No relationships has been established between Cat Facing and K:Ca ratios
- The cause of high incidence of Fruit Cracking might not be the result of poor nutrition


THANK YOU!