To the Graduate Council:

I am submitting herewith a thesis written by Gene S. Swanson entitled "Effects of Black Plastic Mulch and Container Grown Plants On Yield, Growth, Quality and Earliness of 'Harper Hybrid' Muskmelons <u>Cucumis melo</u> Var <u>Reticulatus</u>." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

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A

EFFECTS OF BLACK PLASTIC MULCH AND CONTAINER GROWN PLANTS ON YIELD, GROWTH, QUALITY AND EARLINESS OF 'HARPER HYBRID' MUSKMELONS

CUCUMIS MELO VAR *RETICULATUS*

A Thesis

Presented for the

Master of Science

Degree

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ABSTRACT

Field studies were conducted in 1980 and 1981 in Knoxville, TN to evaluate the usefulness of black plastic mulch, container grown plants and their interaction in increasing early 'Harper Hybrid' muskmelon (Cucumis melo var reticulatus) productivity.

Plastic mulch, container plants and their interaction, as compared to direct seed and no mulch, were responsible for an increase in earliness in both years and had a positive effect on yield in 1980. Marketable yield in 1981 was not significantly different among these treatments. Fruit diameter was decreased by container plants in 1980 but decreased in response to the plastic treatment in 1981. Soluble solids content and degree of netting was decreased by plastic mulch in 1980 but only netting showed a decrease in response to mulch in 1981. Vine growth was accelerated by the use of container plants in 1980. Variation in yearly response was possibly attributable to distinct variations in weather conditions.

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CHAPTER I

INTRODUCTION

The uses of black plastic mulch and/or container plants for increasing muskmelon productivity has been investigated in the west, midwest, deep south and mountainous areas of this country (8, 9, 29, 30, 33, 35, 37). However, no information relative to the performance of these practices in the Great Valley of East Tennessee is available in the literature.

The purpose of this study was: (1) to examine the effect of black plastic mulch, container plants and their interaction on muskmelon productivity as measured by growth, earliness and marketable yield and (2) to monitor quality characteristics from these treatments.

CHAPTER II

REVIEW OF LITERATURE

Morphology and Culture

The species Cucumis melo L. represents a wide range of botanical diversity, in which resides various plant forms successively classified into different species, subspecies, varieties and horticultual groups (13, 32). The only species that is of commerical importance in the United States is C. reticulatus commonly called muskmelons (32).

Muskmelons are andromonoecious, trailing herbaeceous plants which are grown as annuals. The leaves are alternate, simple, palmately five-lobed and pubescent with tendrils borne in the axils. Perfect flowers are found on short, stout solitary pedicels, while staminate flowers are arranged in clusters, both of which are borne on lateral branches and side shoots. The fruit is classifed as a pepo with a central cavity and the edible portion is derived from the pericarp (13, 25, 32).

The cultivars of C. reticulatus are characterized by a meshwork of corky suberized tissue on the surface of the maturing fruit. This netting has been purported to be an indicator of fruit maturity and quality, a deterrent to disease and mechanical injury and an insulator against thermal radiation (25, 45).

Webster and Craig (45) mentioned that the epidermal cells of the fruit have only a short period of cell division and as the fruit enlarges the epidermis as well as the cuticle is ruptured. These researchers also noted that complimentary tissue arising from phellogens protrude through the fissures forming the netting which they characterize as an elaborate system of lenticels.

The pedicels contain an abscission zone which is comprised of 15 to 20 tiers of densely packed parenchyma cells which begin to collapse during the final 10 days of ripening resulting in small cavities which eventually coalesce resulting in fruit drop (44). This fruit drop is referred to in muskmelon production as the full-slip stage which coincides with the climacteric rise in respiration. The half-slip stage occurs when a slight pull on the pedicel will detach approximately one-half of the abscission zone(25). The muskmelon fruit exhibits a simple sigmoid growth curve and continues to grow rapidly right up to time of abscission (32).

Fruit of the muskmelon are set in groups of two to four with intervals of two to three weeks between successive groups, and under optimal conditions, three sets of fruits may be achieved (26, 28). Only 10 percent of perfect flowers actually set fruit but ovaries that will eventually fail to set may grow rapidly for a week before abortion occurs (44). Anthesis of the perfect flowers lasts for only one day which allows for a precise determination of the physiological maturity of various melons by tagging the flowers when they are open and available for pollination (28). This approach is of importance in comparision of fruits because as Pratt (32) emphasized, melon size, shape, flesh thickness and proportion, along with time to maturation, are all predetermined during the early growth stages which may be subject to environmental variations.

Environment

Maynard (27) stated that "plant productivity is the end result of the interaction of the plant with its environment." Consequently any effort to increase productivity must be undertaken with an understanding of how the species is affected by competition, soil and air temperature, solar radiation and soil moisture, fertility, type and structure. These environmental factors are in turn affected by cultural practices such as irrigation, cultivation, fertilization, mulching, liming and population densities.

Davis and Schweers (15) examined some physical properties of soil and how they influenced muskmelons growth. They recognized that root impedance reduced the concentration of soluble solids (SSC) in the fruit and they hypothesized that a hardpan or dense soil strata may be a factor in the occurrence of crown blight. It is possible over a period of time to increase the likelihood of such problems under a regime of intensive irrigation as this may cause downward migration of clay particle and subsequent pan formation. The decrease of salinity with the use of irrigation may also occur resulting in a reduction of soil porosity which was found to be positively correlated with SSC (15).

Cooper (11) reported that root temperature is an important factor in dry matter gain for the whole plant. Obtaining the optimum root temperature is essential in maximizing flowering, fruiting and root and shoot growth. He also pointed out that a decrease in root temperature reduced water absorption in muskmelon. Optimum root temperature for muskmelon as reported by Whitaker and Davis (13) is 15°- 20°C, however, this determination, as well as, plant response in Cooper's (11) investigation were both conducted in the laboratory at a constant temperature which would not reflect the diurnal fluctuations of the soil temperatures found in the field.

Bouwkamp et al. (6) maintained that high levels of solar radiation resulted in a decreased SSC attributable to an increase in fruit temperature which results in an increased rate of respiration. Mann and Robinson (26) in their work with the breeding of muskmelons, stressed the role of temperature in controlling flower and pollen sac opening.

Nitrogen fertilization is essential in order to maximize production of muskmelon, however, rate selection can be confounded by yearly fluctuations in rainfall (7,17). Brantley and Warren (7) observed a greater response to nitrogen in a wet year than in a dry one. Flocker et al. (17) studied nitrogen response coupled with three levels of irrigation and found that the number of culls increased as irrigation or nitrogen was increase above an optimum. Increased yield response was attributable to an increased in the size of melons rather than an increase in total number of fruit. Lower levels of nitrogen fertilization and/or irrigation that tended to retard or limit vine growth acted to concentrate and hasten fruit maturity, as well as, increase the incidence of sunburn due to lack of a protecting vine cover

Davis et al. (14) observed that both genetics and environment influenced the leaf and fruit shape of muskmelon as well as the proportion of the flesh of the fruit. The size of the fruit was found to be positively correlated with eating quality (18) and the number of fruit per vine was negatively correlated with SSC (15). The presence of damaged or diseased vines has also been shown to be negatively correlated with SSC (4, 19).

Wells and Nugent (46) noticed a decline in SSC under a high moisture regime and with certain cultivars found a decrease in dry matter and amino acid content. Webster and Craig (45) indicated that excessive moisture may suppress suberization of the cork cells preventing their maturity and causing the development of callus tissue which could be responsible for premature maturity and decreased SSC.

Quality

Quality is inherently a nebulous concept which can only be defined in terms of the criteria established by the individual investigator's interests. The plant breeder, nutritionist and consumer would undoubtedly consider divergent parameters in assessing the quality of a given product. The situation becomes even more complex because of the desire and need of researchers to make quanitative quality evaluations for the comparisons of various treatments (43).

In the evaluation of muskmelon fruits, SSC has been used as an index for measuring quality and maturity for nearly 60 years

(3, 12, 18, 19, 32). However many parameters are envolved in determining the subjective appeal of the fruit to the consumer and some doubt has arisen as to the validity of using SSC alone as a quality index (3, 15, 19, 47). Currence and Larson (12) obtained a good correlation between SSC and eating quality. Gilbart and Dedolph (18) substantiated these results with their finding of a positive linear regression for quality on percent soluble solids. A curvilinear relationship was also noted for the regression of quality on both sugar/acid ratio and firmness. Aulenback and Worthington (3) concluded that SSC above eight percent was not always an indicator of sweetness, flavor or acceptability. They also found that correlations between SSC and quality varied greatly among cultivars. Yamaguchi et al. (47), in an effort to find a reliable index of muskmelon quality, investigated sensory attributes such as eating quality, aroma, internal color, sweetness, texture and flavor. In the same study physical and chemical properties including weight, external color, volatile compounds, tissue and rind firmness and SSC were assessed. They obtained evidence to show that sweetness is the most important attribute of eating quality and state that the sugar/acid ratio "affects the sensation of sweetness," thus "it is not surprising that a measurement of SSC is not a good indication of eating quality." Despite these conflicting reports, high SSC has resulted in high ratings for sweetness from taste panels (3, 12, 18, 19) and it is evident that while high SSC may not always insure good eating quality, "the absence of high SSC make good quality highly unlikely."(4)

Measurements of soluble solids remains an expeditious and useful tool in determing apparent quality. However discretion must be used in sampling technique as SSC varies within the fruit itself (12, 36). SSC has been shown to decrease progressively as samples were taken from the flesh next to the seed cavity outward toward the rind, from the blossom end toward the stem and from the top of the fruit toward the ground spot (12, 36). Allinger et al. (1) compared SSC values obtained by refractometers and by drying samples and found significant but small variances. The refractive index of melon juice showed a high positive correlation with vitamin C content when investigated by Wagner et al. (42). Starch reserves are essentially absent in muskmelons and for this reason there is no significant change in SSC after harvest or during storage (13, 31, 32, 34).

Although quality can be difficult to define and even harder to measure, Lippert and Legg (24) present an inclusive synopsis of quality and appearance characteristics of the ideal muskmelon fruit. They related that the desirable features would include a round to slightly oval shaped fruit weighing from 1.5 to 3.0 pounds with a heavy external netting. A thick orange flesh high in soluble solids, a small dry seed cavity and a tough thin rind would also be characteristic. Earliness would also be important in order to escape high summer temperatures and disease pathogens and to assure higher prices on the early market. Lippert and Legg (24) also recommend the use of F_1 hybrids since they yield better than standard cultivars and have thicker netting, denser flesh and exhibit freedom from sutures.

Mulches

For over 75 years various mulching materials have been investigated for their ability to control weeds, improve soil moisture conditions and increase yields (8). In the last 30 years much attention has been focused on the use of black pol-ethylene mulch because it is resistant to decomposition, acts as a vapor barrier and is non-toxic to plants (8, 22). Black plastic alters the microclimate of the seed, roots and shoots in a myriad of interrelated ways.

According to several researchers (2, 8, 10, 16, 21, 23, 35) soil covered by black plastic has higher moisture levels than non-covered soils. Although increased temperature generally results in water loss, moisture is conserved by a reduction in surface evaporation, an elimination of weeds which transpire and by condensation on the lower side of the plastic as temperatures decline at night (2, 8, 16, 23, 35). Soil temperature is increased much more efficiently by the conductivity of absorbed heat from the plastic than the conduction of heat from the air and plastic tends to block some re-radiation of heat from the soil (10, 22, 39). The high moisture regime under the plastic, because of the high specific heat of water, reduces the diurnal fluctuation of the soil temperature (11, 22, 38, 39).

Soil moisture and temperature, which are interrelated themselves, have a direct effect on the other parameters of the micro-climate of the plant. These diverse effects, indirectly attributable to black plastic, are observed throughout the literature. Cooper (11) found that soil fungus (Rizoctonia solani) flourished under black plastic, while some species of nematodes were reduced apparently because of biological control by increased populations of soil fungi. Knavel and Mohr (21) investigated root distribution under polyethylene mulch and found that the root system of muskmelon was less fibrous, more shallow, more extensive and had less secondary branching under plastic as compared to bare ground treatments. They attributed this phenomena primarily to increased moisture in the upper regions of the soil profile. Carolus and Downes (8) reported similar findings and remarked that aeration and temperature are more favorable nearer the soil surface. These researchers maintained that the mulch would prevent hard rains from deteriorating the soil structure and help prevent water saturation both of which would decrease aeration and hence, root growth.

Black and Greb (5) investigated nitrate nitrogen accumulation under plastic and in bare ground. Their calculations showed that there was 140 pounds of nitrate nitrogen per acre under the mulch and 80 pounds per acre on bare ground. The initial level of NO_3-N was 26 lbs/ac and the superior increase in the black plastic treatment was ascribed to the warm moist soil conditions that would favor an abundance of microflora for nitrification. Microflora produce carbon dioxide which could exert a positive effect on shoot growth and high CO_2 levels have been reported coming through the holes in the plastic from which the plants were growing (35). The lack of nitrate leaching under plastic along with the nitrification taking place has led Clarkson (10) to state that supplemental sidedressing of nitrogen may not be necessary when using plastic mulch.

Polyethylene mulch is expensive (8), it presents a greater danger of frost due to the plastic blocking re-radiation of heat from the soil (10, 18) and its removal from the field is very difficult (8, 20). However, black plastic mulch remains a viable alternative in minimizing labor costs and increasing production and earliness in high value horticultural crops (8).

Similar Studies

There exists in the literature a number of studies in which researchers have examined the effects of plastic mulch on muskmelon production (8, 9, 35, 37). One study compared container plants and direct seed planting methods with muskmelons (30). There are several studies, similar to this current effort, which have combined the planting method with the use or nonuse of black plastic mulch (29, 33).

Carolus and Downes (8) conducted studies on muskmelons and tomato response to black plastic mulch and found increased early and total yields for muskmelons grown on black plastic. When moisture was a limiting factor, an increase in both fruit number and size was found to be responsible for increased yields. However, where moisture was plentiful the increase was due mainly to an increased number of fruit. These investigators asserted that cucurbits show more response to mulching than any other crop.

Schales and Sheldrake (35) reported higher yields, earlier harvests and increased plant growth of muskmelons grown on black plastic mulch. The increased vigor of the vines was speculated to decrease the negative effects of fruit set on shoot and root growth. The fruit would not act as such a prominent sink of photosynthate since plant vigor would entail an increased photosynthetic area.

Clarkson and Frazier (9) confirmed the increased yields and vine growth of muskmelons grown on plastic. Stiles and McDaniel (37) supported findings of increased yield and increased earliness when muskmelons were grown on black plastic mulch.

Norton (30) investigated the relationship between field seeding and use of container plants on production of 10 varieties of muskmelons. He found that yield and fruit weight were increased by using container plants and that maturity was advanced by two weeks. Soluble solids were higher in fruit from the container plant treatment.

Robbins et al. (33), in a study designed to determine the combined effect of using container plants and mulch, found that use of container plants increased early yields. When container plants were grown on black plastic, early yields, as well as total yields were increased. Yearly variations were found in the total yield response to container plants as compared to direct seed plots.

Morse et al. (29), in a similar study, found black plastic mulch and container plants increased early yields but mulching was the only treatment that increased total martketable yield. These results were consistent for two cultivars of muskmelons ('Harper Hybrid' and 'Burpee Hybrid') and two cultivars of watermelon.

CHAPTER III

MATERIALS AND METHODS

Experiments were conducted in the summer of 1980 and 1981 at the University of Tennessee Plant Science Field Laboratory at Knoxville, Tennessee. Four treatments were arranged in a randomized complete block design and replicated eight times. Two of the treatments consisted of muskmelon (cv. 'Harper Hybrid') plants in containers grown on black plastic mulch and on plots without mulch. Direct seeding of muskmelon into the plastic mulch and direct seeding with no mulch were the other two treatments.

In 1980 plants were seeded in 6.35 cm peat pots in the greenhouse on May 5 and transplanted into the field on May 15. The direct seed treatments were also planted on May 15.

The seed bed was prepared by turning, disking, and then roto-tilling. Fertilizer was incorported with the roto-tiller at the rate of 504 kg of 6-12-12 per hectare. Black plastic of 1.5 ml thickness and 1.22 m width was layed on the seed bed and the edges covered with soil two weeks prior to planting.

Plants were spaced 91.4 cm apart in 6.4 m rows with 2.13 m between rows. Guard rows were planted on each side of the experiment. Holes 5.08 cm in diameter were punched in the plastic with bulb planters and seeds and container plants were planted through them.

One month after planting, 14.5 kg N and 10.9 kg P and K were sidedressed on to all plots.

Chlorothalonil and carbaryl for disease and insect control, were applied at two week intervals at the rate of 2.25 kg and 1.12 kg per hectare respectively.

Plots were cultivated by hand and with small roto-tillers. Plots were irrigated as needed for the first month after planting.

In order to determine the rate of vine growth, tags were placed 15 cm from the tip of the vine and weekly measurements of growth were taken for one month. Because the container plants were at an advanced stage of growth, the initial tagging of their vines was made on June 19, 1980, while the growth rate determination was not started on the direct seed treatments until a week later (June 26, 1980). Two plants per treatment from each replication were selected at random for the growth study.

Fruit were harvested every other day beginning July 17, 1980 at the full slip stage of maturity. Marketable fruits were counted and weighed in the field and then representative samples (at least 15 melons per treatment from each replication) were taken to the laboratory for quality evaluation. Culls (small, cracked, decayed or misshapen fruit) were counted and discarded.

Determination of the degree of netting on the top side (opposite the ground spot) was made subjectively by averaging the score (1 for sparse netting to 10 for very heavy netting) given the melon by three observers.

Fruits were bisected transversely and measurements taken of the flesh, cavity and fruit diameter. These measurements were taken across the largest diameter of the cross section.

Samples of the flesh were removed from half way between the ground spot and the top of the cross section and adjacent to the seed cavity. Soluble solid content was determined from these samples using a hand refractometer.

In 1981 container plants were seeded on April 24 and planting in the field was done on May 4. Fruits were harvested about every fourth day beginning July 20, 1981.

Pendimethalin applied preemergence at a rate of 0.85 kg/ha plus hand hoeing was done in 1981 to control weeds. Irrigation was not needed in the 1981 growing season and the sample size was decreased to five fruit per treatment per replication. Vine growth measurements were not taken in 1981 but all other procedures, with the exception of those listed above, were followed as in the 1980 study.

Data were subjected to analysis of variance calculations and Duncan's Multiple Range Test was employed to separate treatment means.

CHAPTER IV

RESULTS AND DISCUSSION

The results of this study varied considerably between the two years that were involved. Stiles and McDaniel (37) indicated that the benefits of plastic mulch in muskmelon production tended to vary from year to year.

Thompson and Kelly (40) stated that muskmelons grow better and the fruit is of a higher quality in hot, dry climates with plenty of sunshine rather than in more humid climates. These climatic requirements can be extended, in the humid southeast, into a "good year" being characterized by hot, dry and sunny weather, while a "bad year" for growing muskmelons would involve cool, rainy and overcast weather conditions.

The two years in which this study was conducted, 1980 and 1981, were excellent representations of these two extremes; 1980 being the dry year, and 1981 being the rainy, overcast year (47). The NOAA's Annual Summary of Climatological Data (47) showed the 1980 growing season to be hotter and drier than 1981. In addition, there were 35 days during the 1981 growing season in which at least 0.10 inches of rain were received at the Knoxville test site. In the 1980 season there were only 19 days in which that amount of precipitation was recorded (47). This observation would imply that there was a greater incidence of incoming solar radiation in 1980 because of the association between clouds and rainy weather.

Fruit Size and Weight

There was no significant difference in the cavity diameter, flesh thickness or the fruit diameter in 1980 due to the mulching method (Table 1). However, the direct seed treatment was responsible for an increase in both flesh thickness and fruit diameter (Table 1). Conversely, in 1981 plots with no mulch were responsible for an increase in flesh thickness and fruit diameters while the planting method had no effect (Table 2). The flesh thickness of the fruit from direct seed plants grown on plastic mulch (Table 3) was significantly lower than any other treatment while the fruit diameter was significantly lower than the direct seed plants grown with no mulch. There was no significant difference between the direct seed no mulch and either of the container plant combinations except for the cavity diameter which was significantly larger in the no mulch direct seed treatment when compared to the three remaining treatments (Table 3). In 1980 no difference in the interaction of mulching and planting method for these parameters was noted (Table 4).

These results suggest that plastic mulch does not have an influence of increasing fruit measurements in a dry year but it tends to have the opposite effect when moisture conditions are excessive. In addition, the direct seed treatment exhibited increased fruit measurements in the dry year and exhibited a positive interaction with no mulch plots and a negative interaction with the presumably wetter mulched plots in 1981 (Table 1, 3). This phenomena would be expected if direct seeding is positively correlated with increased fruit measurements and if plastic mulch has a negative impact in a wet year.

TABLE 1. Effects of pooled mulching and planting method on average fruit weight and cross sectional measurements of 'Harper Hybrid' muskmelons at Knoxville, TN in 1980.

Pooled Treatment	Average Fruit Weight Kg	Cavity Diameter cm	Flesh Thickness cm	Fruit Diameter cm
Mulching Method[z]				
Plastic Mulch	1.60[NS]	6.56[NS]	3.98[NS]	14.59[NS]
No Mulch	1.61	6.73	3.96	14.80
Planting Method[y]				
Container Plants	1.52*	6.58[NS]	3.88*	14.48*
Direct Seed	1.69	6.71	4.07	14.91

[z]Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

[NS]Pairs of means are not significantly different according to ANOVA.

[y]Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

TABLE 2. Effects of pooled mulching and planting method on average fruit weight and cross sectional measurements of 'Harper Hybrid' muskmelons at Knoxville, TN in 1981.

Pool Treatment	Average Fruit Weight Kg	Cavity Diameter cm	Flesh Thickness cm	Fruit Diameter cm
Mulching Method^{z}				
Plastic Mulch	1.53^{NS}	6.43^{NS}	4.06*	14.57*
No Mulch	1.63	6.76	4.30	15.21
Planting Method^{y}				
Container Plants	1.62^{NS}	6.48^{NS}	4.22^{NS}	14.87^{NS}
Direct Seed	1.54	6.71	4.14	14.91

^{z}Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

^{NS}Pairs of means are not significantly different according to ANOVA.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

^{y}Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

TABLE 3. Effect of interaction of mulching and planting method on average fruit weight and cross sectional measurements of 'Harper Hybrid' muskmelons at Knoxville, TN in 1981.

Mulching Method	Planting Method	Average Fruit Weight Kg	Cavity Diameter cm	Flesh Thickness cm	Fruit Diameter cm
Plastic Mulch	Container Plants	1.61a	6.48b	4.18a	14.84ab
No Mulch	Container Plants	1.62a	6.49b	4.26a	14.90ab
Plastic Mulch	Direct Seed	1.46a	6.39b	3.94b	14.30b
No Mulch	Direct Seed	1.63a	7.02a	4.34a	15.51a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

TABLE 4. Effect of interaction of mulching and planting method on average fruit weight and cross sectional measurements of 'Harper Hybrid' muskmelons at Knoxville, TN in 1980.

Mulching Method	Planting Method	Average Fruit Weight Kg	Cavity Diameter cm	Flesh Thickness cm	Fruit Diameter cm
Plastic Mulch	Container Plants	1.54a	6.58a	3.94a	14.51a
No Mulch	Container Plant	1.51a	6.58a	3.83a	14.45a
Plastic Mulch	Direct Seed	1.66a	6.55a	4.01a	14.66a
No Mulch	Direct Seed	1.71a	6.88a	4.10a	15.15a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

Average fruit weight was significantly higher in the direct seed treatment in 1980 only (Table 1). The other treatments did not affect the average weight and no interaction was obtained in either year (Table 2, 3, and 4). These results are similar to those for fruit diameter, which would be expected since a larger fruit would also probably be heavier. However, there was no significant negative influence of plastic mulch in 1981. A trend toward lighter fruit was found on the direct seed plastic mulch plots in 1981 (Table 3). The possibility that excessive moisture could negatively effect fruit measurements and weight agrees with Webster and Craig (45) who found an increased premature maturity under a high mositure regime.

Fruit diameter was found to be postively correlated (R=0.533 in 1980 and R=0.659 in 1981) with SSC which supports the findings reported by Gilbart and Dedolph (18) that fruit diameter is positively correlated with eating quality (Figure 1).

Soluble Solids Concentration and Degree of Netting

Muskmelons grown with no mulch showed a significant increase in SSC and netting in 1980 but only the degree of netting showed the same trend in 1981 (Table 5). There was no significant difference in these parameters for the planting method in either year (Table 5).

The increased moisture in 1981 might have masked the no mulch treatments effect on SSC. Wells and Nugent (46) reported a decreased SSC with an increased moisture regime. If in a dry year the treatment with the lowest available water supply caused a higher SSC, it might

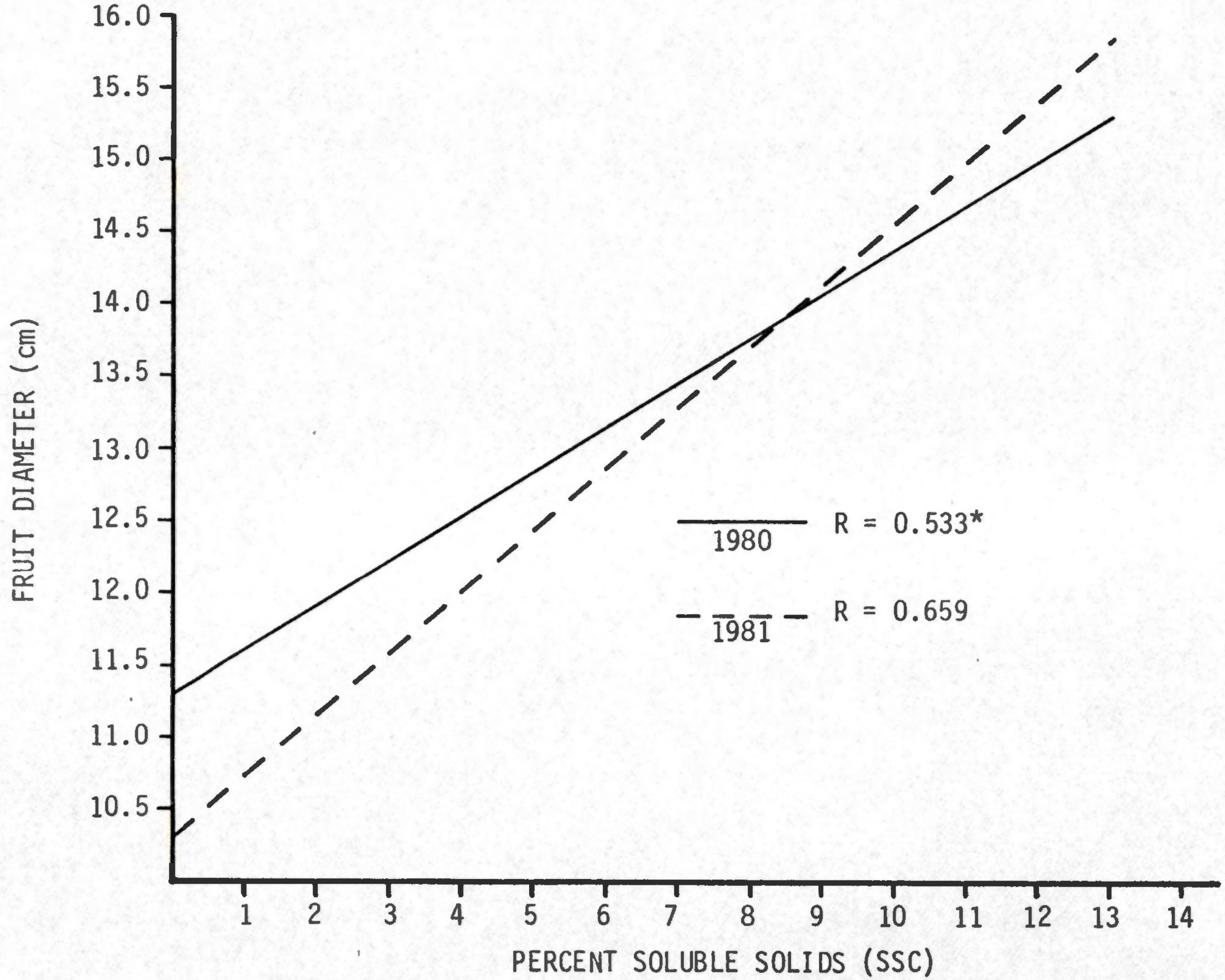

Figure 1. Relationship between fruit diameter and soluble solids content in (SSC) in 'Harper Hybrid' muskmelons at Knoxville, TN.

* R values are significant at $P \leq .05$ according to ANOVA.

TABLE 5. Effect of pooled mulching and planting method on soluble solid content (SSC) and the degree of netting of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN.

Pooled Treatment	1980 SCC	1980 Netting	1981 SSC	1981 Netting
Mulching Treatment[z]				
Plastic Mulch	10.4*	6.9*	10.6^{NS}	7.2^{NS}
No Mulch	11.6	8.0	10.9	7.8
Planting Method[y]				
Container Plants	11.0^{NS}	7.5^{NS}	10.8^{NS}	7.5^{NS}
Direct Seed	11.0	7.4	10.7	7.5

[z]Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

[NS]Pairs of means are not significantly different according to ANOVA.

[y]Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

be expected that in a very wet year that the treatment would not have such a distinctive effect.

Netting and SSC showed a high positive correlation (R=0.820 in 1980 and R=0.646 in 1981)(Figure 2). The variation between the degree of correlation might explain why the no mulch treatment had a positive effect on both SSC and netting in 1980, while the effect in 1981 was limited to the degree of netting. Davis and Schweers (15) found that the number of fruit per vine was negatively associated with SSC. In 1980 the number of fruit per hectare was significantly greater on mulched treatments than on no mulch plots, while in 1981 this relationship did not exist (pages 40 and41). Therefore, in line with the findings of Davis and Schweers (15), the lower yielding no mulch treatment of 1980 showed an increased SSC, while in 1981, planting method had no effect on yield or SSC.

Harvest Distribution

The effects of plastic mulch and container plants on the distribution of yields over four harvests showed a definite trend for both years and in both modes of yield measurement, number of fruit and weight of fruit. The basic pattern as visible in Tables 6, 7, 8 and 9 was one in which plastic mulch and container plants were responsible for a substantially greater yield during the 7/20 harvest. Plastic mulch continued to induce increased yields over no mulch treatments during the 7/27 harvest for both years. While the yield of the 1981 container plant treatment was no longer significantly

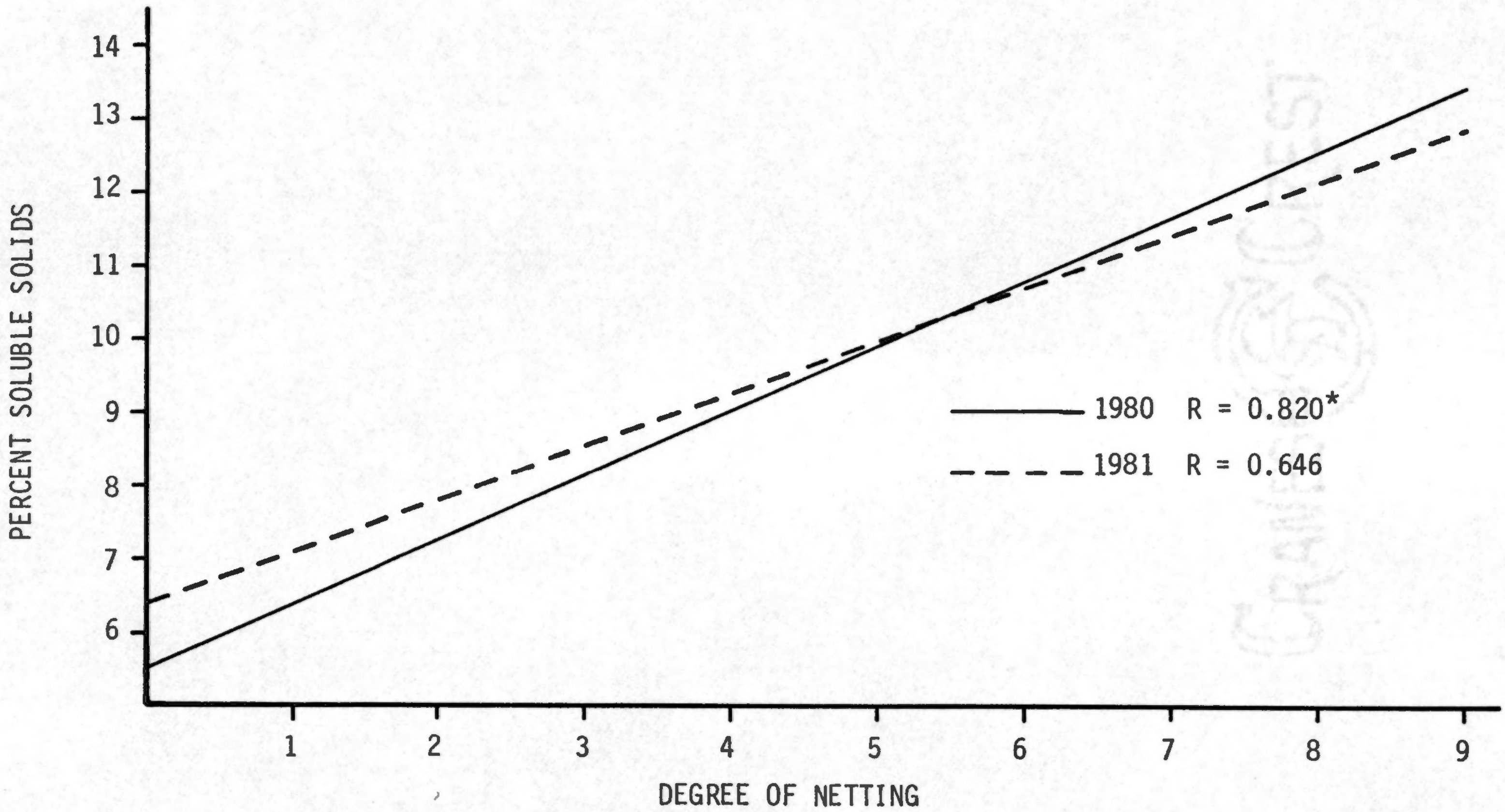

Figure 2. Relationship between soluble solids content (SSC) and the degree of netting of 'Harper Hybrid' muskmelons at Knoxville, TN.

* R values are significant at $P \leq .05$ according to ANOVA.

TABLE 6. Effect of pooled mulching and planting method on number of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1980.

Pooled Treatments	Number of Fruit/Harvest/ha			
	7/20	7/27	8/3	8/10
Mulching Method^{z}				
Plastic Mulch	10, 342*	7,275*	2,335^{NS}	3,843*
No Mulch	2,013	4,253	1,691	7,546
Planting Method^{y}				
Container Plants	11,440*	4,714^{NS}	1,786^{NS}	5,672^{NS}
Direct Seed	915	6,814	2,240	5,716

^{z}Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

^{NS}Pairs of means are not significantly different according to ANOVA.

^{y}Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

TABLE 7. Effect of pooled mulching and planting method on the weight of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1980.

Pooled Treatments	Weight of Fruit/Harvest/ ha (kg)			
	7/20	7/27	8/3	8/10
Mulching Method^{z}				
Plastic Mulch	15,222*	11,896*	4,113^{NS}	6,345*
No Mulch	2,709	6,198	3,101	12,799
Planting Method^{y}				
Container Plants	16,411*	7.058*	2,978^{NS}	9,452^{NS}
Direct Seed	1,521	11,032	4,233	9,694

^{z}Container plants and direct seed treatments combined for plastic mulch anc no mulch analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

^{NS}Pairs of means are not significantly different according to ANOVA.

^{y}Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

TABLE 8. Effect of pooled mulching and planting method on number of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1981.

Pooled Treatment	Number of Fruit/Harvest/ha			
	7/20	7/27	8/3	8/10
Mulching Method^{z}				
Plastic Mulch	2.840*	9,793*	4,531*	410^{NS}
No Mulch	95	5,446	7,641	2,379
Planting Method^{y}				
Container Plants	2,606*	8,329^{NS}	5,768^{NS}	732*
Direct Seed	322	6,909	6,404	2,057

^{z}Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

^{NS}Pairs of means are not significantly different according to ANOVA.

^{y}Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

TABLE 9. Effect of pooled mulching and planting method on weight of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1981.

Pooled Treatments	Weight of Fruit/Harvest/ha (kg)			
	7/20	7/27	8/3	8/10
Mulching Method[z]				
Plastic Mulch	4,797*	14,492*	7,533*	744[NS]
No Mulch	106	7,971	12.470	4,781
Planting Method[y]				
Container Plants	4,505*	12,712[NS]	9,804[NS]	1,441[NS]
Direct Seed	398	9,754	10,202	4,113

[z]Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

[NS]Pairs of means are not significantly different according to ANOVA.

[y]Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

different from the direct seed, the 1980 direct seed treatment showed an increased yield. In the 8/3 harvest, there was no difference noted between yield due to the planting or mulching method in 1980 and in 1981 there was no effect due to the planting method but the yield realized from the no mulch treatment was greater than from mulched plots (Tables 8 and 9). Not until the 8/10 harvest was this increase due to the no mulch treatment noted in 1980 Table 6 and 7). In 1981 the mulching method was no longer responsible for increased yield but the positive influence of the direct seed treatment was apparent (Table 8 and 9).

The essence of these findings is that in both 1980 and 1981 plastic mulch was the greastest significant factor contributing to early yields and the use of container plants significantly increased earliness. These results conformed to the findings of other researchers (8, 29, 30, 33, 35, 37).

The combined effect of mulching and planting method on earliness tend to verify the results discussed above (Tables 10, 11, 12, 13). In the 7/20 harvest, the combination of container plants on plastic mulch was responsible for a significant increase in number of fruit (Table 10 and 12) and weight of fruit (Table 11 and 13) over the other combined treatments for both years. The direct seed plants grown on plastic mulch exhibited a significant increase in number of fruit (Table 10) and weight of fruit (Table 11) during the 7/27 harvest of 1980. There was no significant effects found among the treatment combinations during the second harvest in 1981 (Table 12 and 13). The 8/3

TABLE 10. Effect of interaction of mulching and planting method on number of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1980.

		Number of Fruit/Harvest/ha			
Mulching Method	Planting Method	7/20	7/27	8/3	8/10
Plastic Mulch	Container Plants	19,213a	4,026b	1,647a	4,487a
No Mulch	Container Plants	3,660b	5,402b	1,925a	6,866a
Plastic Mulch	Direct Seed	1,464b	10,525a	3,023a	3,206a
No Mulch	Direct Seed	366b	3,111b	1,464a	8,234a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

TABLE 11. Effect of interaction of mulching and planting on weight of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1980.

		Weight of Fruit/Harvest/ha (kg)			
Mulching Method	Planting Method	7/20	7/27	8/3	8/10
Plastic Mulch	Container Plants	28,243a	6,756b	2,603a	7,463a
No Mulch	Container Plants	4,578b	7,360b	3,353a	11,437a
Plastic Mulch	Direct Seed	2,201b	17,032a	5,624a	5,229a
No Mulch	Direct Seed	837b	5,036b	2,845a	14,157a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

TABLE 12. Effect of interaction of mulching and planting method on number of 'Harper Hybrid' muskmelons collected in four harvests at Knoxville, TN in 1981.

		Number of Fruit/Harvest/ha			
Mulching Method	Planting Method	7/20	7/27	8/3	8/10
Plastic Mulch	Container Plants	5,036a	10,342a	4,941a	549b
No Mulch	Container Plants	183b	6,309a	6,587a	915b
Plastic Mulch	Direct Seed	644b	9,244a	4,121a	278b
No Mulch	Direct Seed	0b	4,575a	8,695a	3,843a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

TABLE 13. Effect of interaction of mulching and planting method on weight of 'Harper Hybrid' muskmelons collected in four harvests in Knoxville, TN in 1981.

		Weight of Fruit/Harvest/ha (kg)			
Mulching Method	Planting Method	7/20	7/27	8/3	8/10
Plastic Mulch	Container Plants	8,798a	15,737a	8,333a	1,056b
No Mulch	Container Plants	212b	9,688a	11,271a	1,829b
Plastic Mulch	Direct Seed	797b	13,247a	6,736a	495b
No Mulch	Direct Seed	0b	6,258a	13,672a	7,732a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

and 8/10 harvests in 1980 (Table 10 and 11) showed no significant differences between the numbers of fruit or weight of fruit in any of the treatment combinations. However, in 1981, the no mulch direct seed combination produced a significant increase in the number of fruit (Table 12) and weight of fruit (Table 13) over other treatment combinations. These trends in yield over the harvests are illustrated in Figure 3 where it can be seen that although variation exists between years the general pattern of distribution is very similar.

Vine Growth Measurements

Black plastic mulch showed tendance to increase the vine growth rate over plants grown on bare ground, whether using container plants (Figure 4-A) or direct seed (Figure 4-B). The growth due to the mulching treatments exhibits very similar curves within each planting treatment but are quite different when the planting treatments are compared. The two growth curves in the transplant treatment are essentially linear while those in the direct seed treatment are not (Figure 4). Approximately one month after planting, muskmelon plants exhibit a period of rapid vine growth lasting for approximately one month. The vines of the container grown muskmelons began running about one week prior to those of the direct seed treatment. Both the container plants and direct seed plants when grown on black plastic mulch (Figure 4) achieved mean vine length measurements of 161 cm 21 days after tagging. However, the container plants grown

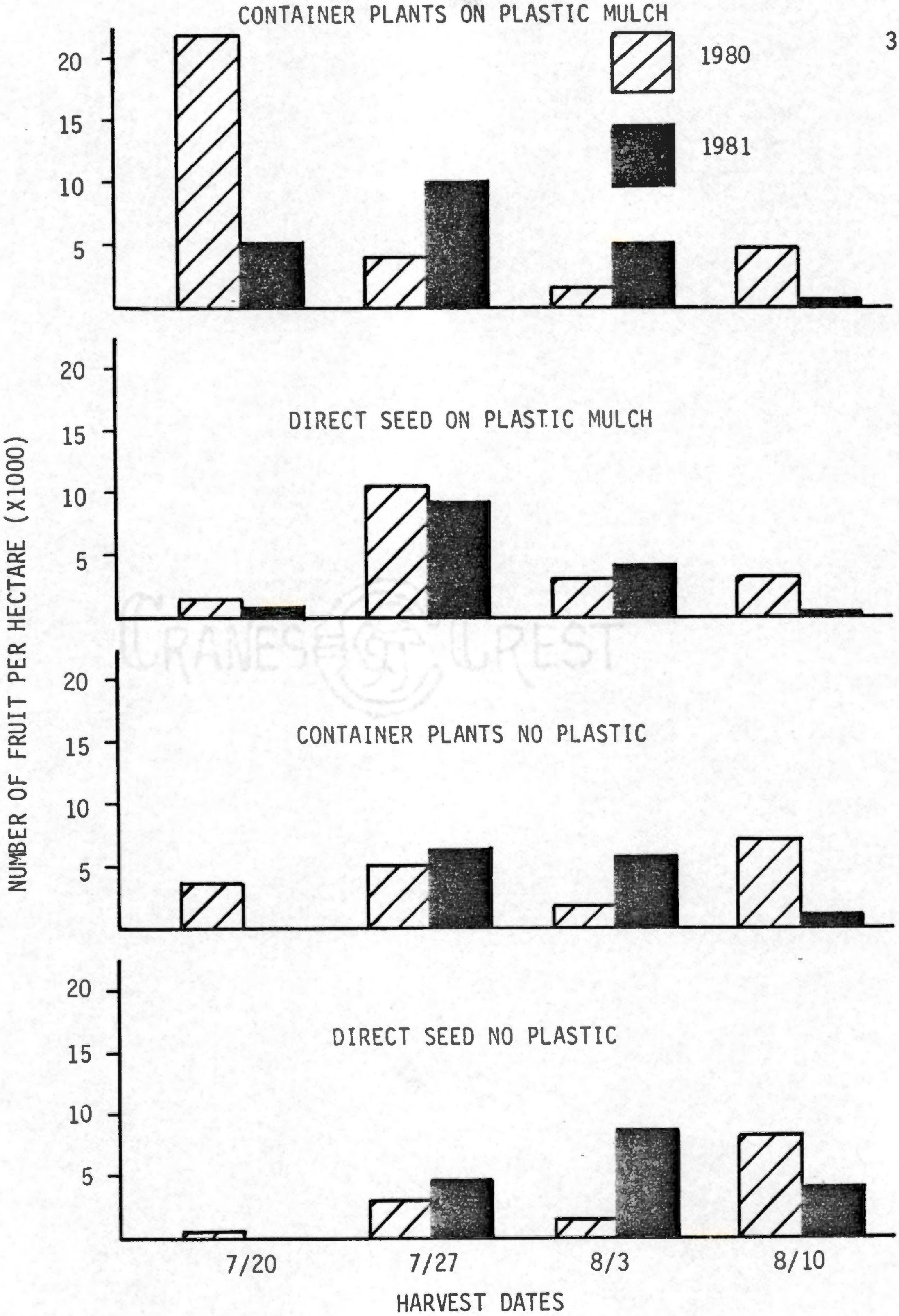

Figure 3. Marketable yield of 'Harper Hybrid' muskmelons for each combination of mulching and planting method collected in four harvests at Knoxville, Tn.

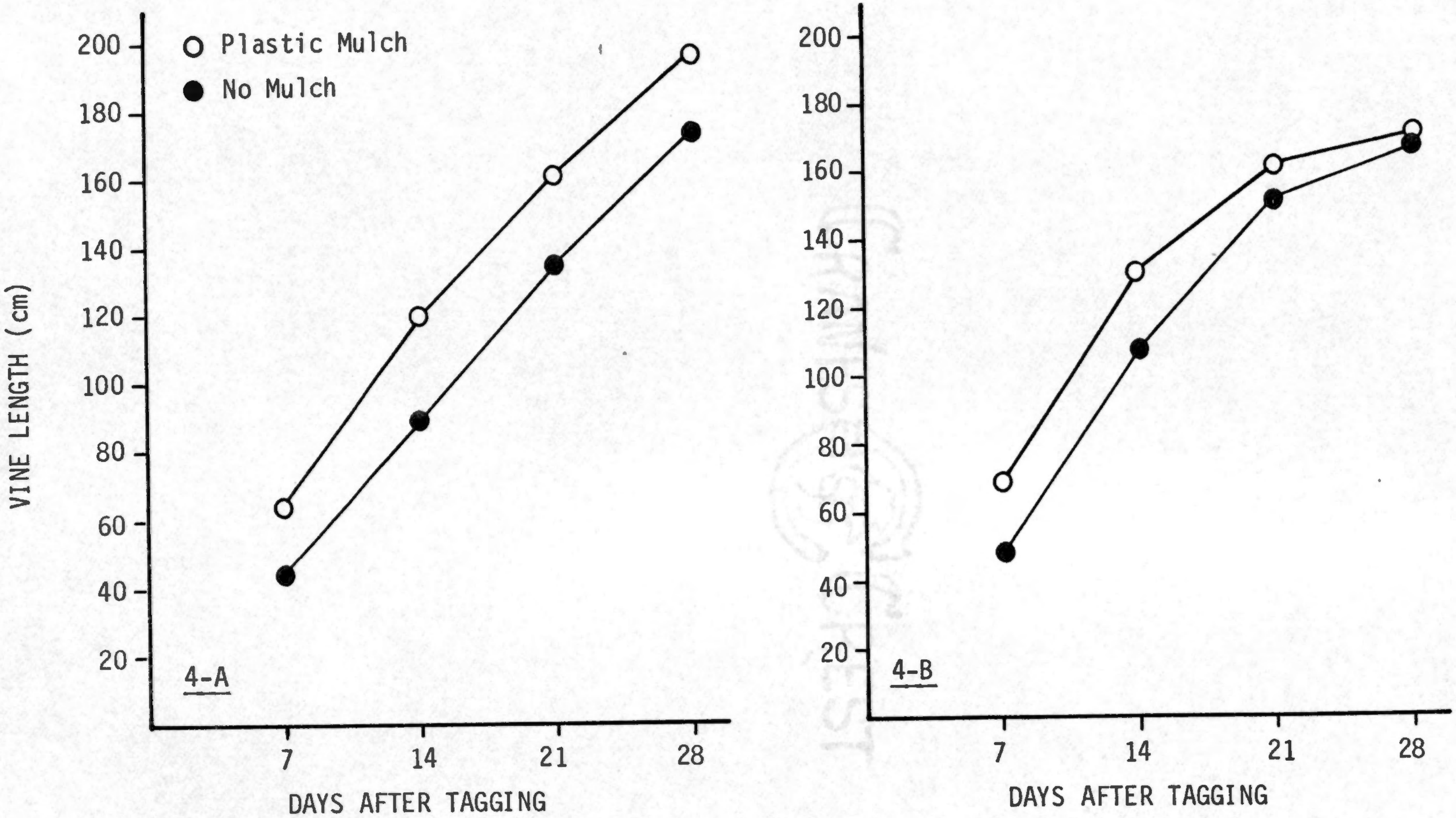

Figure 4. Vine growth measurements of container plants (4-A) and direct seed (4-B) of 'Harper Hybrid' muskmelons grown at Knoxville, Tn. in 1980.

on plastic mulch continued to grow to an average of 197 cm, while the vines of the direct seed plants grown on plastic mulch leveled off to 170 cm in length (Figure 4). The direct seed treatment might have been responsible for this phenomenon if its slower development caused its period of runner development to more closely coincide with photoperiod induced flowering, subsequent fruit set and a resultant increased carbohydrate sink which may act to impair vigorous vine growth. If this sort of process and relationship existed it could help explain the differences in yields found between the treatments.

Total Marketable Yields

In 1980 total marketable yields were significantly increased in conjunction with the individual use of plastic mulch and container plants but the use of plastic mulch caused a significantly higher number of culls (Table 14). In 1981 there were no differences in total yield or culls attributed to the independent effect of mulching and planting method (Table 15). These findings would again lead to the speculation that the less desirable weather in 1981 nullified the positive influence of both the mulch and the container plants reported in 1980. The great difference between the number of culls reported in 1980 and 1981 supports the findings of Flocker et al. (17) that an increased moisture regime leads to an increase in the number of culls (Table 14, 15).

The interaction between mulching and planting method in 1980 (Table 16) exhibited the same trend that was associated with the pooled treatments (Table 14). Container plants on plastic mulch gave

TABLE 14. Effect of pooled mulching and planting method on number, total weight and culls of 'Harper Hybrid' muskmelons at Knoxville, TN in 1980.

Pooled Treatment	Number of fruit/ha	Total weight in kg/ha	Number of culls/ha
Mulching Method[z]			
Plastic Mulch	23,788*	37,609*	7,502*
No Mulch	15,510	24,565	4,304
Planting Method[y]			
Container Plants	23,605*	35,916*	6,134[NS]
Direct Seed	15,693	26,258	5,672

[z]Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

*Pairs of means significantly different at $P \leq .05$ according to ANOVA.

[y]Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

[NS]Pairs of means are not significantly different according to ANOVA.

TABLE 15. Effect of pooled mulching and planting method on number, total weight and culls of 'Harper Hybrid' muskmelons at Knoxville, TN in 1981.

Pooled Treatment	Number of fruit/ha	Total Weight kg/ha	Number of cull/ha
Mulching Method[z]			
Plastic Mulch	17,566[NS]	27,599[NS]	12,721[NS]
No Mulch	15,554	25,345	9,698
Planting Method[y]			
Container Plants	17,427[NS]	28,479[NS]	9,559[NS]
Direct Seed	15,693	24,465	12,853

[z] Container plants and direct seed treatments combined for plastic mulch and no mulch analysis.

[NS] Pairs of means are not significantly different according to ANOVA.

[y] Plastic mulch and no mulch treatments combined for container plants and direct seed analysis.

TABLE 16. Effect of interaction of mulching and planting method on number, total weight and culls of 'Harper Hybrid' muskmelons at Knoxville, TN in 1980.

Mulching Method	Planting Method	Number of fruit/ha	Total Weight kg/ha	Number of culls/ha
Plastic Mulch	Container Plants	29,372a	45,119	7,597a
No Mulch	Container Plants	17,844b	26,713b,c	4,670a
Plastic Mulch	Direct Seed	18,210b	30,096b	7,414a
No Mulch	Direct Seed	13,175c	22,420c	3,938a

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

significantly higher yields than any other combination and direct seed plants with no mulch gave the lowest yields. In 1981 the combined interaction of mulching and planting exhibited marketably different findings (Table 17). Container plants on plastic and direct seed no mulch in 1981 were shown to yield essentially the same amount, while these two treatments did vary significantly from the remaining two treatments. The relationship between the combined treatments are represented in Figure 5. The major point that this graph emphasizes is that container plants on plastic mulch had a positive effect on yield and the direct seed plants with no mulch were insulated from excessive moisture in a wet year while suffering reduced yields in a dry year.

TABLE 17. Effect of interaction of mulching and planting method on number, total weight and culls of 'Harper Hybrid' muskmelons at Knoxville, TN in 1981.

Mulching Method	Planting Method	Number of fruit/ha	Total Weight kg/ha	Number of culls/ha
Plastic Mulch	Container Plants	20,860a	33,924[a]	8,966b
No Mulch	Container Plants	14,002a	23,034a	10,159b
Plastic Mulch	Direct Seed	14,273a	21,275a	16,468a
No Mulch	Direct Seed	17,113a	27,659a	9,244b

Means followed by the same letter in the same column are not significantly different at the 5% level using Duncan's multiple range test.

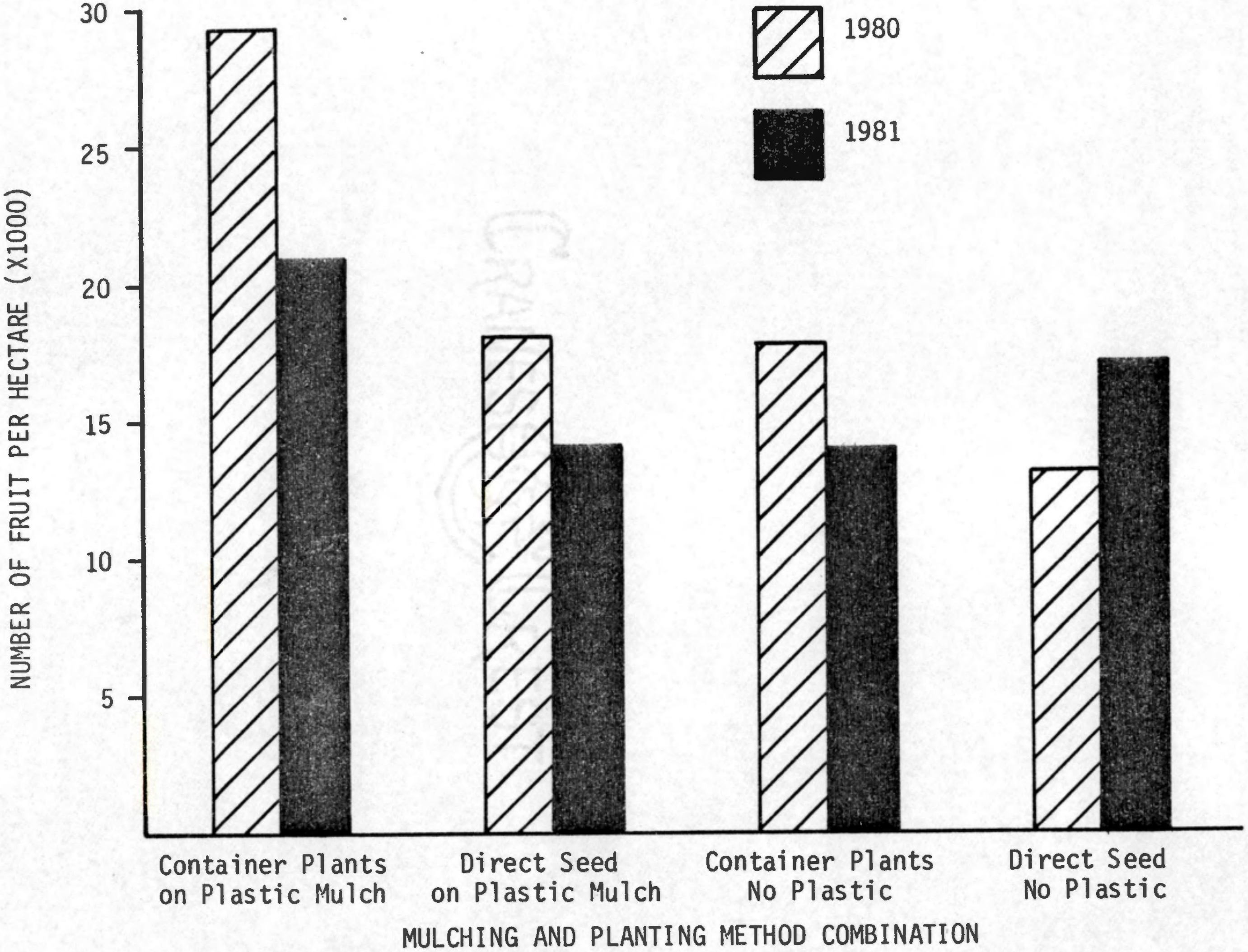

Figure 5. Total marketable yield of 'Harper Hybrid' muskmelons for each combination of mulching and planting method at Knoxville, Tn.

CHAPTER V

SUMMARY AND CONCLUSIONS

As is so often the case in agriculture, macro-environmental variation tends to complicate efforts to optimize micro-environmental conditions that would favor increased productivity. This was the case in this study, which, was greatly affected by the variation in weather between 1980 and 1981. However, some valid conclusions can be drawn.

Direct seeding enhanced the size of the fruit, but there was no substantial treatment effect on the average weight of fruit. The larger the fruit and the heavier its netting the greater the probability that it would posssess a high soluble solid content (SSC).

Container plants and plastic mulch alone or in combintion acted to increase the early yields of muskmelon fruit. This effect was constant over both years in the study.

Vine growth was not significantly different among treatments, however, the initiation of runner development was advanced by the use of container plants.

The increased yield obtained in 1980 associated with both plastic mulch and container plants was not reproduced in the 1981 test. Presumably, the increased moisture regime in 1981 negated the beneficial effect of the plastic mulch in moisture retention. The cool, cloudy weather characterisitic of 1981, along with the earlier planting date, might have reduced the advantage of using container plants. However, these possibilities do not account for the similarities found in earliness for both years.

The reduced effect noted in 1981 apparently was a function of magnitude as opposed to a change in the production trends.

The use of black plastic mulch and/or container plants to increase muskmelon productivity in East Tennessee, like most agricultural ventures, is a risk that could greatly increase revenues in a good growing season or fail to cover their added cost in a poor year.

However, it is likely that over a period of several years that the use of both plastic mulch and container plants would enable the producer to realize increased returns. It is apparent in Figure 5 that in a wet year (1981) little increase in production with the use of container plants on plastic was achieved over that of the direct seeding with no nulch. But, in a drier year (1980) container plants on plastic were responsible for a 223 percent increase in yields (total weight of fruit) when compared to the no mulch direct seed treatment. The increased returns in a good year would far outweigh the added expense incurred in a bad year from the use of plastic mulch and container plants. This, combined with the increased returns realized from increased earliness regardless of weather variation and improved weed control, would make the use of plastic mulch and container plants a viable long term option for increasing muskmelon production in Tennessee.

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