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Effect of Shade Net and Fertilizer Application on Growth and Quality in muskmelon (*Cucumis melo.* L. var. reticulatus) after Harvest

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Light intensity and fertilizer are requirement different for growth and development in plants. Muskmelon (*Cucumis melo* L.) cv. Crystal 705 were planted in clay soil and irrigated by drip method. The planting spacing were 40 cm (plants) × 50 cm (row). Firstly experiment was compare between non-shaded (control) and black net (50% shaded). The second experiment was divided into 2 treatment; chemical (control) and organic fertilizer application. Stem diameter, plant height, chlorophyll content in leaves, number of leaves and flowers, internode length, leaf area and fruit circumference were record. Fruit sample were harvest at 70 day after transplant. Fruit weight, volume, flesh firmness, flesh and peel thickness, total soluble solids (TSS), flesh and peel color. The result showed that, shaded plant had higher significantly different in plant height and internode length from non-shaded plant. While, the stem diameter, chorophyll content from middle leaves and closet fruit were significantly different lowers in shaded plant than non-shaded plant. Non-shaded plant showed highers significantly different in fruit weight, volume, TSS and flesh thickness when compare to shaded plant about 448.37 g, 433.13 cm^3, 4.08 %brix and 7.75 cm, respectively. Fruit firmness in non-shaded plant were 18.76 N, lower significantly different than shaded plant (22.96 N). Organic fertilizer had no affect on plant height, stem diameter and internode length from chemical fertilizer. However, chlorophyll content showed lower significantly different after treated with organic fertilizer. Also, plant treated with chemical fertilizer had higher significantly different in fruit weight, volume and TSS from organic fertilizer about 234.13 g, 202.62 cm^3 and 3.62 %brix, respectively.

Keywords: weight, firmness, chlorophyll, circumference, volume, height

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Introduction

Melon (*Cucumis melo* L.) is native plant in Africa. The growth of melon in cozy climate, day (25-30^{o}c) and night (18-20^{o}c) temperature and harvest at 65-85 day after transplant. A few years ago, Thai government promoted the melon planting by drip irrigation method compensate the rice planting by flooded field method. In Thailand, the fruit melons are expensive price, about 70-80 Baht/kg for wholesale and 100 Baht/kg for retail market. Melon plant attention from many groups include farmer, officer, scholar and student. It is severe damaged from infestation of pests and diseases in during rainy season. The wind and storm have effect on plant and quality of fruits. The farmer need to insecticide and fertilizer for cure in fruit quality. This problem can be solve by planting in greenhouse but this more expensive for revenue less of farmer. Melon planting are generally chemical fertilizers (potassium sulphate and potassium nitrate) insecticides and fungicides for growth and diseases control plant used. Factors reducing the efficiency of fertilizers are preparing soil, number of plant per area unit and planting space Chemical fertilizer have impact on soil, environmental and health. Fast decomposition of organic matter, increase soil organic matter, decrease space between soil aggregation have affect on chemical fertilizer in soil. Edited by organic fertilizer input by post-harvest plowing and rotate with legumes. Organic fertilizers include vermin compost, composting chicken manure and municipal solid compost. Khalid *et at.* (2006) found that organic fertilizers application improve vegetative and reproduction growth of sweet basil. Organic fertilizer include macro and micro nutrition have affect on vitamin c in vegetable and fruit (Vessey, 2003). Organic fertilizer improve structure and water holding capacity of soil for growth plant (Nilsson, 1979).

The rainy season in Thailand is between May to October. Melon planting in greenhouse by farmers interested to reduce too much water that might effect in quality. Black shaed net is inexpensive and commonly used when compare to other color shaded net. This method can protect plant from living things (insect, ratand bird) and non-living things (wind, rain, hail, photosynthetically active radiation) (Teitel *et al.*, 2008). However, this might affect on plant growth and development if use more shaded in case of low light transmitance. Light intensity is requirement different for growth and development. Too much and little light intensity have impaction on reducing the growth plant and fruit yield (Gladstones, 2011). While, sufficient light intensity improve photosynthetic and make carbohydrate for growth plant. Low light intensity have affect on photosynthetic, titratable acidity. Low light intensity had increase of large leave (cause, cell expension and division) and chlorophyll content in barley, red oak

lettuce, arabidopsis and bitter gourd (Havaux and Tardy, 1999; Weston *et al.*, 2000; Konyong *et al.*, 2008). So, this research was to study the effect of shaded net and fertilizer application on growth and quality of muskmelon.

Materials and methods

The field experiment was conducted in the Department field of King Mongkut's Institute of Technology Ladgrabang in Bangkok, Thailand. The experiment were carried out in completely randomized design with 50 plants/treatment and 4 replications about 4 plant/replication. The planting spacing were 50 cm between rows and 40 cm between plants and covered with black plastic mulch. Drip irrigation was conducted and irrigated everyday for 30 minutes twice per day. Soil chemical analysis before planting and after applied with organic and chemical fertilizer were shown in Table 1. This study were comprised of two experiment, firstly experiment was compare between non-shaded and 50% black shaded net on growth and quality. Secondly, chemical (commercial planting) and organic fertilizer application under 50% shaded were also study. Organic treatment were included *Trichoderma harzianum, Beauveria bassiana*, neem extracts and wood vinegar for plant disease control. Organic fertilizer of TPI was applied once week for enhancing plant growth. Chemical treatment were metalaxyl, carbaryl, abamectin and dinotefuran for plant disease control. Chemical fertilizer treatment were N-P-K of 16-16-16 for vegetative stage and 13-0-46 for reproductive stage about 1 g/plant once a week. Seeding was transplant at 10 days after germination. When plant had fully 25 leaves, made shoot cutting and left branches at no. 9-12 of leaf position for stopping growth of the stem and promote the growth of fruit. At 25 days after transplanting, fertilization and Pruning on stem were conducted. Vegetative phase growth rate were record every 10 day at 20-50 day after transplant included; stem diameter, plant height, chlorophyll content in middle leaves (no. 9-12), leaves number and leaf area. Fruit circumference and chlorophyll in closet leaf were record for reproductive phase every 5 day at 30-70 day after transplant. Fruit weight, volume, firmness, flesh and peel thickness, total soluble solid, flesh and peel color were record for fruit quality.

Table 1 Soil chemical analysis before and after planting under shaded with organic and chemical fertilizer application.

Chemical property	before planting	after planting	
		Organic fertilizer	Chemical
pH	6.7	6.33	5.19
EC (μS/cm)	1,056	796	1,041
Organic master (%)	2,68	2.96	2.44
P (ppm)	115	165	240
K (ppm)	381	722	1,949
Ca (ppm)	1,607	3,265	2,226
Mg (ppm)	1,082	1,625	1,189
Fe (ppm)	62.5	96.1	161
Mn (ppm)	36.7	31.6	146
Cu (ppm)	1.68	1.82	2.03
Zn (ppm)	2.43	3.2	2.38

Results and Discussions

During this experiment, the plant grown under non-shaded which showed higher light intensity than shaded. Light intensity increase continuous from 8:00 AM to 2:00 PM. Plant grown under shaded had lower when compare to non-shaded (Δ223.08, 590.56, 566.86 and 750.06 unit ×100 lux, respectively). The growth of melon plant under non-shaded and shaded net had highest significantly different in light intensity at 2:00 P.M. (290.61 and 1040.67 unit ×100 lux, respectively). Light intensity continuously decreased from 2:00 to 6:00 P.M. and shaded had lower compare to non-shaded (Δ750.06, 469.78 and 76.14 unit ×100 lux, respectively) (Figure 1).

The study at vegetative phase showed that shaded plant had higher significantly different in stem diameter and leaf area than non-shaded plant but shading had no effect on leaf number (Table 2). Haque *et al.* (2009) noted that stem diameter under 50% photosynthetically active radiation (PAR) had not different from 100% PAR. Boardman (1977) found that decreased intensity tend to large leaf size, because cell division and elongation. Plant from the shaded treatment had higher significantly different in plant height than plant from the on-shaded treatment but there were no significantly effect of shaded treatment on internode length at 30 day after transplant (Table 2) same to Mangkornkaew *et al.* (1900). However. it revealed that chlorophyll content of leaves under shaded was lower when compare to non-shaded. Consistent with Havaux and Tardy (1999) found that increase light intensity had affect on increasing chlorophyll in leaves of barley (cv. Plaisant). On the contrary, Haque *et al.* (2009) reported that shaded plant had increase in SPAD value than full sunlight.

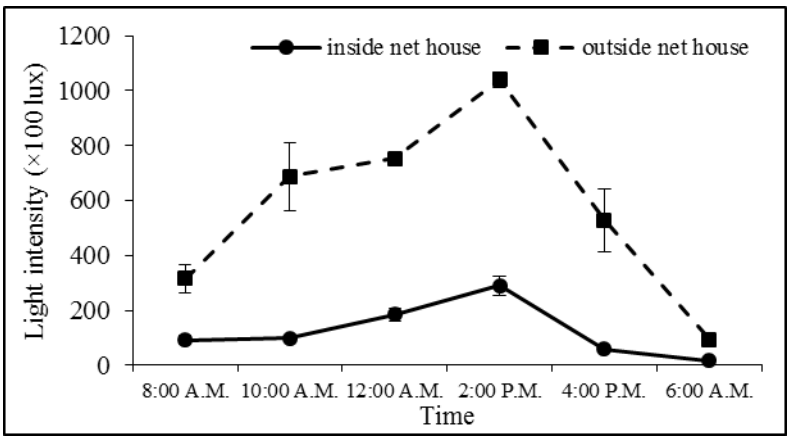

Figure 1 Light intensity of growth melon plant for inside and outside net house.

Organic and chemical fertilizers application had no effect on stem diameter, plant height, internode length, leaf area and leaf number (Table 3). On the other hand, organic fertilizer had lower significantly different on chlorophyll content at 50 day after transplant when compare to chemical fertilizer (Table 3). Mahadeen (2009) showed that organic and chemical fertilizer application had no affect on leaf area while Khalid *et al*. (2006) reported that the compost improve for vegetative growth of sweet basil. The promotion of plant height, internode length, stem diameter and leaves number by organic fertilizer application might be due to the effects of auxin, gibberellins and cytokinin hormone for growth plant (Parmar *et al.*, 2011).

At reproductive growth, fruit circumference for all phases of plant growth was significantly different lower in shaded plant than non-shaded plant. As well as, the chlorophyll content from leaf closed fruit was significantly different lower in shaded plant than non-shaded at 30-60 day after transplant (Table 4). These results indicated that shaded plant had dramatic affect on chlorophyll content for photosynthetic and growth of fruit.

The application of organic and chemical fertilizer showed that these types of fertilizer had no affect on fruit circumference at 30-60 days after transplant. While, chemical fertilizer had higher significantly different in fruit circumference at 65 -70 day after transplant when compare to organic fertilizer. Chlorophyll content from leaf closed fruit that applied chemical fertilizer had higher significantly different from organic fertilizer at 50-70 day after transplant (Table 5). These results agreed with those of Habibi *et al.* (2011) for pumpkin traits, they found that chemical fertilizer applicated had higher and no different from organic fertilizer.

The results in fruit quality showed that shaded plant had lower significantly different in fruit weight, volume, total soluble solids in flesh, flesh

and peel thickness from non-shaded plant (Table 6). While, flesh firmness was significantly different higher in shaded fruit than non-shaded fruit (Table 6). Hence, photosynthesis and carbohydrate accumulate under shaded plant had decrease affect on fruit quality and yield (Morgan *et al.*, 1985; Sriwichai and Ruamrungsri, 2003). In shaded fruit showed lower significantly different in peel L* a* and b* values when compare to non-shaded plant. In addition, the shaded fruit had higher significantly different lower in flesh L* and b* values than non-shaded but had significantly different lower in shaded fruit than non-shaded in a* value (Table 7). Payuyong *et al.* (2011) found that L * and b * values of *Globba williamisiana* bracts was higher in 50% shaded plant than non-shaded plant but lower a* value in shaded plant.

Table 2 Stem diameter, height, internode length, leaves number, leaf area and chlorophyll content on middle position for growth plant under non-shading and shade.

		Days after transplant			
		20	30	40	50
Stem diameter (mm)	Non-shading	12.36±0.08 a	13.99±0.75 a	14.52±0.53 a	14.64±0.64 a
	Shade net	9.16±0.63 b	9.85±0.63 b	10.03±0.33 b	10.03±0.48 b
Height (cm)	Non-shading	70.74±2.99 a	133.63±7.58 b	134.75±6.81 b	135.31±6.68 b
	Shade net	73.75±1.40 a	146.88±4.59 a	147.15±5.01 a	147.81±3.91 a
Internode length (cm)	Non-shading	5.53±0.21 a	5.93±0.71 a	6.17±0.34 a	6.23±0.25 a
	Shade net	6.32±0.66 a	6.63±0.57 a	6.55±0.80 a	6.63±0.84 a
Leave number (leave)	Non-shading	16.00±0.89 a	25.00±0.00 a	25.00±0.00 a	25.00±0.00 a
	Shade net	16.56±0.52 a	25.00±0.00a	25.00±0.00 a	25.00±0.00 a
Leaf area (cm^2)	Non-shading	306.22±7.05 a	444.13±7.58 a	488.31±7.61 a	515.75±8.08 a
	Shade net	264.27±24.19 b	403.38±42.28b	437.98±51.92b	437.07±49.57b
Chlorophyll content middle position (SPAD unit)	Non-shading	47.85±0.39 a	46.99±0.50 a	47.29±1.62 a	47.07±3.01 a
	Shade net	38.69±0.56 b	40.69±1.01b	40.58±0.80 b	40.27±0.44 b

Table 3 Stem diameter, height, internode length, leaves number, leaf area and chlorophyll content on middle position for growth plant under organic and chemical fertilizer application

		Days after transplant			
		20	30	40	50
Stem diameter (mm)	Organic	9.80±0.71 a	10.42±0.47 a	11.08±0.42 a	11.24±0.58 a
	Chemical	9.16±0.63 a	9.85±0.63 a	10.03±0.33 a	10.03±0.48 a
Height (cm)	Organic	75.60±3.85 a	148.44±6.86 a	148.35±6.01 a	144.06±6.86 a
	Chemical	73.75±1.40 a	146.88±4.59 a	147.15±5.01 a	147.81±3.91 a
Internode length (cm)	Organic	6.74±0.54 a	7.02±0.69 a	7.04±0.53 a	7.13±0.39 a
	Chemical	6.32±0.66 a	6.63±0.57 a	6.55±0.80 a	6.63±0.84 a
Leave number (leave)	Organic	17.25±0.20 a	25.00±0.00 a	25.00±0.00 a	25.00±0.00 a
	Chemical	16.56±0.52 a	25.00±0.00 a	25.00±0.00 a	25.00±0.00 a
Leaf area (cm^2)	Organic	327.79±21.75a	410.52±25.17a	425.83±47.40a	414.20±39.39a
	Chemical	264.27±24.19b	403.38±42.28a	437.98±51.92a	437.07±49.57a
Chlorophyll content middle position (SPAD unit)	Organic	40.01±0.11 a	40.68±0.84 a	40.13±0.66 a	36.93±0.54 b
	Chemical	38.69±0.56 a	40.69±1.01 a	40.58±0.80 a	40.27±0.44 a

Fruit weight and volume after applied organic fertilizer was significantly highers than chemical fertilizer. Furthermore, organic and chemical fertilizers application had no effect on flesh firmness and total soluble solids flesh and peel thickness (Table 8). In this study, soil organic matter had lower in potassium level than soil chemical matter (Δ1,227 ppm). These result agreed with those of Spironello *et al*. (2004) for pineapple, they found that increase potassium level had affect on increase total soluble solids. Fruit treated with organic fertilizer had not significantly different in peel and flesh color from chemical fertilizer (Table 9).

Table 4 Fruit circumference and Chlorophyll content in closest leaf for growth plant under non-shading and shade.

		Days after transplant								
		30	35	40	45	50	55	60	65	70
Circumference (cm)	Non-shading	19.43 ±0.97 a	32.00 ±1.83 a	38.50 ±1.55 a	43.06 ±1.48 a	46.50 ±0.43 a	47.79 ±1.01 a	49.98 ±1.80 a	49.98 ±1.80 a	49.98 ±1.80 a
	Shade net	6.12 ± 0.70b	19.01 ±1.49 b	28.09 ±2.65 b	34.06 ±2.67 b	38.64 ±2.02 b	41.49 ±2.17 b	43.48 ±0.76 b	44.19 ±0.77 b	45.30 ±0.85 b
Chlorophyll content of leaf closest to fruit	Non-shading	40.91 ±0.66 a	44.64 ±3.19 a	47.00 ±3.12 a	47.75 ±2.36 a	50.07 ±1.92 a	52.83 ±1.78 a	49.02 ±0.71 a	39.11 ±1.25 a	26.84 ±0.80 a
	Shade net	28.71 ±1.53 b	31.44 ±0.58 b	33.35 ±1.00 b	37.32 ±2.12 b	38.13 ±1.34 b	40.17 ±2.30 b	41.30 ±1.21 b	38.76 ±1.21 a	26.85 ±2.48 a

Table 5 Fruit circumference and Chlorophyll content in closest leaf for growth plant under organic and chemical fertilizer application.

		Days after transplant								
		30	35	40	45	50	55	60	65	70
Circumference (cm)	Organic	5.39 ± 1.08a	17.80 ±2.63 a	26.75 ±1.38 a	32.73 ±1.54 a	37.49 ±0.67 a	40.78 ±0.63 a	40.85 ±0.77 a	41.45 ±0.41 b	41.99 ±0.41 b
	Chemical	6.12 ± 0.70a	19.01 ±1.49 a	28.09 ±2.65 a	34.06 ±2.67 a	38.64 ±2.02 a	41.49 ±2.17 a	43.48 ±0.76 a	44.19 ±0.77 a	45.30 ±0.85 a
Chlorophyll content of leaf closest to fruit	Organic	28.85 ±1.61 a	29.56 ±3.17 a	31.06 ±1.99 a	37.00 ±1.69 a	34.79 ±2.52 b	32.23 ±1.43 b	30.11 ±1.25 b	27.04 ±5.83 b	19.05 ±2.37 b
	Chemical	28.71 ±1.53 a	31.44 ±0.58 a	33.35 ±1.00 a	37.32 ±2.12 a	38.13 ±1.34 a	40.17 ±2.30 a	41.30 ±1.21 a	38.76 ±1.21 a	26.85 ±2.48 a

Table 6 Fruit weight, volume, flesh firmness, flesh and peel thickness and total soluble solids in flesh under non-shaded and shaded treatment.

Fertilizer	Weight	Volume	Flesh firmness	Flesh thickness	Peel thickness	TSS flesh
Non-shading	1,773.50±113.45 a	1,737.38±89.52 a	18.76±0.60 b	31.86±2.00 a	9.93±0.28 a	18.58±0.81 a
Shade net	1,325.13±38.58 b	1,304.25±36.53 b	22.96±1.40 a	24.11±2.63 b	7.42±0.51 b	14.50±1.47 b

Table 7 L*, a* and b* of peel and flesh under non-shaded and shaded treatment

Fertilizer	Peel			Flesh		
	L*	a*	b*	L*	a*	b*
Non-shaded	56.95±0.96 a	-0.71±0.07 a	17.53±0.41 a	65.85±1.31b	-4.28±0.40 a	21.42±0.92 b
Shaded	43.29±1.08 b	-2.72±0.17 b	11.96±1.16 b	69.27±0.39 a	-6.36±0.42 b	25.96±1.49 a

Table 8 Fruit weight, volume, flesh firmness, flesh and peel thickness and total soluble solids in flesh under organic and chemical fertilizer application treatment.

Fertilizer	Weight	Volume	Flesh firmness	Flesh thickness	Peel thickness	TSS flesh
Organic	1,091.38±67.94 b	1,101.63±66.79 b	21.53±0.64 a	24.52±2.16 a	7.61±0.33 a	10.88±0.25 b
Chemical	1,325.13±38.58 a	1,304.25±36.53 a	22.96±1.40 a	24.11±2.63 a	7.42±0.51 a	14.50±1.47 a

Table 9 L*, a* and b* of peel and flesh under organic and chemical fertilizer application treatment.

Fertilizer	Peel			Flesh		
	L*	a*	b*	L*	a*	b*
Organic	42.66±2.63 a	-3.44±0.23 a	14.79±0.51 a	68.99±0.32 a	-7.02±0.31 a	28.18±1.07 a
Chemical	43.29±1.08 a	-2.72±0.17 a	11.96±1.16 b	69.27±0.39 a	-6.36±0.42 a	25.96±1.49 a

Conclusion

The result showed that, plant grown under shaded net had significant effect on stem diameter, high plant, leaf area, chlorophyll content in middle leaves and leaf closet fruit, fruit circumferent, weight, volume, flesh firmness, flesh and peel thickness, total soluble solids in flesh and color value of flesh in non-shaded plant. Internode length and leaves number were not significantly different between shaded and non-shaded net.

Organic fertilizer application under shaded had lower significantly different in fruit weight, volume and total soluble solids in flesh than chemical fertilizer. While, organic fertilizer had no difference in stem diameter, high plant, internode length, leaves number, leaf area, chlorophyll content in middle leaves, fruit circumferent, firmness, flesh and peel thickness and color value of flesh when compare to chemical fertilizer.

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