

Research Article

Growth and Yield of Broccoli Planted Year Round in Songkhla Province, Thailand

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Abstract: Four broccoli (*Brassica oleracea* var. *italica*) varieties were evaluated in year round of Songkhla province, Thailand, from January, 2011 to January, 2012. The results shown that broccoli planting in all months provided high survival rate of seedling (78.90-98.24%). They had higher plant height than other months when planting in January, February, March, July and December (49.58-51.71 cm). Broccoli planting in January, February and March had the early time to 50% flowering and harvest of 33-36 and 43-45 Days after Transplanting (DAT), respectively. The Yok Kheo could respond to the best seedling survival rate and plant height while the Green Queen had the early time to 50% flowering and harvest. The Yok Kheo planted in January had the highest total yield (12.31 t/ha), followed by the Yok Kheo planted in March (10.65 t/ha) and the Top Green planted in January (10.50 t/ha), respectively. The Yok Kheo is a new interesting hybrid variety because it had higher total yield than the Top Green that is the popular variety of farmers in southern Thailand.

Keywords: Brassicaceae family, heat tolerant of variety, planting dates, Thailand

INTRODUCTION

Broccoli is the Brassicaceae family that is considered as cool-season crops. It wants optimum temperature on growth in the range of 18-24°C (Decoteau, 2000; Uzen and Kar, 2004). Broccoli is an Italian vegetable natively in the Mediterranean region, cultivated in Italy's ancient Roman period and England in 1720. On the one hand, in 1806, its first appeared in the United States of America, but the commercial cultivation was started around 1923 (Nooprom and Santipracha, 2013a). It is one of the most prominent vegetables grown all over the world. It has great economic importance due to its medicinal and dietetic values ancient times (Ahmed and Siddique, 2004). According to a report of The American Cancer Society (ACS) indicated that it has several anti-cancerogen effects (Nooprom *et al.*, 2013b). Broccoli production in Thailand has been expanding in recent years and amount of increasing production. It is generally grown in highland where the weather is cool or in the lowlands during the cool season (Nooprom and Santipracha, 2013b). Broccoli has commercial potential vegetable crop that can be grown for commercial production in Songkhla province, southern Thailand which the selection of varieties is crucial for successful cultivation because the weather of southern Thailand is quite humid tropics. This weather condition is suitable for the heat tolerant of hybrid variety broccolis which are better adapted to high temperature of humid tropics

allowing growing and producing high yield during hot season (Nooprom *et al.*, 2013c). The objective of this study was to investigate the influence of different planting dates in year round and varieties on broccoli's growths and yield in Songkhla province, Thailand.

MATERIALS AND METHODS

This study was conducted at Prince of Songkla University, Hat Yai, Songkhla province, Thailand, from January, 2011 to January, 2012. The design was a split-plot in a randomized complete block with four replications. The main plots were planted on dates: January, February, March, April, May, June, July, August, September, October, November and December with sub-plots being early varieties of broccoli: Top Green, Green Queen, Yok Kheo and Special. Broccoli seeds were 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. The plant and row spacing were 0.30×0.60 m and the edge spacing was 0.2 m. Each plot had two rows of 32 plants. The broccoli was regularly watered with a sprinkler early in the morning and early in the afternoon except rainy days. 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

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weeks after transplanting (Nooprom and Santipracha, 2013b).

The measured data, seedling survival rate at 30 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 was measured for 10 random plants in the plot by taking the distance from the soil surface to the top of going point. Other data were recorded from harvested plants in the plot: harvested plant, head diameter, head weight per plant and total yield (Nooprom and Santipracha, 2013a). Data of average daily rainfall, minimum and maximum temperatures from January, 2011 to January, 2012 were recorded by the Kho Hong Agrometeorological Station, Hat Yai, Songkhla province, 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

Seedling survival rate: Broccoli planting in January had the highest seedling survival rate (98.24%) which was not significantly different ($p \leq 0.05$) from planting in April, July and September (89.65-96.25%), followed by planting in February, May and December (86.51-88.48%) as shown in Fig. 1A. The Yok Kheo had the highest seedling survival rate (92.67%), followed by the Green Queen and Top Green (87.33-88.73%). The lowest survival rate was observed from the Special (78.10%). The interaction between planting dates and varieties shown that the Green Queen planted in January had the highest survival rate of seedling (100.00%). The lowest seedling survival rate was

observed from Special when planting in August (54.68%).

Plant height: Broccoli had the highest plant height when planting in January (51.71 cm) (Fig. 1B) which was not significantly different ($p \leq 0.05$) from planting in February, March, July and December (49.58-51.42 cm) while broccoli planting in June had the lowest plant height (40.36 cm). The Yok Kheo had the highest plant height (49.83 cm), followed by the Green Queen (46.72 cm) while the Special had the lowest plant height which was not significantly different ($p \leq 0.05$) from the Top Green (44.88-45.38 cm). The interaction between planting dates and varieties revealed that the Yok Kheo planting in November had the highest plant height (50.30 cm) while the Special planting in August had the lowest plant height (36.22 cm).

Time to 50% flowering: Broccoli planting in January, February, March, July, September and December had the early time to 50% flowering (33-38 DAT), followed by planting in April, May, June and November (42-49 DAT). In August, broccoli had the latest time to 50% flowering (50 DAT) (Fig. 1C). The Green Queen had the early time to 50 flowering (34 DAT) while the Special, Yok Kheo and Top Green had later time to 50% flowering than the Green Queen (41, 43 and 45 days, respectively). The interaction between planting dates and varieties shown that the Green Queen planting in January, February, March and December had the early time to 50% flowering (28-31 DAT). The latest time to 50% flowering time was observed from the Top Green planted in April and May (50 DAT).

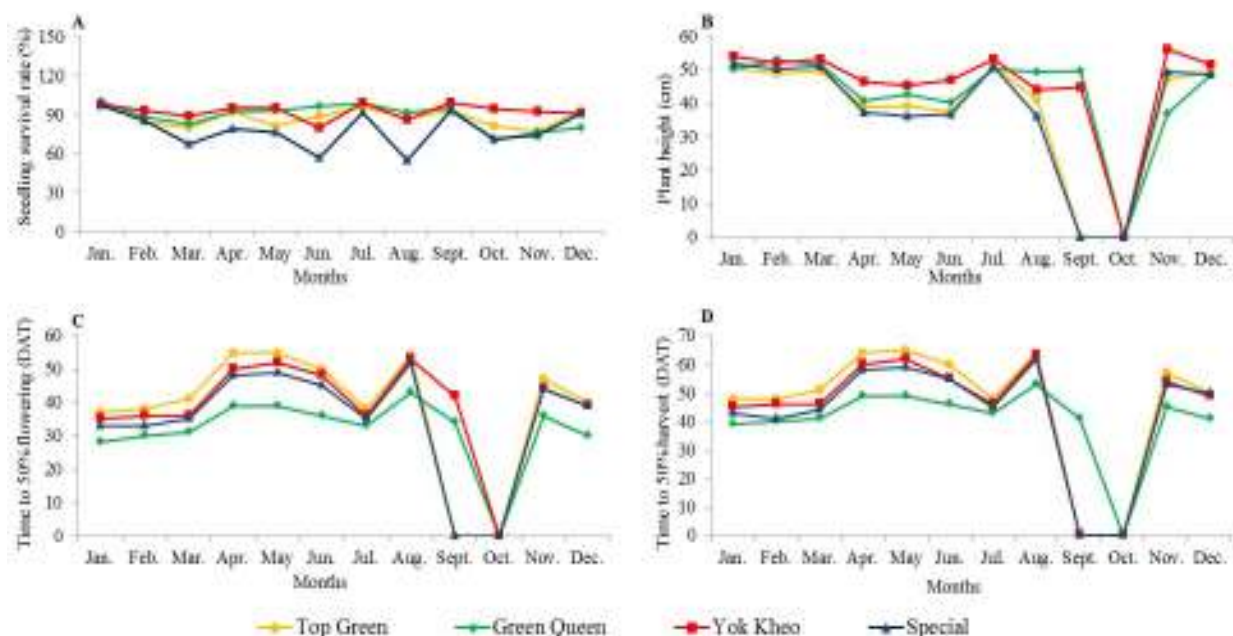


Fig. 1: Interactions of planting dates and varieties on seedling survival rate, (A) plant height; (B) time to 50% flowering, (C) and time to 50% harvest (D)

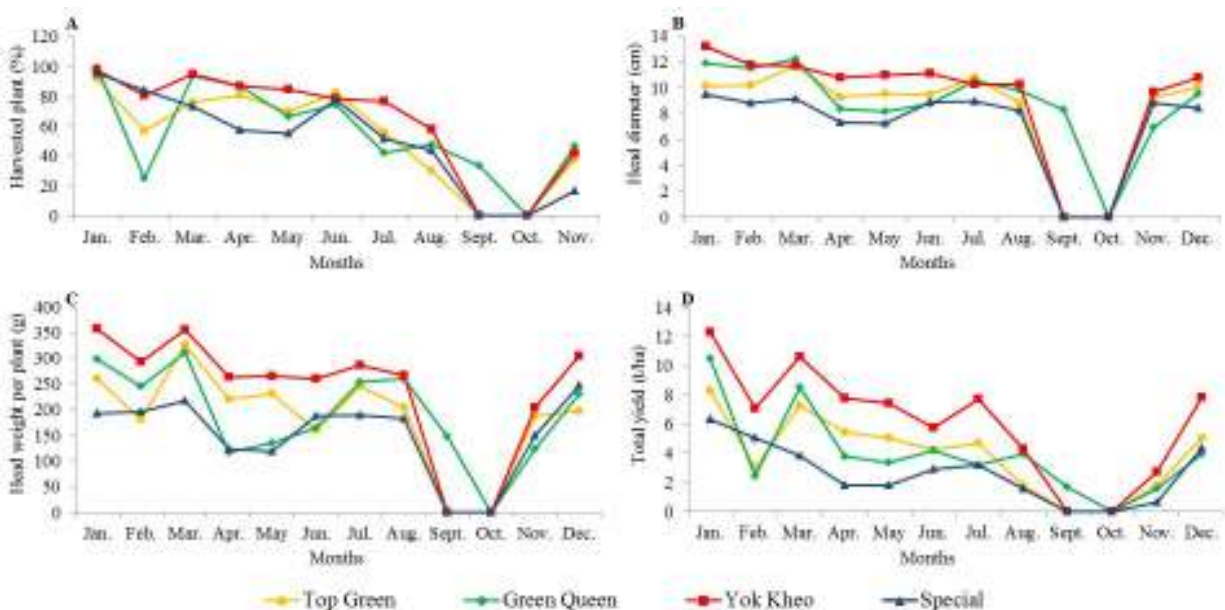


Fig. 2: Interactions of planting dates and varieties on harvested plant, (A) head diameter, (B) head weight, (C) and total yield (D)

Time to 50% harvest: Broccoli planted in January, February, March, July, September and December had the early time to 50% harvest (43-47 DAT), followed by planting in April, May, June and November (52-59 DAT). The latest time to 50% harvest was obtained from planting in August (61 DAT) as shown in Fig. 1D. The Green Queen had the early time to 50% harvest (44 DAT), followed by the Special and Yok Kheo (51-52 DAT, respectively). The latest time to 50% harvesting was obtained from the Top Green (55 DAT). The interaction between planting dates and varieties revealed that the Green Queen planting in January had the early time to harvesting (39 DAT) which was not significantly different ($p \leq 0.05$) from the Green Queen planting in February (40 DAT) while the latest time to 50% harvest was observed from the Top Green planting in April, May and August (64-65 DAT).

Harvested plant: Broccoli planting in January had the highest harvested plant (96.03%) as shown in Fig. 2A, followed by planting in March, April, June and December (71.38-84.58%). The lowest harvested plant was obtained from planting in September (33.75%) which was not significantly different ($p \leq 0.05$) from planting in November (35.83%). The highest harvested plant was obtained from the Yok Kheo (77.94%) while the Top Green, Green Queen and Special had moderate harvested plant (61.39-65.83%). The interaction between planting dates and varieties revealed that the Green Queen planted in January had the highest harvested plant (99.22%) while the Special planting in November had the lowest harvested plant (6.74%).

Head diameter: The highest head diameter was obtained from planting in March (11.18 cm) which was

not significantly different ($p \leq 0.05$) from planting in January (11.17 cm), followed by February, April, May, June, July, August, November and December (8.93-10.62 cm) (Fig. 2B). In September, broccoli had the lowest head diameter (8.32 cm). The Yok Kheo had the highest head diameter (11.24 cm), followed by the Top Green and Green Queen (9.63-9.91 cm) while the Special had the lowest head diameter (8.53 cm). The interaction between planting dates and varieties shown that the Yok Kheo planted in January had the highest head diameter (13.18 cm) while the Green Queen had the lowest head when planting in November (6.90 cm).

Head weight per plant: Broccoli planting in March had the highest head weight per plant (302.37 g) which was not significantly different ($p \leq 0.05$) from planting in January (277.18 g/plant), followed by February, July, August and December (228.36-244.69 g) while broccoli planting in September had the lowest head weight per plant (147.92 g) as shown in Fig. 2C. The Yok Kheo had the highest head weight per plant (285.67 g), followed by the Top Green which was not significantly different ($p \leq 0.05$) from the Green Queen (207.74-221.28 g) while the Special had the lowest head weight per plant (180.53 g). The interaction between planting dates and varieties shown that the Yok Kheo planted in January had the highest head weight per plant (357.55 g) which was not significantly different ($p \leq 0.05$) from the Yok Kheo and Top Green planting in March (325.51-355.14 g) while the lowest head weight per plant was observed from Green Queen planted in April (116.59 g).

Total yield: The highest total yield was obtained from broccoli planted in January (9.36 t/ha) (Fig. 2D),

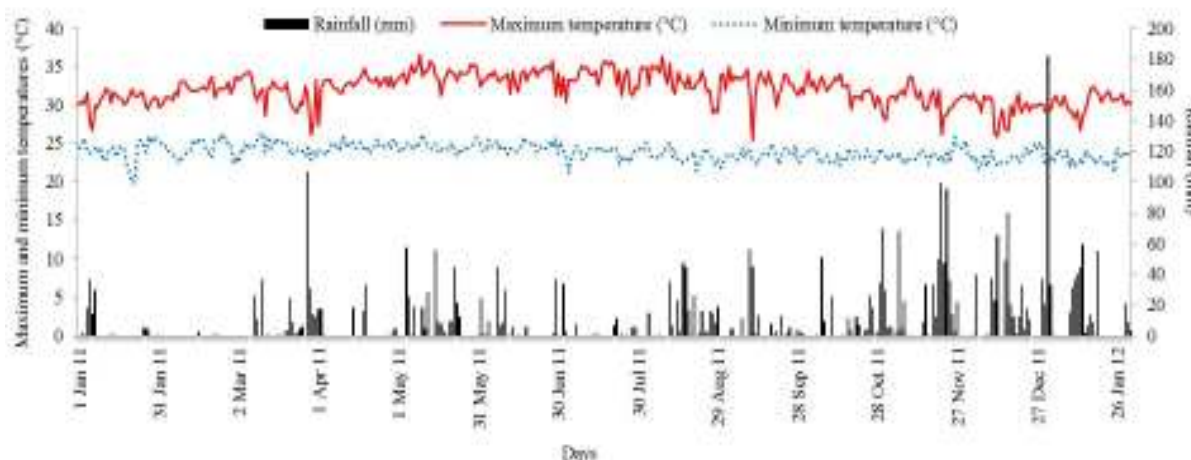


Fig. 3: Daily rainfall, maximum and minimum temperatures from January, 2011 to January, 2012
Kho Hong Agrometeorological Station, Hat Yai, Songkhla province, Thailand

followed by March (7.58 t/ha) while broccoli planted in September had the lowest total yield (1.68 t/ha). The Yok Kheo had the highest total yield (7.37 t/ha), followed by the Green Queen which was not significantly different ($p \leq 0.05$) from Top Green (4.29-4.67 t/ha) while the lowest total yield was observed from the Special (3.15 t/ha). The interaction between planting dates and varieties shown that the Yok Kheo planting in January had the highest total yield (12.32 t/h) while Special planted in November had the lowest total yield (0.65 t/ha).

DISCUSSION

The growth responses shown that broccoli planting in March, June, August, October and November had low seedling survival rates and plant heights (78.90-80.66% and 40.36 cm, respectively). Because of after transplanting, it had continuously heavy raining and high temperature (30.81-33.80°C) as shown in Fig. 3. These factors affected decreasing survival rate in seedling stage. The high temperature in the range of 30-40°C caused decreasing broccoli growths that affected yield losses (Kaluzewicz *et al.*, 2009). This result confirmed (Nooprom *et al.*, 2013a) that over high temperature affected broccoli growth and yield losses. Besides, variety's difference provided the different broccoli growth rates. The growths depended on the characteristics of broccoli variety (Nooprom and Santipracha, 2011). In August, broccoli had the latest times to 50% flowering and harvest because this time had the maximum temperature of 29.10-36.40°C (Fig. 3) which could reduce broccoli growth rates and affected times to 50% flowering and harvest of broccoli delayed. The yield responses revealed that broccoli planted in January and March had high total yield (7.58-9.36 t/ha) because these months had suitable

environment on better broccoli's growths than other months while broccoli planting in September had the lowest total yield (1.68 t/ha) because this time had continuously heavy raining during harvesting period (Fig. 3). The broccoli was infected with head rot from the impact of rain drops (Nooprom *et al.*, 2013a).

CONCLUSION

All varieties of broccoli had high growth rates when planting in January and March. The Yok Kheo could give the highest total yield (12.32 t/ha) when planting in January. Moreover, it could give highly total yield (7.07 and 7.87 t/ha) when planting in February, April, May, July and December when compared with other varieties (1.83-5.45 t/ha). Therefore, the Yok Kheo Planted in January, February, March, April, May, July and December is suitable for suggestion and Extension to farmers in Songkhla province and around this area.

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