Indonesian Journal of Agricultural Science 8(1), 2007: 39-42

EFFECTS OF IRRIGATION FREQUENCY AND LEAF DETACHMENT ON CHRYSANTHEMUM GROWN IN TWO TYPES OF PLASTIC HOUSE

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ABSTRACT

Chrysanthemum is one of important ornamentals in Indonesia and it ranks in the first quantity of cut flower marketed every year. In most cases, the low productivity is still a constraint for the traditional growers to make production process profitable. Several problems revealed in chrysanthemum production were investigated. The study dealt with the effect of two types of plastic house constructions, irrigation frequency, and leaf detachment on the growth and development of chrysanthemum. The experiment was conducted at Segunung, Indonesian Ornamental Plants Research Institute during the dry season of 2005. A nested design with six replications was used. The results showed that plants grown in wood-constructed plastic house had better growth performance and flower quality than those under bamboo plastic house. Longer stem and higher plant fresh weight with more flowers and longer life span were also observed on chrysanthemum irrigated four times per week than those irrigated twice per week. Leaf removal often practiced by the growers is no longer recommended, since the number of leaves on the plant influenced all parameters observed. The more leaves were detached, the more negative impacts on plant growth were found.

[***Keywords***: *Dendranthema grandiflora*, plastic house, irrigation frequency, leaf detachment]

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* [Ramat] Kitam) is one of the major cut flowers in the world. The demand for the flower reached 35% of the overall market request, second only to roses. In Indonesia, chrysanthemum ranks in the first quantity of the cut flower marketed every year.

Most of chrysanthemum growers are in Java with three harvest periods every year. In traditional growers, the plants are usually grown in plastic house constructed from bamboo, since bamboo plants are abundant and naturally grown. However, some constraints revealed during the production process are still unsolved up to this moment and the flower productivity and quality need to be improved. The use of bamboo for plastic house construction is considered less durable compared to other materials such as wood or other permanent materials like aluminum. This condition leads the growers to reconstruct and renovate the plastic house almost every 5 years. The expenses for these activities become additional cost and finally make the production process less profitable (Boudoin and Von Zabeltitz 2002). Instead of the bamboo construction, the life span of wood house is 10 years. In the wood house, there is 20% more radiation compared to that in the bamboo house (Gunadi *et al*. 2006).

Another problem is the use of drip irrigation system. Among some growers, the equipments were installed with the pump to distribute water for plants. This system is cheaper than manual watering. However, some problems often occurred. The excessive water due to the frequent applications contributed to the high humidity in the plant environment under the plastic house. The less light interception to plants was also considered to have contribution to this condition. The dense bamboo constructions especially in the roof were often found, since the bamboos were not easy to be constructed. Less light interception and high humidity then become a limiting factor for the plant growth and lead to the excessive spreading of diseases especially Japanese white rust.

Aside from the pesticide application, in dealing with white rust, growers tend to remove the older infected leaves in the plants regularly. It is not clear whether the activity is only conducted for removing the infected leaves or these have significant impacts on the subsequent appearance of white rust or even for the plant growth and quality of the flower produced. This study was conducted to find out the effects of two types of plastic house construction, i.e. bamboo and wood houses, irrigation frequency, and leaf detachment on growth quality of chrysanthemum.

MATERIALS AND METHODS

The study was conducted at Segunung experimental station of the Indonesian Ornamental Plants Research Institute, located at 1100 m asl, from June to October 2005. Rooted cuttings of chrysanthemum cv. Town Talk were planted and arranged in beds with the density of 64 plants m^{-2}. Long day condition was provided with 100 watt incandescent lamps cyclic lighting (20 minutes off followed by 10 minutes on) from 22.00 pm to 03.00 am for 4 weeks. The lamp points were arranged 2 m x 2 m and 1.5 m above the planting beds.

Manure was applied at the rate of 30 t ha^{-1} for both houses. Fertilizer rates were based on the soil analyses, i.e. $Ca(NO_3)_2$ 4.4 kg + SP-36 1.25 kg and K_2SO_4 11 kg per 100 m^2 for bamboo house, and $Ca(NO_3)_2$ 2.2 kg + SP-36 1.25 kg and K_2SO_4 11 kg per 100 m^2 for wood house. Additional fertilizers comprised of KNO_3 0.7 g, $MgSO_4$ 0.5 g and $Ca(NO_3)_2$ 0.4 g L^{-1} were supplemented through drip irrigation. Standard cultural practices were applied to maintain the plants throughout the experiment.

The experiment was arranged in nested design with six replications. The factors were type of plastic house construction, irrigation frequency, and leaf detachment with the following description.

Types of Plastic House Construction

Plant growth quality was observed under two plastic house types. Traditional construction made of bamboo (Indonesian) and wood (adopted from Malaysian type) were used. The bamboo pipes were served for the pillars and roof, while in Malaysian type, the wood pillars were equipped with galvanized pipe for the roof. Both constructions used UV plastic for the roof cover and 1 mm green screen mass for the whole side wall of plastic houses.

Irrigation Frequency

During the first seven days, the water was given for about 2.5 L m^{-2} everyday to the plants using sprinkler in both plastic houses to maintain the newly planted cuttings. Three lines of drip tubes were installed in each bed to facilitate the irrigation by drip system. The irrigation frequencies were arranged twice (2.5 L m^{-2} per application) and four times (1.25 L m^{-2} per application) per week in both plastic house types.

Leaf Detachment

The leaf detachment was practiced to find out the effect of this activity on the growth quality of plants in both plastic house types. The number of leaves detached were: (1) 6 leaves at 4 weeks after planting (wap); (2) 10 leaves, 6 leaves at 4 wap and 4 leaves at 6 wap; (3) 14 leaves, 6 leaves at 4 wap, 4 leaves at 6 wap, and 4 leaves at 8 wap, and (4) no leaf was detached.

RESULTS AND DISCUSSION

The plants were harvested at 95 days after planting and all parameters were observed hereafter. Analysis of variances revealed that the differences among the replications were not significant and no interaction was found among the factors in all parameters observed.

Irrigation Frequency

The application of different irrigation frequencies gave significant impacts on chrysanthemum growth in both plastic house types. The plants irrigated four times per week had better performance compared to those with twice per week irrigation in terms of plant height, total plant fresh weight, and 80 cm long-stem fresh weight (Table 1).

Water supplied four times per week also gave significant influences on the generative stage. The increase in flower number per stem and longer vase life span in the room temperature were observed on the plants grown in both plastic houses irrigated four times per week (Table 2).

Water availability was considered as an important factor in determining plant growth and quality of the flowers produced. The four times per week irrigation seemed to have supplied the roots with more constant moisture content. This water content was impor-

Table 1. Plant height and stem weight per plant of chrysanthemum treated by different irrigation frequencies.

Irrigation frequency per week	Plant height (cm)	80 cm-long stem fresh weight per plant (g)	Plant fresh weight (g)
Twice	101.26a	42.14a	59.07a
Four times	115.25b	58.41b	70.97b

Values followed by different letters in the same column differ significantly at LSD 5%.

Table 2. Number of chrysanthemum flower and flower life span in room temperature treated by different irrigation frequencies.

Irrigation frequency per week	Number of flowers per stem	Flower life span (days)
Twice	11.05a	11.14a
Four times	13.68b	13.67b

Values followed by different letters in the same column differ significantly at LSD 5%.

tant not only for plant uptake in metabolic activities, but it also provided more favorable condi-tions in the root environment (Karlsen and Bertram 1995) as well as less destructive temperature fluctua-tion in the soil (Klapwijk 1987), since June to October, the experimental sites were in dry season.

Worse growth performance of the plants treated with twice per week irrigation was predictably caused by inconstant water availability in the root system. The longer period between water applications may have caused water deficit in the soil (Mortensen 2000). These conditions influenced the stability of root activities and metabolic process due to the use of additional energy for respiration (Trusty and Miller 1991).

Effects of Leaf Detachment

Leaf removal had significant influences on the growth performance and quality of the flowers produced in both plastic house types. The more leaves removed, the less growth observed in plants. The number of flowers per stem and flower life span also decreased continuously in line with the increase in leaves detached (Table 3).

The decrease in plant height in line with the increase in leaves removed was an evident of the influence of leaves retained on the plants to the subsequent growth, since the decrease in plant fresh weight observed among the treatments can be drifted from the more leaves detached from the plants. The slower subsequent growth after leaf detachment indicated the slower cell division and differentiation. The cell growth retardation inferred that the leaf detachment contributed to the less production of assimilate. This logical pathway was driven, since the more leaves detached might automatically decrease the light harvesting area and consequently the photosynthetic active area. These might directly influence the photosynthetic activity, e.g. decreasing the photosynthetic rate since the photosynthesis takes place mainly in the leaves (Rademaker and De Jong 1987).

The less assimilate produced due to the low photosynthesis activities contributed to the imbalance of carbohydrate partitioning in plant body, since the sink were competed with the limited assimilate. The competition then affected the generative stage, e.g flower initiation and development. These might explain for the less number of flowers produced in plant with more leaves detached, since plant needs abundant carbohydrates as source of energy for flowering (De Ruiter 1997).

The lack of energy sources might not only decrease the number of flowers but also the quality of flowers produced. The carbohydrate content in the plant body might determine the life span of the flower, since the carbohydrates retained in plant body were consumed for respiration after the plant was cut (Chockshull 1982). These might describe the reason for the shorter life span found in plants with harass leaf detachment.

Plant Performance

In general, the plants grown under the different plastic houses showed different characteristics in growth quality and flowers produced. The plants grown under the wood-constructed plastic house grew more vigorously than those plants under bamboo-constructed. This was shown by the higher values of plant height and fresh weight as presented in Table 4.

Tabel 3. Growth quality, number of flowers, and flower life span of chrysanthemum in room temperature treated with different number of leaves detached.

Number of leaves detached	Plant height (cm)	Plant fresh weight (g)	Number of flowers per stem	Flower life span (days)
0	116.08a	68.26a	13.57a	14.51a
6	109.34ab	66.88ab	12.43ab	13.50a
10	108.31b	63.40ab	10.29ab	12.35ab
14	101.75b	61.28b	9.16b	11.31b

Values followed by different letters in the same column differ significantly at LSD 5%.

Table 4. Growth quality, number of flowers, and flower life span in room temperature of chrysanthemum grown under two types of plastic house.

Types of plastic house	Plant height (cm)	Fresh weight per plant (g)	Number of flowers per stem	Flower life span (days)
Bamboo	103.15a	58.72a	35.05a	13.78a
Wood	113.36b	71.08b	48.26b	14.92a

Values followed by different letters in the same column differ significantly at LSD 5%.

The plants grown under wood plastic house also had better flower quality, as reflected by the number of flowers per stem and longer life span.

The light interception under the bamboo-constructed plastic house was lower than that under wood house (data not presented). Light interceptions were only 50-55% under the bamboo plastic house, compared to 71-78% detected under the wood house. The denser bamboo constructions on the roof seemed to be the main reason for this condition.

Lower light intensities under the bamboo house might be limiting the plant growth, since the growth rate of chrysanthemum during the vegetative phase is highest in summer and the rates of the stem elongation, leaf initiation and plant fresh weight linearly correlate with the light intensities (Karlsen and Bertram 1997). The growth performance in vegetative period influenced the flowering stage of the plants as viewed from the higher number of flowers produced and the flower life span.

CONCLUSION

Irrigation frequency gave significant effects on the plant growth and flower quality of chrysanthemum. Plants supplied with water four times per week had better performance than those provided with twice per week irrigation.

Number of leaves detached from the plants affected subsequent plant growth and flower quality. The more leaves on the plants contributed to the higher number of flowers produced and longer life span of the flowers after cut at room temperature.

Plants grown under bamboo and wood-constructed plastic houses showed different performances in the quality of growth and flowers produced. The less optimal environment under the bamboo plastic house contributed to the low plant height, and plant fresh weight, and decreased the number of flowers produced per plant compared to those planted under the wood plastic house.

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