INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-3, Issue-2, April-June-2013
ISSN 2231-4490
Coden : IJPAES www.ijpaes.com
Received: 11th Mar-2013 *Revised: 25th Mar-2013* *Accepted: 26th Mar-2013*
Research article

EFFECT OF SHADING AND VARIETY ON THE GROWTH AND YIELD OF BROCCOLI DURING THE DRY SEASON IN SOUTHERN THAILAND

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ABSTRACT: The effects of shadings and varieties on the broccoli (*Brassica oleracea* L. var. *italica* Plenck.) growth and yield were studied at Prince of Songkla University, Hat Yai, Songkhla, Thailand. The study was conducted in split-plot in a randomized complete block design with four replications. The broccoli can be adapted to shading by increasing seedling survival rate, plant height and plant width. Consequently, the broccoli under the shading had the highest in head diameter, head weight and yield which was significantly better than full sunlight. There was a positive impact of the shading on yield and yield attribute of the three varieties. The highest total yield was obtained from the Yok Kheo under the both full sunlight and shading (10.92 and 8.29 $t{\cdot}ha^{-1}$, respectively), followed by the Green Queen under the shading (6.21 $t{\cdot}ha^{-1}$). The appropriate broccoli variety on growing during dry season in southern Thailand was the Yok Kheo and Green Queen because their growth rate and yield per hectare were higher than of the Top Green and they also had the bigger size and higher quality of head. Particularly, those grown under the shading because of the decreasing light intensive and maximum temperature and the increasing relative humidity compared to the full sunlight. These factors would support the increasing growth and yield of broccoli.

Keywords: Broccoli, shading, dry season, growth and yield, southern Thailand

INTRODUCTION

Broccoli is a member of the Brassicaceae family. Other members of the family include cauliflower, cabbage and kale. All members of the Brassicaceae are considered cool-season crops [2]. Broccoli is one of the most important and popular vegetable crops in many countries of the world because of its good organoleptic properties and high nutritive value [3]. Broccoli has become popular in Thailand as cooked vegetable because of its delicious taste and high nutrition value. It is generally planted in highland where the weather is cool or in lowlands during the cool season [5]. Broccoli has commercially potential vegetable crop that can be grown for commercial production in Songkhla of southern Thailand which the selection of varieties is crucial for successful cultivation because the weather of southern Thailand is quite humid tropics and suitable for the heat of tolerant hybrid varieties which are better adapted to the high temperature of the humid tropics allowing grow and produce high yields during the hot season [4]. However, Thailand is in the tropical regions. High light intensity and temperature conditions are problems of vegetable crop production. Shading is an important way to create the suitable environment on higher growth and yield of vegetable crops [8]. The objective of this study was to investigate the effects of shadings and varieties on the growth and yield of broccoli during the dry season in Songkhla of southern Thailand.

MATERIALS AND METHODS

This study was conducted at Prince of Songkla University, Hat Yai, Songkhla, Thailand (Latitude 7º 00’ 14.20” N Longitude 100º 30’ 1.75” E Altitude 56 m above the sea level) from April to June, 2012. The experimental design was split-plot in a randomized complete block design (RCB). The main plots were two treatments: full sunlight and shading by green shade net with sub-plots being varieties: Top Green, Green Queen and Yok Kheo. These varieties show good performance such as, early growth and yield when growing in Songkhla of southern Thailand [4]. Broccoli seed was sown in plastic baskets (13×16×4 inches). When the first true leaf had emerged, the seedlings were transplanted into 2 inch pots. At the fourth leaf stage, the seedlings were transplanted into the field. The plot size was 1×5 m and the plant spacing was 30 cm and row spacing was 60 cm. The broccoli was regularly watered with a sprinkler early in the morning and early in the afternoon. Fertilizer 21N-0P-0K was applied three times, at 2, 3 and 4 weeks after transplanting. Moreover fertilizer 15N-6.5P-12.5K was applied twice, at 5 and 6 weeks after transplanting. All plots were weeded with a hand hoe, twice, at 2 and 4 weeks after transplanting.

The measured data, seedling survival rate (%) at 30 DAT (i.e., days after transplanting) was determined. The number of days from transplanting to the beginning of time to 50% flowering and harvest was observed in the plot. At time to 50% flowering, plant height (cm) was measured for 10 random plants in the plot by taking the distance from the soil surface to the longest top leaf and plant width (cm) was measured for 10 random plants in the plot by taking the distance from the longest leaf on one side to the other longest one on the opposite side. Other data were recorded from harvested plants in the plot: harvested plant (%), head diameter (cm), head weight (g/plant) and total yield ($t \cdot ha^{-1}$). Light intensity data measured by Light Meter (Li-250 Licor, Inc., USA). Data of daily minimum and maximum temperatures measured by HOBO U23 Pro v2 Temperature/Relative Humidity Data Logger (U23-001, Inc., USA). Data of daily rainfall from April to June, 2012 was received by the Kho Hong Agrometeorological Station, Hat Yai, Songkhla, Thailand. All data were analyzed using the analysis of variance and means separated by Duncan's multiple range test (DMRT) at the 5% level of significance.

RESULTS AND DISCUSSION

The environmental variables: Light intensity, minimum and maximum temperatures of shaded broccoli plants were lower than those of broccoli plants grown under the full sunlight (Figure 1A and 1B, respectively), whereas the relative humidity of the air of shaded plant was higher than of plants grown under the full sunlight (Figure 1D).

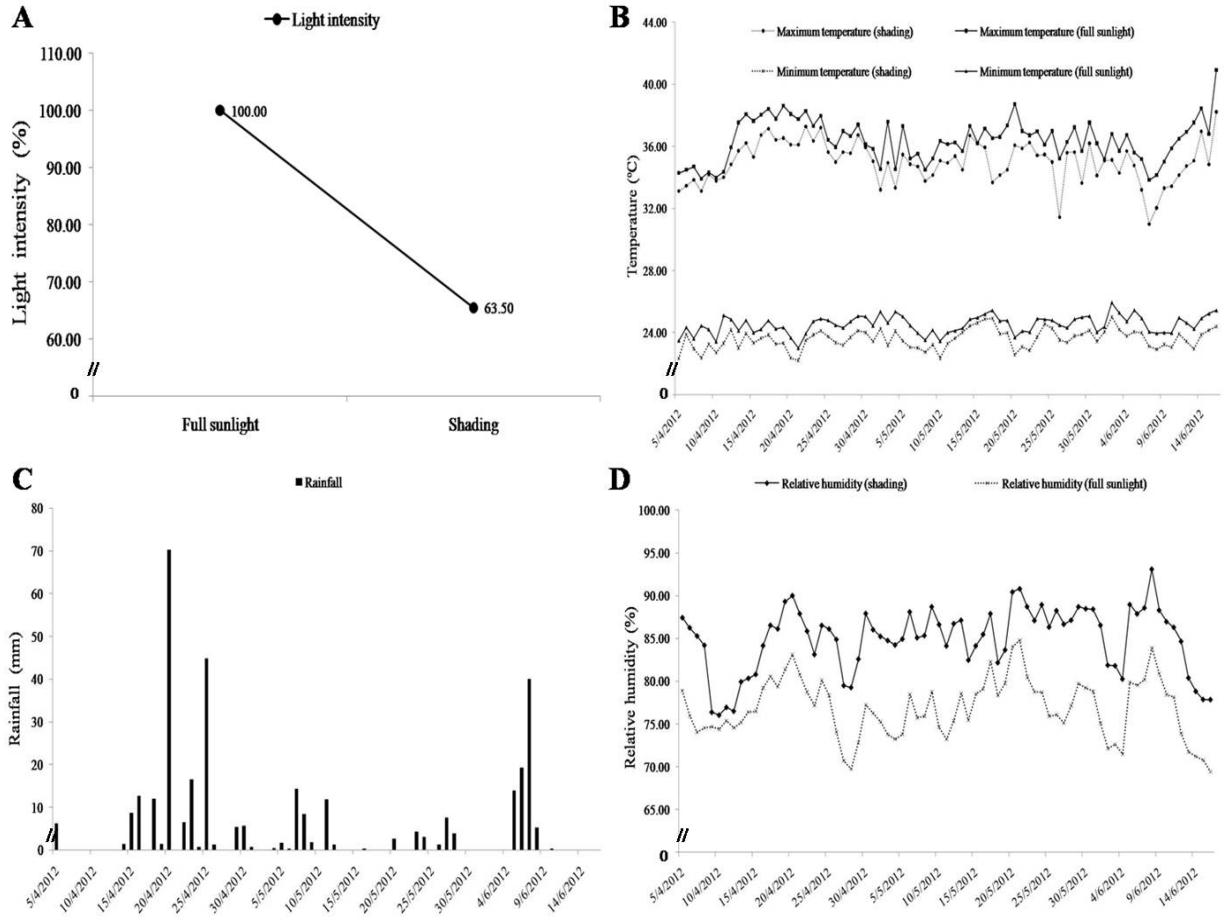

Fig. 1 Data of light intensity (A), daily minimum and maximum temperatures (B), rainfall (C) and relative humidity (D) in experimental location, Department of Plant Science, Faculty of Natural Resources, Prince of Songkla University during April to June, 2012.

Growth responses: Analysis of variance of the data significantly showed effects of shadings and varieties on seedling survival rate, plant height, plant width, 50% flowering time and 50% harvesting time of broccoli. The interaction effect for seedling survival rate is differed from each variety over the range of treatments (Figure 2A). Broccoli under the full sunlight had higher seedling survival rate than the shading which was not significantly different (70.04 and 68.48, respectively). Due to after transplanting, it had continuously raining. Under the shading created the decreasing light intensity (36.50%) and the increasing relative humidity (8.15%) compared to the full sunlight. These factors support the increasing destruction by the bacterium *Erwinia carotovora* ssp. *carotovora* that causes soft rot disease in broccoli plants [1]. The Green Queen and Yok Kheo had high seedling survival rates (74.99-82.81 %) when growing under the both full sunlight and shading. The Top Green had low rate of seedling survival which was 46.09-59.37 %. Its growth rate depends on the characteristic of broccoli varieties [4]. There were significant differences for plant height and width for treatments and varieties, as well as significant interaction effect. Plants under the shading had higher plant height and width than the full sunlight (Figure 2B, C) because of low light intensity that cells expand more to receive light for photosynthesis [8]. The three varieties had high plant height and width (43.64 and 69.07cm, respectively) when growing under the shading but they had moderate sizes (36.78 and 61.11cm, respectively) when growing under the full sunlight. These results are consistent with Phuwiwat [6] who found that the Contra cauliflower growing under the shading had higher plant height than the full sunlight. Plants obtain the low light intensity that stimulated the synthesis of Gibberellins (GA). It accelerates elongation of node and internode [8]. The interactions between treatments and varieties were significantly influenced on the time to 50% flowering and harvest. Under the shading, broccoli could be adapted to growth and the best development that had early time to 50% flowering. The Green Queen had the early time to 50% flowering (33.25 DAT), followed by the Yok Kheo (46.00 DAT). The latest time to 50% flowering was the Top Green (58.75 DAT) when compared to the full sunlight (Figure 2D). This is similar to Phuwiwat and Masari's study [7] which the Fuji cauliflower growing under the 58.37% shading had early time to 50% flowering compared to the full sunlight. This finding is consistent with time to 50% harvest showing that the Green Queen had the early time to 50% harvest (48.25 DAT), followed by the Yok Kheo (53.75 DAT) when growing under the shading. The Top Green had a latest time to 50% harvest which was 78.25 DAT when planting under the full sunlight (Figure 3).

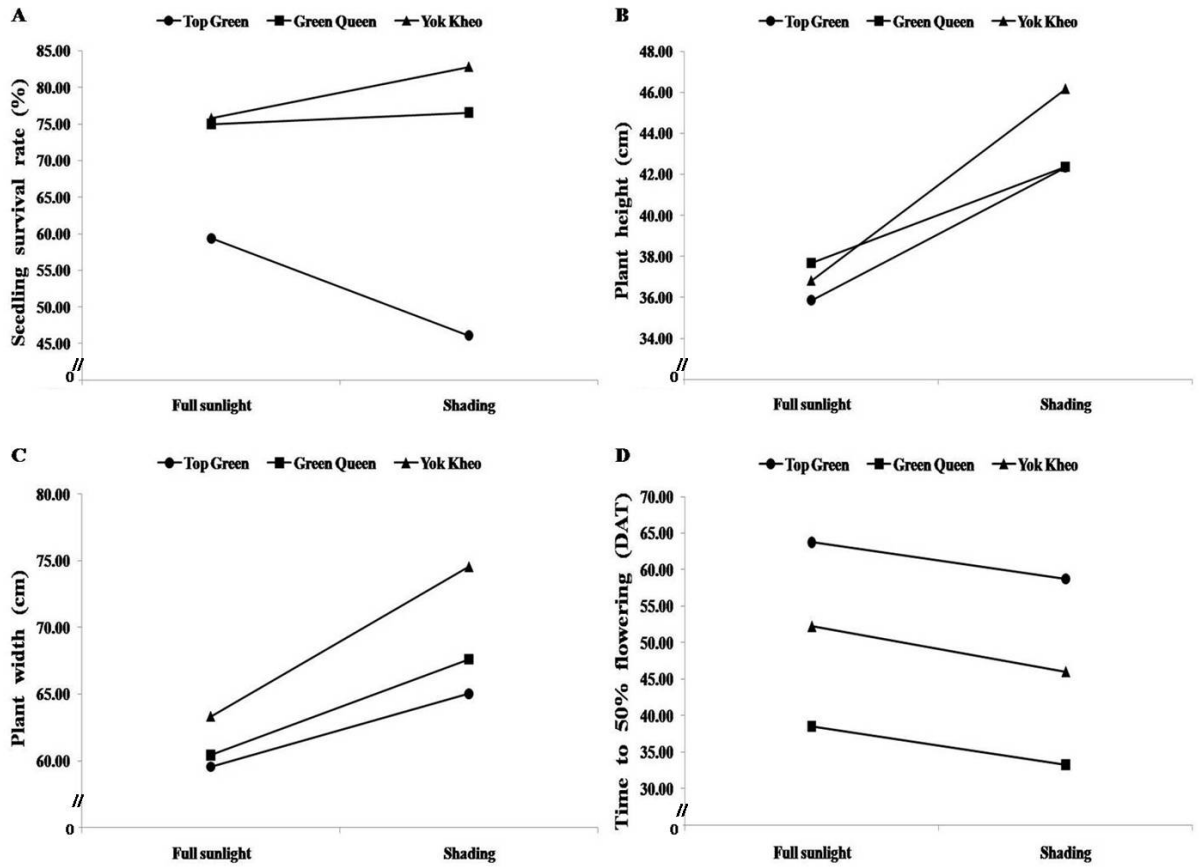

Fig. 2 Significant and meaningful interaction between shading and variety on: (A) seedling survival rate (%); (B) plant height (cm); (C) plant width (cm) and (D) time to 50% flowering (DAT).

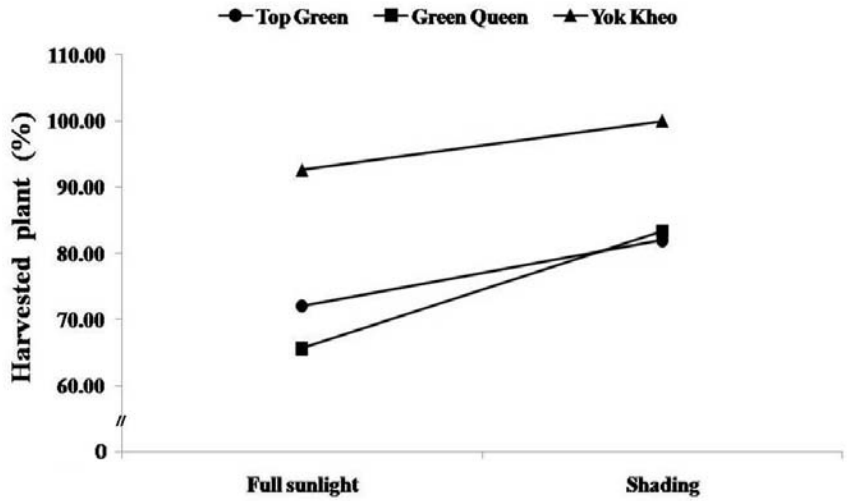

Fig. 3 Significant and meaningful interaction between shading and variety on time to 50% harvest.

Yield response: There were interaction effects of treatments and varieties. Broccoli growing under the shading had higher harvested plant than under the full sunlight as shown in Figure 4A. The Yok Kheo had the highest harvested plant (100%), followed by the Top Green and Green Queen (81.98-83.36 %). The interactions between treatments and varieties were significantly influenced on each particular head diameter and weight. Under the shading, the three varieties had higher head diameter and weight than the full sunlight. The highest head diameter and weight were obtained in the Yok Kheo (12.11 cm and 371.48 g/plant) when growing under the shading (Figure 4B, C). These results are consistent with total yield of the three varieties (Figure 4D). Growing under the shading had high total yield because the environment under the shading had the decreasing average maximum temperature (2.84-3.63ºC) as shown in Figure 1B and the increasing relative humidity (8.15%) as shown in Figure 4B.

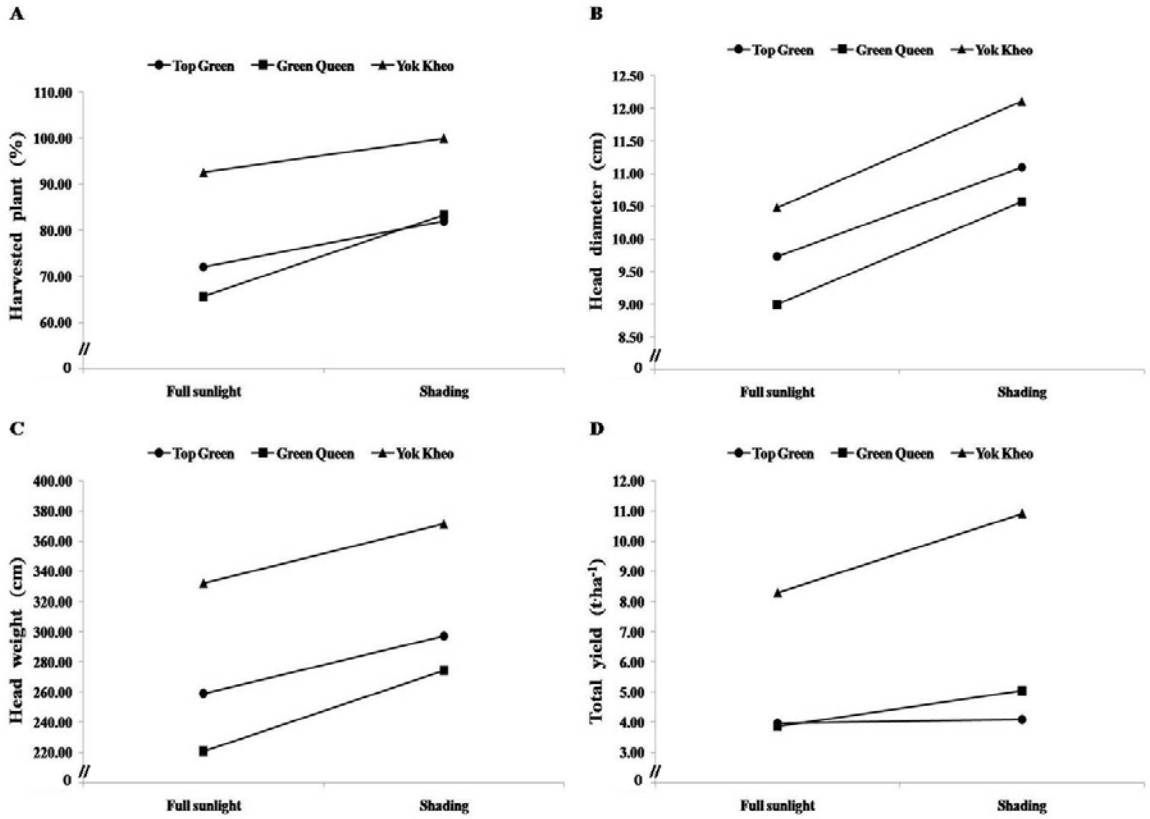

Fig. 4 Significant and meaningful interaction between shading and variety on: (A) harvested plant (%); (B) head diameter (cm); (C) head weight (cm) and (D) total yield (t'ha^{-1}).

Broccoli could be the best growth which had better yield attribute than the full sunlight. The highest total yield obtained from Yok Kheo (10.92 $t{\cdot}ha^{-1}$). The Green Queen and Top Green had lower total yields (3.87-3.96 $t{\cdot}ha^{-1}$, respectively) when growing under the full sunlight. These results are also similar Phuwiwat and Masari's work [7] which the Fuji cauliflower planting under the 58.37% shading had higher weight than the full sunlight. The high light intensity can be plant's growth rate and yield losses [8].

CONCLUSION

The Appropriate broccoli variety on growing during dry season in Songkhla of southern Thailand was the Yok Kheo and Green Queen because their growth rate and yield per hectare were higher than of the Top Green and they also had the bigger size and higher quality of head. Particularly, those grown under the shading because of the decreasing light intensive and maximum temperature and the increasing relative humidity compared to the full sunlight. These factors would support the increasing growth and yield of broccoli.

ACKNOWLEDGMENTS

This work was funded by a grant from The Office of the Higher Education Commission Thailand. Mr. Karistsapol Nooprom was supported by CHE Ph.D. Scholarship. The authors would like to thank The Graduate School and Department of Plant Science, Faculty of Natural Resources, Prince of Songkla University, Hat Yai, Songkhla, Thailand for supporting the scholarship, experimental equipment and the field that the broccoli was planted in.

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