BIBLIOGRAPHY

PASIWEN, AIZA T. APRIL 2010. Effect of Different Mulch Materials on the Growth and Yield of Lettuce. Benguet State University, La Trinidad, Benguet.

Adviser: Percival B. Alipit, PhD.

ABSTRACT

The study was conducted to evaluate the growth and yield of lettuce as affected by different mulching materials in April to May.

Results showed that although earlier head formation was observed with the use of transparent polyethylene plastic and bigger sized heads were developed using black polyethylene plastic, higher marketable yield at 6.60 t/ha and higher return on investment at 60.06% were obtained without mulching. Lesser insect and disease incidence were also observed in unmulched plants.

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INTRODUCTION

Lettuce (*Lactuca sativa L.*) is a temperate, annual or biennial plant of the daisy family Asteraceae. It is the most often grown as a leaf vegetable. In many countries, it is typically eaten cold and raw in salads, hamburgers, tacos and many other dishes. In some places, including China, lettuce is typically eaten cooked and use of the stem is as important as use of the leaf. Both the English name and the Latin name of the genus are ultimately derived from lac, the Latin word for milk referring to the plants milky juice. Mild in flavors, it has been described over the centuries as a cooling counterbalance to other ingredients in a salad.

The earliest depiction of lettuce is in the carvings at the temple of Senuscret I at Karnak, where he offers milk to the God Min, to whom the lettuces was sacred. Later, Ancient Greek physicians believed lettuce could act as a sleeping inducing agent. The Romans cultivated it and eventually made its way to France cultivated of the Popal Court at Avignon Christopher Columbus introduced lettuce to the new world.

There are six commonly recognized groups of lettuce which are classified by head formation and leaf structure; there are hundreds of cultivars of lettuce selected for leaf shape and color, as well as extended field life, within each of these cultivars groups, butter head, also called Boston or Bibb, forms loose head; it has a buttery texture. Butter head cultivars are most popular in Europe, Chinese lettuce types generally have long, sword shaped, non – head – forming leaves, with a bitter and robust flavors unlike western types, appropriate for use in stir – fried dishes and stews, Crisphead, also called Iceberg, which form tight, dense heads that resembles cabbage. They are generally the mildest of the lettuces, valued for more for their crunchy texture than for flavors.

Cultivars of iceberg lettuce are the most familiar lettuce in the USA. The name iceberg comes from the way the lettuce was transported in the US starting in the 1920's on train – wagons covered in crushed ice, making them look like icebergs, loose leaf, with tender, delicate and mildly flavored leaves. This group comprises oak leaf and lollorossa lettuces, Romine lettuce, also called Cos, grows in a long head of sturdy leaves with a firm rib down the center. Unlike most lettuces, it is tolerant to heat, the Summer Crisp called Batavian, forms moderately dense heads with a crunchy texture; this type is intermediate between iceberg and loose leaf types.

Lettuce is a cool – season vegetable and develops best quality under cool, moist conditions. Lettuce seedling will tolerate a light frost. Temperature between 45°F and 65°F are ideal. Such conditions usually planted in the spring as soon as the ground can be worked. Butter head and romaine can be grown from either seeds or transplants, due to its long growing season; crisp head lettuce is grown from transplants. Transplants may be purchased or started indoors about six weeks before the preferred planting time by .

Mulching is the technique of placing of protective materials on top of the soil. Mulch comes in two basic forms; organic and non – organic. Mulching also minimizes weeds growth and also prevents soil splattering during heavy rains. Mulching is also necessary to the plants to minimize the loss of soil moisture. To some extent, mulching reduces the temperature of the soil, Grigson (1978).

In the market the prices of commercial mulching materials are high but even though farmers are still buying and using the products due to this many advantages. What is not known also is the degree of effectiveness of mulching materials, thus the study was conducted.

The objective of the study was to determine the effect of the different mulching materials on the growth and yield of lettuce and to identify the mulching material appropriate for lettuce production.

This study was conducted at the Horticulture Experiment Area, Benguet State University, La Trinidad, Benguet from April – May 2009.

REVIEW OF LITERATURE

Description of the Crop

Lettuce plants has a short stem initially (a rosette growth habit), but when it blooms the stem lengthens and branches, and it produces many flower heads that look like those of dandelions, but smaller. This is called bolting. When grown to eat, lettuce is harvested before it bolts. Lettuce is used as a food plants by the larvae of some Lepidoptera. The largest lettuce head, of the Salad Bowl cultivar weighted 11 kg (25 lbs) grown by Colin Bowcock of Willawston, England in 1974.

All lettuce types should be harvested at full size but young and tender. Over mature lettuce is bitter and woody. Leaf lettuce is harvested by removing individual outer leaves so that the center leaves can continue to grow. Butter head or romaine types can be harvested by removing the outer leaves, digging up the whole plants or cutting the plants about an inch above the soil surface. A second harvested is often possible this way. Crisp head lettuce is picked when the center is firm, The Columbia Electronic Encyclopedia (2004).

Nutritional Value

Some lettuce (especially iceberg) has been specifically bred to remove the bitterness from their leaves. These lettuces have high water content with very little nutrient value. The more bitter lettuce and the ones with pigments leaves contain antioxidants.

Lettuce is a fat free, low calorie food. It is a valuable source of Vitamin A and folic acid. Lactucarium or lettuce opium is a mild opiate like substance that is obtained in all types of lettuce. Both the Romans and Egyptians took advantage of this properly eating lettuce at the end of a meal to induce sleep.

Useful amounts of several nutrients including Vitamin A and C; and minerals calcium and iron. The nutrient contents are highest in the darker green outer leaves. Low calories, each heads contains 65 to 70 kilocalories, Grigson (1978).

Soil and Climatic Adaptation

Lettuce can be grown under a wide range of soils, loose, fertile ,sandy loam soils, well supplied with organic matter are best. The soil should be well drained, moist, but not soggy. Heavy soils can be modified with well rotted manure, compost or by growing a cover crops, like most other garden vegetables, lettuce prefers a slight acidic pH of 6.0 to 6.5.

Head lettuce grows best at 15 to 18 °C. germination takes place at a maximum of 5 °C, has an optimum range of 16 to 20 °C, and an optimum germination temperature of 20 °C (depending on the cultivars and type of lettuce). At soil temperatures over 27 °C germination is poor, Rubatzky and Yamaguchi (1997).

Commercial Importance of the Crop

Lettuce has become a major player in commercial production and marketing of salad crops. Total production worldwide does not compare with the major cereals crops, especially rice, corn and wheat, or with other commodities, such as sugars crops, beans and potatoes. The key word is contemporary use of lettuce is changed; in use of the various types, in the development of world markets, in methods of marketing and in methods of production, Whitaker (1974).

Mulching

Marr (1993) studied the effect of plastic mulch on vegetable. They have successfully grown muskmelon, tomatoes, peppers, cucumber, watermelons, and okra using plastics mulch and have shown significant increase in earliness, yield and fruit quality.

Ricotta and Masiunas (1991) found that mulch plots covered with black polyethylene conserve more moisture than the un

mulched plot. Likewise, soil temperature increased and sometimes hastened the growth of the crop, thus leading earlier fruit development.

Assir *et al*. (1991) found out that the application of clear plastic mulch with or without a fertilizer did not significantly increase the yield of lettuce grown in the fall under green house in the Mediterranean mountains in Lebanon. Yield average from 31 to 38 kg/50 heads. Leaf NO_3 – N and total P level were higher in mulched than the un mulched plants and always above the sufficiency level in all treatments.

The Hort. Sci. Dep., University of Florida (1988) found the benefits of polyethylene mulch and organic mulch on vegetable and fruit production. Firstly, it increased the yield. The largest benefits from black polyethylene mulch are the increase in soil temperature in the bed, which promotes faster crop development and earlier yields. Secondly, it aided in moisture retention. Mulch reduced evaporation from the bed soil surface. As a result, a more uniform soil moisture regime is maintained and the frequency of irrigation is reduced. Irrigation is still mandatory for mulched crops so that the soil under the mulch doesn't dry out excessively. Thirdly, it inhibits weed growth. Fourthly, it reduced fertilizer leaching. Fertilizer placed in the bed under the mulch is less subject to leaching by rainfall. As a result, the fertilizer program is more sufficient and the potential exist for reducing traditional amount of fertilizer. Heavy rainfall that floods the bed can still result in fertilizer leaching. This fertilizer can be replaced if the growers are using drip irrigation, or it can be replaced with a liquid fertilizer injection wheel. Fifthly, it decreased the soil compaction. Mulch acts a barrier to the action of rainfall, which can cause soil crusting, compaction and erosion. Less compaction soil provides a better environment for seeding emergence and root growth. Sixthly, it protected the fruits. Mulch reduced rain splashed soil deposited on fruits. In addition, mulch reduced fruit rot caused by soil inhibiting organism, because there is a protective barrier between the fruit and the organism. Second to the last, it aided in fumigation. Mulches increased the effectiveness of the soil fumigant chemical. It did not cause a barrier but allowed a water layer to form under the mulch and it is this water layer that slowed down the loss of the fumigant. Lastly, it aided in managing other pest. Highly reflective mulches assisted in the pest management strategies for pest and the deceases, especially viruses, they may carry. Metabolized mulches have been shown to repel thrips and reduced the incidence of tomato spotted wilt viruses in tomatoes.

In the study on Strawberry culture in Reunion Island, Catella (1987) found out that using white plastic mulch coved increase the fruit medium weight and decreases waste percentage. The same researcher observed that Sequoia variety improved fruit production to a level of three hundred grams per plant followed by Aiko variety.

Nnadi *et al*. (1984) studied the effect of mulch and nitrogen on maize. They concluded that maize yield responded significantly due to mulching. The mulch crop was taller and more vigorous than the un mulched. They also claimed that mulch provided better soil moisture, temperature regime and reduced weed competition.

Under South Carolina condition, Robbins and Schalk (1982) discovered that the black aluminum and white polyethylene mulches increase the yield and early fruiting set of spring grown tomatoes. Black transparent polyethylene mulches increased the soil temperature resulting in sweet corn, yield earlier and higher than those from un mulched soil. It reduced the incidence of aphids borne viruses and deterred such pest as aphids, thrips, leaf miner on field, ornamentals and vegetable crops.

A reduction of 50% in water losses due to evaporation was realized using clear polyethylene plastic mulch in soybean field.

Knott and Deanon (1967) pointed out that mulch is used by farmers not for the purpose of conserving moisture but to primarily control weeds. For green onions, the use of black polyethylene plastic mulch can be greatly advantageous in controlling weeds.

MATERIALS AND METHODS

Materials

The materials used in the study were lettuce seeds (Great Lakes XL), watering can, fertilizers, fungicides, insecticides, chicken manure and different mulching materials.

Methods

Experimental design and treatments. The study was laid out following the Randomized Complete Block Design (RCBD) with three replications.

The treatments were represented as follows:

Treatments

T_1 – no mulch (control)

T_2 – black polyethylene mulch

T_3 – transparent polyethylene mulch

T_4 – dried pine needles (5 cm thick)

T_5 – coconut sawdust (5 cm thick)

T_6 – dried cogon grass (5 cm thick)

T_7 – dried mountain grass (5 cm thick)

Seedling production. The seeds was sown by broadcasting in a well prepared seedbed before preparing the experiment area. The seedlings were regularly irrigated and sprayed as needed pesticides to control insect pests and diseases.

Land preparation and fertilizer application. An area of 105 square meters was thoroughly prepared. The area was divided into 3 blocks with 7 plots per block with a dimension of 1mx5m. A handful of chicken manure at about 100g was applied in each hole spaced at 30cm x 30cm apart and mixed thoroughly with soil ready for planting.

Transplanting. When the seedlings were four weeks old, they were carefully uprooted and transplanted to their assign plots.

Irrigation. Irrigation was done just after transplanting and every other day until the plants were established after which irrigation was done at weekly interval.

Care and maintenance. All other recommended practices required in the production of lettuce like weeding, cultivation, pest control and fertilizer application were uniformly employed to each treatments plot.

Data to be gathered. The data gathered and subjected to variance analysis and mean separation test by Duncan's Multiple Range Test (DMRT) were as follows:

1. Number of days from transplanting to head initiation. This was done by counting the number of days from transplanting up to 50 % of the plants started to form heads.

2. Number of days from transplanting to harvest. This was the number of days from transplanting to the day heads are firm (by hand pressing) and ready for harvest.

3. Polar circumference (cm). This was determined by positioning a tape measure around the polar section of five sample heads selected at random.

4. Equatorial circumference (cm). This was obtained by positioning a tape measure around the equator of the same sample heads.

5. Percentage heading. This was computed by using the formula:

$$\text{Heading Percentage} = \frac{\text{Number of Heads Harvested}}{\text{Total Number of Plants/Plot}} \times 100$$

6. Average head weight (kg). This was taken using the formula:

$$\text{Head weight (kg)} = \frac{\text{Total Head Weight/Plot}}{\text{Number of Harvested Heads/Plot}}$$

7. Marketable yield (kg/plot). This was the weight of all heads without defects and can be sold in the market.

8. Non – marketable yield (kg/plot). This was the weight of non – marketeable heads that are very small ,malformed and damaged.

9. Total yield (kg/plot). This was the total yield of ld (kg/plot). This was the weight of non – marketable heads that are very small, malformed and damaged. marketable and non – marketable heads.

10. Computed marketable yield (t/ha). The marketable yield per plot was converted to yield per hectare by multiplying with 2,000 plot based on the plot dimension (1m x 5m) used in the study.

11. Cost and return analysis. All expenses incurred in the study were recorded. The return of investment (ROI) was computed using the formula:

$$\text{Return on Investment} = \frac{\text{Gross Sales – Total Expenses}}{\text{Total Expenses}} \times 100$$

12. Incidence of insect pests and diseases. Observation was done on the presence of insect pest and disease identified and rated them using the following scale:

A. Insect

Rating	Description
1	0 – 15% of the plants/plot were infested
2	15 – 30% of the plants/plot were infested
3	30 – 45% of the plants/plot were infested

4 45 - 60% of the plants/plot were infested

B. Disease

Rating	Description
1	10 – 15% of the plants/plot were infected
2	15 – 30% of the plants/plot were infected
3	30 – 45% of the plants/plot were infected
4	45 – 60% of the plants/plot were infected

RESULTS AND DISCUSSION

Days to Head Initiation

There were significant differences observed among the different mulch materials on the days from transplanting to head initiation (Table 1). Results showed that transparent polyethylene plastic effected the earliest days to transplanting to head initiation, followed by black polyethylene plastic and dried pine needles.

Days from Transplanting to Harvest

There were no significant differences among the different mulching treatments in affecting the days from transplanting to harvest ranging from 44 to 46 days.

Percentage Heading

As presented in Table 1, lettuce mulched with black polyethylene plastic had the highest percentage of heading comparable to those of plants mulched with any of the materials used but significantly higher than that of plants which were not mulched. The higher percentage of heading of mulched plants could be attributed to the conservation of soil moisture and suppression of the growth of weeds.

Polar Circumference

As shown in Table 2, lettuce mulch with black polyethylene plastic and those not mulched significantly had wider polar circumference of heads.

Table 1. Days to head initiation, days from transplanting to harvest, and percentage heading

TREATMENT	DAYS TO HEAD INITIATION	DAYS FROM TRANSPLANTING TO HARVEST	PERCENTAGE HEADING
No mulch	37.33[a]	44.33[a]	59.42[b]
Black polyethylene plastic	36.00[ab]	43.67[a]	84.06[a]
Transparent polyethylene plastic	35.67[b]	44.33[a]	78.26[a]
Dried pine needles	36.67[ab]	45.67[a]	71.74[ab]
Coconut sawdust	37.33[a]	45.33[a]	73.91[a]
Dried cogon grass	37.33[a]	45.00[a]	82.61[a]
Dried napier grass	37.00[a]	45.00[a]	74.64[a]

Means with same later are not significant different at 5% level by DMRT

Equatorial Circumference

Table 2, shows that significantly wider equatorial circumference of heads was observed in plants mulched with black polyethylene plastic.

Average Head Weight

In Table 2 there were no significant differences observed on the average head weight as affected by the different mulch materials used. However, lettuce plants that were not mulched and those mulched with coconut sawdust had the highest average head weight.

Table 2. Head size and average head weight

TREATMENT	POLAR CIRCUMFERENCE (cm)	EQUATORIAL CIRCUMFERENCE (cm)	AVERAGE HEAD WEIGHT (kg)
No mulch	15.33[a]	18.67[b]	0.25[a]
Black polyethylene plastic	17.33[a]	21.33[a]	0.13[a]
Transparent polyethylene plastic	16.00[b]	19.33[b]	0.16[a]
Dried pine needles	15.00[c]	19.00[b]	0.16[a]
Coconut sawdust	15.00[c]	18.67[b]	0.21[a]
Dried cogon grass	15.67[bc]	19.33[b]	0.13[a]
Dried napier grass	15.33[c]	18.67[b]	0.14[a]

Means with same later are not significant different at 5% level by DMRT

Marketable Yield per Plot

With regards to the marketable yield, there were no significant differences that were observed. Nevertheless, plants not mulched had the highest marketable yield. This could attributed to better soil aeration and penetration of water during irrigation in unmulched plots.

Non-Marketable Yield

Table 3 shows that unmulched lettuce plants had the highest non-marketable yield, although they had the highest marketable yield.

Total Yield

The total yield as affected by the different mulch materials did not differ significantly as shown in Table 3. However, plants which were not mulched had the highest total yield.

Table 3. Yield

TREATMENT	YIELD (kg/1x5m plot)			COMPUTED MARKETABLE YIELD (t/ha)
	MARKETABLE YIELD	NON – MARKETABLE YIELD	TOTAL YIELD	
No mulch	3.30[a]	3.98[a]	7.29[a]	6.60[a]
Black polyethylene plastic	2.50[a]	1.70[b]	4.20[a]	4.99[a]
Transparent polyethylene plastic	3.10[a]	2.38[ab]	5.48[a]	6.20[a]
Dried pine needles	2.74[a]	2.63[ab]	5.37[a]	5.48[a]
Coconut sawdust	2.58[a]	2.48[ab]	5.06[a]	5.15[a]
Dried cogon grass	2.85[a]	1.97[b]	4.81[a]	5.69[a]
Dried napier grass	2.59[a]	2.07[ab]	4.66[a]	5.18[a]

Means with same later are not significant different at 5% level by DMRT

<u>Computed Yield</u>

Table 3 shows that the computed yield per hectare followed the same trend as in the marketable yield where lettuce plants that were not mulched had the highest yield but not significantly different from the yield of the other treatment plants.

<u>Incidence of slug</u> (*Deroceras reticulatum*)

As shown in Table 4, lettuce plants mulched with black polyethylene plastic significantly had the highest incidence of infestation comparable to plants mulched with any of the materials. Unmulched plants had the lowest incidence of slugs.

The result may imply that the application of mulch will enhance infestation of slugs on lettuce plants.

Table 4. Incidence of slug (*Deroceras reticulatum*)

TREATMENT	MEAN
No mulch	1.70^{b}
Black polyethylene plastic	2.48^{a}
Transparent polyethylene plastic	2.07^{ab}
Dried pine needles	2.07^{ab}
Coconut sawdust	2.07^{ab}
Dried cogon grass	2.07^{ab}
Dried napier grass	2.07^{ab}

Means with same later are not significant different at 5% level by DMRT

Bacterial Soft Rot (*Erwinia carotova*)

As shown in Table 5, the occurrence of bacterial soft rot was higher in plants mulched regardless of the materials used as compared to unmulched plants which had lower disease infection.

Cost and Return Analysis

Table 6, presents the cost and return analysis of producing lettuce as affected by different mulch materials. The highest return on investment of 60.06% was obtained from lettuce that were not mulched followed by 35.11% from using dried cogon needles and 29.89% from the use of dried pine needles.

Table 5. Incidence of bacterial soft rot (*Erwinia carotova*)

TREATMENT	MEAN
No mulch	1.70[b]
Black polyethylene plastic	2.48[a]
Transparent polyethylene plastic	2.07[ab]
Dried pine needles	2.07[ab]
Coconut sawdust	2.07[ab]
Dried cogon grass	2.07[ab]
Dried napier grass	2.07[ab]

Means with same later are not significant different at 5% level by DMRT

Table 6. Cost and return analysis

ITEM	MULCH MATERIALS						
	No mulch	Black plastic	White plastic	Dried pine needles	Coconut sawdust	Dried cogon grass	Dried napier grass
Yield ($kg/15m^2$)	9.90	7.50	9.30	8.22	7.74	8.55	7.77
Sales (Php)	346.50	262.50	325.50	287.70	270.90	299.25	271.95
Farm inputs (Php)							
Seedlings	14.29	14.29	14.29	14.29	14.29	14.29	14.29
Chicken manure	34.29	34.29	34.29	34.29	34.29	34.29	34.29
Urea	5.71	5.71	5.71	5.71	5.71	5.71	5.71
14-14-14	17.71	17.71	17.71	17.71	17.71	17.71	17.71
Lannate	41.43	41.43	41.43	41.43	41.43	41.43	41.43
Anthracol	37.14	37.14	37.14	37.14	37.14	37.14	37.14
Mulch	0.00	35.00	35.00	5.00	10.00	5.00	5.00
Labor							
Land preparation	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Planting	14.29	14.29	14.29	14.29	14.29	14.29	14.29
Weeding	14.30	14.30	14.30	14.30	14.30	14.30	14.30
Irrigation	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Harvesting	14.32	14.32	14.32	14.32	14.32	14.32	14.32
Total Expenses	216.48	251.48	251.48	221.48	226.48	221.48	221.48
Net profit (Php)	130.02	11.02	74.02	66.22	44.42	77.77	50.47
ROI (%)	60.06	4.38	29.43	29.89	19.61	35.11	22.79
Rank	1	7	4	3	6	2	5

Note: Selling price during harvest = Php 35.00/kg

Other Observations

During heavy rains, run-off soil erosion was observed on plots which were not mulched, exposing few roots of the plants but were covered thereafter.

Many weeds were found growing on unmulched plots and those mulched with transparent polyethylene plastic.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted to determine the effect of the different mulching materials on the growth and yield of lettuce and to identify the mulching material appropriate for lettuce production. The study was conducted at the Horticulture Experimental Area, Benguet State University from April-May 2009.

Results of the study show that the earliest to form heads were those mulched with transparent polyethylene plastic. Higher percentage of heading was obtained with the use of black polyethylene plastic and with the use of any of the materials but significantly higher than that of plants which were not mulched. Wider polar and equatorial circumferences of heads were observed in plants mulched with black polyethylene plastic.

Although no significant differences were observed among the treatments, the highest marketable yield at 6.60 t/ha and highest return on investment at 60.06% was obtained from plants that were not mulched. Lesser incidence of slug and bacterial soft rot was observed in unmulched plants.

Conclusion

Based from the results, mulching lettuce during the dry season does not enhance the growth and yield of lettuce.

Recommendation

It is recommended that similar study on mulching lettuce be conducted during the wet season when there are frequent rains.

LITERATURE CITED

ASSIR, A.L., I.G. RHEIZ and R.V. KROURY. 1991. Response of fall green house cost Lettuce to clear mulch and nitrogen fertilizer. J. Plant Nutrition Pp.50: 1017-1022

CATELLA, G. 1987. Strawberry Culture in Reunion Island. International Training Course. Southern Hemisphere close to the topic of Capricorn, Colony of France.Pp.4.

GRIGSON, J. 1978. The Vegetable Book. London, Penguin. ISBN – 14- 046- 352- 6.

HORT. SCI. DEP. 1988. Florida Cooperative Extension Service, Institute of food and Agricultural Science, University of Florida.

KNOTT, J.E. and J.R. DEANON. 1967. Vegetable production in South Asia. College of Agriculture, University of the Philippines, College of Los Banos, Laguna.Pp.310.

MARR. C.W. 1993. Plastic Mulches for Vegetable, Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Kansas State University.

NNADI, L.; B.T. KANG and E.N.O.I. WUAFOR. 1984. Effect of mulch and nitrogen on maize Southern Guinea Savanna, Central Nigeria. IITA Annual Report International Institute of Tropical Agriculture, Oyo Road, Ibadan, Nigeria. Pp. 164 – 165.

RICOTTA, J.A. and J.B. MASIUNAS. 1991. The effect of black mulch and weed control strategies on herb yield. Department of Horticulture, University of Illionois. Horticulture Science 26 (5). Pp. 539 – 540.

ROBBINS, L.M. and J.M. SCHALK. 1982. Reflective Mulches Influence Plant Survival, Production and Insect control in fall Tomatoes. Louisiana State University Agricultural center, Chase, Los Angeles. Pp. 848

RUBATZKY, V.E. and M. YAMAGUCHI. 1997. World Vegetables: Principles, Production and Nutritive Values, New York: Chapman and Hall.2nd ed.

The COLUMBIA ELECTRONIC ENCYCLOPEDIA Copyright @ 2004. Licenced from Columbia University Press.

WHITAKER, T.W. 1974. Lettuce: Evolution of a Weedy Cinderella. Hortscience 9. Pp. 512.

APPENDICES

Appendix Table 1. Number of days from transplanting to head initiation

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	37	38	37	112	37.33
T2	36	37	35	108	36.00
T3	36	36	35	107	35.67
T4	37	36	37	110	36.67
T5	37	37	38	112	37.33
T6	37	38	37	112	37.33
T7	36	38	37	111	37.00

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	1.524	0.762	1.57	0.2472	
Treatment	6	8.476	1.413	2.92*	0.0541	
Error	12	5.809	0.485			
TOTAL	20	15.809				

* - Significant

Coefficient of variation = 1.89%

Appendix Table 2. Number of days from transplanting to harvest

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	44	46	43	133	44.33
T2	44	44	45	133	44.33
T3	44	44	43	131	43.67
T4	45	44	48	137	45.37
T5	46	45	45	136	45.33
T6	45	45	45	135	45.00
T7	45	45	45	135	45.00

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.095	0.048	0.04	0.9633	
Treatment	6	8.477	1.413	7.11 ns	0.4102	
Error	8	15.238	1.270			
TOTAL	20	23.81				

ns - Not significant

Coefficient of variation = 2.52%

Appendix Table 3. Percentage heading

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	52.17	60.87	65.22	178.26	59.42
T2	93.48	76.09	82.61	252.18	84.06
T3	71.74	84.78	78.26	234.78	78.26
T4	63.04	80.43	71.74	215.21	71.74
T5	80.43	69.57	71.74	221.74	73.91
T6	82.61	89.13	76.09	247.83	82.61
T7	67.39	82.61	73.91	223.91	74.64

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	81.505	40.753	0.74	0.4998	
Treatment	6	1215.909	202.615	3.66*	0.0267	
Error	12	665.078	55.423			
TOTAL	20	1962.492				

* - Significant

Coefficient of variation = 9.93%

Appendix Table 4. Polar circumference (cm)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	15	15	16	46	15.33
T2	17	17	18	52	17.33
T3	16	16	16	48	16.00
T4	15	15	15	45	15.00
T5	15	15	15	45	15.00
T6	16	15	16	47	15.67
T7	15	15	16	46	15.33

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	1.238	0.619	5.20	0.0236	
Treatment	6	12.000	2.000	16.80**	0.0001	
Error	12	1.428	0.119			
TOTAL	20	14.666				

** - Highly significant Coefficient of variation= 2.20%

Appendix Table 5. Equatorial circumference (cm)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	18	18	20	55	18.33
T2	22	20	22	64	21.33
T3	19	20	19	58	19.33
T4	20	18	19	57	19.00
T5	19	19	18	56	18.67
T6	20	18	20	58	19.33
T7	18	18	20	56	18.67

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	3.714	1.857	2.17	0.1573	
Treatment	6	16.286	2.714	3.17*	0.0423	
Error	12	10.286	0.857			
TOTAL	20	30.286				

* - Significant

Coefficient of variation = 4.80%

Appendix Table 6. Average head weight (kg)

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
T1	0.35	0.27	0.12	0.74	0.25
T2	0.13	0.17	0.09	0.39	0.13
T3	0.19	0.16	0.12	0.47	0.16
T4	0.21	0.15	0.13	0.49	0.16
T5	0.16	0.17	0.29	0.62	0.21
T6	0.17	0.09	0.13	0.39	0.13
T7	0.17	0.10	0.14	0.41	0.14

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.010	0.005	1.42	0.2806	
Treatment	6	0.035	0.006	1.65ns	0.2163	
Error	12	0.042	0.003			
TOTAL	20	0.087				

ns - Not significant

Coefficient of variation = 35.61%

Appendix Table 7. Marketable yield (kg/1x5m plot)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	4.34	3.12	2.45	9.91	3.30
T2	2.25	3.01	2.23	7.49	2.50
T3	2.99	3.33	2.98	9/30	3.10
T4	3.02	2.85	2.35	8.22	2.74
T5	3.23	2.35	2.15	7.73	2.58
T6	3.34	2.45	2.75	8.54	2.85
T7	2.34	2.55	2.88	7.77	2.59

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.988	0.494	2.13	0.1615	
Treatment	6	1.604	0.267	1.15ns	0.3913	
Error	12	2.784	0.232			
TOTAL	20	5.376				

ns - Not significant

Coefficient of variation = 17.16%

Appendix Table 8. Non – marketable yield (kg/1x5m plot)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	6.20	4.50	1.25	11.95	3.98
T2	1.50	2.50	1.10	5.10	1.70
T3	3.15	2.75	1.25	7.15	2.38
T4	3.00	2.90	2.00	7.90	2.63
T5	2.55	3.00	1.90	7.45	2.48
T6	2.75	1.15	2.00	5.90	1.97
T7	3.00	1.20	2.01	6.21	2.07

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	8.217	4.108	4.25	0.0403	
Treatment	6	9.990	1.665	1.72ns	0.1992	
Error	12	11.607	0.967			
TOTAL	20	29.814				

ns - Not significant Coefficient of variation = 39.98%

Appendix Table 9. Total yield (kg/1x5m plot)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	10.54	7.62	3.70	21.86	7.29
T2	3.75	5.57	3.33	12.59	4.20
T3	6.14	6.08	4.23	16.45	5.48
T4	6.02	5.75	4.35	16.12	5.37
T5	5.78	5.35	4.05	15.18	5.06
T6	6.09	3.60	4.75	14.44	4.81
T7	5.34	3.75	4.89	13.98	4.66

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	14.862	7.431	7.24	0.0086	
Treatment	6	6.648	1.108	1.08ns	0.4262	
Error	12	12.310	1.026			
TOTAL	20	33.82				

ns - Not significant

Coefficient of variation = 19.23%

Appendix Table 10. Computed marketable yield (t/ha)

TREATMENT	REPLICATIONS				
	I	II	III	TOTAL	MEAN
T1	8.68	6.24	4.90	19 .82	6.60
T2	4.50	6.02	4.46	14.98	4.99
T3	5.98	6.66	5.96	18.60	6.20
T4	6.04	5.70	4.70	16.44	5.48
T5	6.46	4.70	4.30	15.46	5.15
T6	6.68	4.90	5.50	17.08	5.69
T7	4.68	5.10	5.76	15.54	5.18

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	3.954	1.977	2.130	0.162	
Treatment	6	6.416	1.069	1.152ns	0.391	
Error	12	11.136	0.928			
TOTAL	20	21.506				

ns - Not significant

Coefficient of variation = 6.62%

Appendix Table 11. Incidence of insect pest (slug)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	1.50	2.55	1.05	5.10	1.70
T2	3.00	2.55	1.90	7.45	2.48
T3	3.00	1.20	2.00	6.20	2.07
T4	2.00	1.20	3.01	6.21	2.07
T5	1.61	1.61	3.00	6.22	2.07
T6	2.55	1.83	1.83	6.21	2.07
T7	2.20	1.00	3.00	6.20	2.07

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	1.437	0.718	1.18	0.3396	
Treatment	6	0.922	0.153	0.25 ns	0.9486	
Error	8	7.291	0.607			
TOTAL	20	9.650				

ns - Not significant

Coefficient of variation = 37.55%

Appendix Table 12. Incidence of disease (bacterial soft rot)

TREATMENT	REPLICATIONS			TOTAL	MEAN
	I	II	III		
T1	1.30	2.50	1.30	5.10	1.70
T2	2.00	4.43	1.00	7.43	2.48
T3	2.20	1.00	3.01	6.21	2.07
T4	2.60	1.83	1.79	6.22	2.07
T5	1.79	3.02	1.40	6.21	2.07
T6	2.00	3.00	1.20	6.20	2.07
T7	3.00	1.25	1.95	6.20	2.07

Analysis of Variance

Source of Variation	Degrees of Freedom	Sum of Square	Mean of Square	Computed F	TABULAR F 0.05	0.01
Replication	2	2.096	1.048	1.03	0.3850	
Treatment	6	0.906	0.151	0.15 ns	0.9857	
Error	8	12.157	1.013			
TOTAL	20	15.159				

ns - Not significant

Coefficient of variation = 48.51%