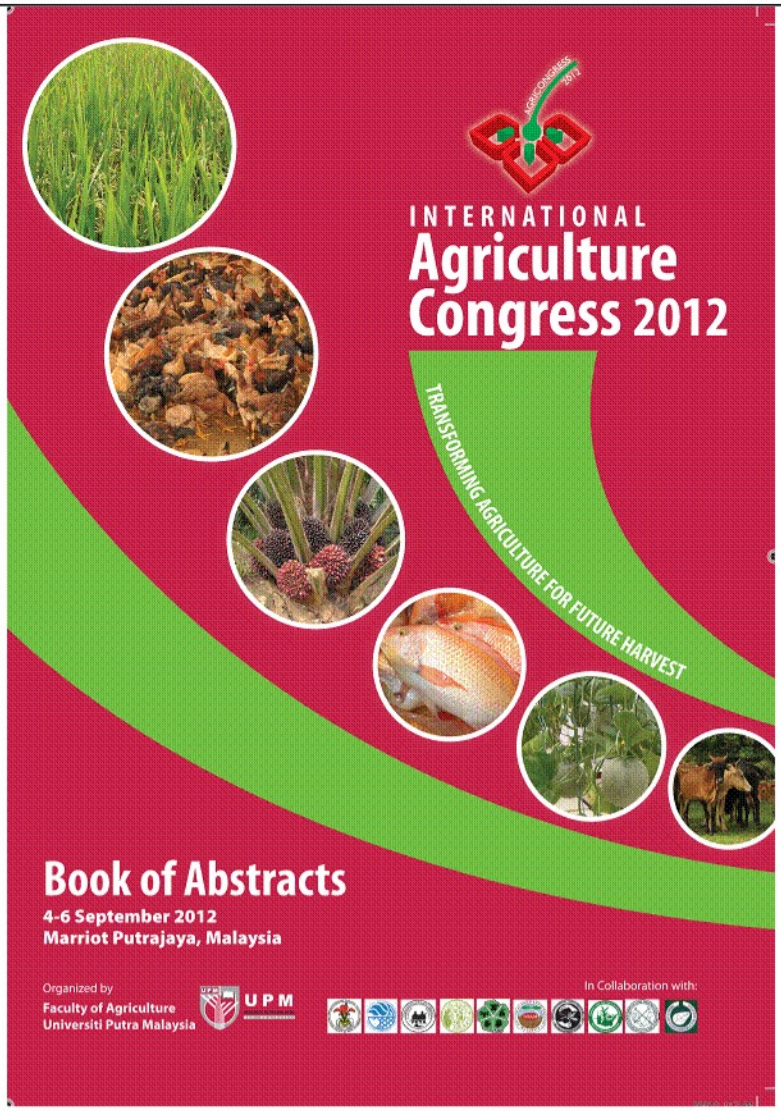

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GROWTH AND YIELD OF CHOY SUM (*BRASSICA CHINENSIS* VAR. *PARACHINENSIS*) IN RESPONSE TO WATER STRESS AND NITROGEN FERTILIZATION LEVELS

Khairun Nisa Kamarudin[1], Hawa ZE Jaafar[2] and Christopher Teh Boon Sung[1]
[1]Department of Land Management, [2]Department of Crop Science,
Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor
Corresponding author: nisa_kamarudin@yahoo.com

INTRODUCTION

Choy sum (*Brassica chinensis* var. *parachinensis*) is one of the main leafy vegetable crops grown in Asian countries in particular in Malaysia. This Chinese flowering cabbage is mostly rich in vitamins and fiber and has a short life cycle which can be harvested in a period of one month. Over 90% of choy sum mass consists of water and contain about 30.0 kcal of energy, 2.0 g of protein, 4.0 g of carbohydrate, 140.0 mg of calcium, 80.0 mg of phosphorus, 1.3 mg of iron, 0.8 g of fiber, and 0.09, 0.27, and 90.0 mg of vitamins B1 (Thiamine), B2 (Riboflavin) and C (ascorbic acid) in 100 g of edible portion, respectively. Both thiamine and riboflavin acts as a coenzyme in body metabolism and they are necessary for converting carbohydrate into energy and also helpful in maintaining healthy nervous system. Meanwhile, ascorbic acid is an antioxidant and important in the synthesis of collagen and immunization system. This crop is expected to grow in adequate water and nitrogen supply. The response of plants to water and nitrogen stresses may be widely reported but much less is known or studied on the response of choy sum. Hence, this study was carried out to evaluate the effects of several watering frequencies and nitrogen rates on vegetative parameters of growth and yield for choy sum as to determine the maximum yield produce under water stress and the relationship for both of water frequency and nitrogen rate on choy sum response.

MATERIALS AND METHODS

The experiment was set up as a double split plot design with four treatments of watering frequency, i.e., once a day (S1), once a week (S7), once every two weeks (S14) and without watering (SX) and five treatments of nitrogen rate ratios, i.e., without N-fertilizer (N0), half of the recommended rate (N0.5), the recommended rate (N1), double the recommended rate (N2) and quadruple the recommended rate (N4) with four replications. The recommended N rate for choy sum is 68 kg N per ha (MARDI, 2000). This experiment was conducted under a rain shelter at Agronomy Research Farm (N 2^{o} 59.47' and E 101^{o} 42.882'), Universiti Putra Malaysia, Serdang, Selangor which started on March 25, 2011 and ended on April 21, 2011. The soil taken from the field was air dried and sieved before being placed in each polyethylene bag which contained about 5 kg of soil. The fertilizers for NPK was then applied manually where the rates used for N, P and K were 68 kg N ha^{-1}, 10 kg P ha^{-1} and 96 kg K ha^{-1} (MARDI, 2000), respectively, by using single fertilizers, i.e., urea, TSP and MOP. The fertilizers were given once only which was before transplanting. The choy sum seedlings were transplanted manually after 14 days sowing in seed trays. Each polyethylene bag was sowed with four of choy sum seedlings. Crop watering was done only in mornings with 1L of water per polyethylene bag. One of the choy sum sample was collected from each bag randomly once every week for four weeks.

The parameters measured were plant height, numbers of leaves, leaf area (LI-3100 Area Meter, Lincoln Nebraska, USA), root length, plant part weights, i.e., leaves (including petiole), stem and root, and total nitrogen (wet ashing method: Auto-Analyzer, 2000 Series, Lachat Ins., Loveland, Colorado). Specific leaf area (SLA), dry mass ratio of plant parts, and shoot to roots ratio were also calculated. Monitoring of soil moisture levels was conducted using the gravimetric method where the mean of soil volumetric water content (VWC) under S1, S7 and S14 treatments were 42%, 35% and 29%, respectively. Meanwhile, the soil VWC at field capacity and permanent wilting point were about 44.6% and 25.3%, respectively. The analysis of variance (ANOVA) was done by using a package of Statistical Analysis System, SAS version 9.1 (SAS Institute Inc., Cary, NC, USA). The mean comparison tests were analyzed by Student-Newman-Keuls (SNK) at 5% of significance level.

RESULTS AND DISCUSSION

The choy sum seedlings planted in the SX treatment died after one day of transplanting due to the soil VWC that was lower than permanent wilting point. Therefore, the ANOVA was carried on the three treatments of watering frequency supply, i.e., S1, S7 and S14 at five levels of N-rate. The ANOVA revealed that the effect of variance components (S, N, SxN, T, SxT, NxT, SxNxT; S (watering frequency), N (nitrogen rate), and T (time)) were significant at $P = 0.01$ and $P = 0.05$ for some of parameters measured. The study indicated that interaction of SxNxT was not significant for all parameters measured except for leaf number and plant height. The interaction

of NxT was significant for root length, SLA and root fraction, and SxT showed significant effect on dry weight of leaves, shoot and total while leaf area was shows significant under both interactions. The interaction of SxN did not show any significant effect on choy sum growth parameters. **Leaf number and plant height:** The effect of water stress and N rate on choy sum leaf number and plant height at DAT 28 did not show clear trend. For instance, an increase in N rate under S14 did not increase both leaf number and plant height of choy sum. However, it was clear that the highest leaf number produced was 14 leaves with 16 cm in height per plant obtained from the combination treatments S7+N0.5. **Root length:** No clear trend in differences could be seen between the treatments except that root length would increase with time for all treatments. The root length was recorded in range of 13 to 15 cm per plant at DAT 28. **Leaf area:** Leaf area generally decreased with increasing N rate at DAT 28. Choy sum under N0.5 produced leaf area of about 911 cm^2 per plant, which is 40% higher than N0 and also gave the highest of leaf area compared to all N treatments. However, added N fertilizer at N1 would give the leaf area about 702 cm^2 per plant which was not significantly different than N0 and was 30% smaller compared to N0.5 rate. The leaf area of choy sum was much smaller at N2 and N4 with about 438 and 216 cm^2 per plant, respectively. Leaf area was also affected by SxT. In this study, S1 and S7 provided the highest of leaf area of 717 and 704 cm^2 per plant, respectively. The treatment of S14 gave the lowest of leaf area about 331 cm^2 per plant which was less compared than S1 and S7 by more than 50%. **Specific leaf area, SLA:** SLA of choy sum was found to decrease with increasing of N rate application at DAT 28. The highest of SLA was obtained by N0 (2.19 $m^2\ g^{-1}$) and N0.5 (1.88 $m^2\ g^{-1}$). N2 and N4 rates reduced the SLA to below than 1 $m^2\ g^{-1}$ per plant. **Biomass production:** The weights of the choy sum plant parts except for the stem and root were significantly affected by SxT. The leaf, shoot and total dry weight decreased with increasing of water stress level. The results show that the highest and lowest of biomass dry weights were obtained by S1 and S14, respectively. Shoot and total dry weight of choy sum were affected by the leaves dry weight because over half of total plant weight came from leaves. Leaves dry weight decreased with increasing of N rate levels. Plants treated by N0.5 showed the highest weight about 1.1 g per plant. However, plants treated by both of N1 and N2 were not significantly different from each other. Their leaf dry weights were about 30% less than N0.5. **Shoot to roots ratio:** S1 and S7 gave the highest shoot to roots ratio, compared to S14. The ratios of shoot to roots for all treatment in increasing order were 7.07, 7.33 and 4.85, respectively. **Nitrogen content:** The ANOVA of nitrogen content in choy sum plants showed a significant interaction of SxN effect at DAT 28. Nitrogen applied below N1 were not affected the nitrogen content for three levels of watering frequency. However, increasing N rate would decrease nitrogen content in particular for S7 and S14. The result shows that total nitrogen content in choy sum tissues at each combination levels of water frequency and N rate was in range of 3.8 to 5.6% per plant.

The reduction of leaf number by water stress decreased the leaf area of choy sum and also reduced the biomass production in particular for leaves which in return would affect the SLA. Reducing the leaf area is one of the effective strategies for drought tolerance to decrease plant transpiration rates. One unanticipated finding in this study was that the leaf area of choy sum was found to decrease with increasing of N rate. This is in contrast with that reported elsewhere for other plants. According to Sun et al. (2011), the plant growth was more affected by water stress than nutrient stress even both of water and nutrient availability determined the plant growth. Meanwhile, the shoot to roots ratio was significantly decreased under water deficit conditions. The reduction of soil water availability would affect the shoot growth more than the root growth (Davies, 2006). In minimizing the drought damage, plants would produce small or fewer leaves and also minimize stem growth as one of the important of adaptation by plants (Coder and Warnell, 2012). In the other words, the plants would become stunted. Both of water and nutrient stresses have been found to significantly affect the concentration of nitrogen in choy sum. However, the result from our study shows that the nitrogen content was over than 4% and higher than that normally reported. Nitrate accumulation in plants is influenced by plant stress and excess of nitrogen applied as depend on the rate of nitrate uptake and reduces by plant (Whittier, 2011).

CONCLUSION

Choy sum responded more positively at watering frequency level of once a week with N rate ratio of 0.5. Hence, there was no need for too frequent watering (once a week) or for the N-rate to be 68 kg/ha.

REFERENCES

Coder, K.D., and Warnell, D.B. 2012. “Drought Damage to Trees.” School of Forest Resources, Uni of Georgia.

Davies, W.J. 2006. Response of Plant Growth and Functioning to Changes in Water Supply in a Changing Climate. In: Plant Growth and Climate Change. Blackwell Publishing Ltd. Oxford, UK.

MARDI. 2000. Panduan Pengeluaran Sayur-sayuran. Malaysian Research and Development Inst., KL, Malaysia.

Sun, C.X., Cao, H.X., Shao, H.B. Lei, X.T., and Xiao, Y. 2011. Growth and physiological responses to water and nutrient stress in oil palm. African Journal of Biotechnology 10(51): 10465-10471.

Whittier, J.C. 2011. “Nitrate Poisoning.” Livestock Series: Health. Fact sheet no. 1.610. Extension, Colorado State University. Accessed May 5, 2012. www.ext.colostate.edu/pubs/livestk/01610.html/