308

YIELD RESPONSES OF TRANSPLANTED AND DIRECT-SEEDED MUSKMELON TO PLASTIC MULCH

BY

THOMAS M. BROWN

B.S. (Anthropology) Kansas State University 1985

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Horticulture
Kansas State University
Manhattan, Kansas

1988

Approved by J. K. Greig
Major Professor

The grower of trees, the gardener, the man born to
farming,
whose hands reach into the ground and sprout,
to him the soil is a divine drug. He enters into death
yearly, and comes back rejoicing. He has seen the light
lie down
in the dung heap and rise again in the corn.
His thought passes along the row ends like a mole.
What miraculous seed has he swallowed
that the unending sentence of his love flows out of his
mouth like a vine clinging in the sunlight and like
water descending in the dark?

Wendell Berry

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

An important principal in the cropping of seasonal produce is the goal of selling produce earlier than the competitor. In many cases, this involves a significant risk on the part of the grower since "early production" implies a marginal environment for the growth and development of the crop in question during the initial part of the season.

Because the prices for early produce are often better than in the main part of the season, many growers are willing to take some degree of risk by planting early in order to benefit from those prices. Attempts are made at minimizing the risk to the crop by protecting it in various ways. If the benefits of early marketing are great enough, the grower will expend considerable capital to bring in an early crop.

The French are famous for their use of large glass bell jars to protect early tomato and eggplant crops and have since led the way in developing other techniques for growing early vegetable crops (21,50). Not only in Europe however, have techniques been used to grow early vegetables. In South Asia, early vegetables are protected from frost and wind damage by removable covers made of stiff mats of grass, and in China rows of bamboo are grown at close intervals in the crop field to protect the crop from mechanical wind damage (57). The ancient desert dwellers of the Negev spread a two to three centimeter layer of small, dark pebbles around their crop plants to prevent evaporation of precious soil moisture in the extremely dry climate. This "stone-mulching," also provides some radiant protection from brief periods of frost, allowing the farmers to extract every benefit from a rather difficult growing season (23). Thus, it is common for growers the world over to try to manipulate the microclimate of their particular area in order to take advantage of potential rewards for that manipulation.

Because of the ample rewards of protecting and forcing crops during cool weather, research has been rather vigorous (34,50,57) in the past thirty years. One of the major dividends of work in the area of plant protection by mechanical means has been the refining of plant mulching techniques.

Dubois defines a mulch as a "protective covering on the soil around the plants with the aim of helping growth and, consequently, crop earliness, productivity and partial protection of the produce by suppression of weeds; protection is also provided from frost and from the action of torrential rain" (20). Mulches are composed of many types of materials; both living and non-living and are capable of great moderations in the immediate environment of the plant (1,20,57). As mulches are used now, they are capable of both warming the soil upon which they are laid and of keeping the soil cool and moist (15,32,42). They may be used for the control of specific insects and nearly all mulches help to control weeds (19,37,53). These various benefits may be derived from mulches by understanding their characteristic capabilities and drawbacks.

The advent of widely available plastic films in the 1950's and 1960's brought an expansion in the utility of mulches. Plastic film may be produced in long, narrow sheets and in many colors. In comparison to the amount of resources required to utilize an organic mulch, plastic mulches can appear very advantageous. Plastic mulches can be far cheaper and easier to lay and have a greater potential for immediate economic benefit than an organic mulch (6,13,22,68,80).

The scope of this study is confined to the effects and characteristics of non-organic, plastic film mulches. Due acknowledgement is given to the fact that plastic films are indeed technically "organic," in the chemical sense.

However, it is also true that plastics are not "organic" in the sense that they are not nor have they ever been "alive" as such. Thus, herein it will be understood that "organic" mulches refer to straw, compost, newspaper, bagasse, and other sorts of readily decayed plant matter refuse, whereas "plastic" mulch will refer to any mulch made from plastic.

LITERATURE REVIEW

Physical Characteristics of Plastic Mulches:

Plastic films display several physical features that are important when they are used as mulches. Both light and thermal transmission properties of polyethylene films are important when they are used as a mulch due to their effects on soil temperature. Clear polyethylene film is capable of 93% solar transmission in comparison to a 91% solar transmission by glass (20). This means that clear plastic film, like glass, admits a good deal of solar radiation. However, in comparison to glass, polyethylene film has very high thermal transmission; with a value of 71% for polyethylene and 4.4% for glass (20). For this reason the differences in soil temperature under clear polyethylene as opposed to black are usually not very great (Fig.1; 14,20). This means that polyethylene film can transmit a good deal of light and heat onto the soil, but also allows a high percentage of the heat that is absorbed by the underlying soil during the day to be radiated back into space at night. This phenomena would present a rather severe problem but for polyethylene's low water permeability (20,24,30,44,66,74).

Water vapor that can not pass through polyethylene film will eventually condense on the film once the relative humidity is high enough or the dew point is reached. This water condensation causes a significant reduction in infra-red or thermal transmission through the film, thus reducing night-time radiant heat loss (20).

Plastic mulch laid on the soil also has a retentive effect on soil moisture (5,20,41,57). Further, soil moisture distribution is also affected by the presence of a water impervious barrier on the soil surface such as a plastic mulch. As the plastic mulch allows for a greater amount of heat to accumulate at the soil surface during the day than on a bare soil surface, water vapor is drawn up from the soil into the space between the soil surface and the plastic film. This area has very high relative humidity and eventually condensation occurs on the underside of the plastic. The water droplets that form eventually drop onto the soil surface and move into the soil, and the process is repeated. This water, though it does not move very far into the soil, is nonetheless available to the plant. Availability to the plant is in fact augmented by the presence of the mulch in that the warmer soil temperatures underneath the mulch stimulate root development closer to the soil surface which will then absorb the water that is returned to the soil surface (37,57,personal observation). This phenomena is quite different from a bare soil system which has no appreciable vapor barrier at the soil surface, where all the water that evaporates from the soil surface is lost to the plant (5,14,16,21,31,41). Schales (62) points out, however, that for maximum soil moisture retention, a straw, peat or equivalent organic mulch should be used rather than plastic film.

The above mentioned physical properties of plastic mulches ultimately result in a root-zone environment that is very beneficial for the plant. The soil is warmer and generally more moist under plastic mulches. These physical phenomena lead to some very significant chemical and biological results. The chemistry of the soil under plastic mulch has not been thoroughly investigated (5,69). For example; What are the effects of the elevated soil moisture levels and soil temperatures on soil organic matter?; soil pH?; soil morphology? What are the effects on agricultural chemicals that are applied to or end up in the soil? There are many other questions that are important in the use of plastic mulches. At this point in the study of their effects, however, most workers are concentrating on production aspects (33).

Responses of Muskmelons to Plastic Mulches:

The literature generally indicates that plastic mulches increase the yield and the quality of muskmelons over those grown on bare soil. Workers have also found that the combination of transplanted melons with plastic mulch results in higher and earlier yields (3,7,45,48,55,76). Trujillo found that plastic mulches promoted rapid early growth for both transplanted and direct-seeded muskmelons and also resulted in greater early yields and greater total yields (76). Bhella found that, with both muskmelon and zucchini, blooming was stimulated by plastic mulch which resulted in earlier yields and greater total yields (3,4).

Swanson found that black plastic and container-grown plants alone or in combination increased early marketable yields of muskmelons (73). However, Swanson also found that "macro-environmental conditions can negate micro-environmental efforts to increase crop productivity" (73). This remark referred to the difference in results from the two seasons during which the study was conducted. One season was very hot and dry during the muskmelons' ripening period and resulted in a "good" melon year. The other season was wet and cool, commonly considered to be poor weather for growing muskmelons. It was stated that the cool, wet season probably negated the benefits of plastic mulch that the previous season had shown (73).

Schales (62) observed that soil moisture levels remained more static under the plastic than under bare soil treatments, and also observed a significant number of muskmelon roots growing on the soil surface under black plastic mulch. He supposed that these roots were in part responsible for the extra productivity by absorbing the soil moisture that moves up through the profile and ordinarily would be lost to the atmosphere. He also mentioned the possibility of CO_2 enrichment from the soil as a stimulant for vine growth.

As can be seen by this review, most of the literature that concerns the yield responses of muskmelons to plastic mulches is in agreement - that is, they will increase their productivity. There is, however, a recurring theme in the literature that in some locations the benefits of plastic mulches are not as assured as in others. An extreme example of this is the study by Harmon in South Georgia, where in two consecutive seasons bare soil treatments outyielded both black and clear plastic mulches in marketable and total fruit (28). It is true, however, that this study did not involve transplanted melons, only direct-seeded.

Thus, in spite of reports of some variability in responses of muskmelons to plastic mulches, it is reasonable to state that in general the research on transplanted muskmelons grown with plastic mulch, either clear or black, promises a very good chance for significant increases in earliness and marketable yields in comparison to bare soil.

Economic Characteristics of Plastic Mulches:

Mulches are generally considered to have beneficial effects on crops with the proper management. Their use often brings a doubling or tripling of marketable melons (3,11,21,67). Research from North Carolina showed that the value per acre of muskmelons increased from $880 per year to $4100 per year by using plastic mulch and trickle irrigation (61). However, it is clear from the literature, that the results of mulching in many crops are highly variable in their degree of benefit to the grower (3,6,16,50,56). Growers in California report varying results from plastic mulching of peppers (35). Research from Florida substantiates this with a description of the varying amounts of return from mulched horticultural crops (6). A major factor in the variable benefit of plastic mulches to the grower lies in the environment in which the crop is being grown. Plastic mulches are best adapted for long-term integration into a vegetable production system in a region where weather patterns are reasonably predictable (52,74).

Plastic mulches, however, are also used very successfully in other areas of the country where weather is far less predictable. Indeed, it is in these areas that plastic mulches have their most spectactular results (12,13,22,50). Late frosts or cool springs are more likely to occur in the Midwest thus allowing plastic mulches to give their greatest benefits. At the same time, however, it is just as probable in the Midwest that Spring will be early and warm, a very suitable environment for many horticultural crops to thrive with minimal protection. Thus the economic benefits of plastic mulches are considerably decreased.

The literature that reports on the economic results and implications of using plastic mulches is usually favorable in its tone. However, it is also clear from both scientific and trade literature that plastic mulches are not a panacea, having liabilities of their own such as the expense of either mechanized or hand application, higher cost of production per acre, plastic disposal problems, and the possibility of the climate negating any benefit derived from the mulch (6,12,13,20,21,50,56).

Because of the many uses and variations in effects of plastic mulches, it was decided to investigate their effects on Kansas crops. Thus, the objective of this study is to compare influences of clear and black plastic mulches on the yield and quality of transplanted and direct-seeded muskmelons with the results from standard bare-soil cultural technique. Because the ultimate purpose of the study is to investigate the potential for growing muskmelons earlier in Kansas, the element of planting method - which is critical to plant performance, is also part of the study.

The hypothesis was that the plastic mulches would substantially increase both total yield and the marketable yield in muskmelons over bare-soil grown muskmelons. It was assumed that this would be a result of the mulches' ability to reduce fruit losses due to rotting and by actually promoting a greater number of good fruit to set on the plants. It was also hypothesized that the transplanted melons would have a considerably earlier first harvest than the direct-seeded melons, with the transplanted, mulched melons having the earliest harvests of all the treatments.

Another element of the study was to evaluate the effects of drip irrigation combined with plastic mulch. It was hypothesized that the use of drip irrigation would result in higher yields and better quality melons.

Materials and Methods

The muskmelon cultivar Edisto was seeded in the Kansas State University research greenhouses on May 2, 1986. The seeds were planted in commercial peat pellets (Jiffy 7's, Jiffy Products, Ltd., Shippegan, Canada). The seeded pellets were placed under a 26 degree C day/night temperature regime and watered as needed.

The field for this study was prepared in March on a Haynie fine sandy loam soil at the Ashland Research Facility, near Manhattan, Kansas. Soil preparation comprised of fall plowing of soybean stubble from the previous season, discing, raising 15 cm beds on 3.7 meter centers. Naptalam (Alanap) and Bensulide (Prefar), preemergent herbicides, were applied at recommended rates and then lightly disced in.

The plots for the study were prepared and staked out on April 3 and 8, 1986, and ammonium nitrate at the rate of 269 kg/ha was applied. Drip-irrigation tubing (T-Tape) was then installed in the centers of the designated rows and anchored to the soil with small wire hoops. Plastic mulch film, .9 meters wide, was then applied to designated plots. The plastic, clear or black, 1.1 mil, was laid down the centers of the raised beds with a mechanical plastic layer.

Three Irrometer tensiometers (The Irrometer Comapany, Riverside, California) were installed at a soil depth of ten centimeters at the same time as the plastic mulch. These instruments were placed in bare soil rather than underneath a plastic mulch assuming that bare soil with would dry out sooner than the mulched soil, thus requirement for water would occur first on the bare-soil plots.

The muskmelon seedlings were transplanted to the field on May 27, 1986. On June 2, seeded plots were planted and watered. A sod plugger was used to punch holes in the plastic for planting both seeds or seedlings. There were eight hills per plot roughly 70 cm from each other. Each plot was about 6 meters long and 3.7 meters wide.

Weed control was hampered by heavy rains in the summer of 1986, eventually requiring hand hoeing for effective control. Some contact herbicide was used in the spaces between tiers where tillage equipment could not reach, but hand weeding was the most important control. Black plastic has the least problem with weed competition since the clear plastic allows the invasion of heat-tolerant plants such as purslane. In the latter part of June, however, there was no longer any weed intrusion underneath the plastic except where there were holes. All of the weeds which had managed to grow underneath the plastic mulch were killed by the high temperatures that occurred under the plastic on warm afternoons.

Due to the heavy rains throughout the summer, soil water tension did not exceed -50 centibars at ten centimeters below the soil surface. The point at which the drip irrigation system would be used was at -60 centibars, a common value (3). Thus, the drip irrigation system was never used in this study.

Commercial practices were used in an attempt to control insects and leaf diseases. Carbaryl, (Sevin) and thiodan (Endosulfan) were the insecticides used and chlorothalonil (Daconil) and maneb were the fungicides used; Applications alternated every seven to ten days.

Harvest of the melons was by hand and harvest date was determined by the degree of slip of the melons. When the stem had either fully or halfway abscised; full or half slip, the melons were harvested. The field was harvested daily and the data thus derived recorded.

Data collected included the number and weight of marketable fruit, average soluble solid content, and the number and weight of cull fruit per plot. A Bausch and Lomb refractometer was used for the determination of soluble solids. Three marketable fruits were selected at the time of harvest to be cut and evaluated for soluble solids. A section of fruit was taken from half-way between the seed cavity and the rind. Other criteria for evaluation were decidedly subjective. Marketable fruit were those adhering to U.S. #1 grade standards (76).

In evaluating the data for the season, the harvest period was broken up into two periods: 'early' and main-season. For the transplanted plots 'early' harvest was considered to be on or before Julian day 209 (August 9), and for direct-seeded plots Julian day 220 (August 20). Harvests after these dates were considered to be main season. Data were analysed using the general linear models procedure. Plots were arranged in a randomized complete block design with eight replications.

RESULTS

Total yields were significantly greater in the transplanted melons than in the direct-seeded melons (Fig. 2, Tables 1,2,3). Marketable yields were also greater in the transplanted melons than in the direct-seeded melons (Fig. 3, Tables 4,5,6).

With respect to earliness, the percentage of marketable melons harvested in their respective early season periods was significantly greater in the transplanted melons than in the direct-seeded melons (Fig. 4). About 50% of the marketable transplanted melons were classed as early and about 22% of the direct-seeded melons were classed as early.

The effects of plastic mulch on yield and earliness are not nearly so pronounced. Though some trends may be apparent from the graphs, there are no statistically significant differences between the effects of clear or black plastic mulches on either total or marketable yield in the transplanted melons (Fig. 5,6, Tables 3,4). However, in direct-seeded melons the average total yield of melons from the clear and black plastic treatments is significantly greater than the average total yield of bare soil (Fig. 5, Tables 5,6). Like the transplanted melons, there are no significant differences in marketable yields as a result of the plastic mulch treatments. Likewise there were no significant differences in soluble solids concentration of the melons (Table 7).

There was never a need throughout the season for any supplemental irrigation because of the extremely high rainfall that occurred in the 1986 season (Fig. 7). Thus the entire drip irrigation element of this study was eliminated.

DISCUSSION

As mentioned in the literature review, there is a general acceptance of the the attributes of plastic mulches. However, also mentioned were several studies where the benefits were not pronounced. This study is yet another example of the latter case.

The transplanted melons showed virtually no response to the mulch treatments. The response of the direct-seeded melons to plastic mulch was a higher total yield from both treatments.

In this discussion, my objective is to examine some of the possible reasons for the outcome of this study and then to speculate briefly on the application of these results to the growth of muskmelons in Kansas.

The most important single factor in the 1986 melon growing season was the high rainfall (Fig. 7). The above average amount was responsible for numerous problems in the conducting of this study. Therefore, the findings of this research should be considered in the light of the presence of an abnormal environment during the study.

The above average rainfall caused vigorous vegetative growth in the melons. However, vegetative vigor was variable in the field because of low spots where water collected, slowing and weakening the nearby vines. When the moisture did drain out of these areas, the weakened vines were subjected to intense weed competition. Those vines which continued in their vegetative growth set a relatively small amount of very large fruit.

Later in the season, the moist conditions caused a severe problem with leaf diseases which took an especially heavy toll on the direct-seeded melons. The disease caused a collapse of many of the plants, thus reducing the yield of the direct-seeded plots considerably.

One of the major benefits of plastic mulches is to trap solar radiation in the root zone of the young plant to stimulate early growth and development. The second benefit is to serve as a moisture and weed barrier. Once the leaf canopy covers the plastic mulch, their benefits quickly diminish. Thus, with over-vigorous vines, the loss of the benefits of the plastic mulch occurs all the sooner. It is probably this effect of vegetative growth that resulted in there being no significant differences between the mulched, transplanted melons and the control. In the direct-seeded melons there was a somewhat greater effect of mulch on both total and marketable yield probably because the plants spent all of the juvenile part of their lives under the influence of the mulches or control. Thus, their root-zones received more of the beneficial environmental alteration brought about by the mulches before their leaf canopy covered the mulches.

Another possible effect of high rainfall on the outcome of the study is its effect on melon quality. Figure 5 shows that both clear and black plastic mulched melons show a trend towards having greater yields than bare-soil grown melons. It is possible that this trend would have been more pronounced had there not been so many melons that were classed as culls from water cracks and rots from sitting in puddles on the plastic.

CONCLUSION

In Kansas, where an unpredictable continental weather pattern prevails, it is important to recognize the impact of macroclimate on cultural practices that are an attempt to modify the microclimate around the plant. Just that happened in this study; An attempt was made to moderate the climate on a micro level but was essentially thwarted by the greater energy on the macro level. The most important practical lesson to be learned from this study is that even widely accepted cultural practices may prove not to be cost effective under slightly abnormal conditions.

TABLE 1. Total yield of melons in kilograms/hectare of each treatment

	CLEAR PLASTIC	BLACK PLASTIC	BARE SOIL
TP	26,700	24,600	23,700
DS	12,900	12,000	9,300

TP = Transplanted
DS = Direct-seeded

TABLE 2. T Tests for total weight in kg per plot of direct-seeded muskmelons for mulch comparison.

Alpha = 0.05

Comparisons significant at the 0.05 level are indicated by '*'

MULCH COMPARISON	LOWER CONFIDENCE LIMIT	DIFFERENCE BETWEEN MEANS	UPPER CONFIDENCE LIMIT	
BP - CP	-7.1	1.5	10.1	
BP - B	4.2	12.5	20.8	*
CP - B	2.3	11.0	19.5	*

BP=Black Plastic, CP=Clear Plastic, B=Bare Soil

TABLE 3. T Tests for total weight in kg per plot of transplanted muskmelons for mulch comparison.

Alpha = 0.05

All comparisons are insignificant at the 0.05 level.

MULCH COMPARISON	LOWER CONFIDENCE LIMIT	DIFFERENCE BETWEEN MEANS	UPPER CONFIDENCE LIMIT
BP - CP	-15.2	-5.9	3.4
BP - B	-8.3	1.1	10.6
CP - B	-2.1	7.0	16.1

BP=Black Plastic, CP=Clear Plastic, B=Bare Soil

TABLE 4. Marketable yield of melons in kilograms/hectare of each treatment (kg)

	CLEAR PLASTIC	BLACK PLASTIC	BARE SOIL
TP	20,100	16,500	18,000
DS	10,800	9,900	7,500

TP = Transplanted
DS = Direct-seeded

TABLE 5. T Tests for marketable weight in kg per plot of transplants for mulch comparison.

Alpha = 0.05

All comparisons are insignificant at the 0.05 level.

MULCH COMPARISON	LOWER CONFIDENCE LIMIT	DIFFERENCE BETWEEN MEANS	UPPER CONFIDENCE LIMIT
BP - CP	-13.5	-6.0	1.59
BP - B	-12.2	-4.5	3.1
CP - B	-6.0	1.4	8.8

BP=Black Plastic, CP=Clear Plastic, B=Bare Soil

TABLE 6. T Tests for marketable weight in kg per plot of direct-seeded muskmelons for mulch comparison.

Alpha = 0.05

All comparisons are insignificant at the 0.05 level.

MULCH COMPARISON	LOWER CONFIDENCE LIMIT	DIFFERENCE BETWEEN MEANS	UPPER CONFIDENCE LIMIT
BP - CP	-8.2	-2.3	3.6
BP - B	-4.7	1.0	6.7
CP - B	-2.6	3.2	9.2

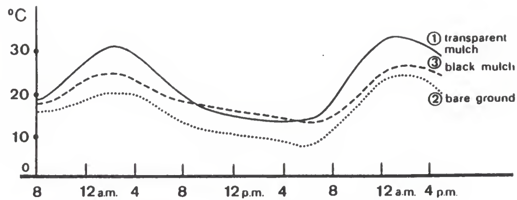
BP=Black Plastic, CP=Clear Plastic, B=Bare Soil

TABLE 7. Mean soluble solids in percents per treatment of transplanted and direct-seeded muskmelons.

	CLEAR PLASTIC	BLACK PLASTIC	BARE SOIL
TP	11.5	11.5	11.2
DS	10.8	10.8	11.0

TP = Transplanted
DS = Direct-seeded

FIGURE 1. Effect of plastic mulch on soil temperature (20).



Effect of plastics mulch film on soil temperature.

FIGURE 2. Comparison of total yields from average plots of transplanted and direct-seeded muskmelon

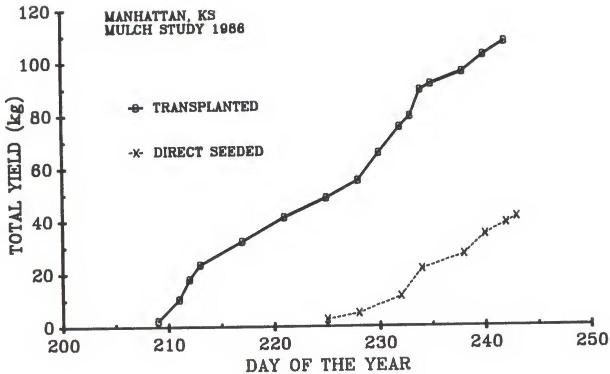

MANHATTAN, KS
MULCH STUDY 1986
TRANSPLANTED
DIRECT SEEDED
TOTAL YIELD (kg)
120
100
80
60
40
20
0
200
210
220
230
240
250
DAY OF THE YEAR

FIGURE 3. Comparison of marketable yields from average transplanted and direct-seeded plots

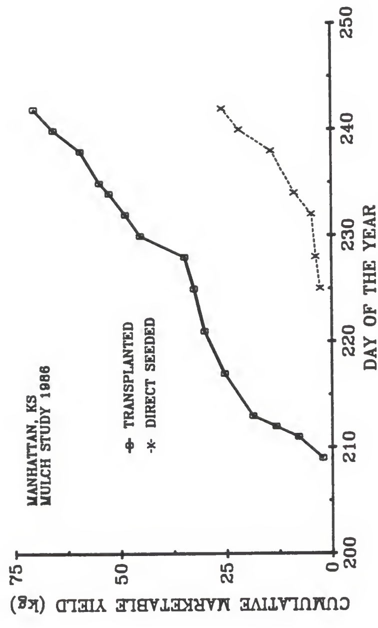

MANHATTAN, KS
MULCH STUDY 1986
TRANSPLANTED
DIRECT SEEDED
CUMULATIVE MARKETABLE YIELD (kg)
0
25
50
75
DAY OF THE YEAR
200
210
220
230
240
250

FIGURE 4. Percent of early marketable yield of average transplanted and direct-seeded plots

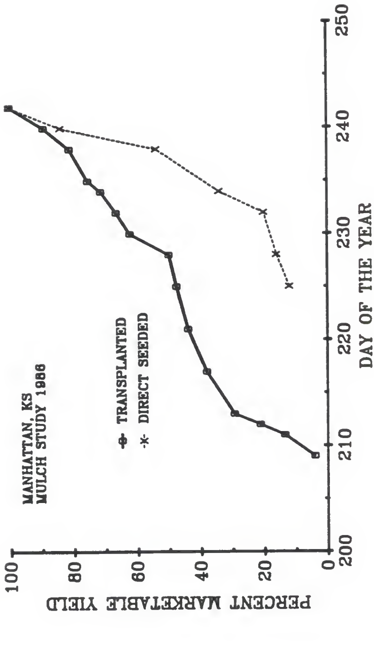

MANHATTAN, KS
MULCH STUDY 1986
TRANSPLANTED
DIRECT SEEDED
PERCENT MARKETABLE YIELD
DAY OF THE YEAR
0
20
40
60
80
100
200
210
220
230
240
250

FIGURE 5. Comparison of total yield response to plastic mulch and planting method from average plots

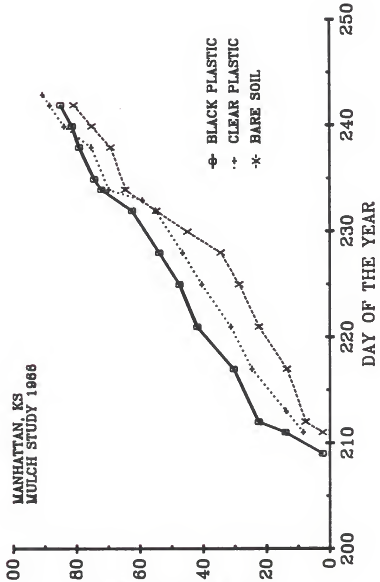

MANHATTAN, KS
MULCH STUDY 1988
BLACK PLASTIC
CLEAR PLASTIC
BARE SOIL
TOTAL YIELD (kg)
DAY OF THE YEAR
0
20
40
60
80
100
200
210
220
230
240
250

FIGURE 6. Comparison of marketable yield response to plastic mulch treatments and planting method from average plots - upper curve represents transplanted melons, lower curve represents direct-seeded melons.

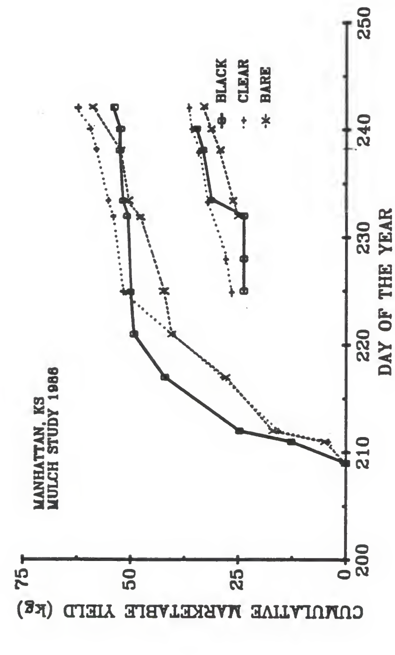

MANHATTAN, KS
MULCH STUDY 1988
CUMULATIVE MARKETABLE YIELD (kg)
0
25
50
75
DAY OF THE YEAR
200
210
220
230
240
250
BLACK
CLEAR
BARE

FIGURE 7. Precipitation recorded at the Kansas State University Evapotranspiration Laboratory Field Lab, Manhattan, KS Summer, 1986.

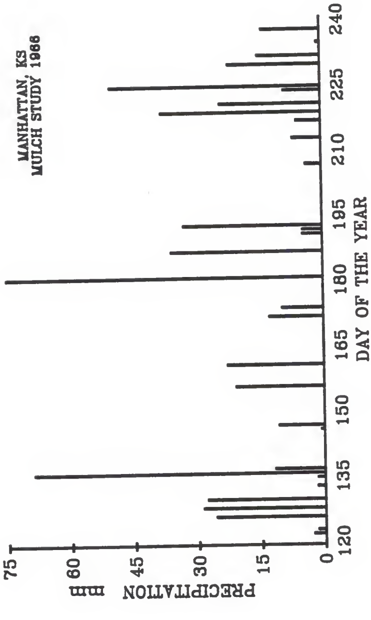
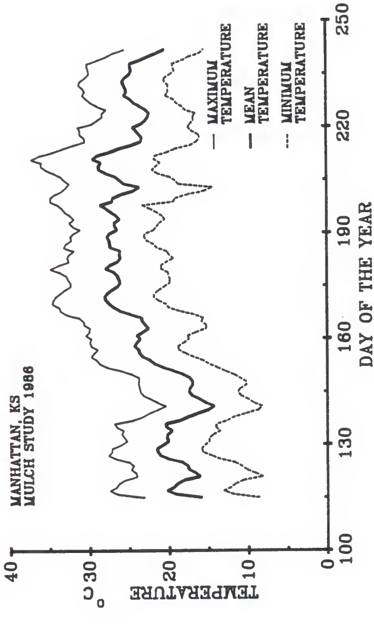

MANHATTAN, KS
MULCH STUDY 1986
PRECIPITATION mm
0
15
30
45
60
75
120
135
150
165
180
195
210
225
240
DAY OF THE YEAR

FIGURE 8. Maximum, minimum and mean daily temperatures recorded at the Kansas State University Evapotranspiration Laboratory Field Lab, Manhattan, KS Summer, 1986.


MANHATTAN, KS
MULCH STUDY 1986
TEMPERATURE °C
0
10
20
30
40
100
130
160
190
220
250
DAY OF THE YEAR
MAXIMUM TEMPERATURE
MEAN TEMPERATURE
MINIMUM TEMPERATURE

BIBLIOGRAPHY

1) Bonanno, Richard & William Lamont Jr. (1987) Effect of polyethylene mulches and row covers on soil and air temperature and yield of muskmelon. J. Amer. Soc. Hort. Sci. 112(5):735-738.

2) Bhattiki, A.M. I. Ghawi (1987) Muskmelon production under mulch and trickle irrigation in the Jordan Valley. HortScience 22(4);578-581.

3) Bhella, H.S. (1985) Muskmelon growth, yield and nutrition as influenced by planting method and trickle irrigation. J. Amer. Soc. Hort. Sci. 110(6): 793-796.

4) ------------, W.F. Kwolek (1984) The effects of trickle irrigation and plastic mulch on zucchini. Hortscience 19(3): 410-411.

5) Brady, Nyle C. (1984) The Nature and Properties of Soils Macmillan Press, New York.

6) Brown, J.E. (1987) Economics of muskmelon production in Alabama using black mulch and row covers. Proc. National Association of Agricultural Plastics, Portland, Ore. 35-39.

7) Bryan, H.H. (1966) Effect of plastic mulch on the yield of several crops in North Florida. Proc. Fla. State Hort. Soc. 79:139-146

8) Burga-Mendoza, C.A. et al. (1973) A comparison of degradable and non-degradable mulches for production of vegetable crops. Proc. Nat. Agricultural Plastics Conference 11:149- 154

9) Cammarata, L.D., (1980) Designing Trickle Irrigation Systems. Purdue University Dept. of Horticulture Cooperative Extension Service Bulletin HO 154.

10) Cantaluppi, C. (1980) Effects of Method, Plastic Mulch, and Fertilizer Rate on the Growth, Yield and Disease Occurance of "Jet Star" Tomatoes. Thesis, Kansas State University.

11) Carolus, R.L., J.D. Downes (1958) Studies on muskmelon and tomato responses to polyethylene mulching. Mich. Agr. Exp. Sta. Bul. 40:770-785

12) ------------, (1968) Raise your yield: use black

plastic. Am. Veg. Grower 6(3):16,56-57

13) Clarkson, V.A. W.A. Frazier (1957) Effect of paper and polyethylene and plastic caps on cantaloupe yields and earliness. Proc. Am. Soc. Hort. Sci. 69:400-404

14) Clarkson, V.A. (1960) Effect of black polyethylene mulch on soil and microclimate temperature and nitrate level. Agron. J. 52(6):306-309.

15) Courter, J.W. N.F. Oebeker (1964) Comparison of paper and polyethylene mulching in yields of certain vegetable crops. Proc. Am. Hort. Sci. 85:526-531

16) Csinzinsky, A.A. (1980) Yield and water usage of vegetable crops with seepage and drip irrigation systems. Florida Sci. 43(4):279-284.

17) DeTar, W.R. et al (1983) Trickle irrigation vs. no-irrigation of five horticultural crops in Pennsylvania. Transactions of the ASAE.

18) Dickson, R.C. E.F. Laird Jr. (1966) Aluminum foil to protect melons from watermelon mosaic virus. Plant Disease Report. 50(5):305

19) Doorenbos, J. et al. (1984) Guidelines for Predicting Crop Water Requirements FAO Irrigation and Drainage Paper No.24 Rome

20) Dubois, P. (1978) Plastics In Agriculture. Applied Science Press, Ltd. London.

21) Emmert, E.M. (1956) The magic of plastic mulches. Am. Veg. Grower 4(6):11,28,34-35.

22) Evanari, Michael (1982) The Negev: Challenge of the Desert Harvard Univ. Press. Cambridge Mass.

23) Finkel, H.J.(ed.) (1982) The Handbook of Irrigation Technology CRC Press.

24) Geiger, Rudolf (1950) The Climate Near the Ground Harvard Univ. Press.

25) Geraldson, C.M. (1962) Growing tomatoes and cucumbers with high analysis fertilizer and plastic mulch. Proc. Fla. St. Hort. Soc. 75:253-260.

26) Goldberg, Dan; et al (1976) Drip Irrigation: Priciples, Design and Practices. Drip Irrigation

Scientific Publications. Kfar Shmaryahu, Israel.

27) Hall, B.J. (1966) Polyethylene Mulches in tomato and cucumber row covers. Proc. Nat'l. Ag. Plastic Conf. 7:56-63.

28) Harmon, Silas; Ray Worley (1964) Effects of plastic mulch sheeting on cantaloupe production in South Georgia. Proc.Fifth Annual NAPA Conf. Athens, Georgia. 93-103

29) Hill, Leas and John Gerber (1982) The Basics of Trickle Irrigation. Univ. Illinois Urbana-Champaign Cooperative Extension Service bulletin No. vc-23-82.

30) Hinkle, C.N. C.F. Moeller. (1965) Infrared transmission of clear plastic films. Proc. Nat'l. Ag. Plastic Conf. 6:138-144.

31) Honma, S. et al. (1959) Soil and air tempertatures as affected by polyethylene film mulches. Mich. Agr. Exp. Sta. Qua. Bull. 41:834-842

32) Hopen, H.J. (1969) Kraft paper-poly mulch spreads melon harvest. Am. Veg. Grower 17(5):22-23.

33) Hopen, Herbert J. and Norman Oebker. eds.(1976) Vegetable Crop Responses to Synthetic Mulches: an annotated bibliography University of Illinois College of Agriculture.

34) Irrigation, Drainage and Salinity: an Integrated Sourcebook (1973) UNESCO/Paris. Hutchinson and Co. Ltd. London.

35) Jones, F.R. R.K. Chapman (1968) Aluminum foil and other reflective surfaces to manipulate the movement of aphid vectors of plant viruses. Proc. N.C. Branch Entom. Soc. Am. 23:146-148

36) Klassen, Parry (1986) Plastics benefit desert vegetables, Plastics aren't all-purpose. Am. Veg. Grower 34(5) 6-10.

37) Knavel, D.E. H.C. Mohr (1967) Distribution of roots of four different vegetables under paper and polyethylene mulches. Proc. Am Soc. Hort Sci. 91:589-596

38) Kramer, Jack (1980) Drip System Watering for Bigger and Healthier Plants W.W. Norton & Co. New York

39) Levitt, Jacob (1974) Introduction to Plant Physiology

C.V. Moseby Co. St. Louis, Mo.

40) Lipe, W.N. et al. (1972) A biodegradable plastic coated paper mulch for cantaloupe production. Tx Agr. Exp. Sta. Program Report No. 3081

41) Lippert, L.F. et al. (1964) Soil moisture under bands of petroleum and polyethylene mulches. Proc. Am. Soc. Hort. Sci. 85:541-546.

42) Lorenz, O.A. D. Maynard (1980) Knotts Handbook for Vegetable Growers 2nd edition Wiley Interscience Publications. New York.

43) Loy, J. Brent; Ortho S. Wells. (1982) A comparison of slitted and spunbonded polyester for plant row covers. Hortscience. 17(3): 405-407.

44) Marian, J.B. (1979) General Physics with Bioscience Essays John Wiley and Sons., New York

45) Marr, C.W. (1986) Vegetable Transplants Extension Bulletin; Kansas State University Dept. of Horticulture

46) Nettles, V.F. (1963) Planting and mulch studies with cucurbits. Proc. Fla. State Hort. Soc. 76:178-182.

47) Ott, Lyman (1984) An Introduction to Statistical Methods and Data Analysis, second edition. Duxbury Press. Boston.

48) Peterson, L.E. (1970) Mulching and transplanting increase early yield of muskmelons. Iowa Farm Sci. 25:718-719.

49) Pew, W.D.; B.R. Gardener. (1983) Effects of irrigation on vine growth, yield and quality of muskmelons. J. Amer. Soc. Hort. Sci. 108(1): 134-137.

50) Plastics In Agriculture: Proceedings from the International Colloquium. volumes 1&2. (1972)

51) Pollack, B.L. et al. (1969) A summary of crop response to various agricultural film mulches. Proc. Nat. Agr. Plastics Conf. 9:17-25.

52) Potter, H. et al. (1967) Use of fumigants and clear plastic mulch on muskmelons. Mich. St. Agr. Exp. Sta. Research Report. No. 62.

53) Reed, G.L. et al. (1987) The effect of black plastic

film mulch and furadan upon yield of muskmelon infested with larvae of the striped cucumber beetle. Proc. NAPA meetings, Portland, Ore. 206-208.

54) Rieckels, J.W. (1960) An evaluation of plastic and aluminum mulches in relation to soil temperature, weed control, and the yield of muskmelons and tomatoes. MS thesis Michigan State University.

55) Robbins, M.L. et al. (1972) Combined influence of mulches and transplanting on earliness and yield of muskmelon, (Cucumis melo, Linnaeus). J. Hort. Sci. 47, 541-545.

56) Rosenburg, Norman (1983) Microclimate: The Biological Environment

57) Rowe-Dutton, P. (1958) The Mulching of Vegetables Commonwealth Bureaux of Hort. and Plantation Crops.

58) Rudich, J., et al. (1984) Optimal growth stages for the application of drip irrigation to muskmelon and watermelon. Netafim Publications

59) Sagiv, B., et al. Trickle Irrigation and Fertilization of Spring Muskmelons at the Besor Experiment Station. Netafim Special Publication No. 179.

60) Saldana, Josefina M. (1985) Frecuencia de riego en el cultivo de melon (Cucumis melo) por trasplante con y sin acolchado con plastico. Tesis. Ingenerio Agronomo Especialidad Fitotecnia. Buenavista, Saltillo, Coah.

61) Sanders, D.C., Berle, D. (1986) Plastic mulch and row cover economics for muskmelons. University of North Carolina research project number: NCO 3869.

61) Schales, F.D. et al. (1965) Muskmelon and tomato response to mulching with black plastic, smoke gray plastic and paper. Proc. Nat. Agr. Plastics Conf. 6:67-70.

62) ------------------- (1966) Mulch effects on soil conditions and muskmelon response. Proc. Am. Soc. Hort. Sci. 88:425-430.

63) ------------------- (1968) Response of several vegetable crops when mulched with metallic and non-metallic mulches. Proc. Nat. Agr. Plastics Conf. 8:119-122.

64) Shadbolt, C.A. et al. (1960) Temperature and plant responses to paper and plastic protectors on cantaloupes. Hilgardia. 30(9): 247-266.

65) -------------------- (1962) The microclimate of plastic shelters used for vegetable production. Hilgardia. 32(4):251-266.

66) Singh, S.D. et al, (1978) Water economy and saline water use by drip irrigation. Agron. J. 70:Nov.-Dec. 948-954

67) Smith, N. et al. (1966) Plastic mulch and soil fumigation influence on melon yield and income. Proc. Nat. Agr. Plastics Conf. 7:48-52.

68) Stephenson, R.E. et al. (1945) Effect of mulches on soil properties. Soil Science. 59:219-230.

69) Stern, P.H. (1979) Small-Scale Irrigation: A Manual of Low-Cost Water Technology Intermediate Technology Publications Ltd. London.

70) Stout, (1958) Successful Truck Farming Macmillan. New York, N.Y.

71) Sumner, Donald R. et al (1978) Influence of film mulches and pesticides on root diseases and populations of soil-borne fungi in vegetables. Plant and Soil 49:267-283

72) Swanson, G.S. (1982) Muskmelon production on plastic. Tennessee Farm and Home Science 124;5-7

73) Thompson, Homer C. (1949) Vegetable Crops McGraw-Hill, New York

74) Tiessen, H. (1969) Effect of paper mulches on vegetable yields. from the Symposium on the Timing and Field Production of Vegetables. Int. Soc. Hort. Sci. Alkmaar, Netherlands.

75) Trujillo, P.M.; J.N. Corgan (1981) Plastic Mulches, Hot Kaps, Transplants for Vegetables in Northern New Mexico University of New Mexico Ag. Bulletin, May.

76) U.S. Dept. Agr., Agricultural Marketing Service. (1979) U.S. Standards for Cantaloup.

77) Wells, J.A.; Perry Nugent (1980) Effect of high soil moisture on quality of muskmelon. Hortscience. 15(3):258-

259.

78) Willis, W.P. (1962) Effect of partial covers on soil evaporation. Proc. Soil Sci. Soc. Am. 26:598-601.

79) Wilson, M.A., et al. (1987) Influence of earliness and yield of watermelons and muskmelons on row covers and black plastic mulch. Proc. NAPA meeting, Portland, Ore. 35-39.

80) Woodbury, G.W. (1966) Increasing vegetable production with plastics. Idaho Agr. Exp. Sta. Res. Bul. 474

ACKNOWLEDGEMENTS

I am grateful to Dr. J.K. Greig, for his giving me a chance to do this work. I appreciate deeply his approach to Horticulture. Thanks also to Dr. C.W. Marr for his encouragement. Thanks to Dr. J. Boyer of the Statistics faculty for his acceptance of my rather cursory knowledge of that circumlocutious discipline. Ineffable gratitude to the Garcias; Rick, Paula, Maria, David, and Daniel, for their willingness to share their time and computer with me in the summer of my discontent. Lastly, thanks to my wife, Gina, whose interest in muskmelons extends only to their organo-leptic properties, but whose interest in and support of my growth is very great indeed.

YIELD RESPONSES OF TRANSPLANTED AND DIRECT-SEEDED MUSKMELON TO PLASTIC MULCH

BY

THOMAS M. BROWN

B.S. (Anthropology) Kansas State University 1985

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Horticulture
Kansas State University
Manhattan, Kansas

1988

Muskmelon (*Cucumis melo* c.v. 'Edisto') was grown from either transplants or direct-seeded in a replicated, randomized study in 1986 at the Kansas State University Horticulture Farm. The plants were mulched with clear or black plastic film or were grown on bare soil as a control. Trickle irrigation and no irrigation were to be used in this study, however, due to high rainfall, soil water tension did not exceed -60 centibars at the ten cm depth so irrigation was not necessary. Transplanted melons produced the highest marketable yields regardless of mulch treatment. Mulch treatment had no apparent effect on marketable yield of transplanted melons in this study. Sugar concentration in the fruits did not vary significantly among the treatments. This study demonstrates the predominance of macro-environmental conditions over cultural practices that attempt to modify the plant micro-environment.