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# EFFECT OF WATER REGIME AND DIFFERENT IRRIGATION SYSTEMS ON GROWTH, QUALITY AND YIELD OF HASSAWI MUSKMELON CULTIVAR (*Cucumis melo*, L.)

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## ABSTRACT

A field experiment aiming to study the effects of different irrigation systems and different volumes of water and their interaction between irrigation systems and volumes of water on growth, yield and quality of Hassawi muskmelon cultivar plants was conducted during two successive seasons (1999 and 2000). The four irrigation systems (drip, 15 cm and 25 cm sub- surface and surface irrigation) were applied to the Hassawi muskmelon cultivar plants with the two volumes of water 100 % (976 mm) and 75 % (710 mm) of field capacity. The results showed that using 15 cm sub-surface irrigation system was in favour for producing the best fresh weight/ plant, dry/fresh ratio weight and leaf area/plant, number of fruits /plant, fruit diameter, total yield and TSS %, while the treatment of using surface irrigation system gave the highest values for plant height, number of branches /plant, fruit height and fruit weight. However the treatment with 100% of field capacity gave the highest values for fresh weight/ plant, plant height, leaf area, number of branches/plant, number of fruits/plant, fruit diameter and total yield. The interaction between volumes of water applied and irrigation systems produced the highest values for fresh weight , dry/fresh weight ratio, fruit height and total yield by using 100 % of field capacity with 25 cm sub- surface system.

Finally it is possibly suggested that 25 cm sub- surface irrigation with 100 % of field capacity could be useful for enhancing the Hassawi muskmelon cultivar growth and fruit yield under Al-Hassa Oasis conditions.

## INTRODUCTION

Muskmelon plants are commonly grown in the Kingdom of Saudi Arabia (KSA) during spring and summer seasons. It is one of the most popular fruits in the Kingdom. The soils in the Al-Hassa Oasis of the KSA are characterized by their common nitrogen (N) and phosphorus (P) deficiency (Al-Taher, 1999). Muskmelon plant is known for their high requierments of water in particular the quantity to produce high yield and good fruit quality, water quality and irrigation system, may be assessed in serveval ways; number of leaves, average fresh weight, dry/fresh weight ratio, leaf area, height plant, number of fruit and total yield of muskmelon plants. In Saudi Arabia there is a wide use of surface irrigation or sprinkler irrigation systems. Many investigators showed that the using of different irrigation systems and different requierements of water had positive effects on the growth characters and yield of muskmelon.

Camp *et al*. (1993) used two surface (surface a and b, either one or two tubes/bed) and one subsurface (subsurface 2, two tubes below each bed) microirrigation treatments and application fequencies, high (three times per

day) and low (one time per day) was evaluated for muskmelon production in the spring season, results showed that the highest yield with two tubes below each bed treatment was obtained. Bhella (1985) found that irrigation decreased depth of root penetration compared with no irrigation. Irrigation significantly increased stem length and diameter, leaf area, mean fruit weight, and yield of muskmelon, but decreased soluble solids in fruit. Leoni and Cabitza (1984) mentioned that the drip irrigation rate for muskmelon (3.45 - 11.8 liters h-$m^2$ gave the highest yield (5.05 kg/$m^2$), while irrigation rate of 8.5 liters h-$m^2$ gave yield of 4.13 kg /$m^2$. Mean fruit weight, sugar content were similar in all treatmens.

Shani (1985) showed that the highest yield and longest root of muskmelon were obtained after using drip irrigation with infiltration model. Mannini *et al*. (1985) on a sandy soil, mentioned that irrigation every 3 days gave higher yields of muskmelon (fruit numubers and weight) than irrigation every 6 days, highest total yields were given by the treatment applying the highest volume (100%). Bogle and Hartz (1986) found that the highest yield of muskmelon was obtained with drip irrigation as compared with furrow irrigation. He also mentioned that fruit size was affected by irrigation method. The highest water use efficiency, 181 kg marketable fruit ha-1 mm-1 total water (irrigation + rainfall) was recorded at 40% soil avaliable water depletion (SWD) treament. Paunel *et al*. (1984) found that the drip irrigation increased yield of muskmelon (21.4 t/ha) compared with 17.6 t/ha with sprinkler irrigation. Callebaut *et al*. (1985) showed that the yield , average fruit weight, number of fruits per unit and area of melon were not significantly affected by rotation the under seasonal water application volumes of 57, 47 and 67 % of field capacity respectively. Similarly Chander and Mangal (1983) mentioned that the best growth, flowering and yield of muskmelon were obtained on plots irrigated at 0.9 pan evaporation coefficient (55.5 mm of irrigation water). Yabe *et al*. (1981) found that the small amount of water at the vegetative growth stage suppressed growth but increased fruit weight and improved fruit quality. While a large amount of water at fruit swelling had no benficial effects. Kashi (1981) reported that the maximum yield of muskmelon and enhanced soluble solid contents, were obtained with irrigation intervals of 6 and 8 days. He also mentioned that the traditional irrigation at 50 cm depth gave better results than modern shallow furrow irrigation. Buitelaar (1988) found that the sprinkler irrigation gave higher fruit numbers/$m^2$, greater average fruit weight and higher yields/$m^2$. Reducing the amount of water applied by drip and sprinkler irrigation method had little effect on fruit numbers /$m^2$ but the average fruit weight was increased.

Mangal *et al*. (1987) mentioned that the muskmelon plants irrigated at 0.8 and 1.0 of pan evaporation coefficient (PEC) in the first year, and at 0.6 and 0.8 PEC in the second year, produced the highest yield and plant growth. Mannini (1988) found that the shorter intervals (3 days) combined with the 100 % evapotranspiration (ETP) irrigation rate noticeably increased yield of muskmelon i.e. higher fruit number and fruit weight. In contrast, the longer interval (6 days) combined with the 100 % (ETP irrigation rate resulted in a significant lower yield, while 150 % ETP irrigation (volume of

3600 - 4200 $m^3$/ha) rate was associated with a redution in the number of days to maturity. Warriner and Henderson (1989) found that the highest yield of muskmelon was obtained by using drip irrigation. Marketable yields for the drip irrigation treatment were 15 and 28 % higher, respectively than those for sprinkler treatments irrigated at 15 and 40 cb while harvest commenced and paked 10 days earlier with drip than with sprinkler irrigation.

This investigation was carried out to study the effect of different water requirements and different irrigation systems on growth, yield and its quality of muskmelon, Hasswi cultivar to establish the best water requirments and methods of irrigation for producing muskmelon plants under AlHassa oasis conditions in the Kingdom of Saudi Arabia.

## MATERIALS AND METHODS

A field experiment was carried out for two successive seasons of 1999 and 2000 at the Agricultural and Veterinary Training and Research Station, King Faisal University, Al-Hassa KSA.

The experiment was done in an open field characterized by its sabdy soil texture (96% sand, 4% silt and clay) low salinty ($Ec_{1:2:5}$ = 1.6 dS $m^{-1}$, slightly acid $pH_{1:2:5}$ = 7.8 and relative low $CaCO_3$ content (7%).

These parameters and other of soil analysis were determined following the methods out lined by Rowell (1994). The irrigation water used has a low total salinty (2.1 dS/m) and low sodium adsorption ratio (SAR = 4.65).

In the current experiment four different irrigation systems (i.e. drip, 15 cm and 25 cm sub- surface and surface irrigation with two levels of irrigation water 100% (976 mm) and 75% (710 mm) of field capacity for season.

In this experiment, the frequency of irrigation was one time a day. It consist of eight treatments and four replications in a split plot design the main plots were arranged for drip irrigation, 15 cm, 25 cm sub-surface and surface irrigation while the sub-plot were the volume of water at 100% and 75% of field capacity). The total area of plot was 24 $m^2$ being divided into 4 rows with 6 m length and 1 m width each. The spacing between the plants was 80 cm. Age of 20 days muskmelon seedlings of the Hasswi cultivar were used. They were transplanted on the 5$^{th}$ and 8$^{th}$ of March, 1999 and 2000, respectively. Other recommended cultural practices of the Minsitry of Agriculture and Water were also followed.

During growth period and pre-harvesting , some measurements on muskmelon plants were done to determine the effect of the water requierments and the irrigation systems, on their vegetative growth parameters, total yield and yield quality. The measureements were completed on a representative sample of 10 plants, randomly were selected from each plot. They included fresh weight per plant (gm) number of brances/plant, dry/fresh weight ratio, leaf area /plant ($cm^2$), average fruit weight (gm), number of fruits per plant, total yield (kg /$m^2$) and total soluble solids % (by handly refractometer).

Data obtained were subjected to the proper statistical analysis according to Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

**A: Irrigation systems:**

Data presented in Tables (1) and (2) revealed that there were high significant differences among the plants irrigated with different irrigation systems in the average two seasons of study.

**Table (1): Average of fresh weight (gm), dry /fresh weight ratio, plant height, leaf area /plant ($cm^2$) and number of branchea /plant of muskmelon as affected by different volume of water and different irrigation systems over both seasons.**

| Characters / Treatments | Fresh weight /plant (gm) | Dry / fresh weight % | Plant height (cm) | leaf area /plant ($cm^2$) | No. of branches /plant |
|---|---|---|---|---|---|
| **A. Irrigation systems:** | | | | | |
| Di | 551.6 | 11.7 | 97.2 | 218.3 | 3.6 |
| Us1 | 555.6 | 16.1 | 125.2 | 229.3 | 3.8 |
| Us2 | 549.3 | 13.8 | 112.5 | 224.5 | 3.7 |
| S | 550.5 | 10.4 | 130.0 | 222.4 | 4.1 |
| LSD at 5 % | 2.75 | 0.5 | 3.1 | 1.5 | 0.1 |
| **B. Volume of water (of field capacity):** | | | | | |
| 100 % | 556.7 | 12.4 | 119.2 | 225.7 | 3.9 |
| 75 % | 546.8 | 13.7 | 113.2 | 221.6 | 3.7 |
| F-test | ** | ** | ** | ** | ** |
| **C.Interaction:** F-test | ** | * | NS | NS | NS |

**Di = drip irrigation, Us1 = 15 cm sub- surface, Us2 = 25 cm sub- surface and S = surface.**

The greatest fresh weight, dry / fresh weight %, leaf area / plant, number of fruits / plant, fruit diameter, total yield and TSS % were produced by treatment with 15 cm sub- surface irrigation in two seasons. While the highest values for plant height, number of branches / plant, fruit hieght and fruit weight were obtained by using surface irrigation. The results were in agreement with those of Bhella (1985) who found that the irrigation significantly increased stem length and diameter, leaf area, fruit weight and yield but decreased soluble solids in muskmelon. Shani (1985) showed that the drip irrigation by using high water volume gave the shortest root of muskmelon. On the other hand, traditional irrigation gave better results of vegetative muskmelon growth than modern irrigation (Kashi, 1984). Camp *et al.* (1993) mentioned that the highest yield of muskmelon was obtained by using sub-surface method (two tubes below each bed) one time per day as compared with surface irrigation. Mannini *et al.* (1985) on the sand soil, reported that irrigation every 3 days gave higher yield (fruits number and

weights) than irrigation every 6 days by using surface system. Bogle and Hartz (1986) showed that the drip irrigation at 20, 40 or 60 % soil water depletion (SWD) gave increased yield of muskmelon with rising water application, but fruit size distribution or soluble solids content were not affected. Paunel *et al.* (1984) found that average yield was 21.4 t /ha with drip, compared with 17.6 t/ha with sprinkler irrigation. Buitelaar (1988) found that sprinkler irrigation gave higher fruits number /$m^2$, greater average fruit weight and higher yiel;d / $m^2$ with compared surface and drip irrigation. There for 15 cm under surface irrigation was the most favourable treatment for the vegetative growth and yield because this treatment gave the highest values of the fresh weight / plant, dry / fresh weight %, leaf area / plant, number of fruits / plant, fruit diameter, total yield and TSS %.

**Table (2): Average of number of fruits /plant, fruit height (cm), fruit diameter (cm), fruit weight (kg), total yield (kg /$m^2$ ) and TSS % of muskmelon as affected by different volume of water and different irrigation systems over both seasons.**

| Characters / Treatments | No. of fruits /plant | Fruit height (cm) | Fruit diameter (cm) | Fruit weight (kg) | Total yield kg /$m^2$ | TSS % |
|---|---|---|---|---|---|---|
| **A. Irrigation systems:** | | | | | | |
| Di | 2.1 | 25.9 | 11.0 | 3.22 | 6.73 | 7.83 |
| Us1 | 2.5 | 27.7 | 13.4 | 3.55 | 8.69 | 8.02 |
| Us2 | 2.3 | 25.0 | 11.2 | 3.12 | 7.16 | 7.82 |
| S | 2.1 | 27.8 | 13.0 | 3.95 | 8.30 | 7.00 |
| LSD at 5% | 0.1 | 0.7 | 0.5 | 0.29 | 0.56 | 0.56 |
| **B. Volume of water (of field capacity):** | | | | | | |
| 100 % | 2.4 | 27.7 | 12.8 | 3.41 | 8.07 | 7.48 |
| 75 % | 2.1 | 25.5 | 11.5 | 3.51 | 7.37 | 7.85 |
| F-test | ** | ** | ** | * | ** | NS |
| **C. Interaction:** | | | | | | |
| F-test | NS | ** | NS | NS | * | NS |

**Di = drip irrigation, Us1 = 15 cm sub- surface, Us2 = 25 cm sub- surface and S = surface.**

**B: Volume of water:**

Data in Tables (1) and (2) showed clearly that the 100 % of field capacity water gave the highest values for fresh weight / plant, plant height, leaf area, number of branches / plant, number of fruits / plant, fruit diameter, and total yield, while the 75 % of field capacity gave the best results for dry / fresh weight %, fruit weight and TSS %. These results are in agreement with those obtained by Chander and Mangal (1983) who reported that the best muskmelon growth was obtained on plots irrigated at 0.9 pan evaporation coefficient (55.5 mm of irrigation water). Yabe *et al.* (1984) found that the small amount of water at the vegetative muskmelon growth stage suppressed growth and increased fruit weight and soluble solids.

Mangal *et al.* (1987) found that the highest muskmelon growth was obtained with irrigation of 1.0 panevaporation coefficient (PEC). Mannini (1985) mentioned that the highest yield of muskmelon (number and weight)

were given by the treatment of applying 100 % of field capacity. Yamagami (1985) mentioned that the highest yield and quality of muskmelon were produced after using irrigation interval of 4 - 6 days with a total application rate of more than 220 mm. The same results was obtained by Callebaut *et al.* (1985) who found that the yield of muskmelon were not significantly affected by rationing the seasonal water volumes to 57, 47 and 67 % of field capacity respectively. Yabe *et al.* (1981) mentioned that a small amount of water increased fruit muskmelon weight and soluble solids.

Vas-Kovskaya (1989) found that the mean yield of muskmelon under rainfed condition in 32.4 t/ha and under irrigation up to 60 t/ha with mean sugar content of fruits is 9.6 %. From the current study, it may be concluded that the yield quantity and quality of muskmelon plants grown in the Al-Hassa Oasis are possible to the improved by using of 100 % volume of water of field capacity.

**C: Interaction between irrigation systems and volume of water:**

Data presented in Tables (1) and (2) showed that the fresh weight / plant, dry / fresh weight %, fruit height and total yield significantly increased with interaction between volumes of water and irrigation systems, while the plant height, leaf area, number of branches / plant, number of fruits / plant, fruit diameter, fruit weight and TSS % were not significantly increased with this interaction. These results are in line with those obtained by Leoni and Cabitza (1985) who mentioned that the yield of muskmelon was the highest (5.05 kg /$m^2$) with irrigation rate of 8.5 litres h-$m^2$, while drip irrigation did not affect ripening time. The similar results were found by Mangal *et al.* (1987), Mannini (1988), Osorio (1987) and Warriner and Henderson (1989) on muskmelon plants. Also the same results found in Tables (1a and 2a) and Figs (1, 2, 3 ý& 4) indicated that the fresh weight, dry / fresh weight %, fruit height and total yield were the highest after using 100 % of field capacity with 25 cm sub- surface sytsem except dry / fresh weight which has the highest value with 100 % of field capacity with surface irrigation.

Therefor 100 % of field capacity with 25 cm sub-surface were the most favourable treatments for the vegetative growth and yield of muskmelon in the Al-Hassa Oasis in Kingdom Saudi Arabia.

**Table (1-a): Average of fresh weight (gm) and dry /fresh weight ratio of muskmelon as affected by interaction between volume of water and irrigation systems over both seasons.**

| Characters | Fresh weight (gm) | | Dry /fresh weight ratio | |
|---|---|---|---|---|
| Volume of water | 100 % | 75 % | 100 % | 75 % |
| **Irrigation system:** | | | | |
| Di | 560.0 | 555.0 | 10.6 | 13.2 |
| Us1 | 543.3 | 543.6 | 12.8 | 14.5 |
| Us2 | 567.7 | 544.3 | 15.8 | 9.8 |
| S | 543.6 | 556.7 | 16.3 | 11.0 |
| **LSD at 5 %** | 2.7 | | 0.7 | |

**Di = drip irrigation, Us1 = 15 cm sub- surface, Us2 = 25 cm sub- surface and S = surface.**

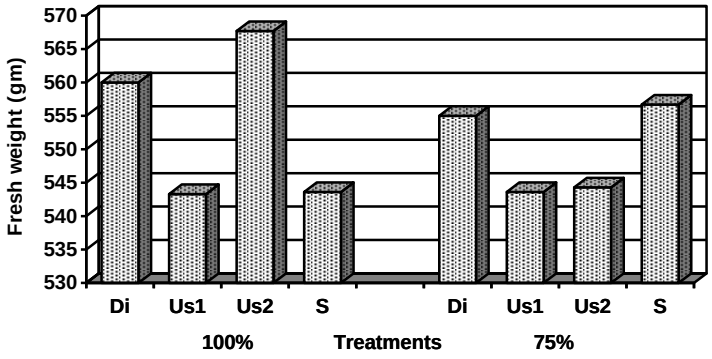


**Fig 1: Average of fresh weight (gm) of muskmelon as affected by interaction between volume of water and irrigation systems over both seasons.**

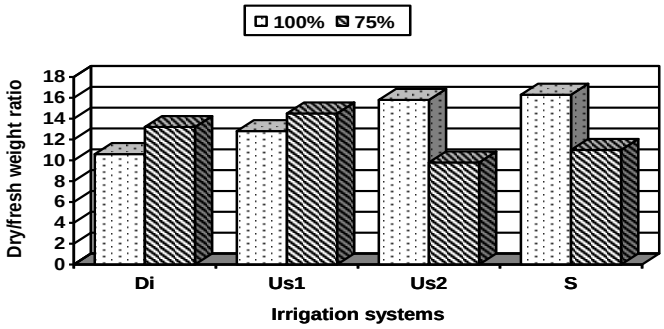


**Fig 2: Average of dry /fresh weight ratio of muskmelon as affected by interaction between volume of water and irrigation systems over both seasons.**

**Table (2-a): Average of fruit height (cm) and total yield (kg /m$^2$) of muskmelon as affected by interaction between volume of water and irrigation systems over both seasons.**

| Characters | Fruit height (cm) | | Total yield kg /m$^2$ | |
|---|---|---|---|---|
| Volume of water | 100 % | 75 % | 100 % | 75 % |
| **Irrigation system:** | | | | |
| Di | 26.7 | 27.0 | 7.10 | 7.29 |
| Us1 | 25.0 | 23.0 | 6.36 | 7.04 |
| Us2 | 28.7 | 28.3 | 9.10 | 8.80 |
| S | 26.7 | 27.3 | 8.28 | 7.80 |
| **LSD at 5 %** | 0.4 | | 0.27 | |

**Di = drip irrigation, Us1 = 15 cm under surface, Us2 = 25 cm under surface and S = surface.**

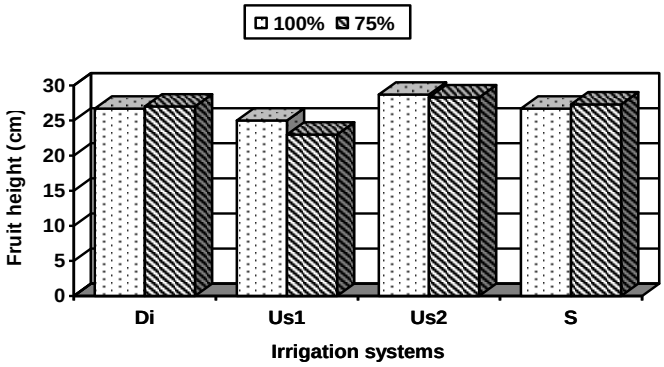


**Fig 3: Average of fruit height (cm) of muskmelon as affected by interaction between volume of water and irrigation systems over both seasons.**

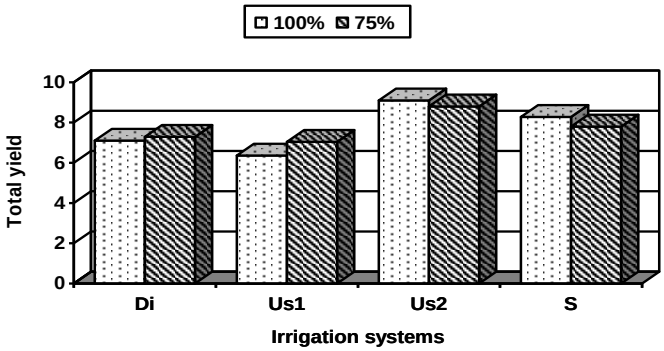


**Fig 4: Average of total yield (kg/m$^2$) of muskmelon as affected by interaction between volume of water and irrigation systems over both seasons.**

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## تأثير مستويات وأنظمة مختلفة للرى على النمو الخضرى والمحصول وجودته فى الشمام صنف الحساوى

**يوسف بن يعقوب الدخيل**

**قسم الأراضى والمياه - كلية العلوم الزراعية والأغذية - جامعة الملك فيصل بالأحساء - المملكة العربية السعودية**

أجريت تجربة حقلية بهدف دراسة تأثير أنظمة مختلفة من الرى (الرى بالتنقيط ، الرى تحت سطح التربة بـ 15 سم ، الرى تحت سطح التربة بـ 20 سم والرى السطحى مع مستويين من الماء هما 100 % (976مم) ، 75% (710مم) من السعة الحقلية على النمو والمحصول وجودته فى الشمام صنف الحساوى خلال موسمى 1999 ، 2000.

**أشارت النتائج إلى:-**

1- استخدام أنظمة الرى بمفردها أعطت أفضل انتاجية فى كل من الوزن الطازج للنبات ونسبة الوزن الجاف/الوزن الطازج ، والمساحة الورقية للنبات ، عدد الثمار للنبات ، قطر الثمرة والمحصول الكلى والمواد الصلبة الكلية عند استخدام الرى تحت سطح التربة بعمق 15 سم ، بينما أعطى الرى السطحى أعلى قيمة فى كل من ارتفاع النبات ، عدد الفروع للنبات، طول الثمرة وزن الثمرة بالمقارنة ببقية الأنظمة الأخرى.

2- أعطت المعاملة باستخدام 100% من السعة الحقلية ماء أعلى قيمة فى كل من الوزن الطازج للنبات ، ارتفاع النبات ، المساحة الورقية للنبات ، عدد الفروع االنبات، عدد الثمار للنبات ، قطر الثمرة والمحصول الكلى بالمقارنة بـ 75% ماء من السعة الحقلية.

3- بالنسبة للتفاعل بين مستويات الرى وأنظمة الرى المختلفة أوضحت النتائج أن أعلى قيمة لكل من الوزن الطازج ، نسبة الوزن الجاف / الطازج ، ارتفاع االثمرة والمحصول الكلى نتجت منباستخدام 100 % ماء مع الرى تحت سطح التربة بـ 25 سم وأخيرا يمكن القول بأن معاملة الرى تحت سطح التربة بعمق 25 سم مع الرى بحجم ماء 100% يمكن استخدامها لزيادة النمو الخضرى والمحصول وجودته فى الشمام صنف الحساوى تحت ظروف منطقة الإحساء بالسعودية.