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IRRIGATION WATER USE AND YIELD OF THYME IN THE VIRGIN ISLANDS

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ABSTRACT

Thyme (*Thymus vulgaris* L) is one of the major culinary herbs with economic importance in the Virgin Islands. In spite of this, little research has been undertaken to improve its crop cultural management practices. The traditional practice of growing herbs in the Virgin Islands requires frequent watering by hand with sprinkler cans or garden hose. This practice is inefficient and uses high amounts of water and labor. This experiment was conducted to determine the minimum irrigation water requirement of thyme with and without mulch. Treatments consisted of 3 irrigation levels corresponding to soil water tensions of 20, 40, and 60 kPa. Half of the treatments were mulched using a black plastic weed barrier ground cover. A rainfed plot without mulch served as the control. Differences in yield among treatments were significant, although rainfall was high during the growing season. Total fresh and dry matter yields were highest from treatment with an irrigation level maintained at soil water tension of 20 kPa without mulch. Generally, all treatments with mulch and the control had yields lower than treatments without mulch. This indicated that mulching is not necessary for thyme when rainfall is high and soil moisture is not a limiting factor. Total irrigation water use was highest (5.85 l/plant) in treatment with higher irrigation level (20 kPa) in both mulch and unmulched plots. Treatments under 60 kPa had the least water use. Based on the results, it appears that the minimum water requirement for growing thyme in the Virgin Islands can be met by maintaining a soil water tension of 60 kPa.

Key Words : drip irrigation, herbs, mulching, thymus vulgaris

INTRODUCTION

Thyme (*Thymus vulgaris* L) is one of the major culinary herbs of economic importance in the Virgin Islands. It is a low-growing perennial herb with spreading woody stems. The stem bears little gray-green sagittate leaves. Thyme ranks as one of the top selling fresh herbs in the local market. At $10-20/kg ($5-10/lb), herb growers can therefore make substantial returns from a small growing area. Although most of the locally produced thyme is sold in local markets, there is potential for an export market since most of the herbs consumed in the U.S. mainland are imported.

Lack of technical information for growing herbs in the Virgin Islands is a major reason for the paucity of vegetable growers engaged in thyme production. In spite of their economic importance little research has been undertaken to improve field production of herbs. Thyme can be easily grown in the tropical climate of the Virgin Islands, but field production is constrained by factors related to environment and management practices. Water is a major limiting resource for agriculture in the Virgin Islands, and without supplemental irrigation, commercial production of high value crops such as herbs is not feasible. The traditional practice of growing herbs in the Virgin Islands involves frequent watering by hand with sprinkler cans and garden hose. This practice is inefficient and involves high labor and water use.

Information on crop management practices for culinary herbs is scanty. There is a void of documented literature on planting methods, fertilizer application, water requirement, weed, insect and disease control. There is very little information on the minimum water requirement of herbs, although soil water availability has a strong influence on plant growth and yield performance. Research with

varying rates of drip irrigation water showed increases in growth and total yield of essential oil from herbs with increasing rates of water application (SIMON, 1987). A similar study conducted one year later during a season with high rainfall showed no benefit from drip irrigation.

The interaction of soil moisture and soil fertility affects the accumulation of plant products, indirectly influencing plant growth in aromatic and medicinal plants (BERNATH, 1986; FRANZ, 1983; PENKE, 1978). Experiments comparing sprinkler with drip irrigation on herbs at the University of the Virgin Islands Agricultural Experiment Station demonstrated a more efficient water use and increased yield under drip irrigation (COLLINGWOOD *et al.*, 1991). Integration of mulch with drip irrigation resulted in additional increase in water use efficiency and yield of basil (PALADA *et al.*, 1992). The minimum water requirement for growing various herb species has not been established. Studies on determining irrigation water requirement of herbs are important in the Virgin Islands where water is usually a costly input in crop production. This experiment was conducted to 1) determine the minimum water requirement of thyme under field conditions and 2) study the effects of mulching on the yield and economic returns of thyme under drip irrigation.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Experiment Station, University of the Virgin Islands in St. Croix, USVI (lat. 17°42'N and long. 64'48'W). The soil at the experiment station is Fredensborg loamy, fine carbonatic, isohyperthermic, shallow, typic calciustolls (LUGO-LOPEZ and RIVERA, 1980). The average annual rainfall is 1016 mm, but evaporation exceeds rainfall 10 months of the year resulting in a negative water balance. The experiment was established using a randomized complete block design with 4 replications. The treatments consisted of 3 irrigation levels corresponding to soil moisture tensions of 20, 40 and 60 kPa. Half of the treatments were mulched using a black plastic, water-permeable weed barrier ground cover. A rainfed control (no mulch) was included as a treatment.

The drip irrigation system consisted of main and submain lines made of 15-mm black polyethylene hose. The laterals were made of 15-mm drip strip with laser drilled orifices 20 cm apart.

Thyme seedlings were grown in the greenhouse from January 8 to March 19, 1992. Seedlings were transplanted on March 20 in 3-row plots. Each plot measured 0.9 m x 2.4 m. Plants were spaced 30 cm between rows and 20 cm within rows. One week after planting, plants were fertilized with granular forms of N, P and K at the rate of 50, 100 and 100 kg/ha, respectively. The plots with no mulch were hand-weeded 6 times during the period from April 6 to June 10.

Soil tensiometers (Irrometer Co., Riverside, CA) were installed at 15 cm depth in each treatment on 2 replications to monitor soil moisture tension. The tensionmeters were read daily and readings were used to turn on the irrigation water when soil moisture tension exceeded the specified level. A water meter and a timer were installed in the irrigation systems for each treatment. Water use was determined from weekly water meter readings. Total irrigation water use was determined over a period of 9 weeks.

Data on rainfall and pan evaporation were collected from a USDA weather station situated on lands adjacent to the experiment station.

The plants (excluding roots) were harvested on June 30, 1992, approximately 3 months after planting. Yield samples were taken from 2-m long sections of the middle rows. Data were collected on plant height, plant fresh weight and dry matter yield. Statistical analysis of data was performed using MSTAT-C, a microcomputer program for the design, management and analysis of agronomic research experiments (Michigan State University, East Lansing, MI). Significant differences among treatment means were determined using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Rainfall and Evapotranspiration

As shown in Fig. 1, total rainfall in 1992 was above normal (1303 mm). May was the wettest month with rainfall of 277 mm. Total

rainfall received during the 3-month growing season (AprilJune) was 371 mm. Most of the rainfall occurred in May which coincided with the active vegetative growth of plants. Irrigation water application was therefore withheld for most treatments. Pan evaporation which is a measure of potential evapotranspiration (ET) followed the yearly normal pattern (Fig. 1) and exceeded precipitation 9 months during the year. Rainfall exceeded pan evaporation only in May, November and December.

Irrigation and Water Use

High rainfall during the growing season resulted in low frequency of irrigation water application to all treatments. Therefore, water applied to various treatments in this study can be considered only as supplemental irrigation. During the period, April to June irrigation water was applied only 5 times for treatment with 20 kPa. Treatment with 40 kPa received 4 applications while treatment under 60 kPa without mulch was irrigated only 3 times. Although the frequency of irrigation varied with treatments, for a given treatment (soil water tension) total water use did not differ between mulched and no mulch plots (Table 1). Total irrigation water use was highest in treatment with irrigation regime of 20 kPa. This treatment used an average of 5.85 liters of water per plant or 492 cu.m. per ha whether mulch or unmulched. Treatment under 60 kPa had the least water use. This treatment also resulted in more efficient use of irrigation water at the least cost (Table 1). This result would suggest that under high rainfull, supplemental irrigation can be minimized by maintaining the soil moisture at 60 kPa. At this level the minimum water requirement of thyme can be met. However, during seasons of low rainfall this level may change, indicating the need to repeat the experiment at different times of the year.

Fresh and Dry Matter Yield

In spite of the high rainfall, differences in yield among treatments were significant (Table 2). Total plant fresh yield was highest (4967 kg/ha) from plots with an irrigation regime maintained at 20 kPa without mulch. Dry matter yield was also the highest in this

treatment, but not significantly different from yields in unmulched plots under 60 kPa. Overall, all plots with mulch and the control (rainfed) produced shorter plants with lower yields than plots without mulch (Table 2). This result is consistent with those obtained in a previous experiment (COLLINGWOOD *et al.*, 1991). Low yield of thyme under black plastic mulch and drip irrigation was attributed to a high incidence of fungal diseases. This result suggests that when soil moisture is not a limiting factor because of high rainfall, mulching is not necessary and beneficial for thyme production in the Virgin Islands.

Economic Returns and Water Use Efficiency

The gross return was highest from non-mulched thyme under an irrigation regime of 20 kPa followed by treatment under 60 kPa (Table 3). Although thyme grown under an irrigation regime of 20 kPa produced the highest yield and gross return, water use and costs were also the highest. This resulted in lower returns to irrigation water. The highest return to irrigation water was obtained from non-mulched plots under 60 kPa (Table 3). For this treatment every dollar spent in irrigation water resulted in econo0ic return of $65.63. This treatment would therefore give the most efficient and profitable use of supplemental irrigation water. All treatments with mulch resulted in lower gross returns and returns to irrigation water when compared to non-mulched and control treatments.

SUMMARY AND CONCLUSION

This study indicated that irrigation water use of thyme in the Virgin Islands was reduced under conditions of high rainfall during the growing season. Under high rainfall, water application is required only as a supplemental irrigation. Minimum water requirement for thyme was met at an irrigation level equivalent to soil water tension of 60 kPa. Mulching under high rainfall was not beneficial and may actually be deterimental to thyme production since it resulted in significantly reduced yields. Under high rainfall, efficient use of supplemental irrigation water can be achieved if soil water tension is maintained at 60 kPa. At this level economic returns to irrigation water was the highest

for thyme production in the Virgin Islands.

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Table 1. Estimated irrigation water use and efficiency of thyme at three levels of irrigation with and without mulch. UVI/AES, June, 1992.

Irrigation level (kPa)	Mulch	Total water use (l/plt)	Irrigation water cost (cu.m	($/ha)[z]	Water cost efficiency ($/kg)[y]
20	No	5.85	492	2081	1.30
40	No	4.5	378	1599	1.62
60	No	1.80	151	639	0.55
20	Yes	5.86	492	2081	3.12
40	Yes	4.51	378	1599	2.50
60	Yes	1.80	151	639	1.92
Rainfed	No	16.35[x]	1372[x]	--	--

[z]Based on water cost of $4.23/cu.m.

[y]Cost of water to produce a kilogram of fresh thyme.

[x]Represents amount of rainfall received during the period and computed based on 1 mm rain = 4047 liters.

Table 2. Plant height, total plant fresh and dry water yield and water use of thyme grown at three levels of drip irrigation with and without mulch. UVI/AES, June, 1992.

Irrigation level (kPa)	Mulch	Plant height[z] (cm)	Plant Fresh wt. (kg/ha)	Yield Dry wt.
20	No	20.4 a[y]	4967 a	1604 a
40	No	20.0 a	2964 b	990 b
60	No	19.3 ab	3495 b	1169 ab
20	Yes	15.2 b	2254 bc	668 bc
40	Yes	16.3 ab	2015 bc	639 bc
60	Yes	17.1 ab	1078 c	332 c
Rainfed	No	16.7 ab	2776 b	981 b

[z]Measured at harvest from ground level to the tip of youngest leaf.

[y]Means within each column followed by the same letters are not significantly different by Duncan's Multiple Range Test, (P=0.05).

Table 3. Yield and economic returns from thyme grown under drip irrigation with and without mulch. UVI/AES, June, 1992.

Irrigation level (kPa)	Mulch	Total fresh yield (kg/ha)	Gross value[z] ($/ha)	Irri. water cost[y] ($/ha)	Returns to irri. ($/$)[w]
20	No	4967 a[x]	59604	2081	28.6
40	No	2964 b	35568	1599	22.24
60	No	3495 b	41940	639	65.63
20	Yes	2254 bc	27038	2081	12.99
40	Yes	2015 bc	24180	1599	15.12
60	Yes	1078 c	12936	639	20.24
Rainfed	No	2776 b	33312	-	-

[z]Calculated from $12.00/kg of fresh thyme.

[y]Calculated from $4.23/cu.m. of irrigation water.

[x]Means within each column followed by common letters are not significantly different by Duncan's Multiple Range Test, (P=0.05).

[w]Calculated from gross value/irrigation water cost.