ROLE OF MULCH AS A CULTURAL PRACTICE
AND ITS INFLUENCE ON GROWTH AND
YIELD OF BHOKARI GRAPE
(Vitis vinifera Linn.)

By
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of the requirements for the degree of
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Lastly, he wishes to reiterate his thanks to staff of the Janeshkhind Fruit Experiment Station for providing facilities to carry out the field work.
I

CHAPTER I.

INTRODUCTION.

Mulching appears to be a very ancient Chinese Cultural practice employed to conserve the scanty supply of moisture available for growing of melons. The use of various materials for mulching on horticultural crops has, however, come into vogue only during the last century. Systematic investigations date back to the past 75 years. In theory, any type of material can be used as a mulch, but normally some are more admirably suited than others. There is an amazing variety in the materials employed, they being as varied as plant residues which include dry leaves, corn-stalks, sawdust, grain-straw, hay, pine-needles, wood-wool, and materials like peat, stones etc, to the manufactured materials like asphalt paper, glass-wool, aluminium-foil, bituminous emulsion, polyethylene plastic. Choice of an individual mulching material would, however, depend upon its availability, efficiency and economy.

In commercial gardening, the chief purposes of all cultural operations is to increase yield and quality of the crop by suitably modifying conditions of plant growth. Data presented in literature indicating the benefits derived by adopting mulching mostly refers to vegetable crops and to some extent fruit crops like strawberry, pine-apple, apples.
Mulching is primarily practiced for conservation of moisture, to suppress weed growth, to protect the upper fertile soil from erosion, to minimize variation in soil temperatures and to afford winter protection. In addition, mulches are also used to improve soil condition, enhance microbial activity.

Problem of winter protection by mulching does not arise in India. Suppression of weed growth, however, will form the most outstanding advantage. Effective weed control would, therefore, depend upon the correct choice of a mulch material. Mulches such as asphalt paper, black polyethylene etc. which radiate solar energy can completely check the growth of weeds. Equally important benefit is conservation of moisture by reduction of evaporation losses. In arid regions, often moisture is a limiting factor for crop growth, use of a suitable mulch would economize on the available water resources, enabling the crop to tide over the periods of water stress.

Several investigators have reported that the use of a suitable mulch resulted in considerable increase in yield in the case of vegetable crops like asparagus, brassicas, tomatoes, peppers, egg-plant, cucurbits, lettuce, onion, peas, beans, potatoes, root crops like beetroot, carrots, celeriac, radish, turnips etc. (4). Similarly in the case of fruit crops like apple, pear,
raspberry, strawberry, blue-berry, walnut, grapes, tung, pine-apple etc. some work on mulching has been reported. In the case of ornamental plants, mulch has resulted in increased flowering.

No systematic investigation on these lines has been carried out in India in the case of fruit crops. It was therefore decided to study the responses of grape to mulching practice.

Maharashtra is the chief grape growing region and has the highest acreage viz. 1600 acres out of a total acreage of about 3000 in India. Of the several varieties under culture Bhokari forms the principal commercial variety, constituting 99% of the crop.

Most pressing problem confronting the grape growers is of weed control and moisture conservation. Conventional methods of weed control adopted like that of hoeing, hand-weeding, growing crops like Udid etc., involve enormous cost and labour. With this object in view it was thought desirable to undertake a detailed investigation to assess the efficacy of different mulching materials, primarily, on control of weeds and the conservation of soil moisture, and in its ultimate analysis on the growth and yield of the Bhokari grapes.

The layout employed was of randomised block design consisting of four treatments namely black polyethylene, dried leaves, sawdust and control (no mulch) with five replications.
The origin of mulch is lost in the mist of time, but as far as records are available it is traced to be of Chinese origin. Considerable research data has been reported on mulching of vegetable crops, ornamental plants, many of the small fruits and to a limited extent on tree fruits.

A wide variety of materials have been tried to assess their suitability as mulches. Straw and hay (12,35,36,49), sawdust (22,27,32,36,37,63,65), mulch paper (32,53), aluminimum foil (41,66) and polyethylene plastic (13,20,43, 52,54,31,61,44) have successfully been used as mulches in vegetable and fruit crops.

As extensive literature has accumulated on the subject, it would be desirable to review the same under separate heads for sake of presentation and clarity.

**EFFECT OF MULCH ON GROWTH AND YIELD.**

Rowe-Button has compiled extensively all the available data with respect to mulching of vegetables (41). The review pertains to the effect of mulching on growth, maturity, yield and quality of the vegetables.

Similar results were reported from mulching of vegetable crops. Chipman (15), White et al (65) and Webster et al (63) reported increased yields of tomatoes when mulched with sawdust. Hassay et al (37) obtained increased yields up to 62% with tomatoes, 33% in cucumbers, 33% in lettuce and 30% in snapbeans with the use of sawdust mulch.
Considerable interest in the use of black polyethylene as a mulching material has been created. According to Emmert black polyethylene film functions better and works out cheaply than any other mulch material tried (43). Carolus et al (13) have obtained increased growth and yield in tomatoes and melons under a plastic mulch, viz. 78 percent and 95 percent higher in unirrigated and irrigated plots respectively, compared to control (no mulch).

**EFFECT OF MULCH ON FRUIT CHOPS.**

*Small fruits:* Hall et al (24), Webster et al (63) and Woods (66) obtained considerably higher yield in boysenberries and loganberries with sawdust mulch. Langori (34) working on sour cherry, Clark (16), Darrow and Fagnness (18), Hill et al (30) working on raspberries reported beneficial effects of mulch. In strawberries (19, 24, 27, 45) gooseberries (24), increased growth and yields were obtained with sawdust mulch. Blassinsky (8) achieved satisfactory results on strawberries by using black polyethylene film.

Woods (66) found that in the mulched trees, the terminal growth was double that of the unmulched trees in respect of cherry. In red raspberries also the growth recorded was considerably more in the mulched plots (16, 18).

Savage et al (47), Griggs et al (20) working on blueberries found sawdust mulchin superior to hay mulching
or clean cultivation. These results were later confirmed by Shutak et al (50) and Jensen et al (19).

In some cases mulching was found also to improve the quality of marketable fruits. Armstrong (4) noted that the strawberries from the mulched plots were the cleanest and brightest.

Beattie (6) found marked increase in the growth and yield up to 48% in concord grapes by straw mulch, the time required for maturity being, however, delayed.

Green and Ballou (Painter et al., 46) noted that the growth and yield of young apple trees was greater with a mulch culture than either with tillage or a cover crop. Similar results were obtained by Baker (5). Boynton (10) reported increased terminal growth, tree girth, nitrogen content of leaves and also some increase in yield and size of fruits in apple. Nott (39) recorded that the use of sawdust mulch of four inch thick had resulted in better growth and leaf colour. Similarly, the use of hay mulch in apple or chards has shown considerable promise (49) and Latimer et al (36) found that the trees mulched with hay made greater annual growth than sawdust, sea-weed or clean cultivation. In the case of Pears also several workers have noted increases in terminal growth and yield of the
crops with hay mulch (21, 63, 66). Thomas (58) working on black walnut found that well rotted sawdust stimulated growth. In the case of tung trees, mulching increased their yield markedly (36).

**Effect of Mulch on Control of Weed.**

Control of weed is of paramount importance and an extremely vexed problem facing the growers and research workers, in irrigated farming. Since the dawn of history various practices have been devised for their control. Anything that cuts weeding cost is of significant interest to the growers. Among the widely varying systems of culture, mulching has proved to be distinctly effective for control of weeds.

As early as 1842, Lundstrom and Arrhenius (Rowe-Button, 41) found that the application of waste straw as a mulch in peas resulted in suppression of weed growth. Sawdust mulch proved equally effective in this respect (41). Excellent results were reported by application of loose organic mulches such as wood chips, buckwheat hulls, shavings, ground cornsob, and various other materials for suppressing growth of weeds in asparagus and several other vegetable crops (41).

Hamner et al (25, 26) advocated an economical method of weed control in which the waste papers were
soaked, shredded and placed around a growing crop.

The possible use as mulches of papers like asphalt, kraft, and ordinary newspaper after soaking in water, has greatly stimulated interest to study their effect not only on growth and yield but also as possible means for control of weeds.

Early experiments with asphalt paper proved so effective in controlling weeds in pineapple that by 1927 nearly 80% of Hawaiian crop was mulched with it (Carolus et al.,). Both asphalt and kraft papers were tested extensively for their suitability as mulch materials for vegetables during 1920-1930. Though they proved quite beneficial in increasing yields yet they were found to deteriorate rapidly. With the advent of a synthetic material like black polyethylene, which is quite durable and does not easily tear off, it is finding increase use as a mulching material for suppressing weeds. Excellent results have been reported by its use (52). In California, black polyethylene strips have been successfully employed for mulching of strawberry fields to suppress weed growth (54, 61). With the use of black polyethylene film as a mulch, weeds presented no problem since sunlight was cut off and prevented the sprouts from making further growth (43). Other workers have also reported similar results (31, 44).
Success to a varying degree in the control of weed growth with the use of different mulching materials was reported by large number of workers. Latimer et al (36) found remarkable differences in the mulch materials like sea weed, hay and sawdust in their ability to prevent weed growth. Grimes et al (23) considered sawdust mulch much more effective in controlling weeds than hay or clean cultivation. Shutak et al (50) observed that "quack grass" in blue berries could easily be controlled with a straw mulch. Armstrong's (2) data showed that mulches of all types retarded growth of weeds in strawberries. Painter et al (40) noted mulch checked weed growth in young tung orchard.

INFLUENCE OF MULCH IN MOISTURE CONSERVATION

The amount of moisture available in the soil is an vital factor directly influencing the growth and yield of the plants and tree fruits. Chinese were the earliest people to realise this fact and used to cover the soil with pebbles etc. primarily with the object of conserving the very scanty moisture present in fields grown to melons (41). Mulches were known to cut down evaporation losses and thus conserve moisture in the soil.

It was in 1850 that Arrhenius (41), recommended mulching peas with straw for preventing the soil from
Mulching proved its benefit on unirrigated lands where periods of summer drought are common and also on irrigated land as a means of reducing the frequency of irrigation required (41).

Organic materials such as straw, corn fodder, sawdust and peat proved satisfactory as mulches for conserving moisture in brassicas (41). Greater retention of moisture was reported with the use of materials like grass clippings, leaves and animal manure as compared to clean cultivation during very dry periods (41). Japtharishi et al (46) by using dry millet straw as a mulch found great benefit in conserving moisture during the dry seasons.

Sawdust mulch is commonly employed for moisture conservation where it is readily available and economical. In 1921, Stockberger (56) proved that a light mulch of sawdust in summer prevents excessive loss of moisture in dry weather. Webster et al (63), Soeds (66) and others reported higher percentage of moisture in the top two inches of the soil under sawdust mulch. Similar results were obtained by other workers (37) (65). Recently Chipman (15) found that the percentage of moisture retained under plots mulched with sawdust was higher than the plots mulched with plastic cover in tomatoes.
Hall and Webster (24) working with small fruits conducted mulching experiments for a number of years and indicated that sawdust mulch was more effective in conserving moisture especially in the top two inches of the soil. Jensen et al (19) reported that with strawberries the moisture percentage was significantly higher under the mulched than the cultivated plots, but among themselves mulches did not differ significantly in respect of soil moisture content. According to Turkin and Partridge (20) the mulches were equally effective on all types of soil in conserving moisture.

Langord (35) showed that straw mulch conserved the maximum amount of moisture as compared to clean and sod cultivation. Kramer et al (33) working on blueberries found 100 per cent more amount of soil moisture under mulches as in cultivated plots. Savage and Darrow (47) and later Shutes et al (50) working on the same crop found similar influence of sawdust mulches while Crigge and Rollins (23) obtained good results with the use of hay mulch.

The use of mulch in apple orchards maintained moisture percentage continuously higher throughout the summer months than clean cultivation or a cover crop (36). Boynton and Batjer (11) showed that the use of manure mulch conserved more moisture than either straw mulch or leguminous hay mulch. According to Shaw (49), apple trees responded favourably to hay mulching and soil
moisture was maintained at a more uniform level in mulched plots than in clean cultivation.

Flint (41) showed that the moisture percentage in the top four inches of the soil was maintained at a considerably higher level with paper mulch. Smith (53) Thompson and Platemeus (59), working with vegetable crops obtained similar results with paper mulches. McGubin et al. (38) using paper mulch on tomatoes found that the soil moisture content in mulched clay soil was higher than in the case of mulched sandy soil. Carolus and Downes (13) reported that polyethylene mulch with well arranged and properly placed slits will conserve more moisture than any other mulching material, employed. Black polyethylene film prevented the evaporation and kept the soil moist throughout (43) and its percentage under the plastic mulch was much greater than under clean cultivation (52).

In a recent experiment carried out at the Regional Cashewnut Research Station, Vengurla (1), the height and girth observation of the plants mulched with grass were significantly superior over those of control plants. The second year results are in conformity with those of last year results (2).

Banasevic (1941) as quoted by Rowe-Button (41) reports almost double the yield by the use of bituminous emulsion film as a mulch. A covering of Soot, similarly
applied as an emulsion in water also had a favourable effect on carrot yield.

Szava-Kovats (1948) as quoted by Rowe-Dutton (41) used thick paper coated with lime and aluminium foil painted white for mulching on tomatoes and harvested 31 percent and 87 percent yield increases respectively. Wall (62) obtained 29.5 percent more yields from aluminium foil mulched tomatoes while in another experiment on beet-root, aluminium foil mulch increased the yields by 70, 110 and 132 percent respectively in the three consecutive seasons.

**EFFECT OF MULCH ON SOIL TEMPERATURE.**

Generally it was found that the variations in diurnal temperatures are considerably reduced by the application of mulches. In practice the reduction of soil temperature is of primary importance in tropical and subtropical countries, and in the production of certain temperate crops in warm climates (41).

Williams in 1842 (41) recommended the use of slates as a mulch to increase the soil temperature for hastening the maturity in melons. Johnson (1872) noted that melons could be ripened in cool summers by covering the soil with 2.5 cms. layer of coal-dust (41). These early attempts with the heat absorbing slates and coal dust in a way represent the modern grower's attempt to use opaque or black asphalt paper, kraft
paper and black polyethylene as mulch materials.

Naturally occurring organic materials such as straw, hay etc. are generally considered effective as mulches in tropical regions, while they tend to reduce soil temperatures in colder regions. In areas where sawdust forms a byproduct of wood industry, its use as a mulch for reducing temperatures of the soil during warm periods was widely tested. Chipman (15) with tomatoes and Hassey et al (37) with vegetable crops proved that soil temperature fluctuations were minimized through the use of sawdust mulch.

Several investigators showed that unperforated paper used as a mulch increased the soil temperature compared to uncovered soil. Thompson and Plateneus (59), using paper mulch with vegetable crops noted that the diurnal difference in the mulched and clean cultivated plots was much more in the morning, and the mulched soil had the higher temperature throughout the night. Bassi (1930) reported that higher temperatures under the paper mulch forced the asparagus to grow more rapidly resulting in cutting 8-15 days earlier compared to plants under clean cultivation (41). Smith (1931) found mulching with black asphalt paper increased soil temperature up to depths of 3 to 12 inches to 3 to 5°C over that observed in cultivated plots (13).
Carloss and Bownes (13) recorded higher temperature under polyethylene mulch, and concluded that it is beneficial for crops that are shallow rooted. By increasing the soil temperature, black polyethylene mulch induced the tomatoes to ripen several weeks ahead of the controls, resulting in 40 percent increase in early yield (20).

Attention was recently paid to the possibility of using mulches to increase the radiation of sun-light. Aluminium foil decreases the soil temperature during hot sunny days and increases it at night thereby advancing the maturity of melons by as much as two weeks (41). Similar results were reported by Wall (62).

An unusual method of mulching, with a film of bituminous emulsion sprayed over the soil surface had attracted considerable interest in Russia (41). Like asphalt mulch paper, the bitumin absorbed heat and increased soil temperature by about 2°C (41).

Barrow and Ragness (15) working with red raspberries reported that the mulch acted as an insulator and kept the soil temperature much more uniform than did the clean cultivation. Shutak and Christopher (50) working on blue-berries showed that in the spring and summer, the soil temperatures under mulched soil were
lower, while in the fall and winter, they were higher compared to clean cultivation plots. Chandler and Mason (14) found that mulch maintains lower soil temperature in blue-berrries. Similar results have been reported by Shaw (49), who reported less variation in soil temperature under a mulch than in a soil in cultivation, in apple orchard. Clark (16) reported that the soil temperature, during mid-afternoon in July, at a depth of 3 to 4 inches in unmulched soil was as much as 20°F higher than in mulched soil, while Denisen et al (19) found that the soil temperatures recorded at 4 p.m. at 1 and 3 inches depths were 8-10°F higher in the unmulched, than in the mulched plots with strawberries.
CHAPTER III

MATERIALS AND METHODS.

The present investigation was initiated in October 1959 at Ganesh-khind Fruit Experiment Station, Poona 7. Upper Bokari, plot No.11 B was selected for conducting the experiment. The soil is medium black.

The vines were planted at 10 feet square distance in the year 1932. The method of planting was such that the planting was in east-west direction. Initially the vines were trained to a single stake system i.e. on Pangara (Erythrina indica) plants. In October 1949, live-stakes were removed and the vines were trained to single-stem two cane khiffen system on single horizontal wires at a height of 6½ feet from the ground level. The area of the plot is 1 acre and 11 gunthas, the total number of vines being 550.

10 rows of fairly uniform growth and size were selected for the present study. They were divided into 5 groups or replicates. Within each replicate, the 20 vines were further sub-divided into 4 treatments consisting of different types of mulching materials. Each treatment plot consisted of 5 vines. The four treatments which were randomised in each replicate
consisted of the following mulching materials.

A = Black Polyethylene (guage 400)
B = Dried leaves.
C = Sawdust
D = Clean cultivation (control).

**Design of the experiment:**

The layout employed is randomised block design.

(i) Number of vines per treatment = 5.
(ii) Number of treatments in a replication = 4.
(iii) Number of replications = 5.
(iv) Total number of vines to a replication = 20.
(v) Net plot size = (50' x 7') = 350 square feet.
(vi) Area of a block = (130' x 50') = 6500 square feet.
(vii) Net area under each treatment = 350' x 5'
     = 1750 square feet.

The experiment was laid out after October 1958, pruning of vines. Mulching materials were spread out on 1st of November, 1958, according to the randomised plan, on the field.

**Cultural operations carried out in the plot.**

Pruning was done between 15th - 19th October 1958. The entire experimental plot was ploughed twice (i.e.
cross ploughing) followed by 6 harrowings and 6 interculturings. After harrowing and interculturings, all the weeds were collected. The mulching materials were laid in the plots as per experimental plan. The vines were irrigated 6 times during the course of the experiment. Infection by anthracnose and downy mildew was noticed and for their control in all 8 sprayings of Bordeaux mixture and Blitox were given. Spraying with wettable sulphur was also done twice for control of powdery mildew.

The details of the various observations recorded during the course of the experiment are given below:

(i) (a) Weed density (count) per square foot.
    (b) Weight of weeds from the entire plots.

(ii) Soil moisture content.

(iii) Temperature of the soil.

(iv) Growth observation on length and girth (diameter)
      (in cms.) of the shoots.

(v) Yield in lbs.

(vi) Number of bunches per vine.

(vii) Size of berries namely length and diameter
      (in cms.) of the Berries.

(viii) Total soluble solids of grape-juice

(ix) Weight of pruned material after harvest
      (April pruning).
LAYOUT OF MULCHING EXPERIMENT IN BHOKARI VARIETY OF GRAPES

LEGEND

● = Guard Rows
○ = Experimental vines.
A = Polythene plastic.
B = Dried leaves.
C = Saw dust.
D = Control.

Layout = Randomized block design.
### Characteristics of Mulching Materials

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<tr>
<th>Characteristics</th>
<th>Sawdust</th>
<th>Straw</th>
<th>Black polyethylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longevity</td>
<td>Decomposes about 1&quot;-2&quot; per year</td>
<td>Not more than one year</td>
<td>Two or more years</td>
</tr>
<tr>
<td>Water retention (reduction of surface evaporation)</td>
<td>Good</td>
<td>Poor</td>
<td>Good (impervious to water)</td>
</tr>
<tr>
<td>Heat absorption</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Weed control</td>
<td>Fair</td>
<td>Poor</td>
<td>Excellent</td>
</tr>
<tr>
<td>Water penetration</td>
<td>Good</td>
<td>Good</td>
<td>None</td>
</tr>
<tr>
<td>Durability (can it be walked on?)</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Effect on soil structure</td>
<td>Poor</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Appearance of mulch</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
</tr>
</tbody>
</table>
Application of mulching materials:

(A) Black polyethylene film:

Polyethylene is a thermo-plastic resin which is pliable, chemically inert, odorless, and nontoxic. Moisture does not penetrate it, but certain gases such as carbon dioxide and oxygen easily pass through.

Seed control, soil moisture conservation, crop yields and fruit disease control of warm season horticultural crops have all been increased or improved. This is based upon research trials with black plastic mulch at the Oregon Agricultural Experiment Station. Use of the plastic also may increase soil temperature, improve fruit cleanliness, and decrease soil compaction.

If the plastic is removed each year, 1⁄2 (.0015") or 2 (.002") mils in thickness is adequate. With perennial crops such as strawberries, grapes etc. 4-mil (.004") plastic may last longer than 2-mil plastic.

Although the initial cost of polyethylene mulch and its handling are some of the disadvantages for employing this material in all crops, however, the beneficial effects outweigh, specially in respect of commercially paying crops like vegetables, fruits and ornamental plants.
Plastic sheets of 52' in length, and 6' and 3' in widths were used for mulching. The lower portion of the stems of the vines were inserted in the slits cut through the plastic film. The polyethylene films (Plastic films 6' and 3' widths laid side by side) were held firm by inserting their four sides 6" inside the soil. After inserting the ends under the soil, the total width covered by the film was only 7 feet.

(E) Dried-leaves:- Dried leaves collected from the garden were used for mulching. They were spread within the plot to a 2" thick layer.

(C) Sawdust:- The plots were covered with 2" thick layer of sawdust.

(D) Clean cultivation (control) :- The plots were left unmulched. Normal cultural operations as and when needed, like weeding and (manual) stirring were attended to.

(1) (a) Counting of weeds:- In the treatments where mulching was adopted, the observations on weed count was taken on 7-3-1966, exactly 140 days after the application of mulches. In the control plots, however, normal weeding was attended regularly and a total of 5 weedicings followed by manual stirring were carried out i.e. on 10-1-1966, 27-1-1966, 6-2-1960, 21-2-1960 and 7-3-1960, dates. The weed count was recorded
each time before weeding and the sum of all these was taken as final observation for the control treatment. Weed count was recorded for one square foot area at 10 spots randomly selected in each plot and the mean of these was considered as the number of weeds in a square foot.

(b) Weight of weeds: After estimating the weed population per square foot under each treatment, the weight of the weeds in the entire plot was also recorded. This observation was recorded on 30-3-1960, i.e. a day prior to April pruning. In case of polyethylene mulch, the film was removed from the plots before the weeds could be uprooted. In case of sawdust and dried leaves mulches, the weeds were removed carefully after freeing them of the external mulch material. In the case of the control treatment the weeds collected at the time of each weeding, namely 10-1-1960, 27-1-1960, 6-2-1960, 20-2-1960 and 30-3-1960 were weighed. The sum of all these observations was considered as the total weight of weeds for the control treatment.

(ii) Soil Moisture determination:

The soil moisture percentage was determined in the upper 6 inch layer of the soil. The soil samples up to 1/2 lb. were collected by means of a soil augur from the centre of the sub-plot. From this 50 gms. soil sample was weighed and kept in an electric oven, at 100°C for
12 hours. The sample was weighed again after drying and the percentage of moisture present was calculated from the loss in weight.

(iii) Temperature of the soil:

Soil temperature under the different treatments was also a subject of study. Non-availability of the soil thermometers made it imperative to use the air temperature thermometers for recording. Since these were not available in adequate number, the observation of soil temperature could be studied in one replication only. The data of soil temperatures at the depth of 10 cms. was recorded daily at 1430 hours. From this data, the mean monthly temperatures were calculated. The data was recorded for 5 months, November 1959 to March 1960.

(iv) Growth of the crop:

The bud-burst occurred within 10-15 days of pruning. In each of the vine, 20 shoots were selected at random and labelled. The length and girth (diameter in cms.) of these shoots were recorded. The first observation was recorded on the 45th day from the pruning and subsequent observations at monthly intervals. From this data, the average length and girth (diameter in cms.) per shoot under each treatment was determined.

(v) Yield:

The bunches from each vine were harvested & weighed.
(vi) **Number of bunches:**

Number of bunches per vine were recorded.

(vii) **Size of berries:**

Size of berries was observed after harvesting the bunches. From each vine 5 bunches were selected and from each bunch randomly, 10 selected berries were used for recording the length and diameter.

(viii) **Sugar content expressed by total soluble solids in berries:**

Total soluble solids were determined by means of low range refractometer (Bausch & Lomb). For this, 10 bunches selected at random were employed. About 10 berries from each bunch were selected at random for determination the total soluble solid percentage. The mean of these was taken as the percentage of total soluble solids in the berries.

(ix) **Weight of pruned material (April or summer pruning):**

Pruning of the vines was done after the harvest of the crop. Pruned material under each treatment was weighed separately to assess the effect, if any, of mulching on the extent of vegetative growth put forth after October 1959 pruning.
CHAPTER IV.

PRESENTATION OF DATA AND RESULTS.

The mulching materials were laid out on 1-11-1959 in the upper Bhokari field, plot No.11.b, Ganeshkhind Fruit Experiment Station Poona-7. The data in respect of 1) (a) weed density per square foot, (b) weight of weeds in temperature of soil 2) soil moisture percentage; 4) growth of the vines (i.e. length and girth); 5) yield in pounds; 6) number of bunches; 7) size of the berries; 8) sugar content in terms of total soluble solids and 9) weight of the prune material (April pruning) were recorded regularly and are presented under separate sub-headings.

I. EFFECT OF MULCHING ON THE CONTROL OF WEEDS.

(1) (a) Density of weeds:

The count for the number of weeds per square foot was made on 7-3-1960, 140 days after the application of mulches. The data showing the effect of different mulches on suppression of weed growth in comparison to the control, along with the necessary statistical information are presented in table 1. The details of the data for the weed count observed at the time of 5 weedings carried out during November through March are presented under appendix A.
### Table No. 1.

Weed density per square foot as affected by mulching treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>0.10</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>5.46</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>4.64</td>
</tr>
<tr>
<td>Control (D)</td>
<td>16.58</td>
</tr>
</tbody>
</table>

S.E. = 0.267

G.D. (at 5% level) = 0.622

G.D. (at 1% level) = 1.153

It will be seen from table 1 that the difference within the treatments are highly significant, and that all mulches employed are superior to control (no mulch). The examination of the results show that the black polyethylene mulch has completely suppressed the weed growth and is highly significant at 1% level over the dried leaves, sawdust and the control (no mulch) treatments. Though the treatments—sawdust and dried leaves mulches—are significant (at 1% level) over the control (no mulch) the difference amongst themselves however is not significant.

(b) **Height of weeds.**

After estimating the weed density per square foot under each treatment, the weight of the weeds was also
recorded on 30-3-1960, just prior to April pruning. For this, the weeds in the individual plots of the mulched treatments were carefully uprooted. These were immediately weighed. In the case of the control the weight of the weeds was recorded after weeding separately for each plot. The data for the weight of weeds under each of the 5 replicates for the 5 weedings is given in appendix B. The data showing the effect of different mulches on the weight of weeds, along with the necessary statistical information are presented in table 2.

### TABLE No.2:

Weight of weeds (in ounces, as affected by different mulching treatments as recorded on 30-3-1960.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>6.48</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>26.90</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>23.40</td>
</tr>
<tr>
<td>Control (D)</td>
<td>94.82</td>
</tr>
</tbody>
</table>

\[ S.E. = 1.287 \]
\[ t_0.05 (at 5\% level) = 3.965 \]
\[ t_0.01 (at 1\% level) = 5.559 \]

It will be seen from table, that the differences within the treatments are highly significant, and that the mulches are superior to control (no mulch). The examination of the results showed that the use of
polyethylene mulch significantly suppressed weed growth and that the weight recorded from these plots is very negligible. Polyethylene mulch is also significantly superior to dried leaves, sawdust and the control (at 1% level). The treatments - dried leaves and sawdust - are also highly significant (at 1% level of testing) over the control, although the differences between them are non-significant.

II. SOIL MOISTURE DETERMINATION

The role of mulching in conservation of soil moisture was studied. The method adopted was to collect the duplicate samples of soil from each treatment for all the replications to estimate the soil moisture. This was assessed in two stages. In the first series, the soil moisture estimation was carried out 1-3 days after each irrigation turn. Of the total number of 6 irrigations given i.e. from 10-12-1959 to 6-3-1960, the range of frequency of irrigation works out to be 7 to 30 days. In the second series, the soil moisture content under each treatment was regularly estimated at weekly intervals, commencing from first estimation under series 1, till the next irrigation. This data namely, the initial moisture content and the subsequent gradient of loss as a result of reduction in soil moisture are presented in appendix C. The data on the effect of different mulches in conserving moisture is presented in table 3.
TABLE 10.3.

Soil moisture percent under each treatment at different intervals.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1st interval</th>
<th>2nd interval</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-3 days after irrigation</td>
<td>At weekly intervals after each estimation</td>
<td></td>
</tr>
<tr>
<td>Polyethylene(A)</td>
<td>30.56</td>
<td>29.19</td>
<td>29.88</td>
</tr>
<tr>
<td>Dried leaves(B)</td>
<td>28.46</td>
<td>26.72</td>
<td>27.59</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>28.91</td>
<td>27.15</td>
<td>28.03</td>
</tr>
<tr>
<td>Control (D)</td>
<td>28.38</td>
<td>25.31</td>
<td>26.84</td>
</tr>
<tr>
<td>Total</td>
<td>116.31</td>
<td>108.37</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>29.08</td>
<td>27.09</td>
<td></td>
</tr>
</tbody>
</table>

S.E. for body of the table = 0.527

C.D. = 2.371

C.D. for average of treatments = 1.677

C.D. for average of intervals = 1.185.

From the two-way table, it will be seen, that the difference between the interval averages for loss of moisture is (29.08 - 27.09) = 1.99, which is greater than the C.D. for average of intervals i.e. 1.185. This shows that there is a significant evaporation losses occurring in the soil.

From the body of the table, it is seen that all the three mulches namely polyethylene, dried leaves and sawdust have effectively minimized the loss of soil moisture.
The loss in moisture (i.e. the difference in the estimated soil moisture between 1-3 days and that of the later period after irrigation) in these three treatments being 1.37, 1.76 and 1.74 respectively, which is less than the C.V. value of 2.371. In the case of control (no mulch), the difference showing the percentage loss of soil moisture is significant, being of the order of 3.07. It may therefore be concluded that the use of these types of mulches help significantly in conserving soil moisture, as compared to the control.

From the study of the means for the treatments (i.e. the average of the total of two intervals) it will be seen that the mean percentage of moisture in the plots under the treatment polyethylene is significantly higher compared to those observed for the treatments dried leaves, sawdust and control. The differences between dried leaves, sawdust, though not significant, have helped in conserving soil moisture.

**III. Temperature**

The variation in the soil temperature under the various mulches was also a subject of study. As soil thermometers were not available, the temperature record was maintained by the use of the air thermometers. The data of soil temperatures at the depths of 10 cms., was recorded daily at 1430 hrs. From this data, the mean monthly temperatures were calculated and are presented in table 4.


**TABLE No.4.**  

*Mean monthly temperature (in centigrade) of the soil at a depth of 10 cms. under different treatments.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene</td>
<td>27.95</td>
<td>27.65</td>
<td>27.50</td>
<td>30.00</td>
<td>33.50</td>
<td>29.30</td>
</tr>
<tr>
<td>Dried leaves</td>
<td>26.15</td>
<td>25.70</td>
<td>25.65</td>
<td>28.55</td>
<td>32.80</td>
<td>27.80</td>
</tr>
<tr>
<td>Sawdust</td>
<td>26.35</td>
<td>25.85</td>
<td>25.80</td>
<td>28.80</td>
<td>33.00</td>
<td>27.96</td>
</tr>
<tr>
<td>Control</td>
<td>25.90</td>
<td>25.40</td>
<td>25.40</td>
<td>28.20</td>
<td>32.80</td>
<td>27.54</td>
</tr>
<tr>
<td>Air temperature</td>
<td>34.00</td>
<td>35.50</td>
<td>35.30</td>
<td>38.70</td>
<td>40.10</td>
<td>36.20</td>
</tr>
</tbody>
</table>

For comparison, record of the air temperature is also given in the table. It will be seen from data that for all the 5 months, November through March, the atmospheric temperatures were consistently higher than that of the soil temperature (i.e. no mulch). The study of the temperatures of the control (no mulch treatment) and the mean temperature for the three types of mulches show that the temperatures in the mulched plots were always higher.

Of the three different mulching materials, the soil temperature record shows that the temperature under the polyethylene mulch was consistently higher than those under the remaining two, the dried leaves showing the least. The
trend however is not consistent.

It may therefore be noted that the use of polyethylene mulch helps in maintaining higher temperature than either the sawdust or the dried leaves mulches.

IV. GROWTH OF THE GROVE

Though the growth observations on length and girth (diameter) of the shoots was taken regularly at monthly intervals, only the final observation for the month of March has been presented here. The growth observations for the months - December to February have been given separately for appendix 3.

The final growth observation was taken on 30-3-1960 i.e. 163 days from pruning. The data on length and diameter growth of the shoots in centimeters (by measuring the length upto the tip of the shoot from its base and its diameter at the base). The data was analysed and presented separately for both length and diameter (girth).

(1) The effect of different treatments on the length of the shoots

The data showing the influence of different mulches on the length of the shoots is presented in table 5.
Length growth of the shoots (in cms) under different treatments as observed in March, 1960.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>90.50</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>86.45</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>88.36</td>
</tr>
<tr>
<td>Control (D)</td>
<td>86.20</td>
</tr>
</tbody>
</table>

S. b. = 0.956
C.D.(at 5% level) = 2.945
C.D.(at 1% level) = 4.129

It will be seen that the differences between the treatments are statistically significant and in all the three treatments where mulching was done, increased length was recorded as compared to that of the control treatment. The use of polyethylene mulch resulted in increased shoot length which was significant over the treatment control (no mulch) (at 1% level) and dried leaves (at 5% level). The differences in the shoot length recorded for vines mulched with sawdust and dried leaves is negligible and non-significant, though both these treatments have induced slightly better growth in length as compared to the control.
(ii) **Effect of different treatments on the diameter of the shoots:**

The data showing the influence of different mulches on the mean diameter of the shoots is presented in Table 6.

**Table 6**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>0.804</td>
</tr>
<tr>
<td>dried leaves (B)</td>
<td>0.780</td>
</tr>
<tr>
<td>sawdust (C)</td>
<td>0.786</td>
</tr>
<tr>
<td>Control (D)</td>
<td>0.772</td>
</tr>
</tbody>
</table>

S.E. = 0.0077

C.O. (at 5% level) = 0.0237

C.O. (at 1% level) = 0.0332

The measurement of the diameter of the shoots shows that in all the treatments where mulch was employed somewhat increased growth in diameter was recorded as compared to that of the shoots in the control treatment. The use of polyethylene mulch alone resulted in significantly increased shoot diameter over the control treatments (no mulch) and dried leaves. The difference in the shoot diameter recorded for vines, mulched with sawdust and dried leaves are negligible and non-significant, though both these treatments have induced slightly better growth in diameter as compared to control.
significantly higher as compared to the yield obtained from vines mulched with sawdust, dried leaves and the control. The increased yields through the use of polyethylene mulch is of the order of 70.60, 76.00 and 86.00 percent over the treatment dried leaves, sawdust and control respectively.

It is of interest to note that the treatments dried leaves and sawdust as mulching materials have not appreciably influenced the yield compared to control.

VI. NUMBER OF BUNCHES

In addition, the record of the number of bunches harvested per vine was also maintained. The data for the mean number of bunches per vine per treatment is presented in table 8. For details refer to appendix F.

<table>
<thead>
<tr>
<th>TABLE NO. 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of bunches per vine as affected by different treatments.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>39.83</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>33.00</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>28.92</td>
</tr>
<tr>
<td>Control (D)</td>
<td>27.84</td>
</tr>
</tbody>
</table>

\[ t = 2.203 \]

\[ t_{0.05}(at 5\% level) = 6.716 \]

\[ t_{0.01}(at 1\% level) = 9.512 \]
The differences with regard to the mean number of bunches between the treatments are highly significant at 1% level. The comparison of the different treatments show that the yield of bunches in polyethylene mulch treatment is highly significant (at 1% level of testing) over the treatments dried leaves, sawdust and the control. Thus it can be stated that the polyethylene mulch has effectively increased the number of bunches per vine. The percent increase in the number of bunches for the mulched treatments being 43.25, 18.53 and 3.9 over the control for the three mulches viz. polyethylene, dried leaves and sawdust respectively. There is practically no difference in the number of bunches harvested from sawdust and control treatments. In the case of mulching with dried leaves, it is found that there is a difference of 5.16 when compared to the control which is nearing significance, C.D. being 6.784. Thus it may be stated that mulching with dried leaves was found to be more beneficial than sawdust mulch.

The increased number of bunches observed under the dried leaves mulch is in line with the yield data by weight (loc.cit).

VII. SIZE OF FRUIT

The observation on the size of the berries i.e., length and diameter was recorded after the harvest of the bunches.
Length and diameter of the berries as affected by different treatments:

The data about the mean length and diameter of berries observed under different treatments are presented in Table 9. For details refer to appendix 6.

Table 9

Length and diameter (in cms) of berries as affected by different treatments:

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Mean for length</th>
<th>Mean for diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>1.736</td>
<td>1.520</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>1.706</td>
<td>1.500</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>1.740</td>
<td>1.518</td>
</tr>
<tr>
<td>Control (D)</td>
<td>1.726</td>
<td>1.514</td>
</tr>
</tbody>
</table>

S.E. for length = 0.0163
S.E. for diameter = 0.0010
C.D. for length = 0.0502 (at 5% level)
C.D. for diameter = 0.00314

It will be seen that the differences within the treatments are not significant. It may, therefore, be concluded that in general mulching has no effect on the mean length of the individual berries.
VIII. TOTAL SOLUBLE SOLIDS.

The effect of different treatments on the total soluble solids in the juice is presented in table 10. For details refer to appendix H.

Table No. 10.

Percentage of total soluble solids in berries (after harvest) as affected by different treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>18.70</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>18.60</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>18.20</td>
</tr>
<tr>
<td>Control (D)</td>
<td>18.50</td>
</tr>
</tbody>
</table>

S.E. = 0.463
S.D. (at 5% level) = 1.364

It will be seen that the differences within the treatments are not significant.

Mulching, irrespective of material employed had no influence on total solids in the juice.

I. WEIGHT OF THE PRUNED MATERIAL AFTER \( \text{THE HARVEST (PER VINE)} \):

The data showing the effect of different treatments upon the mean weight of pruned material per vine is presented in table 11. For details refer to appendix I.
### Table No. 11.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>2.59</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>2.33</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>2.37</td>
</tr>
<tr>
<td>Control (D)</td>
<td>2.05</td>
</tr>
</tbody>
</table>

S.E. = 0.167

C.D. (at 5% level) = 0.515.

The comparison of the different treatments show that the weight of pruned material from polyethylene mulched treatment is significantly higher than that of control. No significant difference was observed amongst the other two treatments namely dried leaves and sawdust mulches.
Chapter Opener Page
CHAPTER V.

DISCUSSION OF RESULTS.

Extensive work has been done to study the effect of mulching on growth and yield of crops. The beneficial effects of mulching can be broadly discussed under two groups namely their effect 1) on the soil conditions and 2) on growth and yield. Under the former comes the control of weeds, reduction of evaporation losses in soil moisture, maintenance of fairly uniform soil temperature by minimizing the diurnal and nocturnal variation in temperatures. The combined effect of these soil conditions (as a result of mulching) in promoting better growth and yield fall under the later group.

The results of the present investigations (Chapter IV) are discussed under these groups.

1. EFFECT OF MULCHING ON SOIL CONDITIONS.

It will be evident from tables 1-3 that the mulching materials have shown varying degree of efficacy in preventing the growth of weeds and reduction in evaporation losses of soil moisture.

Of the mulching materials employed, influence of the black polyethylene - a plastic mulch is the most phenomenal. With the use of this mulch, it was observed
that as against the weed density of 16.53 per square foot in the control (no mulch), the weed count of 0.10 only, per square foot was observed. In terms of actual weight of the weeds, the figures are 94.82 ozs., and 0.48 ozs. respectively. Similarly in respect to soil moisture, the figure is 29.36 as against 26.34 percent in the control i.e. in other words a higher retention of soil moisture by 3.04 percent. All these results are statistically significant, the weed count and the weight of the weeds being significant at 1% level of testing, while retention of soil moisture at 5% level.

These observations closely confirm with those reported by workers in the case of tomatoes, melons, strawberries etc. Jorvill (54), Voth et al (61) working with strawberries indicated that the weed growth could be successfully checked through the use of black polyethylene mulch. According to Spice (55), weed control is undoubtedly the biggest single advantage obtained by the use of black plastic mulching. This was explained on the basis that black polyethylene does not allow the solar ray penetration through it thus preventing the growth of weeds and reducing the evaporation of soil moisture (43). Slater and Brouch (52) reported similar results.

The data indicate that the black polyethylene mulch, besides being highly significant over the control, is much superior to the other types of mulching materials.
namely dried leaves and sawdust, tried in the experiment.

The density (count) and the weight of the weeds under the polyethylene mulch was significantly lower (at 1% level) than in dried leaves and sawdust mulched plots. As against the weed count of 0.10 weighing 0.46 ozs., the figures for the dried leaves and sawdust mulches were 5.46 and 4.64 numbers respectively weighing 26.9 and 23.40 ozs.

In this connection, it is interesting to note that Fletcher et al. (22) observed that though annual weeds could be successfully controlled by two inch sawdust mulch, perennial weeds have to be eradicated prior to mulching. As shown already under the results, the black polyethylene has, for all its practical purposes suppressed completely the growth of weed, both sawdust and dried leaves mulches were less effective - the figures for weed count and weight of the weeds under them being less than 30% to that recorded for the control (no mulch) plots. That this should be so even when the plots were weeded thoroughly before spreading the mulching materials indicate that 'hariaali' is a cthonious weed, and elaborate measures, besides weeding will be required for complete eradication as a suggested pre-requisite for spreading of mulching materials (22). Latimar and Percival (36) report that the use of hay mulch in apple orchard prevented the growth of grass and
weeds, where as sawdust mulch formed an ideal medium
for the growth of 'witchgrass'. This aspect regarding
the effect of sawdust on growth of certain weeds under
Indian conditions needs further investigations.

With respect to the superiority of the mulches in
cutting down the evaporation loss of soil moisture, the
following observations could be made. The study of
the data for the losses in the soil moisture percentages,
estimated within 1-3 days of irrigation and that estimated
at weekly intervals, one week after each estimation, till
the next irrigation showed that in all the three types of
mulching materials namely polyethylene, dried-leaves and
sawdust have significantly influenced the reduction in
evaporation losses of soil moisture compared to the control
(no mulch treatment), the figures for percentage losses
being 1.37, 1.74, 1.76 and 3.07 respectively as against
C.O. value of 2.371.

The study of the means for the data within 1-3 days
and subsequently every week (after each estimation)
after irrigation, nevertheless showed that the polyethylene
mulch significantly helped in conserving soil moisture,
the percentage increase in retention being 3.04, 2.29 and
1.55 over that recorded for the control (no mulch), dried
leaves mulch and the sawdust mulch treatments respectively.
It is interesting to note that though dried leaves and
sawdust mulching treatments had significantly reduced
the rate of evaporation losses of soil moisture (loc. cit.),
the final analysis (i.e., the mean of the first and the
second interval) show that both these mulching materials
did not significantly help in conserving soil moisture
as compared to the control. The amount of moisture, however,
was conserved particularly well by sawdust mulch was higher when
compared to the soil moisture content of the control plots.

White et al (65), Shukla et al (56) reported that
the use of sawdust mulch greatly helps in conserving
soil moisture by cutting down evaporation losses. This
observation is in conformity with observation recorded
in the present investigations, as both sawdust and dried
leaves mulch significantly reduced the rate of evaporation
of soil moisture as compared to control. Nevertheless,
it is observed that the rate of evaporation of soil
moisture in the case of black polyethylene is the least,
and is significantly lower than that observed both for
sawdust mulch and the dried leaves mulch. Further, the
difference between the sawdust and dried leaves in their
efficacy to cut down evaporation losses are not signi-
ficant and are similar to those reported by Benison et al
(19) in respect of sawdust and straw-mulches. Chandler
and Mason (14) observed 42 percent soil moisture in the
mulched plot and 36 percent in the clean cultivated plot
depending upon the dry weight of the soil.
As pointed out earlier that soil temperature record could not be maintained in respect of each subplots for the entire experiment, the data obtained has been discussed here and may be considered as of preliminary nature only.

The study of the data shows that as against a mean difference of 8.37, the difference (i.e. the air temperature minus the soil temperature) for the control was 9.16. In other words, the soil temperatures under all the three different mulches were consistently higher than that of the control (no mulch). Of the three different mulching materials tried, the data shows that the soil temperature under the black polyethylene mulch was higher by 1.76 degrees over that of the control (no mulch). Similarly for the sawdust mulch and the dried leaves mulch, the soil temperature was somewhat higher, being 0.42 and 0.23 degree respectively.

From this, it is clear that the black polyethylene mulch has resulted in maintenance of substantially higher temperatures during winter months, being of the order of 0.46 percent over the control, as compared to 1.53 percent for the sawdust and 0.84 percent for the dried leaves mulches.

These results are similar to those observed by several workers. Spicci (55) reported increase in soil temperature under the black polyethylene mulch as compared to control (no mulch). Peyer et al (42) using strips
of polyethylene in vine nursery reported higher soil temperatures than observed in the unprotected soil. According to an Anonymous report (43), soil under the black polyethylene reached a higher temperature than the unmulched soil and remained warm after the sundown, enabling the plants to grow at night. Slater and Broach (52), have explained that the resultant higher temperature under the black polyethylene is due to the absorption of solar radiation by it, which results in the warming of the soil.

Massey and Judkins (37) using sawdust mulch in vegetable crops observed that the soil temperature variations were greatly minimized by its use. Higher temperature under the different types of mulching material in winter have been reported by Shutak et al (56). The results obtained here are similar to those obtained by several workers.

In the preceding paragraphs, the beneficial effects of mulching practice in improving the soil condition in respect of (i) suppression of weed growth (ii) reduction of evaporation losses of soil moisture and (iii) in minimizing the variation in soil temperatures between the day and night hours were discussed. It is evident that the growth and yield of plants grown under such an environment would be stimulated, as there would be little or no
competition from the weed (as in the case of unmulched plots) and by maintenance of soil temperature at optimum level.

The results of mulching trial obtained on the Shokari grape with regard to the vegetative growth on the vines (shoot growth) and yield of bunches are discussed, in the following paragraphs.

It is seen from the tables 5-8 and 11 that the mulching materials showed varying degree of efficacy in increasing the vegetative growth and yield of the crop.

Data indicated that the black polyethylene mulch had increased the growth and yield as compared to control (no mulch) treatment. The growth data show that as against shoot length of 90.56 cm. in the case of vines mulched with black polyethylene, the vines under control (no mulch) recorded only 86.20 cm. i.e. the difference of 4.36 cm. Similarly the data for the diameter of the shoots observed is 0.804 cm. and 0.772 cm. for black polyethylene and control (no mulch) respectively.

The yield data shows that vines mulched with black polyethylene, recorded a mean yield of 11.74 pounds per vine as against 6.31 pounds or an increase of 85.0 percent over the control. All these results are statistically significant. Similar results have been recorded
for the number of bunches the percentage increase being 43.25.

Further, the dried-leaves and sawdust mulches were found to be not as effective as the polyethylene mulch. Dried leaves and sawdust have not shown any significant results both in respect of growth of shoots and yield of grapes over the control. Similar results were reported by Rott (39) who observed that the use of 4 inch sawdust mulch in apple did not result in significant increase in growth over those of the clean cultivated trees. He however observed that the leaf colour was better in the case of sawdust mulched trees. Sell (48) also reported greener foliage and larger and better coloured fruits in case of pear, apple and peach over that of the unmulched trees when mulched with oat straw. It was, however, observed that though the vines mulched with sawdust put forth better length and girth of the shoots, the yield both by weight and number of bunches was lower than those recorded for the dried leaves mulch.

The substantial increase obtained in growth of polyethylene shoots and the yield of bunches as a result of mulching can be attributed primarily to the root system of the Bhokari grape vines. In Maharashtra, as in the Indian subcontinent, the propagation of grapes by cuttins has been universally adopted. Under such circumstances, most of the rooted cuttings will show abundance growth of adventitious roots and only a few of morphological
roots emerging at the nodes (57). It would be obvious therefore, that after the transplanting of the rooted cutting in the permanent orchard, these advantageous roots which form the main bulk of the root system would be more or less surface feeders, not penetrating below 9-12 inches from the surface soil.

Carolus and Bowes (13), working on tomato and musk-melons stated that the influence of the black polyethylene mulch is more pronounced and specific in case of melons than in case of tomato. This variable response to mulching has been attributed to the differential root system of these two plants - the muskmelon, belonging to the Cucurbitaceae family has a spreading root system mainly confined in the upper layer of the soil compared to tomato which has a deep rooted system. They have obtained 90% more yield of melons from polyethylene mulched plants as compared to that of control plants. Blassinsky (8) reported increased yields by 57.5 percent in strawberries mulched with black polyethylene. Several other workers have reported similar results (15,43).

As regards the influence of mulching on the size and total soluble solid content of berries, it was observed that there exists no significant difference within the mulched and the control treatments.

Though several workers have reported increased
yield by mulching, the size of the individual fruits in apple trees was shown, to increase not appreciably. In strawberries, it was observed that mulching resulted in better quality and cleaner fruits. Under such circumstances it may be stated that quality of fruits can only be influenced by soil and environmental factors and to some extent through fertilizer levels. No pronounced or distinct changes can be brought in these characters as these are primarily controlled genic influences. Bhattacharai (7) who studied the effect of spacing on the quality of bhokari grapes, did observe that the quality of fruits remained unaffected even when the increased yields per vine were obtained by wider spacing. The effect of mulching in increasing yield is attributed to those agronomic and horticultural factors which have brought about increased yield as a result of mulching, and as such it may be concluded that the results of mulching on quality of grape is in conformity with those reported by Bhattacharai (7).

The data of pruned materials showed that the weight for April pruning recorded under black polyethylene was significantly higher as compared to control. The differences in respect of pruned material did not show any significant increase in comparing the two remaining mulches with the control nor was there any significant difference amongst (mulches) themselves.
A mulching trial on Bhokari grape was laid out in plot No. 11 B, on 1st November 1959, at Ganeshkhind Fruit Experiment Station, Poona. The Bhokari vine yard was about 28 years of age. Black polyethylene, sawdust and dried leaves were the three types of mulching materials used in the trial and their effect on the soil conditions in respect of weed control, conservation of soil moisture and in minimizing diurnal variation in soil temperatures, and the combined influence on growth of vines and yield was studied. A control with no mulch was also included in the study for comparison.

(1) Polyethylene film (0.004") was observed to suppress the weed growth completely. This is significant as majority of the weeds were 'Hariali' (Cynodon dactylon) and 'Lavaia' (Cyperus rotundus) which are of perennial type.

(2) Both sawdust and dried leaves also were effective in significantly checking the weed density. The weed growth under these treatments was 20-30 percent of the control.

(3) Irrespective of the mulching treatments, there was a significant reduction in the soil moisture content, following irrigation. (i.e. 2-3 weeks after irrigation).
It was however observed that the use of polyethylene, sawdust and dried leaves as mulches significantly reduced the rate of loss of soil moisture, whereas in the control this reduction in the soil moisture was significantly higher.

(4) Temperature under the mulches were observed to be little higher than the bare soil. Soil under the polyethylene mulch was found to show consistently higher temperatures (during winter months) than under the remaining two types of mulches.

(5) The vegetative growth as indicated by the shoot length and diameter was significantly superior in the vines mulched with polyethylene, the vines under both control and dried leaves treatments havin, put significantly poorer growth. The use of sawdust mulch brought about somewhat better shoot growth than the control.

(6) Yield, both in pounds and number of bunches was found to be significantly higher for the vines mulched with polyethylene. Though mulching vines with sawdust and dried leaves did not significantly influence the yield, the dried leaf mulch was found to result in higher yield both by weight and number of bunches.

(7) The quality of the grapes as determined by size (length and diameter) of individual berries and the total soluble solids in the juice was found to be uninfluenced by the use of different mulches.
(3) The weight of the pruned material (April pruning) was also found to be significantly higher in the case of vines mulched with polyethylene as compared to control. The differences between the remaining two types of mulching materials were not significant.
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<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
<th>Details</th>
</tr>
</thead>
</table>


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* Original articles not seen. (Deferred from other sources).
### APPENDIX A.

Weed density per square foot as recorded at different weedings in the control treatment.

<table>
<thead>
<tr>
<th>Dates</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Total</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-1-60</td>
<td>6.9</td>
<td>5.8</td>
<td>5.7</td>
<td>6.2</td>
<td>7.3</td>
<td>31.9</td>
<td>6.38</td>
</tr>
<tr>
<td>20-1-60</td>
<td>2.3</td>
<td>3.9</td>
<td>2.8</td>
<td>2.1</td>
<td>2.7</td>
<td>13.8</td>
<td>2.76</td>
</tr>
<tr>
<td>6-2-60</td>
<td>1.9</td>
<td>2.4</td>
<td>2.6</td>
<td>1.9</td>
<td>2.3</td>
<td>10.5</td>
<td>2.10</td>
</tr>
<tr>
<td>20-2-60</td>
<td>2.6</td>
<td>2.3</td>
<td>3.0</td>
<td>2.6</td>
<td>2.8</td>
<td>13.30</td>
<td>2.66</td>
</tr>
<tr>
<td>7-3-60</td>
<td>3.0</td>
<td>3.4</td>
<td>2.3</td>
<td>2.8</td>
<td>1.9</td>
<td>13.40</td>
<td>2.68</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>16.7</td>
<td>17.8</td>
<td>15.8</td>
<td>15.6</td>
<td>17.0</td>
<td>82.90</td>
<td>16.58</td>
</tr>
</tbody>
</table>
**APPENDIX A**

Weed density per square foot as affected by different mulching treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>0.11</td>
<td>0.08</td>
<td>0.09</td>
<td>0.12</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>5.06</td>
<td>6.50</td>
<td>4.30</td>
<td>4.50</td>
<td>7.00</td>
<td>5.46</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>4.80</td>
<td>5.20</td>
<td>4.60</td>
<td>3.50</td>
<td>5.10</td>
<td>4.64</td>
</tr>
<tr>
<td>Control (D)</td>
<td>16.70</td>
<td>17.80</td>
<td>15.80</td>
<td>15.60</td>
<td>17.00</td>
<td>16.58</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26.61</td>
<td>29.58</td>
<td>24.79</td>
<td>23.72</td>
<td>29.20</td>
<td></td>
</tr>
</tbody>
</table>
### Table A2.1

<table>
<thead>
<tr>
<th>Dates</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>Group IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-1-60</td>
<td>18.50</td>
<td>11.20</td>
<td>13.00</td>
<td>15.50</td>
<td>13.00</td>
</tr>
<tr>
<td>27-1-60</td>
<td>19.00</td>
<td>12.00</td>
<td>13.50</td>
<td>16.00</td>
<td>14.00</td>
</tr>
<tr>
<td>6-2-60</td>
<td>18.00</td>
<td>10.50</td>
<td>14.00</td>
<td>16.50</td>
<td>13.50</td>
</tr>
<tr>
<td>2-3-60</td>
<td>17.50</td>
<td>11.00</td>
<td>15.00</td>
<td>17.00</td>
<td>15.00</td>
</tr>
<tr>
<td>3-3-60</td>
<td>16.00</td>
<td>12.00</td>
<td>16.50</td>
<td>18.00</td>
<td>17.00</td>
</tr>
</tbody>
</table>

**Mean:** 12.40 12.80 15.00 16.00 14.50
### APPENDIX B

Weight of weeds (in ounces) as affected by different mulching treatments (observed on 30-3-1960).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>A (I)</th>
<th>B (II)</th>
<th>C (III)</th>
<th>D (IV)</th>
<th>E (V)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene</td>
<td>00.50</td>
<td>00.38</td>
<td>00.44</td>
<td>00.60</td>
<td>00.48</td>
<td>00.48</td>
</tr>
<tr>
<td>Dried leaves</td>
<td>25.00</td>
<td>31.50</td>
<td>21.50</td>
<td>22.50</td>
<td>34.00</td>
<td>26.90</td>
</tr>
<tr>
<td>Sawdust</td>
<td>24.50</td>
<td>26.50</td>
<td>23.00</td>
<td>17.50</td>
<td>25.50</td>
<td>23.40</td>
</tr>
<tr>
<td>Control</td>
<td>92.20</td>
<td>98.90</td>
<td>95.00</td>
<td>83.40</td>
<td>99.60</td>
<td>94.82</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>142.20</td>
<td>157.28</td>
<td>139.94</td>
<td>129.00</td>
<td>159.58</td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX C

### Percentage of soil moisture content within 1-3 days following each irrigation.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1st irrigation</th>
<th>2nd irrigation</th>
<th>3rd irrigation</th>
<th>4th irrigation</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-12-59</td>
<td>10-1-60</td>
<td>30-1-60</td>
<td>15-2-60</td>
<td></td>
</tr>
<tr>
<td>Polyethylene</td>
<td>29.90</td>
<td>30.72</td>
<td>30.48</td>
<td>31.14</td>
<td>30.56</td>
</tr>
<tr>
<td>Sawdust</td>
<td>28.70</td>
<td>28.87</td>
<td>28.93</td>
<td>29.12</td>
<td>28.91</td>
</tr>
<tr>
<td>Control</td>
<td>28.10</td>
<td>28.35</td>
<td>28.58</td>
<td>28.48</td>
<td>28.38</td>
</tr>
<tr>
<td>Total</td>
<td>114.95</td>
<td>116.32</td>
<td>116.54</td>
<td>117.42</td>
<td>116.31</td>
</tr>
</tbody>
</table>

- Percentage of soil moisture content following each estimation.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1st irrigation</th>
<th>2nd irrigation</th>
<th>3rd irrigation</th>
<th>4th irrigation</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-12-59</td>
<td>10-1-60</td>
<td>30-1-60</td>
<td>15-2-60</td>
<td></td>
</tr>
<tr>
<td>Polyethylene</td>
<td>28.70</td>
<td>29.10</td>
<td>29.33</td>
<td>29.65</td>
<td>29.19</td>
</tr>
<tr>
<td>Dried leaves</td>
<td>26.40</td>
<td>26.52</td>
<td>26.80</td>
<td>27.18</td>
<td>26.72</td>
</tr>
<tr>
<td>Sawdust</td>
<td>26.88</td>
<td>26.92</td>
<td>27.12</td>
<td>27.70</td>
<td>27.15</td>
</tr>
<tr>
<td>Control</td>
<td>24.92</td>
<td>25.10</td>
<td>25.58</td>
<td>25.65</td>
<td>25.31</td>
</tr>
<tr>
<td>Total</td>
<td>106.90</td>
<td>107.64</td>
<td>108.83</td>
<td>110.18</td>
<td>108.37</td>
</tr>
</tbody>
</table>

- Based on the mean of estimations made at weekly intervals.

1st irrigation: Based on 3 estimations on 10-12-59, 27-12-59, 3-1-60
2nd " " " 18-1-60, 25-1-60.
3rd " " " 9-2-60.
4th " " " 23-2-60.
### APPENDIX C

Percentage of soil moisture estimated on 12-12-1939.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>29.43</td>
<td>29.50</td>
<td>30.40</td>
<td>30.32</td>
<td>29.85</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>27.68</td>
<td>28.54</td>
<td>28.63</td>
<td>28.25</td>
<td>28.17</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>28.25</td>
<td>28.60</td>
<td>28.72</td>
<td>28.83</td>
<td>29.10</td>
</tr>
<tr>
<td>Control (D)</td>
<td>28.20</td>
<td>27.85</td>
<td>28.07</td>
<td>27.76</td>
<td>28.62</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>113.56</strong></td>
<td><strong>114.49</strong></td>
<td><strong>115.82</strong></td>
<td><strong>115.16</strong></td>
<td><strong>115.74</strong></td>
</tr>
</tbody>
</table>

Percentage of soil moisture estimated on 11-1-1960.

<table>
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<tr>
<th>Treatment</th>
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<th>II</th>
<th>III</th>
<th>IV</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>30.38</td>
<td>30.47</td>
<td>30.56</td>
<td>31.26</td>
<td>30.93</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>27.93</td>
<td>28.14</td>
<td>28.18</td>
<td>28.63</td>
<td>29.02</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>28.85</td>
<td>28.60</td>
<td>28.75</td>
<td>29.25</td>
<td>28.90</td>
</tr>
<tr>
<td>Control (D)</td>
<td>28.31</td>
<td>28.10</td>
<td>27.98</td>
<td>28.51</td>
<td>28.85</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>115.47</strong></td>
<td><strong>115.31</strong></td>
<td><strong>115.57</strong></td>
<td><strong>117.65</strong></td>
<td><strong>117.70</strong></td>
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### APPENDIX C.
Percentage of soil moisture estimated on 1-2-60.

![Table](https://example.com/table.png)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Rep I</th>
<th>Rep II</th>
<th>Rep III</th>
<th>Rep IV</th>
<th>Rep V</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>30.43</td>
<td>29.82</td>
<td>31.05</td>
<td>30.42</td>
<td>30.58</td>
<td>30.48</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>27.89</td>
<td>28.30</td>
<td>28.93</td>
<td>28.53</td>
<td>29.10</td>
<td>28.55</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>28.66</td>
<td>28.69</td>
<td>29.16</td>
<td>28.76</td>
<td>29.38</td>
<td>28.93</td>
</tr>
<tr>
<td>Control (D)</td>
<td>28.32</td>
<td>28.00</td>
<td>29.15</td>
<td>28.60</td>
<td>28.83</td>
<td>28.58</td>
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<tr>
<td>Total</td>
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<td>114.81</td>
<td>118.29</td>
<td>116.31</td>
<td>117.89</td>
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</table>

### APPENDIX C.
Percentage of soil moisture estimated on 16-2-1960.

![Table](https://example.com/table.png)

<table>
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<tr>
<th>Treatments</th>
<th>Rep I</th>
<th>Rep II</th>
<th>Rep III</th>
<th>Rep IV</th>
<th>Rep V</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>30.62</td>
<td>30.73</td>
<td>31.53</td>
<td>31.20</td>
<td>31.62</td>
<td>31.14</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>28.17</td>
<td>28.23</td>
<td>29.11</td>
<td>28.59</td>
<td>29.30</td>
<td>28.68</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>28.78</td>
<td>28.83</td>
<td>29.64</td>
<td>29.19</td>
<td>29.16</td>
<td>29.12</td>
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<tr>
<td>Control (D)</td>
<td>28.51</td>
<td>28.05</td>
<td>28.87</td>
<td>28.41</td>
<td>28.56</td>
<td>28.48</td>
</tr>
<tr>
<td>Total</td>
<td>116.08</td>
<td>115.84</td>
<td>119.15</td>
<td>117.39</td>
<td>118.64</td>
<td></td>
</tr>
</tbody>
</table>
Appendix J

Monthly average increase in length and girth of a shoot (in cm.) during different periods of growth in the cropping season after 1959, pruning (October).

<table>
<thead>
<tr>
<th>Months</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length</td>
<td>Growth</td>
<td>Length</td>
<td>Growth</td>
<td>Length</td>
<td>Growth</td>
<td>Length</td>
</tr>
<tr>
<td>December 1959</td>
<td>71.54</td>
<td>0.69</td>
<td>67.54</td>
<td>0.69</td>
<td>68.65</td>
<td>0.68</td>
<td>68.85</td>
</tr>
<tr>
<td>January 1960</td>
<td>83.20</td>
<td>0.76</td>
<td>79.30</td>
<td>0.75</td>
<td>80.15</td>
<td>0.74</td>
<td>79.60</td>
</tr>
<tr>
<td>February 1960</td>
<td>90.34</td>
<td>0.80</td>
<td>86.20</td>
<td>0.78</td>
<td>88.12</td>
<td>0.76</td>
<td>85.94</td>
</tr>
<tr>
<td>March 1960</td>
<td>90.50</td>
<td>0.80</td>
<td>86.45</td>
<td>0.78</td>
<td>88.38</td>
<td>0.76</td>
<td>86.20</td>
</tr>
</tbody>
</table>
APPENDIX D

Length and girth (in cms.) of the shoots under different treatments as observed in March, 1960.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Replication</th>
<th>Girth</th>
<th>Replication</th>
<th>Girth</th>
<th>Replication</th>
<th>Girth</th>
<th>Replication</th>
<th>Girth</th>
<th>Replication</th>
<th>Girth</th>
<th>Replication</th>
<th>Girth</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>86.33</td>
<td>0.79</td>
<td>86.75</td>
<td>0.78</td>
<td>93.62</td>
<td>0.83</td>
<td>90.50</td>
<td>0.81</td>
<td>95.30</td>
<td>0.81</td>
<td>90.50</td>
<td>0.81</td>
<td>90.50 0.80</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>82.30</td>
<td>0.75</td>
<td>86.69</td>
<td>0.76</td>
<td>88.24</td>
<td>0.79</td>
<td>85.79</td>
<td>0.80</td>
<td>89.23</td>
<td>0.80</td>
<td>86.45</td>
<td>0.78</td>
<td>86.45 0.78</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>85.37</td>
<td>0.76</td>
<td>86.85</td>
<td>0.79</td>
<td>90.18</td>
<td>0.78</td>
<td>88.92</td>
<td>0.79</td>
<td>90.58</td>
<td>0.81</td>
<td>88.38</td>
<td>0.78</td>
<td>88.38 0.78</td>
</tr>
<tr>
<td>Control (D)</td>
<td>81.82</td>
<td>0.73</td>
<td>88.18</td>
<td>0.78</td>
<td>90.93</td>
<td>0.80</td>
<td>86.42</td>
<td>0.80</td>
<td>83.65</td>
<td>0.75</td>
<td>86.20</td>
<td>0.77</td>
<td>86.20 0.77</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>335.82</strong></td>
<td><strong>3.03</strong></td>
<td><strong>348.47</strong></td>
<td><strong>3.11</strong></td>
<td><strong>362.97</strong></td>
<td><strong>3.20</strong></td>
<td><strong>351.63</strong></td>
<td><strong>3.20</strong></td>
<td><strong>358.76</strong></td>
<td><strong>3.17</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


# Appendix E

Yield per vine (in lbs.) as affected by different treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>7.60</td>
<td>11.02</td>
<td>15.50</td>
<td>9.50</td>
<td>14.70</td>
<td>11.74</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>4.65</td>
<td>6.85</td>
<td>9.48</td>
<td>6.50</td>
<td>6.90</td>
<td>6.88</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>5.08</td>
<td>5.80</td>
<td>10.05</td>
<td>5.90</td>
<td>6.50</td>
<td>6.67</td>
</tr>
<tr>
<td>Control (D)</td>
<td>3.05</td>
<td>4.50</td>
<td>9.6</td>
<td>5.92</td>
<td>8.50</td>
<td>6.31</td>
</tr>
<tr>
<td>Totals</td>
<td>26.38</td>
<td>28.17</td>
<td>45.03</td>
<td>27.82</td>
<td>36.60</td>
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</tr>
</tbody>
</table>
APPENDIX P.

Number of bunches per vine as affected by different treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Replication I</th>
<th>Replication II</th>
<th>Replication III</th>
<th>Replication IV</th>
<th>Replication V</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>30.80</td>
<td>42.20</td>
<td>55.80</td>
<td>26.80</td>
<td>43.80</td>
<td>39.83</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>23.80</td>
<td>38.40</td>
<td>41.40</td>
<td>24.60</td>
<td>36.80</td>
<td>33.00</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>19.20</td>
<td>27.40</td>
<td>42.20</td>
<td>25.80</td>
<td>30.00</td>
<td>28.92</td>
</tr>
<tr>
<td>Control (D)</td>
<td>18.00</td>
<td>20.00</td>
<td>38.80</td>
<td>33.00</td>
<td>25.00</td>
<td>27.80</td>
</tr>
<tr>
<td>Totals</td>
<td>91.80</td>
<td>128.20</td>
<td>173.20</td>
<td>110.20</td>
<td>139.60</td>
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</tbody>
</table>
APPENDIX G.

Length and Diameter of berries (in cms.) as affected by different treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Replication I</th>
<th>Replication II</th>
<th>Replication III</th>
<th>Replication IV</th>
<th>Replication V</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length</td>
<td>Diameter</td>
<td>Length</td>
<td>Diameter</td>
<td>Length</td>
<td>Diameter</td>
</tr>
<tr>
<td>Polyethylene(A)</td>
<td>1.72</td>
<td>1.53</td>
<td>1.68</td>
<td>1.49</td>
<td>1.79</td>
<td>1.55</td>
</tr>
<tr>
<td>Dried leaves(B)</td>
<td>1.71</td>
<td>1.51</td>
<td>1.72</td>
<td>1.53</td>
<td>1.75</td>
<td>1.50</td>
</tr>
<tr>
<td>Sawdust(C)</td>
<td>1.69</td>
<td>1.51</td>
<td>1.73</td>
<td>1.51</td>
<td>1.77</td>
<td>1.53</td>
</tr>
<tr>
<td>Control(D)</td>
<td>1.69</td>
<td>1.49</td>
<td>1.72</td>
<td>1.53</td>
<td>1.79</td>
<td>1.56</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>6.81</strong></td>
<td><strong>6.04</strong></td>
<td><strong>6.35</strong></td>
<td><strong>6.06</strong></td>
<td><strong>7.10</strong></td>
<td><strong>6.14</strong></td>
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</tbody>
</table>
### ATTENTION II.

Percentage of total soluble solids in berries (after harvest) as affected by different treatments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Replication</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V Means</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>20.00</td>
<td>18.00</td>
<td>19.50</td>
<td>18.50</td>
<td>17.50</td>
<td>18.70</td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>17.50</td>
<td>18.00</td>
<td>19.00</td>
<td>19.50</td>
<td>19.00</td>
<td>18.60</td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>18.50</td>
<td>19.50</td>
<td>17.50</td>
<td>18.50</td>
<td>17.00</td>
<td>18.20</td>
</tr>
<tr>
<td>Control (D)</td>
<td>17.50</td>
<td>18.50</td>
<td>18.00</td>
<td>19.50</td>
<td>19.00</td>
<td>18.50</td>
</tr>
<tr>
<td>Totals</td>
<td>73.50</td>
<td>74.00</td>
<td>74.00</td>
<td>76.00</td>
<td>72.50</td>
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</tr>
</tbody>
</table>
Height of pruned material per vine (in lbs.)
(April pruning).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>REP</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyethylene (A)</td>
<td>2.60</td>
<td>1.70</td>
<td>3.10</td>
<td>2.60</td>
<td>3.55</td>
<td>2.59</td>
<td></td>
</tr>
<tr>
<td>Dried leaves (B)</td>
<td>1.80</td>
<td>2.20</td>
<td>2.50</td>
<td>2.05</td>
<td>3.10</td>
<td>2.33</td>
<td></td>
</tr>
<tr>
<td>Sawdust (C)</td>
<td>2.10</td>
<td>1.80</td>
<td>2.65</td>
<td>2.45</td>
<td>2.65</td>
<td>2.37</td>
<td></td>
</tr>
<tr>
<td>Control (D)</td>
<td>2.00</td>
<td>1.90</td>
<td>2.40</td>
<td>2.20</td>
<td>1.75</td>
<td>2.05</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>7.90</td>
<td>7.60</td>
<td>10.65</td>
<td>9.30</td>
<td>11.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>