Effect of water stress at different phenological stages of muskmelon
(*Cucumis melo* L)

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**ABSTRACT**

Field experiments were carried out at Faculty of Agriculture and Natural Resource Management, Ebonyi State University, Abakaliki in 2011 and 2012 dry seasons to study the effect of water stress at different phenological stages of muskmelon. Results revealed that watering intervals of every six days significantly influenced number of leaves, number of branches and days to 50% flowering. During flowering phase, the plots that were watered in every six and nine days flowered late while early flowering were recorded by plots that were watered once a day and every three days. The highest yield of muskmelon was observed in irrigation intervals of six days. Also watering frequency of six days intervals had maximum net income, closely followed by nine days intervals. It can be inferred that watering frequency of every six days intervals significantly affected both growth and yield characters of the crop studied at different phenological stages and it could be recommended for growing the crop in the study area.

**Key words:** Melon, Phenological stages, Water stress.

**INTRODUCTION**

Field water management practices are the most influential factors affecting crop yield particularly in irrigated agriculture in arid and semi-arid regions (Al-Omran *et al.* 2005). It is necessary to get maximum yield in agriculture by using available water in order to get maximum profit per unit area because existing agricultural land and irrigation water are rapidly diminishing due to rapid industrialization and urban development (Ertek *et al.* 2004). Optimizing irrigation management due to water scarcity together with appropriate crops for cultivation is highly in demand especially during the dry season in the study area. The absence of irrigation facilities and inadequate irrigation scheme capacity as well as limited water sources is among the reasons that force many farmers to reduce production size and attendant to low yield. The potential of water stress tolerance and the economic value of these crops, make them suitable alternative crops in dry land agro ecosystems (Koocheki and Nadjafi, 2003).

Many farmers believe that the more the water, the more the crop yield but on the contrary, over-irrigation have adverse effects on crop yield. (Anonymous 2009). Sensory *et al.* (2007) stated that excessive application of water can damage melon and face fruit quality with problems leading to reduction of the melon fruit yield, lower fruit quality characteristics and plant diseases. Irrigation should be applied frequently and evenly at the early stage to maintain a steady growth and it is also required during the fruit developing periods to improve the quality of the fruits. The time of irrigation is important due to its advantages of cutting down the usage of water to meet the needs of crops (Stewart and Nielsen, 1990). The intermittent water stress can be acceptable and useful with regards to water saving and better water use efficiency (Mitchell *et al.* 1984, Silber *et al.*; 2007). Many authors have reported on irrigation regimes applied for many crop productions such as maize (*Kang et al.* 2000), onion (*Bekele and Tilahun*, 2007) and watermelon (*Gonzalez et al.* 2009).

Water stress at flowering reduces pollination and thus less number of grains are formed per spike which results in low grain yield (Ashraf 1998). Adequate water at or after anthesis period not only allows the plant to increase the rate of photosynthesis but also gives extra time to translocate the carbohydrate to the grains which improves grain size and thereby lead to increase grain yield (Zhang and Oweis 1998). The crop water need is related to moisture sensitive periods. Salter and Goode (1967) described such periods as certain development phases in which the plant is or appeared by its observed response to be more sensitive to moisture conditions than at other stages of development. All stages of crop growth are not uniformly susceptible to water stress but some stages can cope –up with water shortage very well while others are more susceptible and water shortages at such stages may result in distinct yield losses. Therefore, the objective of this study is to determine the most critical stages of growth and development to soil moisture stress as well as yield responses of melon to time of irrigation.

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MATERIALS AND METHODS

A study was conducted in the growing seasons of 2012 and 2013 at the research farm of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki (Latitude: 36°, 15/N, longitude: 59°, 28/E and elevation, 928 m) to investigate the effects of irrigation regimes on the three phonological stages of muskmelon. The treatment consists of four irrigation regimes (once a day, every three days, every six days, and every nine days) and three phonological stages (stage I: from germination to flowering, stage II: from flowering to pod formation, stage III from pod formation to harvesting), which gave 12 treatment combinations. The treatments were laid out in a randomized complete block design and were replicated three times. Each plot measured 3x3m (9m²) with 0.5m between adjacent plot and 1m between replicates. At planting, two seeds per hill were planted at a spacing of 1m x 1m. Fertilizers were applied at rate of 90 kg N, 30 kg P₂O₅ and 30 kg K₂O per hectare. Then nitrogen fertilizer was applied as split, 30 kg of nitrogen fertilizer together with 30 kg P₂O₅ and 30 kg K₂O were applied once on the on the plots before planting while the second half of nitrogen were applied at the flowering stage. The parameters measured were vine length, number of leaves, number of branches, Days to 50% flowering, number of fruits, fruit weight and total yield. Data collected were subjected to analysis of variance (ANOVA) using a General Linear Model in SAS and Duncan Multiple Range Test was used to separate the treatment means at 5% probability level (Duncan 1955).

RESULTS AND DISCUSSION

Effect on growth parameters: The growth parameters such as vine length, number of leaves, number of branches and days to flowering are presented in (Table1). Irrigation intervals significantly influenced number of leaves, number of branches and days to 50% flowering. The highest number of leaves were recorded from the plots that were watered in every six days, followed by plots that were watered every day which was statistically similar with the plots that were watered in every three days while the least number leaves were recorded by plots were watered in every nine days. The highest number of branches were produced by the plots that were watered in every nine days and was statistical similar with all other treatments expect the plots that were watered in every three days. During flowering phase, the plots that were watered in every six day flowered late, followed by the plots that were watered in every nine days while early flowering were recorded by plots that were watered once a day and every three days. In this study, increasing watering intervals to nine days decreased allmost the growth parameters and therefore, it is unnecesary. The results indicates that irrigation intervals of every six days favours the growth parameters. This shows that Irrigation should be applied frequently and evenly at the early stage to maintain a steady growth. This is also required during the fruit developing periods to improve the quality of the fruits. Watering should be reduced when the plants are flowering to ensure a good fruit-set and during fruits ripening to prevent fruit cracking. The time of irrigation is important due to its advantages of cutting down the usage of water to meet the needs of crops (Stewart and Nielsen 1990). Watering frequency is primarily based on the idea of plant sensitivity to water stress. Therefore the intermittent water stress can be acceptable and useful with regards to water saving and better water use efficiency (Mitchell et al; 1984, Silber et al; 2007). The crop water need is related to moisture sensitive periods. Salter and Goode (1967) described such periods as certain development phases in which the plant is or appeared by its observed response to be more sensitive to moisture conditions than at other stages of development. All stages of crop growth are not uniformly susceptible to water stress, on the other hand, some stages can cope –up with water shortage very well while others are more susceptible and water shortages at such stages may result in distinct yield losses. The impact of water stress at fruiting stage was more severe than that of flowering stages and also when given for longer periods (Patil et al. 2014).

Table 1: Effect of watering frequency at different growth stages on growth parameters of muskmelon.

| Treatments              | Vine length | Number of leaves | Number of branches | Days 50 % flowering |
|-------------------------|-------------|------------------|--------------------|---------------------|
| Watering Frequency (Days) |             |                  |                    |                     |
| Every day               | 29.67a      | 43.75b           | 4.83ab             | 28.17c              |
| Every three days        | 30.88a      | 42.08b           | 3.83b              | 28.17c              |
| Every six days          | 30.02a      | 51.00a           | 4.00ab             | 32.00a              |
| Every nine days         | 30.46a      | 38.75c           | 5.00a              | 30.50b              |
| SE ±                    | 1.35        | 0.31             | 0.50               | 0.38                |
| Growth Stages           |             |                  |                    |                     |
| Vegetative stages       | 36.50a      | 50.63a           | 5.00a              | 34.19a              |
| Flowering stages        | 28.40b      | 48.88a           | 4.19b              | 29.00b              |
| Pod formation stages    | 26.32b      | 32.19b           | 4.00b              | 25.94b              |
| SE ±                    | 1.17        | 3.03             | 0.27               | 1.20                |

Means followed by same letter (s) within same column and treatment group are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT).
Effect on yield parameters: Irrigation intervals have significant effect on number of pods, pod weight and total yield Table 2. Increasing irrigation intervals up to nine days decreased significantly the number of pods and pod weight. However, irrigation interval of six days was statistically similar with nine days on total yield of muskmelon. This is in agreement with that of Nadjafi and Rezvani Moghaddem, (2002) who reported that irrigation interval of seven days had significantly higher seed yield when compared with 14, 21 and 28 days irrigation intervals. Similarly, Ertek, et al. (2004) showed that irrigation interval of five days fruit yield of Cucurbita pepo is higher than ten days irrigation intervals. Water stress treatments affected number of pods, pod weight and total yield of muskmelon and the possible reason can be deficiency of water during critical phases that showed physiological process as similar observations were made by Cabello et al. (2009) and Ibrahim (2012) on muskmelon.

In fruiting stage due to high sensitivity of water stress, the number of pods reduced which resulted in less number of pods per plant. Onset of blooming and fruit setting is a critical periods where differentiation of vegetative and reproductive structures takes place and this period being highly sensitive to water deficits (Barlow et al. 1980). During flowering in six days water stress condition, physiological changes might have occured which induced mild stress that probably ineffective to bring about considerable reduction in yield. The other reason is that flowering period started after 35 days of crop establishment and continued 20 days from onset of blooming to early fruit setting. This minor shock period gets sufficient time to produce more number of flowers resulting fruit setting which may not have affected the quantitative traits so much. However, more than six days interval of water stress at flowering stage was detrimental as flower bud initiation period is already over. It is interesting to note that after crop establishment, early fruit setting to setting of first two fruits is a critical period that is very short (maximum 15 days). Hence onset of blooming to early fruit setting requirement of period are 55 days. Therefore, more than six days interval of water stress during fruiting phase is critical. Instead of young fruit enlargement, dropping of fruits took place. Water stress during fruit setting and swelling period reduced fruit weight drastically. Water deficit during blooming and fruit differentiation phase observed poor fruit setting are in confirmation of earlier findings (Fabeiro et al. 2002 and Kusvuran et al. 2010). The higher value of crop yield obtained at regular irrigation and six days water stress during flowering phase might be due to adequate moisture in active root zone, sufficient moisture concentration, better utilization of nutrients and fast recharge mechanism. Low crop yield obtained may be due to infrequent application of water during stress resulting in a lack of moisture in active root zone, inadequate moisture conservation and poor nutrient utilization as reported (Rashid and Seyfi, 2007).

### Table 2: Effect of watering frequency at different growth stages on yield and yield components of muskmelon.

| Treatments          | Number of Pods | Pod weight | Total yield |
|---------------------|----------------|------------|-------------|
| Watering Freq. (Day) |                |            |             |
| Every day           | 7.83b          | 1.94b      | 65.50b      |
| Every three days    | 7.50b          | 1.83b      | 61.50b      |
| Every six days      | 12.08a         | 2.99a      | 101.25a     |
| Every nine days     | 7.08b          | 1.96b      | 70.33ab     |
| SE ±                | 0.91           | 0.29       | 10.93       |
| Growth Stages       |                |            |             |
| Vegetative stages   | 11.19a         | 2.27a      | 94.75a      |
| Flowering stages    | 7.81b          | 2.38a      | 78.56ab     |
| Pod formation stages| 6.88b          | 1.19b      | 50.63ab     |
| SE ±                | 0.79           | 0.25       | 10.34       |

Means followed by same letter (s) within same column and treatment group are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT).

### Table 3: Economics of watering frequency at different growth stages of muskmelon.

| Treatments          | Gross income (ha⁻¹) | Total cost (ha⁻¹) | Net income (ha⁻¹) | Cost Benefit Ratio (BCR) |
|---------------------|----------------------|-------------------|-------------------|--------------------------|
| Watering Frequency (Days) |                      |                   |                   |                          |
| Every day           | 67432                | 52470             | 14962             | 1.50                     |
| Every three days    | 53378                | 47829             | 5549              | 1.00                     |
| Every six days      | 92676                | 45332             | 47344             | 3.65                     |
| Every nine days     | 77467                | 34578             | 42889             | 2.85                     |
| Growth Stages       |                      |                   |                   |                          |
| Vegetative stages   | 34267                | 23176             | 11091             | 1.00                     |
| Flowering stages    | 47254                | 34275             | 12979             | 1.21                     |
| Pod formation stages| 52832                | 37842             | 14990             | 1.43                     |

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Sufficient water must be present in active root zone for fruit setting, swelling and ripening, evapo-transpiration, nutrient absorption by roots, root growth and soil microbiology.

**Economics of watering frequency on muskmelon**: Watering frequency of six days intervals had maximum net income, closely followed by nine days intervals. Highest BCR was recorded by nine days watering frequency. The lowest net income with BCR was observed by the six days intervals. The highest net gain per hectare at nine days watering frequency was due to higher yield (Table 3).

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