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Effect of Calcium Boron Solution and Non-irrigation Before Harvesting on Growth and Quality in Muskmelon (*Cucumis melo* L. var. recticulatus)

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The effect of calcium boron solution and non – irrigated before harvest on growth and fruit quality in muskmelon were study. Seedling melon were planted in clay soil at Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand and irrigated by drip method, every day for 30 minutes twice per day. Plant spacing were 50 × 40 cm (row × plant spacing). The experiment were separated into 4 treatments; sprayed with tap water (control), 500 ppm Magic® calcium boron solution (Ca-B), tap water plus non-irrigated 5 days before harvest and 500 ppm calcium boron solution plus non - irrigated 5 days before harvest. This experiment was a completely randomized design (CRD) with 4 replications about 12 plant each. Plant growth and development parameters included stem diameter, plant height, internode length, chlorophyll contents in leaf, leaf area, number of leaf and fruit circumference were record. Fruit quality included fruit weight and volume, peel and pulp thickness, firmness, number of seed, total soluble solids (TSS), L*, a* and b* values were also determined. The results showed that, the application of Ca-B solution had stem diameter, plant height, internode lenght and number of leaf were not different when compared to the control. Ca-B solution had higher significantly different in chlorophyll contents in leaf closet fruit, leaf area, fruit volume and weight from control. Fruit with non - irrigated 5 days before harvest had affect on L* (68.45) and fruit firmness (16.12 N) with significantly different from control (66.18 and 18.72 N, respectively). Application of Ca-B solution plus non - irrigated 5 days before harvest gave the highest TSS (18.7%brix) and significantly different from control (15.8%brix). However, non - irrigated 5 days before harvest were not affect on pulp and peel thickness, a*, b* values and fruit weight when compare to the control.

Keywords: chlorophyll, firmness, irrigation, total soluble solids

Introduction

Melon (*Cucumis mel*o L.) is belongs to Cucurbitaceae family, it is one of

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the most important and famous vegetable crops and more expensive fruits in the world. Plant nutrition is essential of living of the plants. Nutrients has affect on growth, yield and quality of the fruit. The plant has been fully nutrients requirements often appear higher yield and quality. In some areas are experiencing a lack of soil nutrients certain plants showed poor growth and quality. Calcium is not mobile within the plant. When calcium is deficient, new tissue such as root tips, young leaves, and shoot tips often exhibit distorted growth from improper cell wall formation. In melon, there is evidence that calcium regulates fruit softening and senescence at the membrane level (Lester, 1996; Lamikanra and Watson, 2004). Boron are the important nutrition, Boron (B) plays an important role in the physiological process of plants, such as, cell elongation, transport sugar, meristematic tissue development and cell wall synthesis (Mengel and Kirkby, 1982). Boron deficiency appears as thickened, wilted, or curled leaves and the cracking and rotting of fruit, tubers, or roots. Adequate B levels help to maintain leaf K levels in tomato during fruit development (Sperry, 1995). Foliar nutrition plays an important role in increased nutrient content in fruit using calcium and boron fertilizers.

Melon are sensitivity to water, irrigation optimum of this crop should be linked with its ability to consume water, therefore, water requirement and improvement to quality of fruit. Excessive application of water can damage melon and cause fruit low quality. (Sensoy *et al*., 2007). However, water deficit give fruit sugar content is affected positively. (Mirabad *et al.*, 2013) . Thus, This study was to investigate the effect of foliar application of Magic® calcium boron solution alone and in combination with non-irrigation before harvest on fruit quality characteristics of melon.

Material and Method

Melon seeds were planted in trays containing peatmoss. Melon seedling of 10 days old were transplanted to main field. Two lines of raised beds were prepared and mulched with black plastic polyethylene mulch after installing a drip irrigation system in row. Field experiments were conducted in clay soil at King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand. Plant spacing were 50 × 40 cm (row × plant spacing). Irrigation by drip every day for 30 minutes twice per day. The experiment was laid out in Completely Randomized Design (CRD), with four replications about 12 plant each. The four treatment were included 1) Sprayed water (Control), 2) sprayed 500 ppm Magic® calcium boron, 3) sprayed water without irrigated 5 days before harvest and 4) sprayed 500 ppm Magic® calcium boron without irrigated 5 days before harvest. Melon plant must have only 25 leaves and bear only one

fruit for best results, according to these experts. Hand pollination at 25 days after transplanting. Plant height, stem diameter, internode length, leaf area, number of leaf, leaf area and chlorophyll content were measured at 20, 30, 40, 50 and 60 days after transplanting date. Chlorophyll index of the leaf closet fruit and middle leaf (9-12 leaf at main stem) measured by Chlorophyll meter. Fruit circumference were measured every 5 day before pollination until harvesting. Fruit quality included fruit weight and volume, peel and pulp thickness, firmness, total soluble solids (TSS), L*, a* and b* values were also determined. Collected data were statistically analyzed using analysis of variance (ANOVA). Differences among treatments means were separated according to LSD ($P \leq 0.05$). Details of soil chemical and physical properties of the research site are shown in Table 1.

Table 1 Chemical and physical properties of the of the soil in the experimental site (0-30 cm depth)

Chemical property	Before planting	After planting	
		Control	Ca-B
pH	6.7	5.98	5.98
EC (S/cm)	1,056	825	1,297
Organic master (%)	2,68	2.54	2.80
P (ppm)	115	128	130
K (ppm)	381	1,171	857
Ca (ppm)	1,607	2,470	2,617
Mg (ppm)	1,082	1,349	1,521
Fe (ppm)	62.5	103	111
Mn (ppm)	36.7	46.9	44.1
Cu (ppm)	1.68	1.75	1.86
Zn (ppm)	2.43	2.67	2.97

Result and Discussion

The application of Ca-B had not significantly difference in stem diameter when compare to control during vegetative stage. After 60 days from transplanting, the highest (14.51 mm) and lowest (13.85 mm) main stem diameter was recorded with Ca-B and control treatment, respectively**.** Ca-B application did not significantly affect on height and internode length and number of leaf when compare to control (Table 2). The result obtained by different researchers (Kabir et al., 2013; Sharma and Yadav, 1997) and Rahman (2006) show that stem diameter, height, internode length and number of leaf is not affected by Ca-B

Table 2 Effect of Ca-B solution on stem diameter, height, internode lenght, number of leaf, chlorophyll content and leaf area of melon

Growth parameter	Treatment	Day after transplanting				
		20	30	40	50	60
Stem diameter (mm)	Control	9.04a	12.22a	13.41a	13.77a	13.85a
	Ca-B	9.08a	12.45a	13.85a	14.42a	14.51a
Height (cm)	Control	18.45a	103.46a	151.58a	152.83a	152.93a
	Ca-B	18.42a	103.43a	152.90a	153.80a	154.25a
Internode lenght (cm)	Control	2.10a	5.46a	5.99a	6.23a	6.27a
	Ca-B	2.15a	5.41a	5.77a	6.30a	6.36a
No. of leaf	Control	10a	21a	25a	25a	25a
	Ca-B	10a	21a	25a	25a	25a
Chlorophyll (spad unit)	Control	42.67a	46.97a	45.92a	43.89b	46.17b
	Ca-B	42.26a	47.82a	46.99a	46.58a	48.86a
Leaf area (cm^3)	Control	323.21a	449.37a	470.96b	481.86b	482.79b
	Ca-B	322.22a	444.13a	488.31a	515.75a	518.24a

In this study, Ca-B increased chlorophyll content at 50 and 60 days after transplant and singnificantly difference to control. Milivojevic and Stojanovic (2003) reported that, Ca solution has a positive effect on the chlorophyll content and on photosynthetic carotenoids in soybean. Bukatsch (1942) have also reported that effect of boron on photosynthesis is to be assigned to increased chlorophyll content in plants. Chlorophyll and carotenoid content had decrease when B deficient and B excess condition in comparison to B optimum treatments. (Inbaraj and Muthuchelian, 2011) In addition, Yamauchi *et al*. (1986) observed that B deficiency inhibited Ca translocation in rose. In this study, leaf area of Ca-B treatment had not significantly difference until at 50 and 60 days after transplanted, it was found significantly difference when compare to control. Shafeek *et al*. (2013) reported Ca had affect on increased day matter and leaf area in cucumber. Ca and B deficiency is reported to reduce mitotic activity the terminal meristem, leaf growth, due to Ca and B play role cell division and cell elongation is also involved in cell membrane stability thus strengthening the plants (Hirschi, 2004; Kastori *et al*., 1995; Nelson and Niedziela, 1998)

Table 3 Effect of Ca-B solution on fruit circumference and chlorophyll in leaf closet fruit on melon

Parameter	treatment	Day after transplanting								
		30	35	40	45	50	55	60	65	70
Circumference (cm)	control	18.51a	32.53a	39.38a	43.75a	44.65a	46.24ab	47.61b	47.89a	47.89a
	Ca-B	19.61a	32.16a	38.85a	43.29a	46.32a	47.46ab	49.98a	49.98a	49.98a
	non-irrigate	17.63a	32.31a	39.59a	43.12a	44.80a	45.48b	47.52b	47.79a	47.79a
	Ca-B + non-irrigate	19.11a	32.55a	40.31a	44.61a	46.29a	47.66a	50.07a	50.07a	50.07a
Chlorophyll in leaf closet fruit (spad unit)	control	39.38ab	40.27b	41.58b	42.09b	45.10b	42.58b	41.46b	29.25b	24.45b
	Ca-B	40.73a	44.05ab	46.01ab	42.29a	49.93a	51.32a	48.76a	40.07a	27.12a
	non-irrigate	39.45b	40.29b	42.01b	41.72b	45.21b	42.81b	41.20b	29.66b	22.75bc
	Ca-B + non-irrigate	40.54ab	44.28a	47.1a	47.07a	50.60a	51.79a	48.77a	39.67a	21.00c

Fruit shape is one of the most important physical properties in melon fruit for commercial grade. In this experiment, Ca-B and Ca-B combination with non-irrigation before harvest had higher fruit circumference more than control and non-irrigation, but it not significant. Table 3 shows that, Chlorophyll content in leaf closet fruit when sprayed Ca-B and Ca-B combination with non-irrigation before harvest at 30 – 65 days after transplanted had higher than control and non-irrigation before harvest and significant difference. Next, Ca-B had highest chlorophyll content and significantly difference when compare with other treatment at harvesting day.

Table 4 Effect of foliar application of Ca-B and non-irrigated before harvest on weight, volume, peel and pulp thickness, firmness, TSS in placenta and pulp and TA in melon fruit

Fruit quality	Treatment			
	Control	Ca B	non-irrigate	Ca B + non-irrigate
Weight (g)	1811b	2104a	1783b	2034a
Volume (cm^3)	1744b	1963a	1728b	1949a
Peel thickness (mm)	9.21b	10.58a	9.07b	10.55a
Pulp thickness (mm)	31.64ab	33.48a	30.70b	32.52ab
Firmness (N)	18.73b	20.44a	16.13c	15.61c
TSS in placenta (%brix)	13.9a	14.1a	14.0a	14.5a
TSS in flesh (%brix)	15.8c	16.4c	17.6b	18.7a

Ca-B alone and Ca-B combination with non-irrigation before harvest had the higher fruit weight and volume and significantly difference from control and non-irrigation before harvest. The highest peel thickness was obtained by Ca-B and Ca-B combination with non-irrigation before harvest (10.58 and 10.55 mm, respectively). In the same way, pulp thickness was significantly difference higher in Ca-B than other treatment. The result show that, peel thickness had relation with weight and volume. Rab and Haq (2012) reported the combination of $CaCl_2$ and borax increased the yield and B application also increase in weight of tomato. Since boron helps in the absorption of water and carbohydrate metabolism (Haque *et al*., 2011). Fruit under non-irrigation and Ca-B combinated non-irrigation 5 days before harvest is not affect to fruit weight. Yildirim *et al*. (2009) reported melon that has been water deficit at maturity stages not affect the weight and volume. Application of Ca-B solution gave the highest firmness and significantly different from other treatments.

In melon, firmness retention is an important quality parameter in fruit for commercial. Bouzo and Cortez (2012) reported the effectiveness of treatments with calcium to increase firmness of strawberry. The influence of calcium to improve firmness has been attributed to the pectin in the cell wall in the form pectrate calcium can be detected immediately after treatment (Valero *et al*., 1998).

All treatments have not affect on total soluble solids in placenta but Ca-B combination with non-irrigation 5 days before harvest had highest significantly difference when compare with other treatments. While, it was found that Ca-B combination with non-irrigation before harvest had affect on total soluble solids in pulp and significantly difference when compare with the other treatments. Sarrwy *et al*. (2012) reported combination of both boric acid and calcium nitrate increased significantly total soluble solids content that treated with 250 ppm boric acid combines 1% calcium nitrate when compare with control. Boron had affect on chlorophyll content in leaf closet fruit (Table 3) and increased to carbohydrate and transpot sugar content in to fruit. Isarangkul Na Ayutthaya (2000) showed that application of boron increased the carbohydrate content in shoots and fruit. Gil *et al*. (2000) reported the irrigation close to harvest causes decline of the total soluble solids in the fruit flesh of melon and limited irrigation can improve the total soluble solids.

Table 5 Color indices of melon fruit as influenced by spray of Ca-B and non-irrigated before harvest

Color indices	Treatment			
	Control	Ca-B	non-irrigated	Ca-B + non-irrigated
L*	66.19b	66.17b	67.95a	68.46a
a*	-4.49a	-4.23a	-3.96a	-4.24a
b*	21.45a	21.37a	20.96a	21.05a

The treatment with Ca-B combination non-irrigation applied had the highest L*value, while treatments with control and Ca-B had the lowest L* value. In addition, the results show that a* and b* values were not affect by Ca-B and non-irrigated before harvest. Rajbir *et al*. (2006) reported that pre-harvest spray of Ca-B solution has little effect on fruit color while Bordonaba and Terry (2010) reported that, the highest L* value under water stress in strawbery.

Conclusions

Calcium and boron play an important role in cell elongation and metabolism of carbohydrates and quality improvement. The use of calcium boron solution had affect on chlorophyll content, weight, total soluble solids and firmness. While, non-irrigated before harvest had affect on firmness and gave higher in L* value. Thus, application Ca-B combination with non-irrigated before harvest helps to improve total soluble solids but reduce the fruit firmness.

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