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# Effects of Irrigation Practices on Vine Growth, Yield, and Quality of Muskmelons[1]

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***Abstract.*** **Higher yields, larger fruit size, and earlier maturity were achieved in muskmelons (*Cucumis melo* L.) by irrigating when soil moisture tensions at the 25-cm depth reached 50 and 75 kPa compared with tensions of 25 kPa. More fruits were culled in the wet treatment due to decay while the drier treatments produced more fruits with growth cracks. Melons from the drier treatments were higher in soluble solids. Irrigation did not affect the other storage and shipping quality factors measured. A prethinning irrigation caused restricted root development, vine growth, fruit size, and yield.**

Irrigation management is a critical part of profitable muskmelon production in Arizona; yet, irrigation practices vary widely. Muskmelons are planted in the cool winter months and harvested in the hot months of early and mid-summer. The tendency is to irrigate too frequently during the cooler part of the season when the plants are small. Pew et al. (7) found that excessive irrigation resulted in surface root development and restricted the growth of deeper, extensive roots. Plants with shallow root systems are more susceptible to vine decline during harvest when temperature and evapotranspiration are high and irrigation is usually ineffective and impractical. Erie et al. (1) reported that 31% of the moisture used by muskmelons was obtained from the 60- to 120-cm depth. MacGillivray (6) found that muskmelons could obtain moisture from as deep as 180 cm in well-aerated soils.

Studies by Flocker et al. (2) showed that yield response to irrigation was mostly expressed by increased fruit size. They also reported frequent, heavy irrigations increased the number of cull fruits which were associated with increased vine growth and succulence.

The purpose of this investigation was to study the effects of irrigation practices on vine growth and on yield, quality, and earliness of muskmelons.

## Materials and Methods

Several irrigation experiments were conducted over 4 seasons in cooperation with a commercial muskmelon grower in the North Gila Valley, Yuma County, Ariz. The soil is classified as Indio silt loam. 'PMR 45' muskmelons were direct-seeded in the south slope of 2-m commercial-type western muskmelon beds (7) in early February. Prior to bedding, 56 kg of N/ha and 49 kg of P/ha were broadcast over the experiment area. Applications of 56 kg/ha as ammonium nitrate were sidedressed or applied in the irrigation water to each treatment when the appropriate level was indicated by petiole analyses.

A randomized block design was used with 5 replications in 1967, 8 in 1968 and 1969, and 10 in 1970. Each plot consisted of 4 beds; each bed was 30-m long and 2-m wide. The plants were thinned to an in-row spacing of 30 cm when they had 2 to 3 true leaves. One inside bed with a uniform stand was used for harvesting and getting yield information. Petiole samples for $NO_3$–N analyses were taken from the other inside bed.

Irrigation timing was determined by vacuum guage tensiometers which were placed in the seed row between 2 healthy plants with the bulb 25-cm deep. Irrigation was applied to germinate the seed and establish a stand. Subsequent irrigations were applied when the mean moisture tensions at the 25-cm depth were 25 kPa (wet), 50 kPa (medium), or 75 kPa (dry) (Table 1). The prethinning irrigation treatment received an additional 10-cm irrigation prior to thinning. This treatment was included because it is common practice to irrigate ahead of thinning to make thinning easier. No information concerning this practice appears in the literature.

The melons were harvested daily, sized into the commercial sizes, counted, and graded into U.S. No. 1 of the various sizes and culls. From these data, yields were calculated as commercial crates (56 × 33 × 33 cm)/ha. At 2 different times during the harvest period, 8 uniformly mature melons were randomly selected from each plot. These melons were graded and sized, commercially waxed, packed by commercial packers, iced, and transported to the Univ. of Arizona laboratory at Mesa. They were stored at 13°C for an 8- to 10-day period, simulating transit to eastern markets. The melons were then graded by 3 trained persons for general appearance, outside color, depth and extent of netting, presence of vein tracts, internal wateriness (water log), loose seed and placenta (shakers), flesh color, and flesh firmness. Color was judged by comparing cut surfaces to a preestablished color series that showed the usual variations in flesh color.

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Table 1. Number of irrigations applied to muskmelons from germination through harvest.

| Moisture treatment | Mean tension at 25-cm depth when irrigated (kPa) | No. of irrigations | | | |
|---|---|---|---|---|---|
| | | 1967 | 1968 | 1969 | 1970 |
| Wet | 25 | 9 | --- | 10 | 8 |
| Wet + prethinning | 25 | ---[z] | 9 | --- | 9 |
| Medium | 50 | 6 | 6 | 6 | 4 |
| Dry | 75 | 4 | 4 | 4 | 3 |

[z]Treatment not applied.

Firmness was determined either by applying thumb pressure or using a penetrometer having a 50.5-g plunger with a 3-mm diameter penetration surface. The plunger was dropped 4 cm through a guide tube striking the cut flesh. Measurements were also made to determine the ratio of seed cavity to flesh. Soluble solids were determined with a hand refractometer from the juice of a 1-cc core from each melon. Samples were taken by pushing a 13-mm "seed sampling tool" through the melon from outside into the cavity of the melon. While the core was still in the tool, about 2 mm was trimmed before it was removed to extract the juice from making the determinations. Since we found that the level of total solids vary with position on the fruit (unpublished data), all cores were taken from the blossom end of each test melon and at a location opposite the groundspot. This minimized position variation. The numbers 27 and 36 refer to the number of melons packed in a commercial muskmelon crate. The larger the number, the smaller the melons.

Table 2. Effect of irrigation treatment on muskmelon yield, size, earliness, and cull fruit.

| Year | Moisture treatment | Marketable fruit (Crates/ha)[z] | | Size 27 & 36 (%) | Culls (%) |
|---|---|---|---|---|---|
| | | Total[y] | Early[x] | | |
| 1967 | Wet | 568a[w] | 66.9a | 47.8a | 15.4a |
| | Medium | 672b | 201.1b | 57.5a | 16.8a |
| | Dry | 716b | 216.6b | 55.5a | 16.4a |
| 1968 | Wet + prethinning | 479a | 68.9a | 23.6a | 25.0b |
| | Medium | 674b | 179.1b | 40.0b | 11.9a |
| | Dry | 595b | 220.6b | 40.4b | 19.2ab |
| 1969 | Wet | 1198b | 560.2c | 75.5a | 14.2a |
| | Medium | 1109a | 446.6b | 77.2a | 12.0a |
| | Dry | 1092a | 332.4a | 81.8a | 11.8a |
| 1970 | Wet | 580b | 289.9b | 40.3a | 28.0a |
| | Wet + prethinning | 504a | 193.4a | 43.6a | 28.6a |
| | Medium | 622b | 282.6bc | 59.3b | 32.3a |
| | Dry | 724c | 328.3c | 63.8b | 26.3a |

[z]Commercial crate (56 × 33 × 33 cm).
[y]Total yield includes a composite of 45, jumbo 45, 36, 27, and 23 size melons.
[x]First week of harvest.
[w]Mean separation within years in a column by Duncan's multiple range test, 5% level.

## Results and Discussion

The effect of irrigation treatment on yield, size, earliness, and percent culls is shown in Table 2. Each year, except 1969, the wet treatments resulted in lower yields and smaller fruit. The 1969 season was a very favorable growing season, as evidenced by the higher yields and greater percentage of larger melons, compared with the other years. Irrigation frequency had no consistent effect on proportion of culled fruit. The drier treatments produced greatest yields during the early part of the harvest season except for 1969.

The plants receiving a prethinning irrigation were visibly smaller. When 25 plants were taken from each plot at thinning and dried in a forced-air oven, they were found to contain significantly less dry matter than those not receiving this irrigation (Table 3). The prethinned irrigated plants were also yellowish-green. Vine-growth differences persisted throughout the growing season. The data indicate that the prethinning irrigation was detrimental and should be avoided as a commercial practice. At the conclusion of harvest, 30 plants from both the prethinning irrigation treatment and the wet treatment were dug and the root system characterized (Table 4). Plants without the prethinning irrigation had more extensive lateral roots, while those receiving the irrigation produced more plants without taproots, were more forked, and had larger and shallower lateral roots.

The appearance of the small tops of the plants in the prethinning irrigation treatment plots at thinning, coupled with the unnatural appearance of the root system from the mature plants, indicated a restricted, atypical plant- and root-growth pattern. This could have resulted from low oxygen levels. Russell (8) reported that low levels of oxygen in the rooting medium restricted growth or even caused death. In the absence of adequate oxygen, the roots were thickened, shorter, and darker and had fewer root hairs. These were the characteristics of the roots from the overwatered plants in these tests. Letey et al. (3, 5) found a general increase in dry weight with increased oxygen levels. Low soil oxygen was most detrimental during the early stages of growth following germination. Russell (8) also reported that root growth at various levels of oxygen was strongly influenced by temperature, and increased oxygen levels were needed to maintain good plant growth with higher temperatures. Most workers agree with Letey et al. (4) that the oxygen supply to a root surface under a given set of conditions was reduced by lowering the temperature. The prethinning irrigation in this test, when the soil moisture was near field capacity and temperatures at 8 to 10°C, probably brought about low oxygen tensions and a reduced oxygen supply to the roots, accounting for the poor growth.

In 1969, the wet treatment produced more sunburn-damaged

Table 3. Effect of a prethinning irrigation of muskmelons on plant dry weight at thinning.

| Treatment | Dry wt/plant (g)[z] | |
|---|---|---|
| | 1968 | 1970 |
| With a prethinning irrigation | 2.1 | 1.8 |
| With no prethinning irrigation | 2.8 | 2.2 |

[z]Difference statistically significant by *t* test, 1% level.

Table 4. Effect of prethinning irrigation on the root system of mature muskmelon plants, 1970.

| Treatment | No. plants without taproot | No. plants with forked taproot | Major lateral (Roots/plant) | Forked lateral (Roots/plant) | Laterals larger than 6 mm at base (Roots/plant) |
|---|---|---|---|---|---|
| With no prethinning irrigation | 3 | 3 | 12.8 | 0.0 | 0.5 |
| With a prethinning irrigation | 8 | 5 | 9.7 | 0.5 | 1.4 |
| Statistical significance | * | NS | ** | ** | ** |

NS,*,**Nonsignificant (NS) or significant at 5%(*) or 1%(**) level by *t* test.

fruit, whereas in 1970, more fruit was sunburned in the drier treatments (Table 5). This seems inconsistent but the amount of sunburn damage in 1969 was associated with early, rapid vine growth where limited shallow root systems developed. In most growing seasons sudden stress conditions (> 40°C temperature and < 10% relative humidity) usually occur at or near harvest. When this happens, the vines with large leaves and long succulent petioles wilt earlier, for longer periods and more severely than those with less luxuriant foliage. Plants under theseconditons expose the previously covered and protected fruit to excessive sunburn damage. These conditions of high temperature and low humidity prevailed in 1969. With these stresses wilting occurs because restricted, weak root systems are incapable of supplying enough water to maintain turgor.

More fruits were culled due to decay where more irrigations were used. Decay was related to wetness of the tissue in contact with the soil. Ground spots remained about the same size as that of the initial infection, which depended on the amount of melon surface in direct contact with the soil. No significant increase was noted relative to fruits culled because of the size of ground-spot damage due to irrigation. No consistent influence of irrigation treatment was found related to fruits culled because of poor netting or softness, but the drier treatments produced more fruits with growth cracks. The reasons for this have not been identified.

Some significant effects of treatment were found associated with vein tracts, flesh color, flesh firmness, and ratio of flesh to cavity, but these were not consistent from year to year (Table 6). In part, this was associated with climatic variability. In 1969, cooler temperatures and a delay in the normal hot, dry conditions probably accounted for the differences. The dry treatments significantly increased the percentage of soluble solids.

Table 5. Effect of irrigation treatment on muskmelon defects of culled fruit.

| Year | Treatment | Avg no. of fruits/plot | | | | |
|---|---|---|---|---|---|---|
| | | Sunburn | Decay | Soft fruit | Poor netting | Growth cracks |
| 1967 | Wet | 4.1a[z] | 8.0b | 2.0a | 12.4a | 2.1a |
| | Medium | 1.2a | 1.9a | 1.8a | 18.4a | 3.2a |
| | Dry | 2.3a | 2.1a | 1.8a | 18.6a | 4.4a |
| 1968 | Wet + prethinning | 8.2a | 12.8a | 5.2b | 11.6a | 4.0a |
| | Medium | 3.2a | 6.0a | 1.4a | 5.0a | 1.8a |
| | Dry | 5.8a | 7.0a | 2.0a | 13.4a | 2.8a |
| 1969 | Wet | 8.5b | 12.9b | 4.0a | 4.1a | 10.1a |
| | Medium | 5.6a | 3.9a | 2.0a | 3.2a | 17.4b |
| | Dry | 4.6a | 3.9a | 2.8a | 2.2a | 15.4ab |
| 1970 | Wet | 11.2ab | 10.4b | 5.2a | 14.7a | 9.2ab |
| | Wet + prethinning | 8.4a | 9.4b | 5.4a | 14.2a | 8.1a |
| | Medium | 15.9c | 7.9ab | 4.9a | 19.6b | 14.6bc |
| | Dry | 13.1bc | 5.0a | 5.1a | 12.3a | 18.4c |

[z]Mean separation within years in a column by Duncan's multiple range test, 5% level.

Table 6. Effects of irrigation treatments on shipping and storage quality of muskmelons.

| | | Avg 10 randomly selected melons | | | | |
|---|---|---|---|---|---|---|
| Year | Treatment | Vein tracts rating[z] | Flesh color rating | Flesh firmness rating[x] | Soluble solids (%) | Ratio flesh to seed cavity |
| 1967 | Wet | 5.8a[y] | 5.6a | 5.4a | 10.6a | 19.0a |
| | Medium | 6.6a | 6.2a | 5.8a | 11.2a | 19.4a |
| | Dry | 6.2a | 6.4a | 6.8a | 11.4a | 18.6a |
| 1968 | Wet + prethinning | 6.6a | 7.0a | 6.0a | 9.4a | 18.2a |
| | Medium | 6.6a | 7.0a | 7.4a | 10.3a | 20.8b |
| | Dry | 7.4a | 7.0a | 6.8a | 10.7a | 20.1a |
| 1969 | Wet | 6.0ab | 6.0a | 5.8b | 12.4a | 20.1a |
| | Medium | 6.8b | 7.2b | 6.3b | 12.6b | 20.4a |
| | Dry | 5.5a | 6.1a | 4.9a | 12.3a | 21.9b |
| 1970 | Wet | 6.5a | 6.6a | 2.2a | 10.8a | 21.1a |
| | Wet + prethinning | 6.7a | 7.3a | 2.4a | 10.7a | 21.2a |
| | Medium | 6.6a | 6.8a | 2.6a | 11.7b | 21.1a |
| | Dry | 5.8a | 6.8a | 2.4a | 11.9b | 21.8a |

[z]Ratings for vein tracts, flesh color, and flesh firmness are based on a scale 1 (poorest) through 9 (best).
[y]Mean separation within years in a column by Duncan's multiple range test, 5% level.
[x]In 1967 and 1968 the flesh firmness was measured subjectively, based on a scale of 1 through 9, with 9 being the firmest. In 1969 and 1970, it was measured using a penetrometer. The lower readings indicate firmer flesh.

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