Some Effects of Soil Moisture and Various Mulch Treatments on the Growth and Metabolism of Sweetpotato Roots[1]

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Abstract. Studies were conducted to determine the effects of mulch treatment and soil moisture on plant production, soil temperature and the metabolism of sweetpotato roots. The use of petroleum agricultural mulch resulted in the harvest of sweetpotato slips 2 weeks before any of the other mulch treatments produced usable plants. A single layer or clear plastic, roofing felt, and also black plastic increased the earliness of sweetpotato plant production. The use of a single and a double layer of clear or clear over black plastic resulted in lower slip production and injury to the bedded roots. At a depth of 3 inches all the mulch treatments increased average soil temperatures when compared to the unmulched treatment. A double layer of clear plastic gave the highest average soil temperature at the 3 inch depth. There was little difference in average soil temperature 3 inches under the clear over black plastic, clear plastic, or petroleum mulch treatments.

Sweetpotatoes growing in soil and in soil covered with a layer of petroleum mulch (ENCAP) or hexadecanol (TAGE) had a higher respiration rate than roots growing in air at 30°C. ENCAP and TAGE increased the CO_2 emission of sweetpotato roots in comparison to non-mulched controls. Roots growing in soil and in soil mulched with ENCAP had more top and root growth than roots growing in air. TAGE restricted top and root growth of sweetpotato roots growing in soil. Soil moisture increased the respiration rate of sweetpotato roots more than ENCAP at 30°.

THE economical production of sweetpotatoes is often hindered by the difficulty of producing early plants (5). The effects of black and clear polyethylene plastic as a mulch on sweet potato plant production has been reported (2, 5, 6, 7, 12). The effect of petroleum agricultural mulch as a covering for dryland seed drills of agronomic crops has also been investigated (8). More recently the effect of petroleum agricultural mulch has been investigated for its effect upon soil temperature and soil moisture (9), (11).

The purpose of this experiment was to evaluate the effects of mulching materials on the growth and metabolism of sweetpotato roots in the field and under controlled temperature conditions at 30°C.

Materials and Methods

On March 18, 1964, a test consisting of 7 mulch treatments was initiated using the 'Centennial' variety and a Youden square experimental design (4). Each mulch treatment was replicated 3 times. The 50 lb. lots of sweetpotatoes contained an average of 253 roots that weighed approximately 3.2 oz. each. These roots were treated with Semesan Bel and then bedded in a 6 × 4 ft space along a propagating bed. The roots were covered with a 3 inch layer of Bowie fine sandy loam soil. Forty pounds of an 8–8–8 complete fertilizer was applied per 800 ft² of propagating bed. The mulch materials were spread over the 3 inches of soil covering the roots and the edges of the film material covered with soil.

The 7 treatments were as follows: 1) 4 mil clear plastic in a solid piece, 2) 2 mil black plastic that overlapped in the middle of the bed, 3) a double layer of 4 mil clear plastic, 4) a layer of 4 mil clear plastic over a layer of 2 mil black plastic, 5) bare soil (control), 6) roofing felt overlapped in the middle of the bed, and 7) petroleum agricultural mulch at 0.02 gal/ft² of bed.

Copper Constantan thermocouples were inserted to a depth of 3 inches in the soil under each of the 7 mulch treatments. Temperatures were recorded with a recording potentiometer 24 hr a day for 16 non-consecutive days between the time of bedding on March 18 and the removal of the roofing felt on April 16. All other mulch covers were removed on April 22.

The following controlled temperature studies were conducted using 'Copperskin Goldrush' sweetpotatoes in combination with various mulch materials and soil moisture conditions.

Samples of sweetpotato roots weighing 1.5 k were placed in sealed 2.5 gal containers in a 30°C constant temperature room. Inside these containers, the sweetpotato roots were grown either in 6 k of an unmulched Izagora fine sandy loam soil or in the same soil mulched with ENCAP[2] or TAGE[3] (Fig. 3). Similar samples of roots inside polyethylene bags were also placed in soil inside the above containers. Two control treatments consisting of the Izagora soil only and sweetpotato roots in air only were also included. All 6 treatments were replicated 4 times. The CO_2 content of the humidified air immediately above all treatments was maintained at approximately 0.5% by the use of capillary flowmeters. The CO_2 content of the air stream from the containers was determined every 12 hr over a 14 day period (3).

To determine whether volatile materials in ENCAP were a factor in respiration of the plant material, sweetpotato roots were placed in respirometer jars with shredded paper toweling or toweling that had been impreg-

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[2]This research was supported in part by Humble Oil and Refining Company, Baytown, Texas Suppliers of ENCAP petroleum mulch. ENCAP was applied at approximately .02 gal/ft².

[3]TAGE was supplied through the courtesy of Dr. J. R. Runkles, Texas A&M University and applied at approximately 10 g/ft².

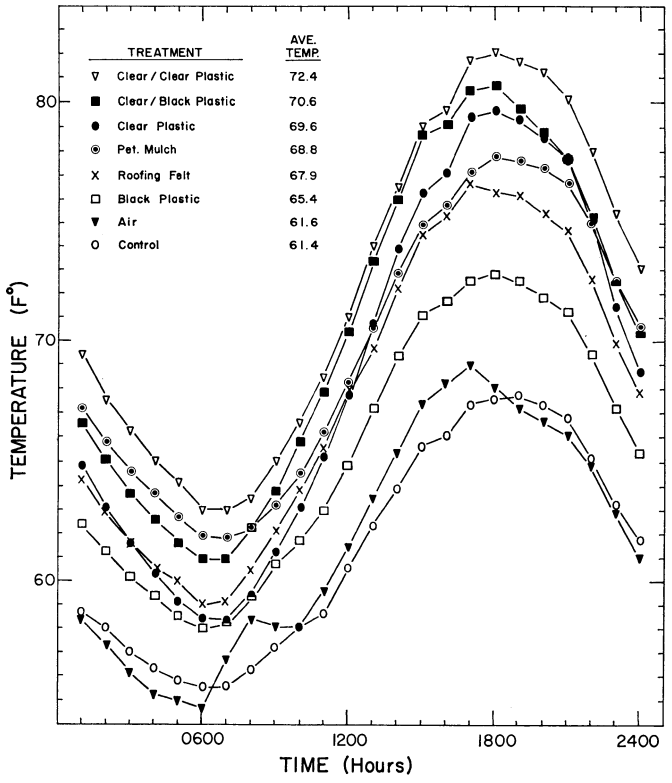

Fig. 1. Daily variation of soil temperature under various mulch treatments over a 16-day period.

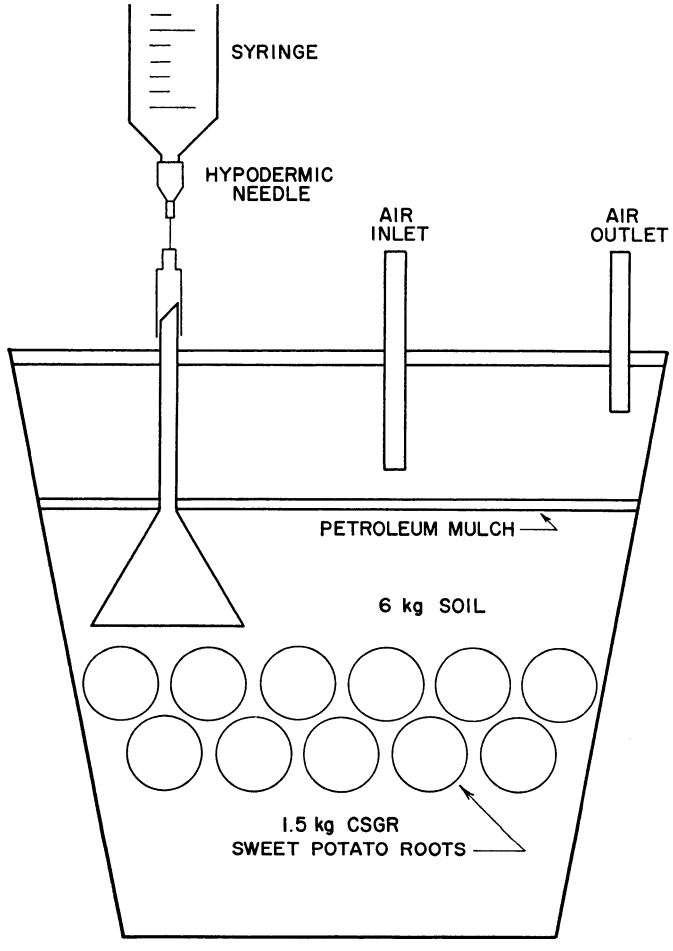

Fig. 3. Container used to measure respiration rate of sweet potato roots growing in soil under various mulch treatments.

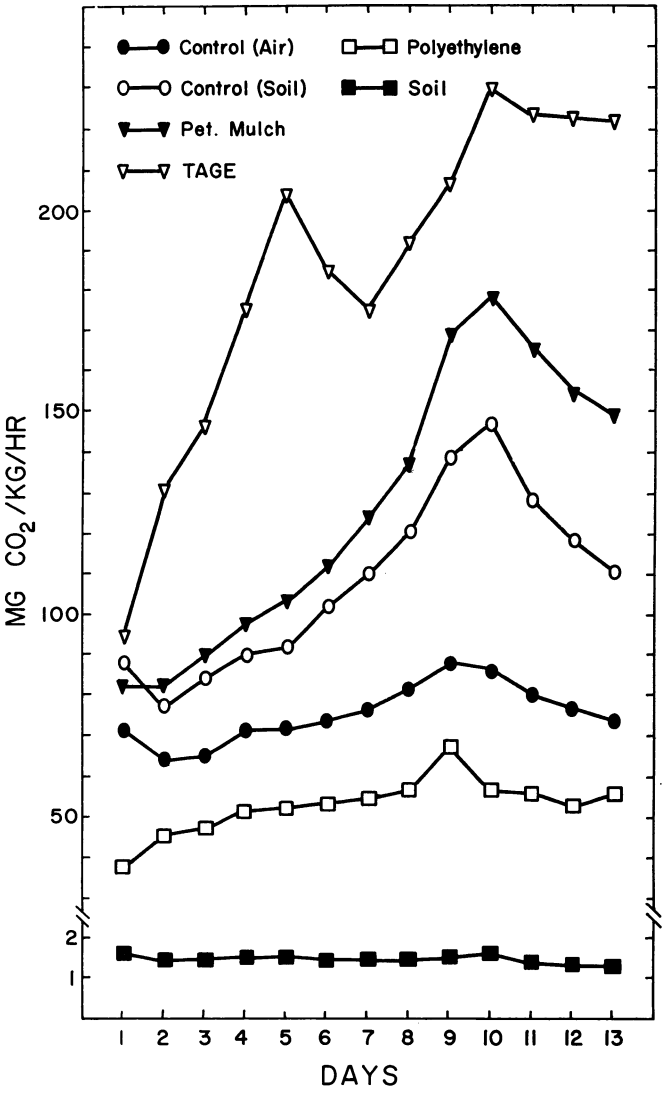

Fig. 2. Respiration rate of Copperskin Goldrush sweet potato roots at 30°C growing in Izagora fine sandy loam soil and in soil under mulch treatments.

Table 1. Effect of various mulch treatments on the field production of Centennial sweetpotato slips. Martin's Mill, Texas. 1964.

Treatment	Number of slips					
	Date				Total	Total corrected for blocks
	4–23	5–6	5–20	6–4		
Clear plastic[a]	—	1033	317	346	1696	1480
Control	—	386	698	374	1458	1356
Petroleum mulch	390	489	267	272	1418	1398
Black plastic	—	679	321	361	1361	1352
Roofing felt	—	692	223	417	1332	1395
Clear over black plastic[a]	—	371	551	310	1232	1367
Clear over clear plastic[a]	—	534	392	217	1143	1292
Total	390	4184	2769	2297	9640	
L.S.D.[b] Total slips. Date × treatment 5%—257 1%—345						

[a]Injury.
[b]Treatment differences not significant.

nated with ENCAP. The CO_2 evolution was monitored on 3 replications of each treatment as noted above at 30°C.

Triplicate lots of sweetpotato roots were evaluated for CO_2 evolution over a 14 day period under high and low moisture conditions. These roots were subjected to a 2 × 2 factorial treatment of 2 soil moisture levels i.e. 10.9% and 0.5% with and without ENCAP as described above at 30°.

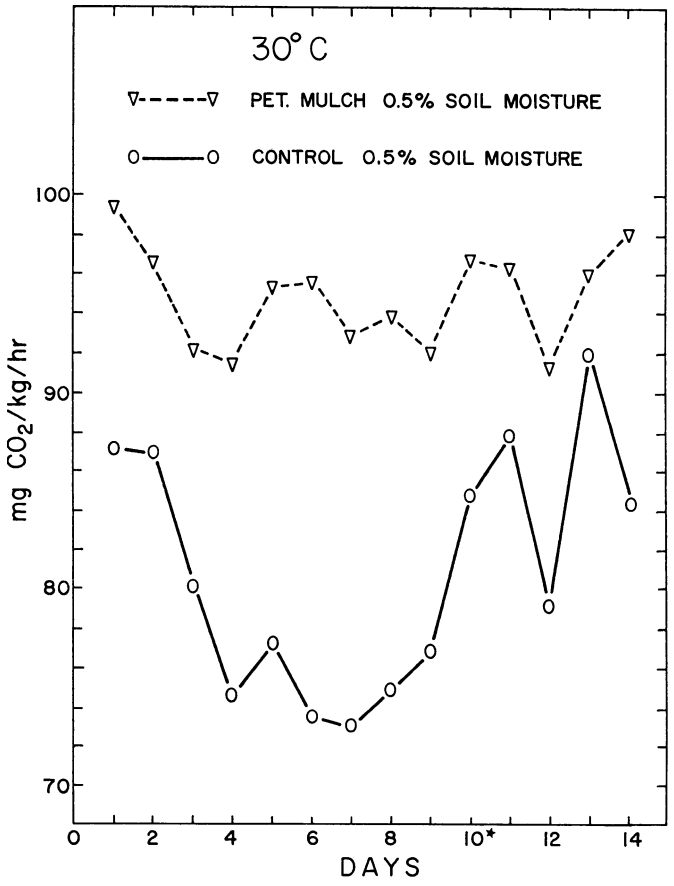

Fig. 4. Respiration rate of sweet potato roots at 0.5% soil moisture with and without ENCAP.

In another experiment non-replicated 1.5 kg lots of sweetpotato roots were dipped in 3 liters of tap water and then kept moist by allowing water to drip onto the roots throughout a 5 day storage period. Other treatments in this experiment included sweetpotato roots that were submerged in 3 liters of tap water for 48 hr and a non-treated control. The respiration rate of the sweetpotato roots was determined at 12 hr intervals in a 30°C room.

Results and Discussion

As shown in Fig. 1, the double layer of clear plastic gave the highest average soil temperature at the 3 inch depth. There was little difference in average soil temperature under the clear over black, clear or petroleum mulch treatments. The use of roofing felt resulted in a higher soil temperature than did black plastic. The Bowie fine sandy loam soil followed the air temperature throughout the test. The petroleum mulch treatment cooled off less at night than any other mulch treatment with the exception of the double layer of clear plastic (Fig. 1).

The use of ENCAP resulted in the harvest of 'Centennial' sweetpotato slips 2 weeks before any of the other mulch treatments. The clear plastic, black plastic and roofing felt treatments resulted in earlier plant production than the control or the double layer of clear over clear and clear over black plastic treatments. The use of a double layer of clear over clear or clear over black plastic resulted in a lower slip production. The difference in total plant production between the different mulch treatments was not significant (Table 1).

There was a striking difference among the respiration

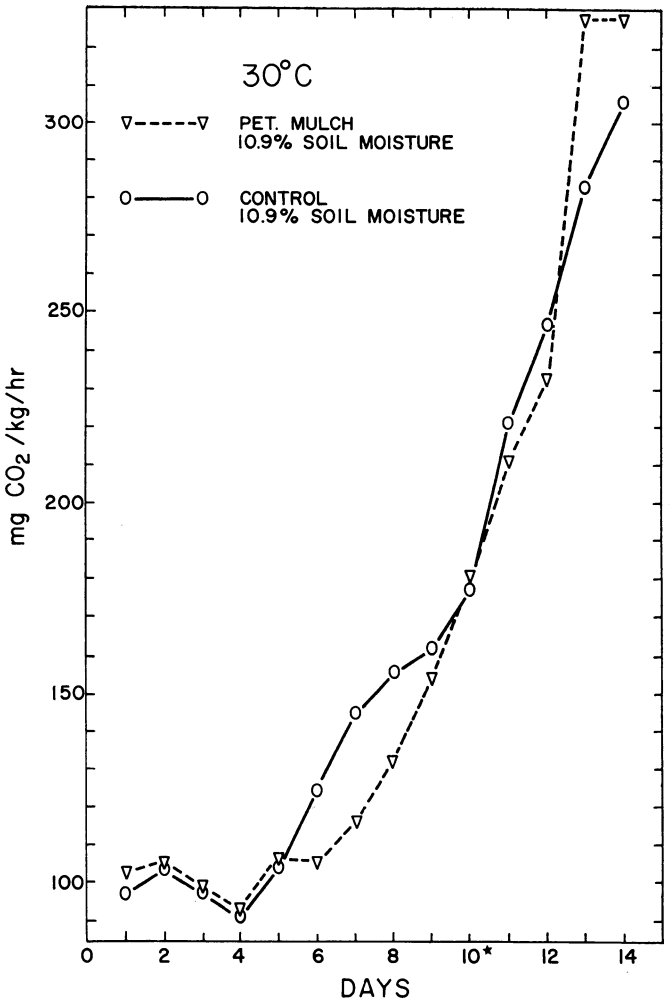

Fig. 5. Respiration rate of sweet potato roots at 10.9% soil moisture with and without ENCAP.

rates of the 'Copperskin Goldrush' sweetpotatoes growing in air and in soil under the various mulch treatments at 30°C (Fig. 2). ENCAP and TAGE increased the CO_2 emission of sweetpotato roots in comparison with the non-mulched control lot growing in soil. All 3 of these treatments produced more CO_2 than the control roots in air (Fig. 2). There was only a limited amount of sprout growth on the roots growing in air. There was little difference in the amount of top and root growth of the sweet potato roots growing in soil and in soil mulched with ENCAP. TAGE severely restricted both the top and root growth of sweetpotatoes. There was very limited growth of either tops or roots in the polyethylene bags covered with soil. Polyethylene, TAGE and ENCAP increased the incidence of Java Black Rot in the sweet potato roots (1), (10).

The presence of petroleum mulch on paper toweling in close proximity to sweet potato roots had no significant effect on their respiration rate.

Soil moisture had a greater effect on increasing the respiration rate of sweetpotato roots in soil that did ENCAP (Fig. 4, 5, 6). There was a highly significant difference between the 0.5% and the 10.9% soil moisture levels in the respiration rate of sweet potato roots (Fig. 6). ENCAP gave a higher respiration rate than bare soil when the soil moisture was 0.5% (Fig. 4). With 10.9%

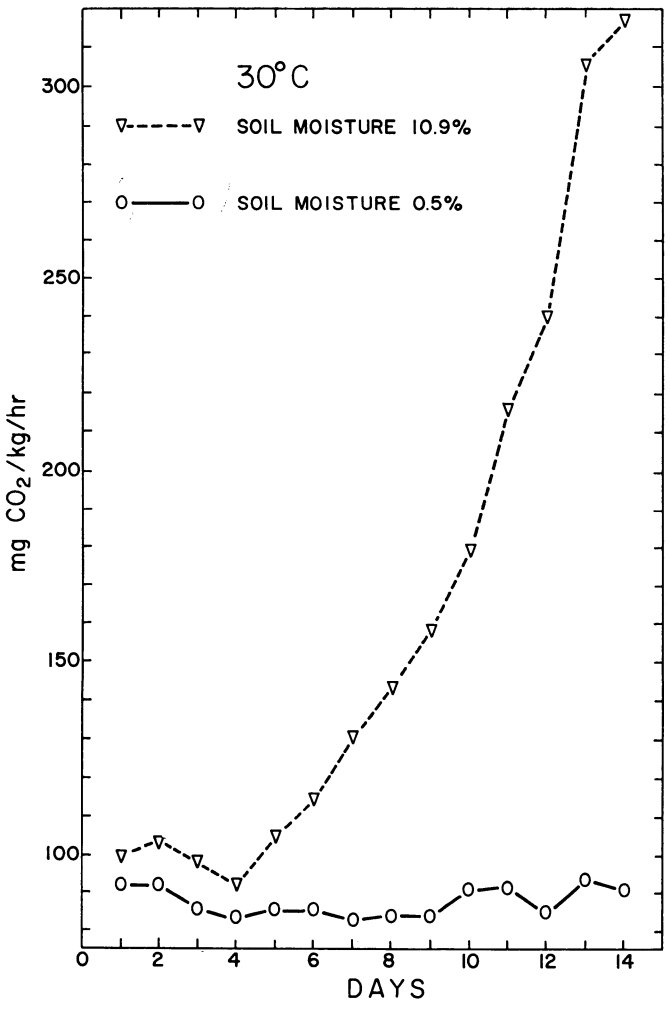

Fig. 6. The single effect of 0.5 and 10.9% soil moisture on the respiration rate of sweet potato roots.

soil moisture, a layer of ENCAP mulch made little difference in the respiration rate of the roots (Fig. 5).

As shown in Fig. 7, sweetpotato roots that were held under moist surface conditions or roots that were submerged for 48 hr in tap water showed almost no CO_2 evolution for 12 to 24 hr. This suggests that the roots are fixing CO_2; subsequent studies have confirmed this observation. The depression in CO_2 evolution was followed by a striking rise in its evolution (Fig. 7).

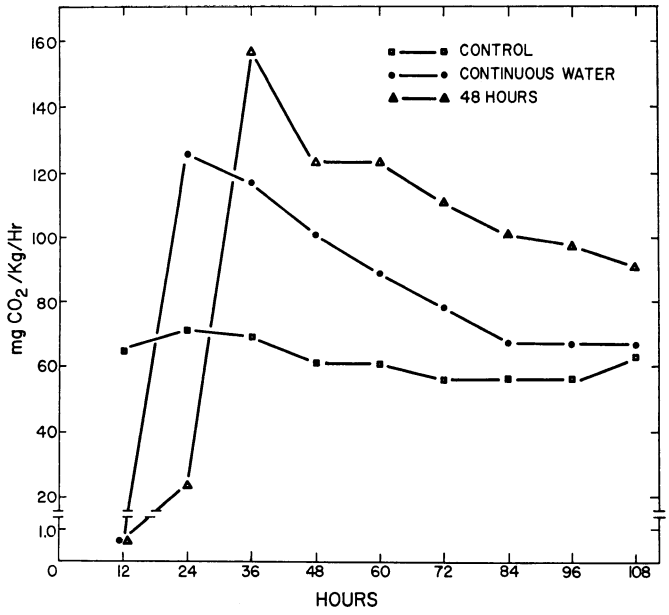

Fig. 7. The effect of maintaining free surface moisture on sweet potato roots and/or a 48-hour continuous water soak on the evolution of CO_2 by sweet potato roots.

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