BIBLIOGRAPHY

ARAÑAS, EMMANUEL T. OCTOBER 2008. Effect of Various Colors of Polyethylene on the Growth and Yield of Strawberry. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted to determine the effect of the different color of polyethylene plastic mulch on the growth and yield of strawberry, to identify the best color of polyethylene plastic mulch appropriate for strawberry production and to determine if the different colors of polyethylene plastic mulch are suitable mulching materials.

The days to first flower appearance and days from transplanting to first harvest showed that plants mulched with white polyethylene plastic enhanced earlier flower formation and harvesting. The days from transplanting to last harvest showed that strawberry plants mulched with polyethylene plastics had highly significant effects as compared to the plants that were not mulched with polyethylene plastics.

Strawberry plants mulched with black polyethylene plastic had significantly higher marketable yield per plot over the plants that were mulched with the other colored polyethylene plastics. In the total yield per plot and computed yield per hectare strawberry plants mulched with black, yellow and orange polyethylene plastics had the highest total yield of berries produced.

The results on the percentage of abnormal fruit showed that black polyethylene plastic mulch had the lowest percentage as compared with the other plastic mulch used.

Using different polyethylene plastic mulch on the growth and yield of strawberry did not have significant effect on the percentage of fruit set, non – marketable yield, monthly sugar content and incidence of insect pest.

Lastly, the cost and return analysis shows that black polyethylene plastic used as a mulching material induced a higher return on investment followed by silver polyethylene plastic.

TABLE OF CONTENTS

INTRODUCTION

Nature of the study

Strawberry (*fragaria x ananassa*) is one of the most commonly visited fruit by tourist here in Baguio and La Trinidad, Benguet province where much of it is grown or produced. It belongs to the family Rosaceae; its fruit is technically known as an accessory fruit where the fleshy part is derived not from the plant ovaries (achene's) but from the peg at the bottom of the bowl-shaped hypanthium's that hold the ovaries.

There are two main types of strawberry plants: short day plants and ever bearing plants. Short day plants produce a single crop each year when the photoperiod is under 14 hours per day that usually occurs during cool summer temperature. Ever bearing plants produce fruit throughout the growing season and there are two types such as; long day and day neutral plants. As the name suggests, long day plants have continuous flowering through the summer as the days grow longer, on the other hand, day neutral plant flower several times per year regardless of the length of the photoperiod. The majority of the strawberry producers use short day plant; however, the use of day neutral plants is increasing in California.

The variety Sweet Charlie is considered a short day cultivar, early fruiting and produces fruit that has a distinctively sweet flavor and resistant to anthracnose (caused by Colletotrichumacutatum). Plants of "Sweet Charlie" generally start producing ripe fruit about two weeks earlier than the "Camarosa" variety. Sweet Charlie may vary in height from 19 to 26 centimeters and width from 29 to 42 centimeters. The top of the leaves are medium to dark green in color. The bottom of the leaves is colored yellow green. The

Leaves demonstrate a distinct cupped appearance. This typical characteristic is often confused with symptoms of powdery mildew. (Hort.Sci.Dep.,University of Florida)

The strawberry fruit is composed of many parts such as, the stem where the berry is attached to the plant. The sepal is what remains of the flower of the plant after the berry form. The bundle, the cortex and finally the epidermis surround the center of the berry, or the pith. Located on the epidermis are the achenes or what are commonly referred to as the seed of the strawberry. The fruit of the berry or the achene's are what we consider the seed of the berry, but in reality is the reproductive portion of the plant or the fruit of the plant.

The technique of mulching is a practice that growers can undertake in strawberry farm that will produce a result that one could never imagine. Mulching is the technique of placing a protective skin of material on the top of the soil. Mulch comes in two basic forms; organic and non-organic. The most commonly used in organic mulching on strawberry is the coggon grass and straw while the most common item used in non-organic mulching is the polyethylene plastic mulch.

Mulching is very necessary in strawberry because it serves as protection against fruit rotting. The practice also minimizes weed growth and also prevents soil splattering during heavy rains, thus keeps the fruit clean. Mulching is also necessary to the plant to minimize the lose of soil moisture. To some extent, mulching reduces the temperature of the soil, which is favorable to strawberry being a temperate plant.

La Trinidad, Benguet strawberry growers are using black polyethylene plastic mulch because of its effectiveness and due to its advantages such as, increase early

yields, aids in moisture retention, inhibits weed growth, reduces fertilizer leaching, reduces soil compaction and cleaner product or it protects the fruit.

In the market, the prices of commercial mulching or the polyethylene plastic mulch is high but even though farmers are still buying and using the product due to its many advantages. What is not known also is the degree of effectiveness especially the other colors, thus, the study is being conducted.

The objective of the study is to determine the effect of the different color of polyethylene plastic mulch on the growth and yield of strawberry, to identify the best color of polyethylene plastic mulch appropriate for strawberry production and to determine if the different colors of polyethylene plastic mulch are suitable mulching materials.

The study was conducted at the Balili experimental area, Benguet State University, La Trinidad, Benguet from October 2007 to April 2008.

REVIEW OF LITERATURE

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

Broadly (1992), found out that the growth, yield and more importantly the harvesting quality of the fruit from these low growing plant are greatly affected by weeds. As a result, strawberries are grown almost exclusively on mulch. Mulching is needed especially during fruiting stage. Mulch is necessary to minimize direct contact of fruit within the soil, thus the decay of berries is controlled.

In relation to weed control, Balaki (1992), reported that the area of strawberry production does not increase due to high cost of weeding strawberry field. The cost of weeding work account for almost 32% of the total cost of production. The same researcher also pointed out that the farm labor supply during the peak season of strawberry production become scarce.

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 NO3 – 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), earlier 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 healthy runners of strawberry (Sweet Charlie), different colors of polyethylene plastic mulch, tie wire, watering can, organic and inorganic fertilizer, insecticide and fungicide, snap sack sprayer, weighing scale and record book.

Methods

Experimental design and treatment. The experiment was laid out following the randomized complete block design (RCBD) with 3 replications.

The treatments were represented as follows:

Treatments

T1 – no mulch (control)

T2 – black plastic

T3 – silver

T4 – white (clear)

T5 – light green

T6 – yellow

T7 – orange

Land preparation and fertilizer application. An area of 105 sq. meters was thoroughly prepared and divided into 3 blocks with 7 plots in each block. Each plot was measured 1m x 5m. Chicken manure was applied at the rate of 3/ha and inorganic

fertilizer particularly triple fourteen (14 -14 -14) was applied at the rate of 500g per 5 sq. meter – plot and properly incorporated with the soil.

Polyethylene plastic mulch application. The different colors of polyethylene plastic mulch were placed on the top of each plot in a single layer. The plastic mulch was secured tightly at the both ends of the plot to ensure unnecessary movement during strong typhoons or rains. The plastic mulch was holed in a double row at a distance of 22 cm between rows and hills.

Planting and irrigation. Healthy runners of Sweet Charlie were planted at the holed portion of the polyethylene plastic that had been prepared. Irrigation was done just after planting and every other day for two times until the plants were fully established.

Care and management. Other cultural management practices such as insect pest and disease management, weeding and leaf pruning were done uniformly to ensure optimum growth and development of the plants.

Harvesting. The strawberry fruits were harvested by hand picking throughout the fruiting stage.

Data Gathered

1. Days to first flower appearance. This was the number of days from transplanting to the day the first flower bud will occur.

2. Days from transplanting to first harvest. The number of days from transplanting to first harvest were determined.

3. Days from transplanting to last harvest. The number of days from transplanting to last harvest were determined.

4. Percentage of fruit set (%). Ten sample flowers was tagged with thread and

the number of berries to be formed were counted and it was divided by 10 and multiplied by 100.

5. Percentage of abnormal fruit (%). This was obtained by counting the number of abnormal fruit and divided by the total numbers of fruits multiplied by 100.

6. Marketable yield per plot (kg). The large, medium and small sized berries that were free from disease or bruises was considered as marketable yield.

7. Non – marketable per plot (kg). Rotten and decayed berries as well as the very small fruit were considered as non – marketable yield.

8. Total yield (kg). The summation of total marketable and non – marketable berries from the first to the last harvest was recorded.

9. Computed yield per hectare (t/ha). The marketable yield per plot was converted to a hectare basis by multiplying it by 2,000. Two thousand is the number of plots per hectare based on the plot dimension (1mx5m) used in the study.

10. Taste test. Flavor was judge by a panel of 30 members. They were rated the fruit as:

Rate	Description
1	very sweet
2	sweet
3	slightly sweet
4	moderately sweet
5	moderately sour
6	slightly sour
7	sour

11. Sugar content (°B). The sugar content of the fruit at the red ripe stage was determined using a hand refractometer.

12. Incidence of Insect pest and disease. 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 are infested
2	15 – 30% of the plants/plot are infested
3	30 – 45% of the plants/plot are infested
4	45 60% of the plants/plot are infested

b. Disease

Rating	Description
1	0 – 15% of the plants/plot are infected
2	15 – 30% of the plants/plot are infected
3	30 – 45% of the plants/plot are infected
4	45 – 60% of the plants/plot are infected

13. Return of investment (ROI). All expenses incurred in the study was recorded. The return of investment (ROI) was computed using the formula.

$$ROI\% = \frac{\text{Gross sales – total expenses}}{\text{Total expenses}} \times 100$$

14. Other observations.

RESULTS AND DISCUSSIONS

Days to First Flower Appearance

There were significant differences that were observed among the different plastic mulch on the days to first appearance of flower (Table 1). Results showed that the white polyethylene plastic mulch effected the earliest days to the first flower appearance from transplanting with a mean of 27.67 followed by the yellow polyethylene plastics. The light green and orange polyethylene is comparable with each other attaining significantly the same days to show flower appearance followed by the silver plastic mulch. The strawberry plants that were not mulched with polyethylene took a significantly longer period for the flower to appear from transplanting as compared to the strawberry plants mulched with polyethylene plastics.

The study shows that using white polyethylene mulch took earlier days for the flower to appear as compared to the other plastic mulch. Meanwhile, the study of Kudan (2006) showed that planting strawberry during the off – season under green house took 21 days for the flower to appear. The polyethylene was used as greenhouse while in these study, the polyethylene plastics were directly applied as mulch to the soil. This might be one reason of their difference and it can also be attributed to the different environmental conditions and planting season.

Days from Transplanting to First Harvest

Table 2 shows significant differences among the different treatments used in the study affecting the days from transplanting to first harvest. The strawberry plants mulched with white polyethylene plastic attained the earliest days to first harvest from

Table 1. Days to first flower appearance

TREATMENT	MEAN
No – mulch	34.67a
Black	31.00bc
Silver	32.33ab
White	27.67d
Light green	29.67bcd
Yellow	29.00cd
Orange	29.67bcd

Means with the same letters are not significantly different at 5% level by DMRT

transplanting which is significantly comparable to strawberry plants mulched with yellow and orange polyethylene plastics followed by strawberry plants mulched with black, light green and silver plastics. The strawberry plants that were not mulched with polyethylene attained the longest days to first harvest which took more days over the plants mulched with polyethylene plastics.

The study reveals that using polyethylene plastic mulch in strawberry will enhance earlier days to harvest from transplanting as compared to the strawberry plants that was not been mulched with polyethylene plastics.

Days from Transplanting to Last Harvest

As shown in Table 3, there were slight significant differences on the days from transplanting up to the last harvest. The strawberry plants that were not mulched with the different plastic mulches attained the earliest days up to the last harvesting time when

there are no more fruits to be harvested while all the strawberry plants mulched with polyethylene plastics were all harvested on a much latter day.

The study may imply that strawberry plants mulched with polyethylene mulch will induce longer days up to the last harvest. However , in the study of Himelrick and Akridge (1999) stated that after 3 years of research on the feasibility of using variety of plastic mulches to maximize production and possible extend fruiting season revealed that using black plastic mulch is still the best choice for commercial planting of strawberry.

Percentage of Fruit Set

As presented in Table 4, there were no significant differences observed on the percentage of fruit set as affected by the different polyethylene mulches used. However numerical results showed that strawberry plants having black and white polyethylene plastic mulches effected the highest percentage of fruit setting followed by strawberry plants mulched with silver, light green, yellow and orange polyethylene plastics all of which and are very much comparable to each other while the strawberry plants that was not mulched attained a much lower percentage of fruit set.

Based on the results of the study, black and white polyethylene plastic mulch may enhance high percentages of fruit set as was noted on strawberry plants that were mulched with such materials which coved be very much helpful in the production of strawberry fruit. High percentage of fruit set may possibly mean that there will be a high expected yield to be produced granting that all the flowers will develop successfully into a fruit.

Table 2. Days from transplanting to first harvest

TREATMENT	MEAN
No – mulch	58.67a
Black	53.33b
Silver	51.67bc
White	48.67c
Light green	50.67bc
Yellow	50.00c
Orange	49.67c

Means with the same letters are not significantly different at 5% level by DMRT

Table 3. Days from transplanting to last harvest

TREATMENT	MEAN
No – mulch	196.00b
Black	213.00a
Silver	213.00a
White	213.00a
Light green	213.00a
Yellow	213.00a
Orange	213.00a

Means with the same letters are not significantly different at 5% level by DMRT

Table 4. Percentage of fruit set (%)

TREATMENT	MEAN
No – mulch	93.33b
Black	100.00a
Silver	96.67ab
White	100.00a
Light green	96.67ab
Yellow	96.67ab
Orange	96.67ab

Means with the same letters are not significantly different at 5% level by DMRT

Table 5. Percentage of abnormal fruit (%)

TREATMENT	MEAN
No – mulch	19.99ab
Black	13.22c
Silver	14.64bc
White	17.97abc
Light green	15.91bc
Yellow	15.65bc
Orange	21.74a

Means with the same letters are not significantly different at 5% level by DMRT

Percentage of Abnormal Fruit

The results in Table 5 shows significant differences observed among the different polyethylene plastic mulches used affecting percentage of abnormal fruits. The strawberry plants applied with orange polyethylene plastic mulch affected the highest percentage of abnormal fruits. It was followed by the strawberry plants that were not mulched and plants mulched with white polyethylene plastics while the strawberry plants mulched with silver, light green and yellow polyethylene plastic obtained comparable percentages. The strawberry plants mulched with black polyethylene plastic attained the lowest percentages of abnormal berries.

Based on the data presented, the black polyethylene plastic decreases the production of abnormal berries of strawberry plant which is very good for the market and commercial trade of the commodity because if the production of abnormal fruit or non – marketable berries will be significantly lowered, the total yield will surely increase which will be translated to higher profits.

Marketable Yield per Plot (kg)

With regards to the marketable yield per plot, there were significant differences that were observed in Table 6 showing the effects of the different polyethylene plastic mulches on the yield performance of strawberry plants. Statistically, the black, yellow and orange polyethylene plastic mulches affected the highest marketable yield per plot which is also comparable with strawberry plants mulched with silver and white polyethylene plastics. Meanwhile, strawberry plants that were un mulched obtained the least produced marketable berries per plot which is almost half the yield of strawberry plants mulched with the various colored polyethylene plastics.

Table 6. Yield per plot

Treatment	Marketable yield per plot (kg)	Non – marketable yield per plot (kg)	Total yield per plot (kg)	Computed yield per hectare (t/ha)
No mulch	7.77c	2.79a	10.56c	21.11c
Black	14.68a	1.92b	16.60a	33.19a
Silver	12.95ab	2.13ab	15.08ab	30.16ab
White	11.24b	2.12ab	13.36b	26.73b
Light green	12.53ab	2.29ab	14.83ab	29.65ab
Yellow	14.00a	2.73a	16.73a	33.46a
Orange	13.99a	2.58ab	16.57a	33.15a

Means with the same letters are not significantly different at 5% level by DMRT

Based on the results of the study, using polyethylene plastic as mulching materials can increase the marketable yield of strawberry plants. The results agrees with the results of the study of Himelrick and Akridge (1999) as was previously discussed in Table 3 stating that the use of plastic mulches increases production and possibly extending the fruiting periods.

Non – Marketable Yield per Plot (kg)

Table 6 shows the influence of the various color of polyethylene plastic mulches on the production of non – marketable berries per plot.

Numerically, results reveals that strawberry plants that were not mulched and applied with yellow polyethylene plastics produced the highest non – marketable yield of

berries followed by strawberry plants mulched with silver, white, light green and orange polyethylene plastics which is comparable with each other. The lowest non – marketable berries which significantly differed from all the other treatments was produced from strawberry plants mulched with black polyethylene plastics.

The results of the study means that using black polyethylene plastic coved possibly decrease the production of non – marketable berries which is significantly resistant to the economic aspect of production. On the contrary, the application of other polyethylene plastic mulching materials including its non application may increase the more production of berries which are considered as unfit for the market or with abnormalities.

Total Yield per Plot (kg)

The total yield per plot as influenced by the various polyethylene plastic mulches is shown in Table 6.Statistical analysis shows highly significant differences between all the treatments. Strawberry plants mulched with yellow, black and orange polyethylene plastics produced the highest total marketable yield of berries followed by the plants mulched with light green and silver polyethylene plastics but it is also comparable to the plants mulched with white polyethylene plastics. The strawberry plants that were not mulched obtained the lowest total yield which significantly differed to the strawberry plants mulched with polyethylene plastics.

The results corroborates with the study of Pangus (2000) that the effect of the different mulching materials on the growth and yield of strawberry showed that black polyethylene plastic mulch enhanced the production of higher total marketable yield which is highly significant as compared to the other mulching materials used. Likewise,

the strawberry plants that were not mulched attained the lowest total yield as compared to the strawberry plants mulched with the different polyethylene plastics obtaining higher total yield which might be attributed to the protective effect of the plastics thus lessening the non – marketable qualities of the berries produced.

Computed Yield per Hectare (t/ha)

Statistical results in Table 6 shows that the computed yield per hectare followed the same trend as the total yield per plot where in strawberry plants applied with black, yellow and orange polyethylene plastic mulches out yielded the rest of the entries evaluated.

However, numerical figures shows that strawberry plants mulched with yellow polyethylene plastics produced higher yield per hectare followed by plants mulched with orange and black polyethylene plastics. The lowest computed yield per hectare was obtained from plants that were not mulched.

Taste Test

As presented in Table 7, the application of polyethylene plastic mulch affected the taste of strawberry fruits as reflected in the taste test evaluations. The results of the taste test revealed that in terms of sweetness, fruits produced from strawberry plants mulched with polyethylene plastics were rated by the evaluators to be sweeter as compared to the fruits of strawberry plants that had not been mulched.

In the entire taste test evaluation, results showed that all the strawberry fruits were evaluated as having a moderately sweet taste except for the berries produced in the plants

Table 7. Taste test

TREATMENT	SOUR	SLIGHTLY SWEET	MODERATELY SWEET	SWEET
No – mulch	10	8	10	2
Black	3	3	15	9
Silver	7	3	14	6
White	9	4	12	5
Light green	9	3	11	7
Yellow	5	10	9	6
Orange	3	1	15	11

mulched with yellow polyethylene which is rated to be less moderately sweet and the berries produced from plants without mulching materials.

Monthly Sugar Content

The monthly sugar content from January, February and March is presented in Table 8. The sugar content of strawberry fruits during the month of January were not significantly affected by the various color of polyethylene plastic mulches as well as the plants that were not mulched. However, numerical figures showed that strawberry plants mulched with white plastics and plants that were not mulched had the highest sugar content while plants mulched with orange plastic had the lowest sugar content.

In the month of February, statistical results showed no significant differences among the treatments. Numerically, strawberry plants mulched with yellow polyethylene

Table 8. Monthly sugar content (°B)

TREATMENT	JANUARY	FEBRUARY	MARCH
No – mulch	6.53a	9.40a	7.13b
Black	6.20a	8.40a	9.80a
Silver	6.27a	8.33a	9.80a
White	6.53a	8.33a	9.13a
Light green	6.40a	9.40a	9.57a
Yellow	6.07a	10.33a	9.73a
Orange	5.73a	9.53a	9.93a

Means with the same letter are not significantly different at 5% level by DMRT

plastics had the highest sugar content while plants mulched with silver and white plastics were the lowest, although it s comparable with the sugar content of fruits obtained from plants mulched with black, light green, orange plastics and strawberry plants that were not mulched.

For the month of March, all strawberry plants mulched with polyethylene plastics attained the highest sugar content and it is comparable with each other except the strawberry plants that were not mulched obtaining the lowest sugar content which is significantly different from plants mulched with the different polyethylene plastic mulches.

The higher sugar content of fruits was obtained from fruits of the plants mulched with various polyethylene plastics which could be attributed to the higher temperature brought about by the plastic mulches. Tipayno (1976) has pointed out that temperature of

the season affects the sweetness of strawberry fruits.

a. Incidence of Strawberry Mites (Phytonemos pallidus)

As shown in Table 9, strawberry plants mulched with polyethylene white plastic showed the highest incidence of strawberry mite infestations but are comparable with the plants mulched with light green, silver, yellow, orange and the strawberry plants that had no mulch. The strawberry plant mulched with black plastic obtained the lowest incidence of mites but it is not significantly different with all of the treatments.

The results may imply that the application of black plastic mulch will lessen the infestation of mites on strawberry plants.

The presence of mites is often seriously felt during hot, dry growing months when numerous mites retard the growth of strawberry plant which may results in plant death.

Table 9. Incidence of Insect Pest and Disease

TREATMENT	MEAN
No – mulch	2.00ab
Black	1.33b
Silver	1.67ab
White	2.33a
Light green	2.00ab
Yellow	1.67ab
Orange	1.67ab

Means with the same letter are not significantly different at 5% level by DMRT

b. Strawberry Leaf Spot

The occurrence of strawberry leaf spot disease did not seriously effect the growth and yield of the strawberry plants.

The disease is caused by the fungus Mycosphaerella fragariae. Leaf spot infects the leaves, petioles runners, fruits stalk (pedicles) and berry caps or calyxes. Small dark purple to reddish – purple round spot appeared on the upper leaf surfaces and only the young succulent parts are infected by the leaf spot fungus (Ries 1996).

Cost and Return Analysis

Table 10 presents the cost and return analysis of producing strawberry using various polyethylene mulch as well as the sales of marketable and non – marketable berries and their ranks according to profitability.

The use of black polyethylene mulch attained the highest return on investment of 44.99 %or Php .44 for every peso spent in strawberry production. This was followed by silver polyethylene plastics attaining 22.67%, orange polyethylene plastics with 19.38%, yellow (13.94%), light green (2.15%), white (12.33%) and lastly the strawberry plant that were not mulched which obtained 24.07%. White polyethylene plastics attained negative ROI which might be due to the high prices of the polyethylene plastics. The strawberry plants that were not mulched obtained the least negatively ROI as it had the lowest marketable yield.

In addition to productivity, it was previously cited that Himelrick and Akridge (1999) stated that inconsistent performance of other mulches and their cost, availability and weed control factors, all suggest that black plastic mulch is the most effective and efficient choice.

Table 10. Cost and return analysis

ITEM	VARIOUS POLYETHYLENE MULCH						Orange
	No mulch	Black	Silver	White	Light green	Yellow	
Yield (kg)	31.67	49.79	45.24	40.09	44.48	50.19	49.72
Sales (Php)	1426.75	2616.00	2213.25	1938.25	2158.25	2542.75	2437.50
Farm inputs (Php)							
Polyethylene	-	28.50	28.50	312.50	217.00	336.00	146.00
Seedlings	720.00	720.00	720.00	720.00	720.00	720.00	720.00
Chicken manure	42.00	42.00	42.00	42.00	42.00	42.00	42.00
Urea	7.14	7.14	7.14	7.14	7.14	7.14	7.14
14 - 14 -14	34.50	34.50	34.50	34.50	34.50	34.50	34.50
Lannate	82.86	82.86	82.86	82.86	82.86	82.86	82.86
Romectin	108.57	108.57	108.57	108.57	108.57	108.57	108.57
Paspas	64.29	64.29	64.29	64.29	64.29	64.29	64.29
Byleton	64.29	64.29	64.29	64.29	64.29	64.29	64.29
Thiram	54.29	54.29	54.29	54.29	54.29	54.29	54.29
Gasoline	31.14	31.14	31.14	31.14	31.14	31.14	31.14
Labor							
Land preparation	57.14	57.14	57.14	57.14	57.14	57.14	57.14
Polyethylene installation	-	16.67	16.67	16.67	16.67	16.67	16.67
Planting	14.29	14.29	14.29	14.29	14.29	14.29	14.29
Weeding	320.00	200.00	200.00	320.00	320.00	320.00	320.00
Irrigation	107.14	107.14	107.14	107.14	107.14	107.14	107.14
Leaf pruning	171.43	171.43	171.43	171.43	171.43	171.43	171.43
Total Expenses	1879.08	1804.25	1804.25	2208.25	2112.75	2231.75	2041.75
Net Income/loss (Php)	-452.32	811.75	409.00	-270.00	45.50	311.00	395.75
ROI (%)	-24.07	44.99	22.67	-12.23	2.15	13.94	19.38
Rank	7	1	2	6	5	4	3

Note: Selling price during harvest = Php 45.00 – 100.00/kg

Other observation

During rainy season or heavy rains, the strawberry plants that were not mulched with polyethylene plastic was damaged specially the flowers and fruits. The rain splattering the soil caused soil erosion and after the rain, a few roots of the strawberry were exposed.

Early and heavy rains during the fruiting season caused fruit cracking and rotting of fruits. Some insect pest also damaged the berries like slugs and worms which bored the berries that made it non – marketable.

On weed growth, it was observed that the plot beds mulched with white, light green, yellow and orange polyethylene plastics had the fastest growth of weeds that tends to move up the plastic mulch which caused water stagnant at the surface area of the polyethylene that caused fruit rotting. The sunlight can directly pass through the polyethylene plastic mulch enhancing faster growth of the weeds which is comparable to the strawberry plants that were not mulched with plastics.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The was study was conducted to determine the effect of the different color of polyethylene plastic mulch on the growth and yield of strawberry , to identify the best color of polyethylene plastic mulch appropriate for strawberry production and to determine if the different color of polyethylene plastic mulch are suitable mulching materials. The study was conducted at the Balili experimental area, Benguet State University, La Trinidad, Benguet from October 2007 to April 2008.

Based on the study, the following results were obtained. Highly significant differences was observed on the days to first flower appearance; strawberry plants mulched with white polyethylene plastic mulch were the earliest to show flower appearance while the strawberry plants with no mulch had the longest day to produce flower as compared to the plants mulched with polyethylene plastics. The same results were obtained from the days from transplanting to last harvest. The marketable yield per plot showed highly significant results with strawberry plants mulched with the various polyethylene plastics attained as having attained the highest marketable berries while the strawberry plants that were not mulched with polyethylene plastics had the lowest marketable fruit produced. Statistical analysis showed that strawberry plants mulched with black, yellow and orange polyethylene plastic attained the highest total yield per plot which is comparable to each other while strawberry plants that were not mulched with plastics had the lowest yield. The results on the percentage of abnormal fruit showed that the strawberry plants mulched with orange plastics had the highest percentage of

abnormal berries while plants mulched with black plastics attained the lowest percentage of abnormality.

There were no significant differences observed on the percentage of fruit set, non – marketable yield, monthly sugar content, and incidence of insect pest.

As compared with the other treatments, strawberry plants mulched with black polyethylene plastic attained the highest return on investment based on the results of the study while the strawberry plants with no mulch and plants mulched with white plastics obtained negative return on investments.

Conclusion

Based from the results, the use of black polyethylene plastics as a mulching material for strawberry production enhanced higher percentage of fruit set; lowered percentage of abnormal fruit produced and affected lesser non – marketable berries as well as influencing higher return on investment. Likewise, using white polyethylene plastic as mulch enhanced earlier days to flower appearance and days from transplanting to the last harvest. On the other hand, the use of yellow polyethylene plastic is comparable with black polyethylene if marketable yield is to be considered.

Recommendation

From the proceeding results and discussions, using black polyethylene plastic as a mulching material for the growing of strawberry is highly recommended since it was found out to be effective and it enhanced higher profits.

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APPENDICES

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	34.00	36.00	34.00	104.00	34.67
T2	32.00	34.00	27.00	93.00	31.00
T3	31.00	32.00	34.00	97.00	32.33
T4	27.00	29.00	27.00	83.00	27.67
T5	29.00	31.00	29.00	89.00	29.67
T6	29.00	31.00	27.00	87.00	29.00
T7	29.00	31.00	29.00	89.00	29.67

Appendix Table 1. Days to first flower appearance

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	22.571	11.286			
Treatment	6	97.810	16.302	7.31**	0.0255	0.0018
Error	12	26.762	2.230			
TOTAL	20	147.143				

** - highly significant

Coefficient of Variation = 4.88%

Appendix Table 2. Days from transplanting to first harvest

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	58.00	60.00	58.00	176.00	58.67
T2	54.00	58.00	48.00	160.00	53.33
T3	51.00	54.00	50.00	155.00	51.67
T4	48.00	50.00	48.00	146.00	48.67
T5	50.00	51.00	51.00	152.00	50.67
T6	51.00	51.00	48.00	150.00	50.00
T7	50.00	51.00	48.00	149.00	49.67

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	41.238	20.619			
Treatment	6	205.238	34.206	11.81**	0.0092	0.0002
Error	12	34.762	2.897			
TOTAL	20	281.238				

** - highly significant

Coefficient of Variation = 3.29%

Appendix Table 3. Days form transplanting to last harvest

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	197.00	197.00	194.00	588.00	196.00
T2	213.00	213.00	213.00	639.00	213.00
T3	213.00	213.00	213.00	639.00	213.00
T4	213.00	213.00	213.00	639.00	213.00
T5	213.00	213.00	213.00	639.00	213.00
T6	213.00	213.00	213.00	639.00	213.00
T7	213.00	213.00	213.00	639.00	213.00

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.857	0.429			
Treatment	6	743.143	123.857	289.00**	0.3966	0.0001
Error	12	5.143	0.429			
TOTAL	20	749.143				

** - highly significant

Coefficient of Variation = 0.31%

Appendix Table 4. Percentage of fruit set (%)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	90.00	100.00	90.00	280.00	93.33
T2	100.00	100.00	100.00	300.00	100.00
T3	100.00	90.00	100.00	290.00	96.67
T4	100.00	100.00	100.00	300.00	100.00
T5	90.00	100.00	100.00	290.00	96.67
T6	90.00	100.00	100.00	290.00	96.67
T7	100.00	90.00	100.00	290.00	96.67

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	28.571	14.286			
Treatment	6	95.238	15.873	0.63ns	0.5841	0.7079
Error	12	304.762	25.397			
TOTAL	20	428.571				

ns - not significant

Coefficient of Variation = 5.19%

Appendix Table 5. Percentage of abnormal fruit (%)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	22.12	19.01	18.85	59.98	19.99
T2	14.27	12.46	12.94	39.67	13.22
T3	13.88	13.40	16.64	43.92	14.64
T4	18.25	19.00	16.65	53.90	17.97
T5	16.52	17.10	14.10	47.72	15.91
T6	14.52	17.18	15.26	46.96	15.65
T7	29.33	21.53	14.37	65.23	21.74

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	28.886	14.433			
Treatment	6	165.699	27.617	3.03*	0.2456	0.0485
Error	12	109.489	9.124			
TOTAL	20	304.055				

* - significant

Coefficient of Variation = 17.75%

Appendix Table 6. Marketable yield per plot (kg)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	7.71	7.92	7.67	23.30	7.77
T2	15.38	13.29	15.36	44.03	14.68
T3	13.09	14.18	11.59	38.86	12.95
T4	11.72	11.10	10.90	33.72	11.24
T5	11.66	13.18	12.76	37.60	12.53
T6	13.65	16.06	12.30	42.01	14.00
T7	15.57	11.72	14.68	41.97	13.99

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.903	0.451			
Treatment	6	100.201	16.700	8.95**	0.7888	0.0007
Error	12	22.379	1.865			
TOTAL	20	123.483				

** - highly significant

Coefficient of Variation = 10.97%

Appendix Table 7. Non – marketable yield per plot (kg)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	3.35	2.75	2.27	8.37	2.79
T2	2.31	2.17	1.28	5.76	1.92
T3	1.94	2.09	2.35	6.38	2.13
T4	2.13	2.46	1.78	6.37	2.12
T5	2.21	2.52	2.15	6.88	2.29
T6	3.50	2.54	2.14	8.18	2.73
T7	3.16	2.42	2.17	7.75	2.58

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	1.453	0.726			
Treatment	6	2.032	0.339	2.45ns	0.0230	0.0881
Error	12	1.660	0.138			
TOTAL	20	5.145				

ns - not significant

Coefficient of Variation = 15.72%

Appendix Table 8. Total yield per plot (kg)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	11.06	10.67	9.94	31.67	10.56
T2	17.69	15.46	16.64	49.79	16.60
T3	15.03	16.27	13.94	45.24	15.08
T4	13.85	13.56	12.68	40.09	13.36
T5	13.87	15.70	14.91	44.48	14.827
T6	17.15	18.60	14.44	50.19	16.73
T7	18.73	14.14	16.85	49.72	16.573

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	4.646	2.323			
Treatment	6	90.733	15.122	7.82**	0.3345	0.0014
Error	12	23.202	1.933			
TOTAL	20	118.580				

** - highly significant

Coefficient of Variation = 9.38%

Appendix Table 9. Computed yield per hectare (t/ha)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	22.12	21.34	19.88	63.34	21.11
T2	35.38	30.92	33.28	99.58	33.19
T3	30.06	32.54	27.88	90.48	30.16
T4	27.70	27.12	25.36	80.18	26.73
T5	27.74	31.40	29.82	88.96	29.65
T6	34.30	37.20	28.88	100.38	33.46
T7	37.46	28.28	33.70	99.44	33.15

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	18.583	9.292			
Treatment	6	362.932	60.489	7.82**	0.33	0.00
Error	12	92.807	7.734			
TOTAL	20	474.322				

** - highly significant

Coefficient of Variation = 9.38%

Appendix Table 10. Sugar content (January)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	7.60	5.00	7.00	19.60	6.53
T2	5.20	5.40	8.00	18.60	6.20
T3	5.00	6.80	7.00	18.80	6.27
T4	7.00	6.20	6.40	19.60	6.53
T5	6.00	7.00	6.20	19.20	6.40
T6	6.20	7.00	5.00	18.20	6.07
T7	6.00	5.00	6.20	17.20	5.73

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.940	0.470			
Treatment	6	1.459	0.243	0.21 ns	0.6738	0.9663
Error	12	13.832	1.153			
TOTAL	20	16.232				

ns - not significant

Coefficient of Variation = 17.18%

Appendix Table 11. Sugar content (February)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	9.80	10.00	8.40	28.20	9.40
T2	8.00	8.60	8.60	25.20	8.40
T3	8.00	8.00	9.00	25.00	8.33
T4	8.60	8.40	8.00	25.00	8.33
T5	10.60	8.60	9.00	28.20	9.40
T6	9.60	9.40	12.00	31.00	10.33
T7	8.60	8.40	11.60	28.60	9.53

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	1.992	0.996			
Treatment	6	10.663	1.777	1.58ns	0.4372	0.2345
Error	12	13.474	1.123			
TOTAL	20	26.130				

ns - not significant

Coefficient of Variation = 11.64%

Appendix Table 12. Sugar content (March)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	7.00	7.00	7.40	21.40	7.13
T2	10.00	10.40	9.00	29.40	9.80
T3	10.00	10.60	8.80	29.40	9.80
T4	9.80	9.00	8.60	27.40	9.13
T5	9.00	7.70	12.00	28.70	9.57
T6	10.00	9.80	9.40	29.20	9.73
T7	9.40	10.00	10.40	29.80	9.93

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.089	0.044			
Treatment	6	17.647	2.941	2.54*	0.9626	0.0800
Error	12	13.905	1.159			
TOTAL	20	31.640				

* - significant

Coefficient of Variation = 11.57%

Appendix Table 13. Incidence of insect pest (strawberry mites)

TREATMENT	REPLICATIONS I	II	III	TOTAL	MEAN
T1	2.00	2.00	2.00	5.00	2.00
T2	2.00	1.00	1.00	4.00	1.33
T3	2.00	1.00	2.00	5.00	1.67
T4	2.00	2.00	3.00	7.00	2.33
T5	2.00	2.00	2.00	6.00	2.00
T6	1.00	2.00	2.00	5.00	1.67
T7	1.00	2.00	2.00	5.00	1.67

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean of square	Computed F	TABULAR F 0.05	0.01
Replication	2	0.381	0.190			
Treatment	6	1.905	0.317	1.29ns	0.4828	0.3320
Error	12	2.952	0.246			
TOTAL	20	5.238				

ns - not significant

Coefficient of Variation = 27.41%