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Influence of Different Types of Mulches on Eggplant Production

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Abstract. Field studies conducted during the summers of 1983 and 1984 evaluated the influence of different types of mulching materials on growth and development of 'Black Beauty' eggplant (*Solanum melongena* L.). Treatments consisted of a) pine needles, b) newspaper, c) black plastic, and d) no mulch. The effects of mulching on earliness, growth index, soil moisture, temperature, pH, leaf nutrient content, weed control, and yield were measured. In 1983, a year of limited rainfall, all of the mulching treatments caused a significant increase in growth when compared to the unmulched treatment. Growth was unaffected by mulching in 1984, a year of abundant rainfall. Earliness, measured by the number of fruit per plant prior to the first harvest, was significantly increased by black plastic in 1983 but was not affected in 1984, which suggests the effectiveness of mulching under limited rainfall. In both years, mulching did not affect soil pH, leaf nutrient content, or soil temperature. Black plastic or pine needles were significantly more effective than newspaper in conserving moisture and controlling weeds. Black plastic increased yields significantly compared to the unmulched control in 1983, whereas black plastic or pine needles increased yields in 1984.

Organic or synthetic mulches used in the home garden or for commercial vegetable production increase plant growth, hasten maturity, and increase yields (1, 2, 4-6, 10, 12). Moderation of soil temperatures (1, 3, 6, 11), conservation of water (1, 11, 14), reduction of nutrient loss by leaching (9, 13), and control of weeds (1, 14) are some of the advantages of mulching. Most of the mulching materials that have been considered are suitable for commercial production but may be too costly and/or unavailable for use in the home garden. Studies suggest that good mulching materials must be readily available and inexpensive (7, 14).

During Fall 1982, a survey was conducted in Peach County, Ga. to identify types of inexpensive mulching materials used by home vegetable gardeners (8). Results from this survey showed that pine needles, newspaper, or leaves were the most inexpensive mulching materials commonly used in this area,

but pine needles were the most available to home gardeners. Based on these results, field studies were undertaken to evaluate the influence of inexpensive mulching materials on growth, earliness, and yield of garden vegetables. Their influence on soil pH, soil temperature, soil moisture, and weed control was also studied. To date, eggplant, tomato, broccoli, and collards have been tested (1, 7); however, this paper reports only on eggplant.

Field studies were conducted during the summers of 1983 and 1984 on the Fort Valley State College Agricultural Research Farm to determine the influence of different types of mulching materials and black plastic on growth and development of eggplant. Black plastic (0.10 mm), newspaper, pine needles, and a control (no mulch) were the treatments used. Each experimental plot consisted of two 4.5-m rows spaced 0.9 m apart. Plants within each row were 0.6 m apart. Except for the black plastic, each mulching treatment was applied immediately after transplanting. Prior to the transplanting, one sheet of 0.10-mm black plastic was placed over the two-row plots and anchored with loose soil along the outer edge. For the newspaper treatment, four superposed sheets were spread over the plots and anchored with loose soil on the surface and outer edges. The pine needle treatments were 8 to 10 cm thick.

Eight-week-old 'Black Beauty' eggplant seedlings were used both years. Plants for the 1983 and 1984 studies were transplanted on 25 and 28 May, respectively. Both studies were designed as randomized complete blocks with four replications. The experimental layout for the 1984 study was identical to that of the 1983 experiment. The 1984 study was repeated in the same location to determine the effect of continuous use of these mulching materials on soil pH when incorporated and decomposed in the soil.

Prior to the 1983 experiment, the plots were limed as needed to raise the pH to 6.0-6.5. Seventy Kilograms of N/ha, 60 kg P/ha, and 110 kg K/ha were incorporated into the soil prior to planting for both years. At the fruit-setting stage, the plants were sidedressed with 50 kg N/ha as NH_4NO_3 . A bi-

Table 1. Durability of mulching materials and their effects on soil moisture and weed control.

Mulch ^a treatment	Durability ^b (after 4 months)	Percent soil moisture (by wt)	Weed control ^c (over 4 months)
1983			
Control	---	14.0 c	1.0 c
Pine straw	7.2 a	24.8 a	9.7 a
Newspaper	2.2 b	20.2 b	7.5 b
Black plastic	8.5 a	23.7 a	10.0 a
1984			
Control	---	14.7 c	1.0 c
Pine straw	8.0 a	21.0 a	9.5 a
Newspaper	2.0 b	17.7 b	7.2 b
Black plastic	9.0 a	18.2 b	10.0 a

^aMean separation in columns by Duncan's multiple range test, 5% level.

^bVisual rating: 1 (worst) to 10 (best).

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Table 2. Mean monthly temperature and precipitation for Fort Valley, Ga.

	April		May		June		July		August		September	
	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984
Mean daily max. temp (°C)	20	25	27	29	31	34	37	34	36	34	31	31
Mean daily min. temp (°C)	6	11	12	15	17	19	22	21	23	11	18	17
Precipitation (cm)	3.45	2.12	2.79	11.50	15.26	9.37	9.63	27.56	4.83	11.71	15.69	0.25

Table 3. Effect of mulching materials on the growth and development of eggplant prior to the first harvest.

Mulch ^a treatment	Growth index ^b (cm)		Leaves/plant		Fruit/plant	
	1983	1984	1983	1984	1983	1984
	Control	18.6 c	22.3 a	6.1 b	5.8 a	1.6 b
Pine straw	23.5 b	23.9 a	10.3 a	5.5 a	1.7 b	2.1 a
Newspaper	21.3 b	24.0 a	8.3 a	4.9 a	1.9 b	1.6 a
Black plastic	25.4 a	24.9 a	9.8 a	5.1 a	2.9 a	2.5 a

^aMean separation within columns by Duncan's multiple range test, 5% level.

^b(Plant height + maximum plant width)/2.

Table 4. Effect of mulching materials on the yield of eggplant.

Mulch ^a treatment	Yield					
	Fruit/plant		Total fruit wt (g)		Avg. fruit wt (g)	
	1983	1984	1983	1984	1983	1984
Control	19.2 b ^z	35.7 b	778 b	9,035 b	426 a	255 b
Pine straw	25.2 ab	37.7 b	9,927 ab	11,389 a	391 a	304 a
Newspaper	28.2 ab	39.7 ab	10,871 ab	10,117 ab	389 a	264 b
Black plastic	34.2 a	42.5 a	12,480 a	11,380 a	366 a	275 b

^aMean separation in columns by Duncan's Multiple range test, 5% level.

weekly spray program consisting of 1-naphthylalanyl methylcarbamate (carbaryl) and methyl[1-(butylamino)carbonyl]-1H-benzimidazol-2-yl]carbamate (benomyl) at the respective rate of 2 and 1.5 kg·ha⁻¹ to prevent and control insects and diseases was followed throughout the experiments.

Data on growth index (plant height + maximum width/2) and number of leaves were collected on 22 and 13 July, i.e., 1 week before the first harvest in 1983 and 1984, respectively. Prior to the first harvest, data were also collected on the number of fruits per plant and used as an indication of earliness. Soil thermometers were placed in the soil 10 cm below each mulching treatment, and soil temperatures were recorded twice a week at 0900, 1200, and 1600 HR throughout the experiment. Soil samples were taken once a month at a depth of 15 cm for pH determinations, using 1:1 ratio (v/v).

For both years, in the latter part of August, leaf samples were taken for each treatment and sent to the Soil Testing and Plant Analysis Laboratory of the Univ. of Georgia, Athens, for N, P, K, Ca, Mg, Mn, Fe, B, Cu, and Zn determinations. Composite samples were taken for each treatment at a depth of 15 cm for gravimetric determination of soil moisture. The effectiveness of weed suppression by each mulch treatment was determined by visual comparison of the weed density per plot. Weed suppression and durability of the mulch treatment were rated on a scale of 1 (worst) to 10 (best). Fruit yields

were determined by weight and fruit count. The same procedures described above were used for both 1983 and 1984 studies.

Soil pH. In 1983, soil pH was not affected by the mulching treatments during the cropping season. Soil pH data (May 1984) collected prior to the establishment of the 1984 experiment showed no change due to the incorporation of newspaper, black plastic, or pine needles into the soil. Little or no change in soil pH was recorded at the end of the 1984 season (data not shown). These results concur with previous findings that most mulching materials do not have a strong effect on soil pH (12, 14).

Soil temperature. Contrary to the findings that different types of mulch created specific soil temperature regimes (1, 14), our study generally showed that the mulch treatment did not affect the soil temperature (data not shown). However, in 1984, when the 1200- and 1600-HR measurements were compared to the control, there was a slight increase in soil temperature under the black plastic and a slight decrease under pine needles or newspaper. These trends agree with the findings of Schultz (13) that organic mulches, such as straw, keep the soil cool, whereas synthetic mulches such as plastic have the opposite effect. This difference in soil temperature may be due to the difference in heat retention or insulation of the soil by the organic and synthetic materials under some specific climatic conditions.

Soil moisture. All the mulching treatments

in both years caused a significant increase in soil moisture compared to the control (Table 1). In the first study (1983), pine needles or black plastic were significantly more effective than newspaper in conserving soil moisture. Liptay and Tiessen (11) showed that paper mulches were not as effective as polyethylene-coated paper mulches in reducing soil moisture evaporation. They also suggested that mulch materials such as leaves and straw are absorbent, whereas newspaper dries rapidly. The absorbing capacity of leaves and pine needles may have the effect of decreasing the water vapor deficit in the surrounding environment, thus reducing the evaporation rate of the soil moisture. During the 2nd year (1984) there were no differences in the soil moisture due to black plastic or newspaper. This lack of difference was probably due either to the high soil temperature under the black plastic causing an increase in soil water evaporation through the plastic holes or the increase in rainfall in 1984 compared to 1983 (Table 2).

Weed control and durability. The mulching treatments in both years significantly suppressed weeds compared to the control (Table 1). However, black plastic or pine needles was significantly better than newspaper. Weed seedlings grew through the newspaper and around the outer edges, causing it to be less effective. The lack of effectiveness of the newspaper in controlling weeds could be attributed to its rapid disintegration as compared to the other mulching materials (Table 1). In effect, the results over a 4-month period showed that the black plastic or pine needles were significantly more durable than the newspaper. The black plastic was the most stable of the treatments, with little or no deterioration during the growing season. The pine needles matted slightly, but remained intact throughout the growing season whereas the newspaper disintegrated completely. Ashworth and Harrison (1) reported similar results with organic and synthetic mulches with regard to their effectiveness in controlling weeds and their durability.

Nutrient content. The nutrient content of eggplant leaves was not affected by the mulch treatments (data not shown). This result is contrary to that of Jones and Jones (9), who showed that mulches generally reduce loss of NO₃, SO₄, Ca, Mg, and K and that bacterial activity associated with decaying organic mulches temporarily can tie up N levels.

Growth and development. Prior to the first harvest in 1983, all of the treatments significantly improved growth compared to the control, with black plastic superior to pine

needles or newspaper (Table 3). In 1984, growth of the eggplant was not affected by the mulches. The mulch treatments increased the number of leaves prior to the first harvest in 1983, whereas no differences were observed in 1984. The number of fruit per plant prior to the first harvest was used as an indication of earliness. Black plastic caused a significant increase in fruit number compared to the other treatments in 1983, but not in 1984. The difference in growth and fruit number response between 1983 and 1984 could be related to the wide variation in the monthly temperature and precipitation for these years (Table 2).

Yields. In both years, black plastic significantly increased the number of fruit per plant compared to the control (Table 4). In 1983, average fruit weight was not affected by mulching but, in 1984, black plastic significantly increased the average fruit weight. Black plastic significantly increased yields in 1983 and, in 1984, black plastic or pine needles significantly increased yields. During these studies, black plastic or pine needles were shown to suppress weeds and to increase soil moisture levels. These factors could be related to the yield increases caused by these treatments. Increased yields from the use of black plastic could be attributed to early fruit production and a prolonged fruiting period.

Results from these studies indicate that pine needles compared favorably with black plastic in improving the growth and development of eggplant, whereas newspaper was shown to be inferior. Thus, it appears that pine needles may have some potential as an inexpensive mulching material for home vegetable gardens.

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Growth Analysis of Three Cucumber Lines Differing in Plant Habit

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Abstract. Growth analyses were conducted in the greenhouse on two commercial lines, 'Calypso' and M 21 [of cultivated cucumber (*Cucumis sativus* L. var. *sativus*) differing in growth habit and one line, LJ 90430, of the wild cucumber *Cucumis sativus* L. var. *Hardwickii* (R.) Alef., to determine relationships between morphological characteristics and fruit yield. Multiple fruiting in LJ 90430 was associated with high leaf area and multiple branching. The standard commercial pickling cultivar, Calypso, which usually produces one to two fruit per plant per harvest, had less leaf area and fewer branches per plant than LJ 90430. Competition between early fruit development and vegetative growth was possible in 'Calypso' and M 21, but not in LJ 90430, which did not begin fruit development until vegetative growth was completed. Dry weight percentage in the fruit of LJ 90430 was low initially and increased steadily until the final harvest. Dry weight percentages in the fruit of 'Calypso' and M 21 were high initially and decreased generally thereafter. Relative growth rates of the whole plant followed similar trends in LJ 90430, 'Calypso', and M 21.

The growth of a developing fruit on a cucumber plant inhibits the development of fruits that set later (4). It also affects the development of the roots and the main shoot apex (9, 13). The inhibitory effect ceases when the growing fruit is removed, allowing the production of several fruit per plant under multiple-harvest conditions. However, yields of only one to two fruit per plant are typical for crops harvested once-over (10).

McCollum (9) proposed that the mechanism of inhibition was the result of growth-

regulating substances produced by fertilized ovaries. This possibility was investigated by Nienhuis (11), who made reciprocal grafts of *Cucumis sativus* var. *sativus* and *Cucumis sativus* var. *hardwickii* (referred to as *sativus* and *hardwickii*, respectively, hereafter). *Hardwickii* is a progenitor or feral cucumber that sets a large number of fruit, apparently lacking the inhibitory effect of one fruit on another (8). Nienhuis did not find any evidence for an inhibitory growth substance that could be translocated from developing *sativus* fruits across a grafted union and inhibit fruit setting on a *hardwickii* recipient scion (11).

Another explanation for the inhibitory effect of one fruit on another could be that fruit of the commercial cultivars of cucumber constitute strong sinks for assimilates, which draw heavily on plant supplies and inhibit the development of other fruit. Photosynthetic leaf area was found to be a limiting factor in cucumber yield (13).

The objective of this study was to determine if morphological characteristics or developmental features contribute to production of greater fruit weight and number in cucumbers. In addition, *hardwickii* was evaluated as a multiple-fruiting line for use in plant breeding programs as a source of genes for high yield.

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