ABSTRACT

"STUDIES ON EFFECT OF DIFFERENT MULCHES ON GROWTH AND YIELD OF CHILLI (*Capsicum annuum* L.) Cv. PHULE JYOTI"

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The present experiment was conducted during *summer,* 2013 at the Horticulture Farm, College of Agriculture, Kolhapur. The experiment was laid out in randomized block design with 7 treatments *viz*; black-black polyethylene mulch, silver-black polyethylene mulch, yellow-black polyethylene mulch, rice straw mulch, sugarcane trash mulch, dry grasses and control replicated three times.

The results indicated that the maximum plant height was reported at 45 DAT, 90 DAT and 135 DAT in silver-black polyethylene mulch (30.60 cm, 58.33 cm and 67.09 cm), while lowest plant height was recorded in control. The maximum plant spread in East-West direction at 45 DAT, 90 DAT and 135 DAT was recorded in silver-black polyethylene mulch (21.10 cm, 42.04 cm and 60.12 cm) and the maximum plant spread in North-South direction at 45 DAT, 90 DAT and 135 DAT in silver-black polyethylene mulch (19.17cm, 45.10 cm and 58.73 cm). The maximum number of branches at 45 DAT, 90 DAT and 135 DAT in silver-black polyethylene mulch (8.52 cm, 16.28 cm and 21.42 cm).

The minimum days to first flowering and 50 per cent flowering (46 and 67.67 days) was recorded in silver-black polyethylene mulchand black-black polyethylene mulch while maximum days to first flowering and 50 per cent flowering (53.33 and 76.67 days) was recorded in yellow-black polyethylene mulch.

The maximum number of fruits per plant (252.20), highest fruit girth (1.23cm) and fruit length (8.19 cm) was recorded in treatment silver-black polyethylene mulch. The minimum number of fruits per plant (202.97) and lowest fruit girth (0.82 cm) was recorded in control and lowest fruit length (7.10 cm) was recorded in the treatment yellow-black polyethylene mulch.

The highest average yield per plant (647.33 g), per plot (31 kg) and per hectare (23.97 t) was recorded in treatment silver-black polyethylene mulch.

The minimum days to first picking (66.0) was observed in black-black polythene mulch and the maximum days of last picking (161.33) was recorded in silver-black polyethylene mulch.

The highest average fresh and dry weight of shoot and root (329.60 and 77.20 g) and (143.97 and 31.60 g) was recorded in silver-black polyethylene mulch while lowest fresh and dry weight of shoot and root was recorded in yellow-black polyethylene mulch.

The lowest infestation of thrips and aphids (0.27 and 0.34 %) was observed in silver-black polyethylene mulch. The lowest leaf curl incidence (0.67 %) was also observed in silver-black polyethylene mulch

The maximum leaf area per plant at 45 DAT, 90 DAT and 135 DAT (1764.99, 2565.37 and 2570.30 cm^2) was recorded under in silver-black polyethylene mulch. The minimum leaf area per plant was recorded in control.

The highest chlorophyll contain in leaves (2.83 mg/100 g) was recorded in silver-black polyethylene mulch.

The soil pH was maximum in sugarcane trash mulch (7.34). The highest electrical conductivity of soil (0.45 ds/m) was recorded in yellow-black polyethylene mulch.

Abstract contd..... ***Mehetre Y.D.***

The highest organic carbon in soil (0.62 %) was recorded in sugarcane trash mulch.

Nutrient status of soil was not influenced significantly due to various mulches. The soil temperature was significantly increased in black polyethylene mulch on morning and afternoon (29.99^{0}C and 34.82 ^{0}C) than control and soil moisture (22.51 %) was also increased in black polyethylene mulch.

The highest soil microflora (Fungi and Bacteria) (32.10 CFU × 10^{-5}/g and 30.90 CFU × 10^{-9}/g) was recorded in sugarcane trash mulch. The lowest soil microflora (Fungi and Bacteria) (20.10 CFU × 10^{-5}/g and 19.33 CFU × 10^{-9}/g) was recorded in yellow polyethylene mulch.

The highest net returns (Rs. 2, 49, 029) and the highest benefit : cost ratio (3.25) was obtained in silver-black polyethylene mulch, while the lowest net returns (Rs. 1, 30, 499) and the lowest benefit : cost ratio (2.24) was recorded in yellow-black polyethylene mulch

1. INTRODUCTION

Chilli (*Capsicum annuum* L.) is an important spice crop and belongs to the family Solanaceae. Chilli is widely cultivated throughout warm temperature, tropical and subtropical countries and it is native to Mexico. It is used in every Indian cuisine due to pungency, spicy taste, appealing odour and flavours. Chilli fruits are rich source of vitamin C, A and E.

In India, important chilli growing states are Andhra Pradesh, Maharashtra, Karnataka, Orissa and Tamil Nadu forming more than 70 per cent area under its cultivation. The area under chilli in India is 793.584 million hectares with production of 1299.91 million tonnes. The productivity of chilli in India (0.8 to 1.00 t ha^{-1}) is very low as compared to progressive chilli producing countries like Korea and Indonesia (2 to 3 t ha^{-1}) may be due to prevalence of diseases like viruses, fruit root and lack of high yielding adaptable varieties. India is the major producer, consumer and exporter of chillies and contributes 40 per cent to total world production. India exported 2.81 lakh tonnes of chilli in the year 2012-2013. The value of export was Rs.1614.17 crores (Anon., 2013). Export comprised chilli powder, dried chilli, pickled chillies and chilli oleoresin. The area under chilli in Maharashtra is 9,950 ha with an average production of 4560 MT and the productivity of 2.1MT/ha. (Anon., 2013). About 75% area under chilli production is in Ahmednagar, Jalgoan, Dhule, Nashik, Solapur, Kolhapur, Nanded, Nagpur, Amravti, Chandrapur and Usmnabad districts in Maharashtra.

The word mulch has probably derived from the German word “Molsh” means soft to decay, which apparently referred to the process or practice of covering the soil/ground to make more favourable condition for plant growth, development and efficient crop production. Mulches are usually done with the organic materials like green leaves, dry leaves, straw, rice husk, sugarcane trash, dry grasses, weeds and compost have been used for centuries. During last 60 years, the advent of synthetic material has altered the method and benefits of mulching. When compared to other mulches, plastic mulches are completely impermeable to water; it therefore prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface.

Organic or inorganic soil mulches influence the crop in a number of ways. Plastic mulches can offer a barrier against weeds, moisture loss, nutrient loss, erosion, insect and disease injury, while it encourages plant establishment and an earlier crop of potentially higher quality**.**

The combined effects of soil temperature, soil moisture and weed suppression not only work to improve crop growth but they also facilitate hand picking and lead to higher yield and increased fruit size. Increase in soil temperature by application of plastic mulch caused a significant reduction in pathogen levels. The effect of plastic mulch and its colour improves soil structure, crop growth and its development. (Kumar and Bhardwaj, 2012).

Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and checks the water evaporation. Thus, it facilitates more retention of soil moisture, helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crop (Dilip Kumar *et al.*, 1990).

The Kolhapur district comes under sub montane zone of Maharashtra, where the temperature during summer season goes upto 39^0C. During *summer* season the chilli is grown for green chilli, where there is maximum demand in market; but because of shortage of irrigation water there is limitation for its cultivation.

With these ideas in view, an experiment was conducted to study the effect of different mulches on growth and yield of chilli during *summer*, 2013 in sub montane zone of Maharashtra, with the following objectives:

1. To study the effect of different mulches on growth and yield of chilli.
2. To study the effect of mulches on soil properties.
3. To work out the economics of different mulching treatments.

2. REVIEW OF LITRATURE

The literature pertaining to the effect of different mulches on growth and yield of chillies as well as a few related crops has been reviewed and presented in this chapter.

2.1 Plant growth parameters

2.1.1 Plant height

Decoteau *et al.* (1990) observed significantly highest plant height (42 cm) in red plastic mulch followed by black plastic mulch (39 cm), white polythene mulch (35 cm) and lowest plant height was observed in silver plastic mulch (33 cm) in bell paper.

Gonzales and Vives (1990) conducted an experiment with organic and inorganic mulches (Black polythene, blue polythene, rice husk and saw dust) on tomato in Costa Rica and reported that black, blue and red polythene mulches increased plant height than rice husk or saw dust mulches.

Deka and Shadeque (1994) conducted an experiment to find out the effect of various mulching materials as well as different clove size on growth and yield of garlic and reported that the effect of mulching on plant height was statistically significant at all the stages of growth observations with highest plant height of 43.0 cm recorded in paddy straw mulch at 120 DAS.

Baten *et al.* (1995) studied the effect of different mulches on growth and yield of late planted garlic and reported that plant treated with any of the mulches showed significant increase in

plant height, number of leaves per plant, length of leaf and length of pseudostem.

Chakraborty (2000) studied the effect of paddy straw mulch on growth, yield and water use efficiency of chilli grown in saline ecosystem and reported that plant height was increased by 37.10 % in paddy straw than control.

Rahman and Khan (2001) observed the effect of mulches on morpho-physicalogical attributes of onion and reported that the dry matter accumulation, leaf area index, plant height and root length were significantly influenced by mulches. Ash mulch induced early flowering than other mulches.

Christopher (2003) reported that the mulching of chillies with black linear low density polyethylene film in (25 μ) thickness significantly influenced plant height (47.5 cm) in plastic mulch followed by organic mulch (46.1 cm) and lowest height was observed in unmulched plot (43.8 cm) respectively.

Assi and Rayyan (2007) noticed that plant height increased in mulches than bare land and the highest plant height was observed on black polythene than the other mulches (Transparent polythene mulch, straw mulch and saw dust) in onion.

Anisuzzaman *et al.* (2009) revealed that the maximum plant height was recorded in onion covered with black polythene mulch (47.53 cm) followed by water hyacinth (42.53 cm) and white polythene mulch (36.79 cm). Black polythene and water hyacinth covered plants did not differ significantly. Plant heights

were significantly low in the bared or no-mulched plots (32.56 cm).

Iftikhar *et al.* (2011) observed that highest plant height in chilli cv. sanam in transparent plastic mulch (54.3 cm) followed by black polythene mulch (51.0 cm), rice straw mulch (49.3 cm), sugarcane bagasse mulch (49.0 cm), wheat straw mulch (46.0 cm) and lowest (32.0 cm) in control.

Mochiah *et al.* (2012) revealed that straw mulch enhanced the plant height of pepper (25.0 cm) followed by control (24.9 cm), plastic mulch (24.4 cm), PAWA (24.3 cm) and minimum plant height was observed in live cow pea mulch (23.8 cm).

Rajablariani *et al.* (2012) noticed that tomato plants grown with plastic mulch had highest plant height (82.3 cm) and lowest plant height (53 cm) in weedy plots. The increased plant height in mulched plants was possibly due to better availability of soil moisture and optimum soil temperature provided by the mulches.

Abubaker (2013) reported that the height of tomato plant showed significant response to mulch types. Compost mulch resulted the highest plant height (207 cm). This height was not significantly different from black plastic mulch (203 cm), tuff gravel (196 cm) and clear plastic (199 cm). On the other hand, the control treatment (without mulch), which produced the shortest plant height (183 cm) which was statistically similar to that of shredded wood which showed 188 cm average plant height.

Hamma (2013) indicated that there was significant difference among means of plant height due to mulches. White polythene mulch significantly produced a highest plant height (42.65 cm) over other treatments, followed by black polythene mulch (36.68 cm), water hyacinth (32.57 cm) and the lowest mean plant height was recorded by the control (30.25 cm) in onion.

2.1.2 Number of branches per plant

Shinde *et al.* (1999) observed that the number of branches of chilli increased with mulches with being the maximum in sugarcane trash mulch.

Chakraborty (2000) studied the effect of mulch on growth and yield of chilli and reported that mulching showed a significant positive correlation with branch number.

Halim (2006) studied the effect of polythene mulches (transparent, blue and black colour) on chilli and reported that branch production was maximum in black polythene mulched plots than control.

Belel (2012) studied the effect of grassed and synthetic mulching material on growth and yield of sweet pepper and reported that black polythene mulch recorded maximum number of branches (13.59), followed by white polythene mulch (13.57), grass mulch (13.09) and minimum (10.62) branches per plant in control plot.

Parmar *et al.* (2013) revealed that different types of mulching materials significantly influenced the growth parameters of watermelon viz., number of branches per vine,

main vine length and number of nodes per vine over control. Amongst different mulching treatments, treatment T_3 (Silver on black plastic mulch) resulted maximum number of branches per vine, increased main vine length and number of nodes per vine. However, the minimum growth was recorded in control plant.

2.1.3 Days to first flowering

Abu-Baker *et al.* (2003) observed that the plastic mulch resulted earlier flowering in okra. The appearance of the first flower was 13.1, 8.5 and 7.6 days earlier in the black, green and transparent mulches respectively, as compared to the control.

Iqbal *et al.* (2009) noticed that hot pepper hybrids with plastic mulches had significant effect on this variable and transparent plastic mulch reduced the number of the days to first flower. Plants grown on transparent plastic mulch took 69.16 days to start flowering followed by black plastic mulch (72.10 days), while plant grown without mulch took 74.91 days to start flowering.

Iftikhar *et al.* (2011) observed that minimum days required to flowering in chilli cv. sanam in transparent polythene mulch (57.0 days) followed by black polythene mulch (60.3 days) that was statistically at par with wheat straw (60.0 days) and rice straw (62.0 days). Maximum days to flower were taken by the control (73.33 days) followed by the sugarcane bagasse (64.33 days).

2.1.4 Days to 50 per cent flowering

Anisuzzaman *et al.* (2009) opined that the number of days required for emergence of 50 per cent flower stalk in onion plants grown with the black polythene mulch took minimum time (50.50 days), which was identically followed by white polythene mulch (51.79 days) and water hyacinth (53.35 days). However, the maximum time period required under control treatment (55.21 days).

Mochiah *et al.* (2012) recorded the maximum days to 50% flowering in pepper (57.0 days) in live cowpea mulch followed by plastic mulch (56.0 days), 55.7 days in straw mulch, 55.0 days in control plot and lastly minimum days to 50% flowering was (54.0 days) recorded in PAWA.

2.1.5 Fruit length (cm)

Iftikhar *et al.* (2011) reported that the highest fruit length in chilli cv. sanam (8.83 cm) was recorded in black polythene mulch that was statistically similar to transparent polythene mulch (8.58 cm) followed by sugarcane bagasse (7.18 cm), wheat straw (7.00 cm) and rice straw (5.66 cm) respectively. The lowest fruit length (3.31cm) was noted when no mulched material was applied.

Belel (2012) studied the effect of mulching material on growth and yield of sweet pepper and noticed the highest mean fruit length of 7.78 cm in black polythene mulch followed by white polythene mulch (6.92 cm), while lower fruit length was observed in control (4.52 cm).

Khan *et al.* (2012) reported that the significant increase in fruit length of chilli (6.80 cm) from hand weeded plot which was followed by sorghum mulch plots (5.93 cm), while minimum (4.62 cm) was recorded from weedy check plots.

Parmar *et al.* (2013) indicated that different mulching material significantly increased fruit length of watermelon than control. Maximum fruit length was observed in treatment silver on black plastic mulch, whereas the minimum fruit length of watermelon was noted in control. The highest fruit length under silver on black mulch was due to congenial soil moisture results higher uptake of nutrition for better growth of fruit, the reduction in evaporation losses of soil moisture caused by mulches which covered the soil surface in rows of watermelon.

2.1.6 Fruit girth (cm)

Christopher (2003) noticed that mulching chillies with black linear low density polyethylene film in 25 µ thickness significantly influenced fruit girth (3.6 cm) followed by organic mulch (3.5 cm) over unmulched plot (3.3 cm).

Parmar *et al.* (2013) indicated that the different mulching material significantly increased the fruit girth of watermelon Cv. Kiran over control. Maximum fruit girth was observed in treatment white on black plastic mulch (17.68 cm), whereas the minimum fruit girth of watermelon was noted in control (14.59 cm).

2.1.7 Fresh weight of root and shoot (g)

Ashrafuzzaman *et al.* (2011) revealed that all plastic mulches produced significantly higher fresh weight of root and shoot against the control treatment in chilli. The highest fresh weight of root and shoot was observed in black plastic mulch (60.56 and 419.38 g) followed by blue plastic mulch (58.59 and 398.38 g). In contrast, control treatment recorded the lowest fresh weight of root and shoot (32.31 and 238.30 g) respectively.

2.1.8 Dry weight of root and shoot (g)

Azam (2005) observed the effect of different mulches on growth and yield of onion and reported the highest total dry mass production under black polythene mulch followed by transparent polythene mulch.

Halim (2006) evaluated the influence of different types of polythene mulches (Transparent, blue and black mulch) on growth, yield and yield attributes of chilli and reported that total dry mass production was greater in polythene mulch treated plants than the control one.

Kayum *et al.* (2008) studied the effect of indigenous mulches on growth and yield of tomato and reported that the highest dry weight of roots in tomato plant (3.39 g) in water hyacinth mulch followed by straw mulch (3.11 g), am-ada leaf (2.72 g), banana leaf (2.47 g). Lowest dry weight of root was observed in control (2.31 g).

Ashrafuzzaman *et al.* (2011) studied the effect of plastic mulches on growth and yield of chilli and reported that black polythene mulching produced significantly higher dry weight of

root and shoot (26.23 and 148.93 g) followed by blue (24.51 and 144.33 g) and transparent polythene mulch (24.34 and 141.20 g). In contrast, control showed the lowest dry weight of root and shoot per plant (13.13 and 78.31 g).

Rajablariani *et al.* (2012) revealed that all coloured plastic mulches produced significantly higher dry matter as compared to bare soil in tomato. The highest dry matter (11191 kg ha^{-1}) was observed in blue plastic mulch possibly due to light reflectance from the mulch surface. However, there was no significant difference between silver/ black plastic mulch. In contrast, the bare soil showed lowest dry matter, followed by weedy treatment.

Abubaker (2013) indicated that the dry matter contents of leaves and stems were significantly affected by mulch types. However, dry matter was highest (19.4 %) in the compost treatment, showing similarity with those of crushed stones (18.8%) and black plastic (18.3 %) mulches in tomato.

2.2 Yield and yield contributing characters

2.2.1 Number of fruits/plant

Ravinder *et al.* (1997) conducted an experiment to know the effect of different mulches on yield and yield attributes of tomato and reported that mulching significantly increased number of fruit.

Nagalakshmi *et al.* (2002) conducted an experiment with different mulches on chilli and obtained maximum number of fruit per plant (97.67) with application of black LLDPE mulch compared to organic mulch and no mulch. Plastic (polyethylene) mulches have the potential to alter soil temperatures, reduce

crop water use, improve crop quality and control weeds, thereby improving crop development and increasing yields. Black mulch warms the soil by absorbing light then transferring heat by conduction to the underlying soil, provided that the mulch is in close contact with the soil.

Hutton *et al.* (2005) studied the effect of reflective mulch and white inter-row mulch for increasing yields of bell pepper and reported that the number of fruits harvested from the inter-row mulch plots was (21 %) greater than the amount harvested from the control treatment and (18 %) greater than the silver mulch treatment.

Khan *et al.* (2005) revealed that maximum number of fruits per plant in tomato was observed in 4 inch thick grass mulch (89.00) followed by transparent mulch (85.37), 4 inch thick wheat straw mulch (84.99), black polythene mulch (75.65) and minimum number of fruits per plant was observed in control (56.19) treatment.

Iftikhar *et al.* (2011) observed that maximum number of chilli fruits per plant (61.0) was recorded in black polythene mulch and was statistically same in transparent mulch (58.4) followed by sugarcane bagasse (51.0). The number of fruits per plant (47.3) noted in rice straw was statistically not different from the wheat straw (46.0), while minimum number of fruits per plant (38.0) obtained in control.

Belel (2012) recorded that number of sweet pepper fruits per plant was higher in black polythene mulch (21.60) followed by white polythene mulch (21.20), grassed mulch (21.09) and

lowest number of fruits was recorded in control (9.30) respectively.

Khan *et al.* (2012) noticed that the higher number of fruits per plant (58.1) was recorded in hand weeding plots, followed by sorghum mulch (52.5) and minimum (31.9) was recorded from control plot in which there was no weeding.

Mochiah *et al.* (2012) observed that chemical insecticide sprayed plot recorded the largest number of pepper fruits (23.9) followed by plot treated with straw mulch (21.8), whilst the control plot recorded the least number of fruits (11.4).

2.2.2 Yield per plant (kg)

Iqbal *et al.* (2009) recorded that the fruit yield per plant in hot pepper hybrid was higher (1.42 kg) in black plastic mulch followed by clear plastic mulch (1.32 kg). Lower fruit yield (0.88 kg) was recorded in unmulched treatment.

Ashrafuzzaman *et al.* (2011) reported that the highest fruit yield per plant in chilli (533.45 g) was recorded by plastic mulch, followed by blue and transparent plastic mulch (479.33 and 461.43 g). Obviously, control plant showed the lowest fruit yield per plant (336.30 g).

2.2.3 Yield per ha (t)

Salau *et al.* (1992) recorded that mulching significantly enhanced vegetative growth (*Musa* sp. Cv. AAB) and increased bunch yield in both first and second year crops. Increase in total yield (first and second year crops) was on an average 41 % higher with mulched treatments than with the control. Among the mulched treatments, total yield was highest with the elephant

grass on plastic treatment. The yield of the second year crop was on an average 57 % lower than that of the first year crop.

Jayawardena *et al.* (1994) observed that an average yield of chilli was increased by 175 per cent due to mulching. Significant increase in yield is due to increase in number of pickings since crop duration is increased from 5 months to 8 months. These results suggest the possibility of increasing the rainfed chilli yield by adoption of mulching and suitable varieties.

Brown *et al.* (2001) reported that bell peppers grown on black plastic mulch alone or in combination with drip irrigation increased pepper yields 18 mt ha^{-1} respectively when compared with bare soil (16 mt ha^{-1}).

Luis *et al.* (2001) observed that total yield of bell pepper was increased by BPM (black plastic mulch) alone or combined with row covers by around 10 t ha^{-1} compared with control.

Shahoo *et al.* (2002) conducted an experiment to study the effect of plastic film mulching on potato and revealed that mulching increased the tuber yield by 19.5 and 29.5 qt ha^{-1} over unmulched condition during the 2 years, respectively.

Shinde *et al.* (2002) reported that yield attributes and yield of chilli was higher in mulched plants than control.

Simone *et al.* (2002) observed that different varieties of okra had significantly higher yields when grown on plastic mulch rather than bare soil.

Jamil *et al.* (2005) studied the effect of different type of mulches and obtained maximum yield from garlic plants which

were grown under straw mulch (6.35 t ha^{-1}) followed by plastic mulch (5.98 t ha^{-1}) and sawdust (4.67 t ha^{-1}) mulch, while minimum yield (3.59 t ha^{-1}) was obtained from control plots.

Azam (2005) conducted an experiment on effect of different mulches on growth and yield of onion and concluded that the highest bulb yield in onion was recorded by black polythene mulch (11.83 t ha^{-1}) followed by transparent polythene mulch (11.63 t ha^{-1}), rice husk mulch (10.84 t ha^{-1}), rice straw mulch (8.87 t ha^{-1}) with lowest bulb yield in unmulched plot (6.67 t ha^{-1}).

Halim (2006) studied the effect of different mulches (transparent, blue and black) on yield attributes in chilli and reported that all polythene mulches significantly influenced the yield attributes and yield in chilli. He also reported that the black polythene mulch produced the highest fruit yield (35.3 t ha^{-1}).

Pramanick *et al.* (2006) conducted an experiment to observe the effect of different coloured mulches on weed management as well as bulb yield in onion field and reported that the highest bulb yield was recorded under off-white coloured polythene mulch followed by blue and black polythene mulch. The bulb yield was increased by (29.64-54.21 %) in polythene mulched plots than control.

Singh and Ahmed (2008) reported that the highest potato tuber yield of 35.2 t ha^{-1} was recorded with black polythene mulching and was significantly superior to white polythene (31.5 t ha^{-1}) mulching and no mulching (26.6 t ha^{-1}).

Ekinci and Dursun (2009) conducted an experiment to study the effects of different mulch materials on plant growth, some quality parameters and yield in melon (*Cucumis melo* L.) cultivars in high altitude environmental condition and observed that the average marketable yield increased by 25-28 % in clear plastic mulch and 15 % in black plastic mulch compared to the control application in watermelon.

Kaswala *et al.* (2012) reported that maximum yield was observed in brinjal with black plastic mulch (40.7 t ha^{-1}) followed by trash mulch (39.2 t ha^{-1}) and minimum yield was observed in unmulched control (35.5 t ha^{-1}) treatment.

Rajablariani *et al.* (2012) reported that the application of plastic mulches increased the yields compared to non-mulched plots. The highest total and marketable yield although produced on silver-black mulch, there was statistically no significant difference among plastic mulches. Black and silver-black plastics resulted in 50 and 65 % increase in marketable tomato yield relative to bare ground, respectively.

Singh and Kamal (2012) reported that tomato yields from plants grown on bare soil were significantly lower than those grown with black plastic mulch and the yield increase in black plastic mulch was 21.7 % to 29.8 % as compared to bare soil.

Parmar *et al.* (2013) reported that in all the mulching treatments, maximum fruit yield was recorded in treatment silver on black polyethylene mulch. Yield of watermelon was higher in plants mulched with silver on black polyethylene, which was higher as compare to other mulch and no mulch.

Plants under polyethylene mulch (silver on black) produced larger fruit and have higher fruit yield per vine because of better plant growth due to favorable hydro-thermal regime of soil and complete weed free environment.

2.3 Incidence of pest and diseases (%)

Caldwell and Clarke (1999) found that the aluminum covered mulch reduced cucumber beetles but there was no significant difference in yield than squash grown on black plastic.

Nasrun *et al.* (1999) indicated that all the treatment with mulch application gave the better effect on reducing anthracnose infection and also gave the higher yield than no mulch treatment, while alang-alang leaves mulch application determined the lowest anthracnose infection and the highest yield of chillies.

Bextine *et al.* (2001) reported that the row covers prevented the transmission of yellow vine disease (a phloem limited bacterium) in squash plants. The disease is transmitted by spotted cucumber beetles (*Diabrotica undecimpunctata howardi*), striped cucumber beetles (*Acalymma vitatum*), and squash bugs (*Anasa tristis*). The disease did not occur in squash with row covers because the row covers prevented the access of harmful insects that act as vectors for the disease to plants.

Asmaniar *et al.* (2002) revealed that the plastic mulch can reduce thrips *Parvispinus karny* (26.1 %) compare to the treatment without mulch, but not for *Helicoverpa armigera* Hubner in chilli.

Johnson *et al.* (2004) revealed that straw mulch could impact on arthropod pest and predator population and suggest that insect pest may be negatively impacted, whereas natural enemies population may be enhanced in watermelons and potatoes.

Larentzaki *et al.* (2008) studied the impact of straw mulch on populations of onion thrips (Thysanoptera: Thripidae) and reported that populations of *T. tabaci* adults and larvae can be significantly reduced by the use of straw mulch without compromising overall onion yield.

Saucke *et al.* (2009) indicated that mulches have no significant effect on aphid colonization in faba beans (*Vicia faba*). This may be due to fact that straw and other mulching material used in this study probably do not exhibit pest repellant properties.

Kareem *et al.* (2012) indicated that at 5 weeks after sowing (WAS), there was no significant difference in the okra mosaic virus (OMV) incidence on plants mulched with *A. indica, E. uniflora* and *T. catappa* with values ranging from (11.91 to 15.48 %), while a low virus incidence of 0.5 % was recorded for the plastic mulched plants. The mean virus disease severity ranged from (0.7 to 4.0) on a scale of 1-4 scoring system with plastic mulched plants showing little or no symptom of OMV at 5 WAS. However, the plants on the unweeded plots were stunted with deformed fruits. Similar trend was observed at 7 WAS with plastic mulched plot having the least incidence and severity

score, while the unweeded plot has the highest OMV incidence and severity.

Mochiah *et al.* (2012) observed that cow pea mulch was more effective in suppressing pest population of pepper but straw mulch provides a better refuge for the natural enemies and should be recommended as an integral option for pest management in pepper production.

2.4 Quality parameters

2.4.1 Leaf area (cm^2)

Decoteau *et al.* (1990) observed maximum leaf area of bell pepper in red plastic mulch (3232 cm^2) followed by the black plastic mulch (2935 cm^2), silver plastic mulch (2893 cm^2) and minimum leaf area was recorded by white polythene mulch (2812 cm^2), respectively.

Khan *et al.* (2005) revealed that the maximum leaf area in tomato plant was produced with transparent polythene mulch (65.23 cm^2) followed by 4 inch wheat straw mulch (60.78 cm^2), 4 inch thick grass mulch (60.05 cm^2), black polythene mulch (56.93 cm^2) and minimum leaf area per plant was observed in control, respectively.

Kayum e*t al.* (2008) observed highest leaf area in tomato plant by (1007.00 cm^2) in water hyacinth mulch followed by straw mulch (671.50 cm^2), am-ada leaf (671.50 cm^2), banana leaf (610.60 cm^2) and lowest leaf area was observed in the control (575.00 cm^2), respectively.

Iqbal *et al.* (2009) reported that hot pepper hybrids with black plastic mulch showed significantly higher leaf area (7200.08 cm^2) followed by clear plastic mulch (6322.58 cm^2) and lower in unmulched treatment (4913.55 cm^2), respectively.

Iftikhar *et al.* (2011) noticed that the maximum leaf area (7.03 cm^2) was produced by chilli plant when transparent polythene mulch was applied that is statistically similar to black polythene mulch (6.26 cm^2). The average leaf area was observed in rice straw mulch (5.35 cm^2) that was statistically analogous to wheat straw (5.20 cm^2).The minimum leaf area was noted in control plant (4.20 cm^2) that was statistically a like to sugarcane bagasse (5.0 cm^2).

2.4.2 Chlorophyll content in leaf (mg/100 g)

Hassan *et al.* (1995) conducted an experiment to study the effect of different mulches on growth, yield attributes and yield of chilli and reported that leaf chlorophyll content increased in mulches compared to content with being the highest in coconut frond followed by black plastic mulch.

Panchal *et al.* (2001) noticed that mulches had significant positive effect on chlorophyll content in leaf and the black polythene mulch was the best for total chlorophyll content among the organic and inorganic mulches.

Nagalakshmi *et al.* (2002) reported that mulches increased chlorophyll content in chilli leaf compared to control.

Zhai *et al.* (2006) revealed that the chlorophyll content of grafted *Cucumis sativus* under wheat straw plus plastic film mulching and wheat straw mulching was 1.8 % and 3.15 %

higher than the control, but under plastic film mulching chlorophyll content was (3.8 %) less than the control.

2.5 Soil analysis

2.5.1 Soil nutrient status

Worthington (2001) reported that an increase in available nitrogen content stimulates proteins production, in cabbage following serradella and vetch mulches which, living in symbiosis with nitrogen–fixing bacteria, are additional source of available nitrogen.

Muhammad *et al.* (2009) observed that mulched treatments showed significantly greater total uptake of nitrogen, phosphorus and potassium than corresponding unmulched ones. Higher organic content of soil recorded with sunhemp mulch (0.71 %) followed by silkworm bed waste (0.68 %) and paddy straw (0.66 %) mulched plots. Least organic carbon content was recorded in no unmulched plot (0.48 %).

2.5.2 Mulching effect on soil moisture (%)

Singh *et al.* (1987) observed that mulching by paddy straw decreased soil water depletion and increased water use efficiency under both irrigated and rainfed conditions.

Hassan *et al.* (1994) conducted an experiment in chilli to study the effect of mulches on soil moisture content and reported that all type of mulches increased soil moisture content compared to control. They further reported that the maximum soil moisture content was observed in black polythene mulches followed by transparent polythene mulch.

Hassan *et al.* (1995) noticed that effect of mulch on soil moisture varied with materials used. Without mulch, soil moisture was lower than with mulch. Soil moisture under coconut frond mulch was 13 % and 7.5 % higher than that of control and reflective plastic mulch, respectively.

Jamil *et al.* (2005) carried out an experiment on different mulches in garlic and reported that transparent polythene mulch was inferior in case of soil moisture to black polythene mulches.

Islam (2007) studied the use of black polythene, white polythene and water hyacinth mulches on garlic field and reported that black polythene mulch hold the maximum soil moisture followed by water hyacinth and transparent polythene mulch.

Patil *et al.* (2013) noticed that the straw mulch conserved higher soil moisture to extent of 55 per cent more compared to control. Average available soil moisture stored up to 1.5 m depth of soil and increased significantly by mulching of wheat residue @ 6730 kg/ha compared to bare soil.

2.5.3 Mulching effect on soil temperature (^{0}C)

Hassan *et al.* (1995) reported that the soil temperature was influenced at 10 cm depth by mulches. Under plastic mulch, a soil temperature was higher in black plastic mulch (32.00 ^{0}C) and lowest (28.22 ^{0}C) with coconut frond mulch. However, the soil temperature in control was lower than normal ambient temperature.

Brown *et al.* (1998) revealed that the increase in the yields of sweet potatoes was a direct result of increased soil temperatures caused by the use of row cover with plastic mulch.

Rao and Pathak (1998) reported that mulching with black polythene showed maximum soil temperature throughout the experiment in Aonla, while sugarcane trash maintained minimum temperature followed by grass, paddy straw and rice husk.

Schonbeck and Evanyla (1998) reported that organic mulches reduced afternoon soil temperature and maintained higher soil moisture levels than other treatments. Black plastic mulch increased soil temperatures by 1–2 ^{0}C, but sometimes resulted in lower soil moisture levels in early summer, probably by hindering penetration of rainfall. Both undyed kraft paper and black paper mulches reduced afternoon soil temperature slightly. Oiled paper initially increased afternoon soil temperature by 4 ^{0}C, but this effect diminished over time.

Shinde *et al.* (1999) studied that the effect of micro-irrigation system and mulches on microclimate, growth and yield of summer chilli and reported that soil temperature was highest in control and lowest in sugarcane trash mulch.

Harender and Bhardwaj (2000) reported that the mulching with transparent polythene increases the temperature of soil in vegetables. The average soil temperature was highest at 8 cm soil depth in solarization treatment. The temperature was 4^{0}C higher in solarized beds than unsolarized plots.

Abu-Bakr *et al.* (2003) indicated that the soil temperature was significantly higher under the plastic mulches than the control. It increased by 5.6 ^{0}C, 5.2 ^{0}C and 3.9 ^{0}C in the morning and 6.1 ^{0}C, 5.7 ^{0}C and 3.3 ^{0}C at midday under the clear, green and black mulches, respectively, as compared to the control in okra.

Locher *et al.* (2005) observed that in sweet pepper light colored mulches (clear, violet, light green) increased the soil temperature by 2.5-2.9 ^{0}C than the un-mulched control and they also reported that the dark colored mulches (black, dark green, red) increased soil temperature (1.4-2.1 ^{0}C) compared to un-mulched (control). Overall studies indicated that higher yields of sweet peppers were achieved from mulched treatments due to higher soil temperatures than the un-mulched treatment.

Awodoyin *et al.* (2007) reported that the difference between morning and afternoon soil temperatures at 5 cm depth of soil were low under grass mulch, woodchip mulch and unweeded control (5.0-5.9 ^{0}C) but high under plastic mulch and hand weeded control (8.7-8.9 ^{0}C) in tomato.

Hutton and Handley (2007) found that in bell pepper production, reflective mulch (silver colour) slightly increased the soil temperature compared to the other treatments, but there were no significant differences in pepper yield.

Ekinci and Dursun (2009) observed that the average mean soil temperatures under clear and black mulches were higher by 5-8 ^{0}C and 1-4 ^{0}C, respectively as compared to control application in watermelon.

Mochiah *et al.* (2012) studied the effect of mulching on pest of pepper and observed that the highest soil temperature (33.9 ^{0}C) in unmulched plot followed by PAWA (33.8 ^{0}C), plastic mulch (31.7 ^{0}C), live cowpea mulch (31.5 ^{0}C) and lowest soil temperature (30.2 ^{0}C) in straw mulch plot.

Rajablariani *et al.* (2012) studied coloured plastic mulched in tomato and noticed that the highest soil temperature under the blue mulch (30.7 ^{0}C) followed by red plastic mulch (30.1 ^{0}C), clear plastic mulch (29.5 ^{0}C), black plastic mulch (27.6 ^{0}C), silver/black (27.4 ^{0}C), control plot (24.1 ^{0}C) and lowest soil temperature (23.0 ^{0}C) obtained by weedy plot.

Singh and Kamal (2012) reported that soil temperature and yield of tomato was significantly improved with mulching over control. The highest soil temperature observed under black polyethylene which was 2.2 to 3 ^{0}C more than the bare soil. In general, this effect was more evident during the early crop season when tomato plants shaded less soil surface. Black plastic mulches are more effective in increasing soil temperature due to a greater net radiation under the mulch compared to bare soil.

2.5.4 Soil microflora (CFU/g)

Brown *et al.* (2001) mentioned that mulching practices gave positive effect on the soil biota. Important role of mulch to support existence of most species of soil macro invertebrates. Soil biota increase under mulched soil environment thereby improving nutrient cycling and organic matter build up over a period of several years. Organic mulching technology support

diversity of beneficial soil macro invertebrates. Crop residue mulch supplied a lot of food for soil macro invertebrates and nutrient to ensure the vegetation growth and created suitable environment for soil macro invertebrates.

Shashidhar *et al.* (2009) reported more number of bacterial, fungal and actinomycetes colonies found in *Cassia sericea* (32 CFU x 105/g), paddy straw (53 CFU x 104/g) and sunhemp (53 CFU x 103/g) mulched plots over other treatments respectively.

Kaswala *et al.* (2012) reported that in brinjal crop mulching with black plastic significantly suppressed the bacterial and fungal population (238 cells/ml) and (42 CFU/ml) than control (277 cells/ml) and (68 CFU/ml). However, trash mulch showed considerable beneficial effect on bacterial and fungal population (307 cells /ml) and (127 CFU/ml) in soil.

2.6 Economics

Dixit and Mujumdar (1995) reported that among organic mulches in potato, paddy straw mulching was most profitable. It recorded highest benefit : cost ratio (1:2.59) followed by control (1:2.04), while lower benefit : cost ratio was noticed under polyethylene mulches because of higher cost of polyethylene.

Christopher (2003) revealed that plastic mulching recorded higher gross returns of Rs. 90,600 ha^{-1} as compared to Rs. 74,600 ha^{-1} under unmulched control. The higher gross returns recorded under plastic was mulching due to significantly higher yield recorded in this treatment. Thus, though cost of cultivation was high due to cost of mulch film, net returns were higher in

this treatment (Rs. 74,600 ha^{-1}) compared to control (Rs. 64,600 ha^{-1}). Thus increase net return by use of plastic mulches was Rs. 10,000 ha^{-1}.

3. MATERIAL AND METHODS

The details regarding the material used and methods followed during the course of the present investigation have been given in this chapter.

3.1 Experimental site

The field experiment was conducted during *summer,* 2013 in a medium black soil at the Horticulture Farm, College of Agriculture, Kolhapur. The soil of experimental plot was medium black, porus, well drained and low in organic carbon content.

3.2 Climate and weather

The experimental farm, College of Agriculture, Kolhapur, Dist. Kolhapur is situated in tropical region at 14^0 42' North latitude and 74^0 14' East longitudes. Ecologically this area comes under the Sub-montane zone of Maharashtra with annual rainfall ranging from 700 to 2500 mm. The average annual maximum and minimum temperature was 33.73 ^{0}C and 17.96 ^{0}C. The average annual maximum and minimum relative humidity was ranging from 86.92 % and 37.36 % during *summer*.

3.3 Experimental layout

The present investigation was carried out in randomized block design. Seven treatments were allocated with three replications. The size of unit plot was 6.0 × 3.60 m.

3.4 Experimental details

The period of experiment was from January 2013 to July 2013 with following details.

a. Treatment details

There were 7 treatments

i. Black- Black Polyethylene paper sheet (100 µ)
ii. Silver-Black Polyethylene paper sheet (100 µ)
iii. Yellow-Black Polyethylene paper sheet (100 µ)
iv. Paddy straw
v. Sugarcane trash
vi. Dry grasses
vii. Control (Without mulch)

b. No. of Replications : 3
c. Design : Randomized Block Design
d. Variety : Phule Jyoti
e. Season : Summer- 2013
f. Time of sowing : 7th January, 2013
g. Method of transplanting : Transplanting on raised beds
h. Time of transplanting : 7th February, 2013
i. Spacing : 60 x 45 cm
j. Plot size (m) : 1) Gross plot : 6.00 × 3.60 m
2) Net plot : 3.60 × 2.70 m

3.5 Preparatory tillage

The experimental site was ploughed with the help of tractor and tractor drawn cultivator. The clod crushing was done by tractor drawn rotavator. The field was levelled with the help of wooden plank and was made ready for layout.

3.6 Selection of variety

The variety of chilli grown was Phule jyoti which is developed by M.P.K.V., Rahuri. This variety is recommended for kharif and summer season in western Maharashtra. The salient features of Phule jyoti is tall plant and spreading, leaves broad and dark green, fruit smooth, medium long, born in cluster of 5-6 and pendulus, ripe fruits red in colour. The average yield of green chilli is 18 to 22.5 t ha^{-1}.

3.7 Nursery details

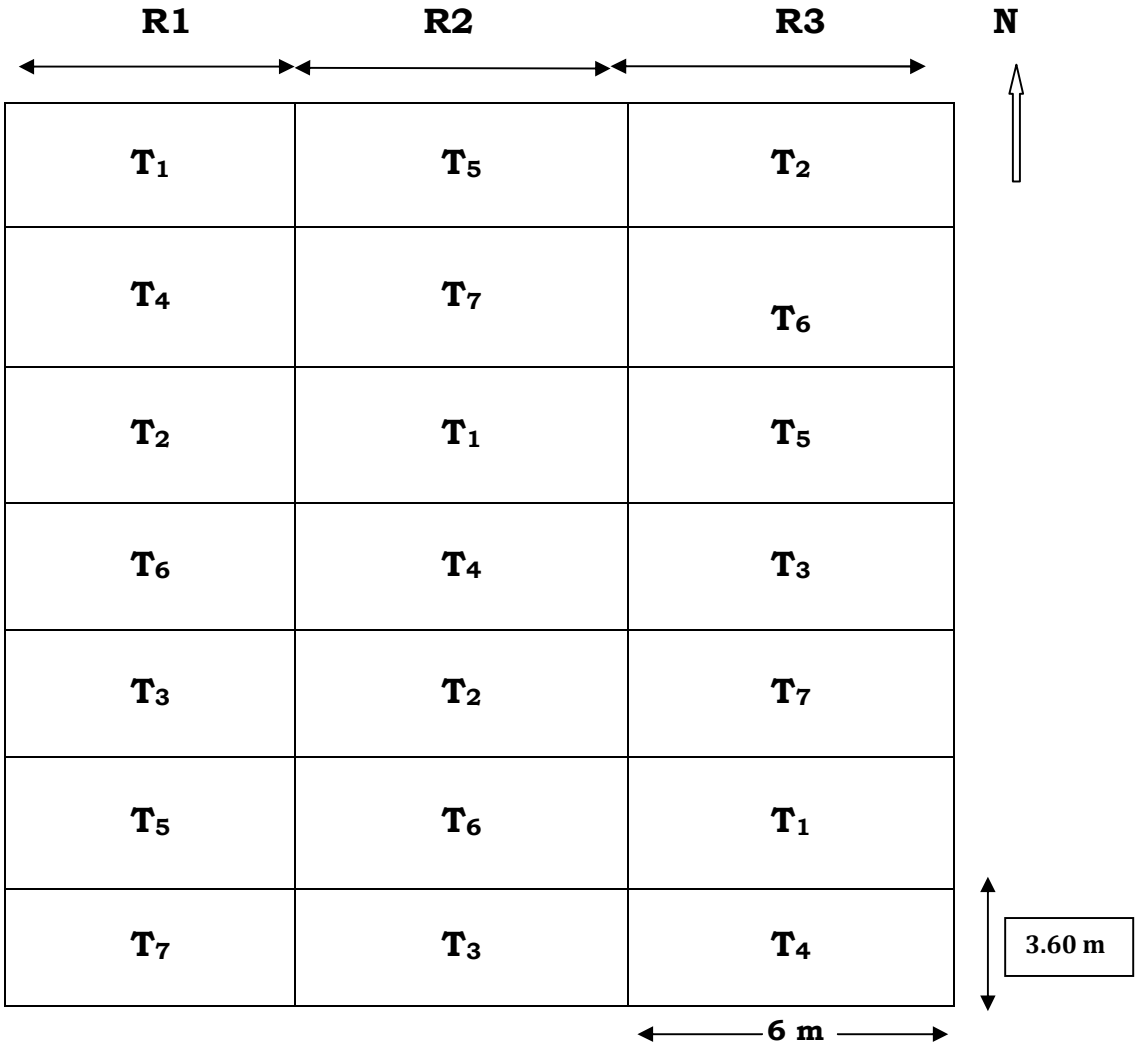
The soil was brought to fine tilth and raised seed beds having size 3 × 2 m with 20 cm height were prepared and well rotten powdered farm yard manure was applied and incorporated into the soil. The seed were treated with thiram (2.5 g/kg). Chilli seeds were sown in rows 5 cm apart and covered with a thin layer of soil. The nursery beds were watered regularly with rose can. The seedling in the nursery beds were sprayed with Quinolphos 15 ml + Mancozeb 20 gm + 10 lit. water to control pest and diseases. The beds were irrigated and brought to wapsa condition. The 30 days old seedling were uprooted at morning and transplanted on experimental plots.

3.8 Plan of layout

Plan of layout of the experimental field is given in Fig. 1

3.9 Soil analysis

Soil samples from each treatment plot of the experimental field were collected randomly before transplanting with a view to



Plot size (m) : 1) Gross plot : 6.00 × 3.60 m

2) Net plot : 3.60 × 2.70 m

Fig.1: Lay out plan

know initial fertility status of the soil as well as after harvest of crop to know the uptake of the nutrients.

The soil samples were dried under shade, ponding was done in wooden mortar and pestle and sieved through 0.5 and 2 mm sieve. Standard methods were adopted for determination of soil pH, EC, organic carbon, available N, P and K status (table 1).

Table 1. Standard methods for soil analysis

Sr.No.	Parameter	Method used	References
1.	pH	Potentiometric Method	Jackson (1973)
2.	EC	Conductometric Method	Jackson (1973)
3.	Organic Carbon	Walkely-Black Method	Jackson (1973)
4.	Available Nitrogen	Alkaline Permangnate Method	Subbiah and Asija (1956)
5.	Available Phosphorus	Olsen Method	Watanbe and Olsen (1965)
6.	Available Potassium	Neutral Normal Ammonium Acetate (pH - 7)	Knudsen and Peterson (1982)
7.	Soil temperature	Soil thermometer	Taylor and Jackson (1986)
8.	Soil microflora	Cereal dilution	Vincent (1970)
9.	Soil moisture	Gravimetric method	Black (1965)

3.10. Cultural practices

3.10.1. Mulching of the beds

Black-black polyethylene film (100 µ), silver-black polyethylene film (100 µ), yellow-black polyethylene film (100 µ), paddy straw, sugarcane trash and dry grasses with height (5-6 cm) were used as mulch material.

3.10.2 Manures and Fertilizer application

The recommended dose of FYM 20 t/ha was applied at last harrowing and fertilizer dose was applied at the rate of 100 kg N+50 kg P_2O_5 + 50 kg K_2O /ha, out of which $^1/_2$ dose of N and complete dose of P and K was applied as basal dose and remaining ½ dose N was applied at 30 days after planting.

3.10.3 Irrigation

Irrigation water was supplied through drip irrigation method to maintain the soil at field capacity.

3.10.4 Intercultivation and weeding

Intercultivation was carried out at regular intervals (15 days after transplanting) followed by two hand weedings at 15 and 45 days after transplanting (DAT) other than mulch treatments.

3.10.5 Gap filling

Gap filling was done 8 days after transplanting to ensure optimum plant population.

3.10.6 Harvesting

Green but mature fruits were harvested at weekly intervals depending on the maturity. Harvesting was started at 66 DAT and continued till 165 DAT. Six plants from each plot were selected at random and marked with pegs for recording observations.

3.11. Plant growth parameters

3.11.1 Plant height (cm)

The plant height was measured at 45, 90 and 135 DAT from ground level to tip of the plant. It was measured in cm and mean of plant height was calculated.

3.11.2 Plant spread (cm)

The spread of plants was measured at 45, 90 and 135 DAT in East- West and North-South direction and the mean value was calculated.

3.11.3 Number of branches per plant

Total number of branches per hill were counted in randomly selected six plants at 45, 90 and 135 days and average was worked out.

3.12 Flowering observations

3.12.1 Days to first flowering

Number of days required from sowing to the day on which the first flowering of plants was observed

3.12.2 Days to 50 per cent flowering

After transplanting of the seedlings, each plant was regularly observed for appearance of flowers. When 50 per cent of the plant from the plot showed flowering, the date was noted. The days to 50 per cent flowering, from the date of transplanting in each treatment was worked out.

3.13 Days for first picking

Number of days taken from the date of transplanting to date of first picking were recorded separately for six plants per plot and average was calculated

3.14 Days for last picking

Number of days taken from date of transplanting to date of last picking were recorded separately for six plants per plot and average was calculated.

3.15 Yield and yield attributes

3.15.1 Number of fruits per plant

The number of fruits in each harvesting were counted from randomly selected six observational plants and summed up after last harvesting and average fruit number per plant was worked out.

3.15.2 Fruit length (cm)

The length of fruit (including pedicel) was measured from pedicel end to tip of fruit by selecting six fruits randomly from each observational plants and later on the average was worked out.

3.15.3 Girth of fruit (cm)

The diameter of six randomly selected fruits, at peak harvest, was measured (center of the fruit) with the help of vernier caliper for all the treatments and mean was recorded.

3.15.4 Yield per plant (g)

The fruits of selected plants were harvested and fresh weight of fruit was taken and summed up after last harvesting for each observational plant.

3.15.5 Yield per plot (kg)

Immediately after harvest, fruits in each treatment and from each plot were weighed on weighing balance and the mean of all replications as per treatment were calculated. The cumulative yield was expressed in kilograms.

3.15.6 Yield per ha (t)

The plot wise fruit yield was converted into tonnes per hectare.

3.16 Fresh weight of root and shoot (g)

From each plot six plants were selected and uprooted for recording data on yield attribute at 130 DAT. The plants were separated into shoot and root and their corresponding fresh weight was recorded.

3.17 Dry weight of root and shoot (g)

From each plot six plants were randomly uprooted and soil adhering to the roots was washed gently with water to open the root system. The plants were separated into root and shoot and their corresponding dry weights were recorded after oven drying at 80 ^{0}C for 72 hrs.

3.18 Incidence of pests and diseases

Incidence of aphids, and thrips was recorded at each harvest. The fruit punctured by pest were separated and the weight of these fruits was taken on weighing balance. Thus weight of infested fruits obtained from each plot was calculated and the percentage of infested fruit on total weight basis was worked out.

3.19 Quality parameters

3.19.1 Leaf area (cm^2/hill)

The leaf area per plant was measured from the leaves of the six plants taken for dry matter at each observation. The green leaves were detached from the each plant and leaf area reading was taken on an automatic leaf area meter (cm^2) and average is recorded as mean leaf area per plant.

3.19.2 Chlorophyll content of leaves (mg/100 g)

Leaf chlorophyll (a+b) was measured at 70 DAT i.e at early and fruiting stages. Leaf chlorophyll (a+b) was measured using the method of Yoshida *at el*. (1976). Firstly, 50 mg of fresh leaf sample was weighed and placed into mortar and then crushed thoroughly with pestle. 10 ml of 80% acetone was added to allow tissue to be thoroughly homogenized and centrifuged for 5 minutes at 4000 rpm. The supernatants of the solution taken out and their absorbance were recorded at 645 and 663 nm wavelength by a Spectrophotometer. Total chlorophyll was calculated by the following formula:

$$\text{Total chlorophyll} = (20.2 \times D645 + 8.02 \times D663) \times \frac{10}{1000 \times 0.05} \text{ mg } g^{-1} \text{ fw}$$

3.20 Soil moisture (%)

The variation of soil moisture content at different growth stages of the crop for different mulched plots was estimated by weighing and drying of the representative soil sample in oven at 105 ^{0}C for 24 hours. Differences in soil moisture content before and after drying in oven were calculated. Soil moisture content (in percentage) was calculated as follows:

$$\text{Moisture content (\%)} = \frac{W_2 - W_1}{W_2} \times 100$$

W_2 : Weight of soil before oven drying

W_1 : Weight of soil after oven drying.

3.21 Soil temperature (^{0}C)

Soil temperature was recorded for each treatment in degree Celsius (^{0}C) using soil thermometer at weekly interval from planting to harvesting.

3.22. Economics

3.22.1 Input cost net return

Input cost (cost–A) was worked out by considering the amount required for the purchase of inputs like seed, mulch paper, manures and fertilizers, irrigation, weeding and pesticide charges etc. and amount spent on the labour charges required for all the operations. The net returns were worked out by

subtracting the total input cost of cultivation from the gross returns of the corresponding treatments.

3.22.2 Cost: benefit ratio

The cost: benefit ratio was worked out by considering per hectare values of net profit and input cost of cultivation.

3.23 Statistical analysis

The data obtained on various observations was analyzed as per the method advocated for randomized block design by Panse and Sukhatme (1985).

4. EXPERIMENTAL RESULTS

A field experiment entitled "Studies on effect of different mulches on growth and yield of chilli (*Capsicum annuum* L.) Cv. Phule Jyoti" was conducted during *summer,* 2013 in a medium black soil at the Horticulture sectional Farm, College of Agriculture, Kolhapur. The present investigation deals with effect of different mulches on different aspects viz., on growth, yield and soil properties in chilli. Results of the experiment are presented in this chapter.

4.1 STUDIES ON GROWTH PARAMETERS

Data on effect of different mulches on plant growth attributes viz., plant height, plant spread and number of branches per plant are presented in Tables 2 to 4.

4.1.1 Plant height (cm)

Data pertaining to mean plant height as periodically influenced by different treatments are presented in Table 2 and graphically depicted in Fig. 4.2.

4.1.1.1 Plant height at 45 DAT

Data on the mean plant height at 45 DAT presented in Table 2 revealed no significant difference due to various mulch treatments. However, maximum plant height (30.60 cm) was recorded in treatment T_2 (Silver-black polyethylene mulch), while minimum plant height (25.27 cm) was recorded in treatment T_7 (Control).

Table 2. Effect of various mulches on plant height (cm) on chilli

Sr. No.	Treatment	Plant height (cm)		
		45 DAT	90 DAT	135 DAT
1.	**T_1** B-B. P. mulch	29.80	56.67	64.03
2.	**T_2** S-B. P. mulch	30.60	58.33	67.09
3.	**T_3** Y-B. P. mulch	26.00	42.40	49.90
4.	**T_4** Rice straw	29.30	53.53	62.27
5.	**T_5** Sugarcane trash	29.77	54.73	62.43
6.	**T_6** Dry grasses	27.89	53.07	62.02
7.	**T_7** Control	25.27	42.73	49.31
	S. E ±	0.992	1.172	1.565
	C.D. at 5 %	N. S	3.612	4.823

4.1.1.2 Plant height at 90 DAT

Data on the mean plant height at 90 DAT presented in Table 2 revealed that there was significant difference due to various mulch treatments. The maximum mean plant height (58.33 cm) was recorded in treatment T_2 (Silver-black polyethylene mulch) which was at par with treatment T_1 (56.67 cm) and T_5 (54.73 cm) and was significant over rest of the

treatments. The minimum plant height (42.40 cm) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

4.1.1.3 Plant height at 135 DAT

Data on the mean plant height at 135 DAT presented in Table 2 revealed that there was significant difference due to various treatments. The maximum mean plant height was recorded (67.09 cm) in treatment T_2 (Silver-black polyethylene mulch), which was at par with treatment T_1 (64.03 cm) (Black-black polyethylene mulch), T_5 (62.43 cm) (Sugarcane trash mulch) and T_4 (62.27 cm) (Rice straw mulch). The minimum plant height (49.31 cm) was recorded in treatment T_7 (Control).

4.1.2 Plant spread (cm)

The data pertaining to the East-West and North-South plant spread per plant as influenced by various mulch treatments is presented in Table 3.

4.1.2.1 Plant spread at 45 DAT

4.1.2.1.1 In East-West direction

The results with regards to plant spread in East-West direction per plant at 45 DAT presented in Table 3 revealed no significant difference due to various mulch treatments. Maximum plant spread in East-West direction (21.10 cm) was recorded in treatment T_2 (Silver-black polyethylene mulch) and minimum plant spread (11.93 cm) was recorded in treatment T_7 (Control).

4.1.2.1.2 In North-South direction

Data on the mean plant spread in North-South direction at 45 DAT presented in Table 3 revealed that there was significant difference due to various mulch treatments with significantly higher plant spread in North-South direction (19.17 cm) in treatment T_2 (Silver-black polyethylene mulch). Minimum plant spread in North-South direction (11.0 cm) was recorded in treatment T_7 (Control).

Table 3. Effect of various mulches on plant spread (cm) on chilli

Sr. No.	Treatment	Plant spread (cm)					
		45 DAT		90 DAT		135 DAT	
		EW	NS	EW	NS	EW	NS
1.	**T_1** B-B. P. mulch	18.03	18.00	40.81	40.02	57.03	57.64
2.	**T_2** S-B. P. mulch	21.10	19.17	42.04	45.10	60.12	58.73
3.	**T_3** Y-B. P. mulch	13.60	11.63	34.05	33.50	51.00	53.57
4.	**T_4** Rice straw	18.13	15.07	37.40	37.73	54.07	54.80
5.	**T_5** Sugarcane trash	18.57	17.43	38.07	38.83	56.00	57.00
6.	**T_6** Dry grass	17.60	14.87	35.43	34.67	53.53	52.80
7.	**T_7** Control	11.93	11.00	33.03	33.40	50.63	51.07
	S. E ±	0.323	0.288	0.426	0.366	0.310	0.401
	C.D. at 5 %	N.S	0.888	1.313	1.128	1.954	1.235

4.1.2.2 Plant spread at 90 DAT

4.1.2.2.1 In East-West direction

The results with regards to mean plant spread in East-West direction at 90 DAT presented in Table 3 revealed significant differences due to various mulch treatments. Maximum plant spread in East-West direction (42.04 cm) was obtained in treatment T_2 (Silver-black polyethylene mulch) which was at par with treatment T_1 (40.81 cm) (Black-black polyethylene mulch) and significant over rest of the mulch treatments. The minimum plant spread (33.03 cm) in East-West direction was recorded in treatment T_7 (Control) which was at par with treatment T_3 (34.05) (Yellow-black polythene mulch).

4.1.2.2.2 In North-South direction

Data on the mean plant spread in North-South direction at 90 DAT are presented in Table 3. From table it could be revealed that treatment T_2 (Silver-black polyethylene mulch) was significantly superior over rest of the treatments with maximum plant spread in North-South direction (45.10 cm). Minimum plant spread (33.40 cm) in North-South direction was recorded in T_7 (Control), which was at par with treatment T_3 (33.50 cm) (Yellow -black polythene mulch).

4.1.2.3 Plant spread at 135 DAT

4.1.2.3.1 In East-West direction

The results with regards to mean plant spread in East-West direction at 135 DAT presented in Table 3 revealed that there were significant effects of various mulch treatments on plant

spread in chilli. Significantly maximum plant spread in East-West direction (60.12 cm) was observed in treatment T_2 (Silver - black polyethylene mulch) and was significantly superior over rest of the treatments. The minimum plant spread (50.63 cm) was recorded in treatment T_7 (Control).

4.1.2.3.2 In North-South direction

Data on the mean plant spread per plant at 135 DAT (N-S) direction presented in Table 3 revealed that maximum plant spread in North-South direction (58.73 cm) was observed in treatment T_2 (Silver-black polyethylene mulch) which was at par with treatment T_1 (57.64 cm) (Black-black polyethylene mulch) and was significantly superior over rest of the treatments. The minimum plant spread (51.07 cm) was recorded in T_7 (Control).

4.1.3 Number of branches per plant

4.1.3.1 Number of branches per plant at 45 DAT

Data on the number of branches per plant at 45 DAT presented in Table 4 and graphically depicted in Fig. 4.3 revealed that there was significant effect on number of branches per plant in chilli due to various mulch treatments. The maximum number of branches per plant was recorded (8.03) in treatment T_2 (Silver-black polyethylene mulch) which was at par with treatment T_4 (Rice straw) (7.57) and T_5 (Sugarcane trash mulch) (7.63). The minimum number of branches per plant (7.07) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

4.1.3.2 Number of branches per plant at 90 DAT

Data on the number of branches per plant at 90 DAT presented in Table 4 and graphically depicted in Fig. 4.3 revealed that there was no significant effect on number of branches per plant in chilli due to various mulch treatments. The maximum number of branches per plant (16.28) was recorded in treatment T_2 (Silver-black polyethylene mulch), which was at par with treatment T_1 (Black-black polyethylene mulch) (15.31) and T_5 (Sugarcane trash mulch) (15.28) and was significant over rest of the treatments. The minimum number of branches per plant (11.76) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

Table 4. Effect of various mulches on number of branches per plant on chilli

Sr. No.	Treatment	Number of branches plant^{-1}		
		45 DAT	90 DAT	135 DAT
1.	**T_1** B-B. P. mulch	7.85	15.31	20.72
2.	**T_2** S-B. P. mulch	8.03	16.28	21.42
3.	**T_3** Y-B. P. mulch	7.07	11.76	13.57
4.	**T_4** Rice straw	7.57	15.00	18.92
5.	**T_5** Sugarcane trash	7.63	15.28	20.22
6.	**T_6** Dry grass	7.33	14.70	18.71
7.	**T_7** Control	7.09	12.77	15.64
	S. E ±	0.191	0.384	1.476
	C.D. at 5 %	0.573	1.182	4.42

4.1.3.3 Number of branches per plant at 135 DAT

The results with regards to number of branches per plant at 135 DAT presented in Table 4 and graphically depicted in Fig. 4.3 revealed significant difference due to application of various mulch treatments. Maximum number of branches per plant (21.42) was recorded in treatment T_2 (Silver-black polyethylene mulch) which was at par with treatment T_4 (Rice straw) (18.92), T_5 (Sugarcane trash mulch) (20.22) and T_6 (Dry grasses) (18.71). The minimum number of branches per plant (13.57 cm) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

4.2 STUDIES ON FLOWERING

4.2.1 Days to first flowering

Data recorded on days to first flowering presented in Table 5 and graphically depicted in Fig. 4.4 revealed to significant differences due to the application of different mulch treatments. Minimum days to first flowering (46.00) was recorded in T_2 (Silver-black polyethylene mulch) while maximum days to first flowering (53.33) was recorded in T_3 (Yellow-black polyethylene mulch) which was at par with treatment T_6 (Dry grasses) (50.33) and T_7 (Control).

4.2.2 Days to 50 per cent flowering

Observations pertaining to days to 50 per cent flowering in chilli Cv. Phule Jyoti were recorded and presented in Table 5. The days of 50 per cent flowering were significantly influenced by different mulch treatments. Minimum number days for 50 per cent flowering (67.67) were recorded in treatment T_1 i.e. Black-

black polyethylene mulch, which was significantly earlier than all other treatments. While, maximum number of days for 50 per cent flowering (76.67) were recorded in treatment T_3 (Yellow-black polyethylene mulch) which was at par with treatment T_5 (75.33) (Sugarcane trash mulch).

Table No. 5 Effect of various mulches on days to first flowering and 50 per cent flowering on chilli

Sr. No.	Treatment	Days to first flowering	Days to 50 per cent flowering
1.	**T_1** B-B. P. mulch	49.00	67.67
2.	**T_2** S-B. P. mulch	46.00	71.33
3.	**T_3** Y-B. P. mulch	53.33	76.67
4.	**T_4** Rice straw	49.33	74.00
5.	**T_5** Sugarcane trash	49.00	75.33
6.	**T_6** Dry grass	50.33	72.67
7.	**T_7** Control	50.33	74.00
8.	S. E ±	1.215	0.763
9.	C.D. at 5 %	3.64	2.351

4.3 STUDIES ON YIELD AND YIELD CONTRIBUTING CHARACTERS

4.3.1 Days to first picking

Results pertaining to days to first picking of chilli are recorded and presented in Table 6. The days of first picking were significantly influenced by different mulch treatments. The minimum days to first picking (66.0) were observed in treatment

T_1 (Black-black polyethylene mulch) and was followed by treatment T_2 (Silver-black polyethylene mulch) which recorded 66.33 days for first picking of green chilli fruits. The maximum days of first picking (73.33) were observed in treatment T_3 (Yellow-black polyethylene mulch), which was at par with treatment T_2 (Silver-black polyethylene mulch), T_4 (Rice straw mulch) and T_6 (Dry grasses).

Table No. 6 Effect of various mulches on days to first picking and last picking on chilli

Sr. No.	Treatment	Days to Ist picking	Days to last picking
1	**T_1** B-B. P. mulch	66.00	150.00
2	**T_2** S-B. P. mulch	66.33	161.33
3	**T_3** Y-B. P. mulch	73.33	135.33
4	**T_4** Rice straw	67.67	143.00
5	**T_5** Sugarcane trash	69.67	137.67
6	**T_6** Dry grass	69.33	136.00
7	**T_7** Control	71.33	135.00
	S. E ±	1.160	1.194
	C.D. at 5 %	3.576	3.680

4.3.2 Days to last picking

Results pertaining to days to last picking of chilli are recorded and presented in Table 6. The days of last picking were significantly influenced by different treatments. The maximum days to last picking (161.33) was recorded in treatment T_2

(Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The minimum days to last picking (135.0) was recorded in treatment T_7 (Control), which was at par with treatment T_3 (135.33), T_6 (136.00) and T_5 (137.67) days respectively.

4.3.3 Number of fruits per plant

Significantly good amount of variation was observed for number of fruits per plant and reported in Table 7 and graphically depicted in Fig. 4.5. Maximum number of fruits (252.20) per plant was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The minimum number of fruits (202.97) per plant was recorded in the treatment T_7 receiving absolute control, followed by T_3 (210.53) (Yellow-black polyethylene mulch).

Table No. 7 Effect of various mulches on number of fruits plant^{-1}

Sr. No.	Treatment	Number of fruit plant^{-1}
1	**T_1** B-B. P. mulch	239.63
2	**T_2** S-B. P. mulch	252.20
3	**T_3** Y-B. P. mulch	210.53
4	**T_4** Rice straw	234.00
5	**T_5** Sugarcane trash	234.67
6	**T_6** Dry grass	221.00
7	**T_7** Control	202.97
	S. E ±	3.901
	C.D. at 5 %	12.022

4.3.4 Fruit length (cm)

The data with regards to fruits length is presented in Table 8. There was significant difference among different treatments with regard to length of chilli fruits. Highest length (8.19 cm) was recorded in treatment T_2 that received (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The lowest fruit length (7.10 cm) was recorded in the treatment T_3 (Yellow-black polyethylene mulch), which was at par with rest of treatments.

Table No. 8 Effect of various mulches on fruit length (cm) and fruit girth (cm) on green chilli

Sr. No.	Treatment	Fruit length (cm)	Fruit girth (cm)
1	**T_1** B-B. P. mulch	7.45	1.13
2	**T_2** S-B. P. mulch	8.19	1.23
3	**T_3** Y-B. P. mulch	7.10	0.82
4	**T_4** Rice straw	7.47	1.00
5	**T_5** Sugarcane trash	7.43	1.10
6	**T_6** Dry grass	7.37	0.92
7	**T_7** Control	7.17	0.90
	S. E ±	0.122	0.073
	C.D. at 5 %	0.377	0.219

4.3.5 Fruit girth (cm)

The results with regards to fruit girth presented in Table 8 revealed significant difference due to various treatments. However, highest fruit girth (1.23 cm) was recorded in T_2 (Silver-black polyethylene mulch) which was at par with treatment T_1 (Black- black polyethylene mulch) (1.13) and T_5 (Sugarcane trash mulch) (1.10), while lowest fruit girth (0.82 cm) was recorded in T_3 (Yellow-black polyethylene mulch).

4.3.6 Yield per plant (g)

The data pertaining to yield per plant which is presented in Table 9 revealed that highest average yield of green fruits per plant (647.33 g) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. Lowest yield of green fruits per plant (425.67 g) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

4.3.7 Yield per plot (Kg)

The data pertaining to yield per plot is presented in Table 9 and graphically depicted in Fig. 4.7, showed that highest yield per plot (31.0 kg) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The lowest yield per plot (20.40 kg) was recorded in treatment T_3 (Yellow-black polyethylene mulch), followed by T_7 (21.34 kg) Control.

4.3.8 Yield per ha (tonne)

The data with regards to yield per hectare is presented in Table 9 and graphically depicted in Fig. 4.7, is showed

significant difference among different treatments with regards to yield. The highest yield (23.97 t ha^{-1}) was recorded in treatment T_2 (Silver-black polyethylene mulch) which was at par with treatment T_1 (Black-black polyethylene mulch). The lowest yield (15.74 t ha^{-1}) was recorded in treatment T_3 (Yellow-black polyethylene mulch), followed by T_7 (16.47 t ha^{-1}) Control.

Table 9. Effect of various mulches on yield and yield attributes on green chilli

Sr. No.	Treatment	Yield $plant^{-1}$ (g)	Yield $plot^{-1}$ (Kg)	Yield ha^{-1} (tonne)
1	**T_1** B-B. P. mulch	620.67	29.79	22.92
2	**T_2** S-B. P. mulch	647.33	31.0	23.97
3	**T_3** Y-B. P. mulch	425.67	20.40	15.74
4	**T_4** Rice straw	543.12	26.41	20.11
5	**T_5** Sugarcane trash	545.50	27.27	20.22
6	**T_6** Dry grass	526.80	25.56	19.51
7	**T_7** Control	444.67	21.34	16.47
	S. E ±	4.305	0.259	0.434
	C.D. at 5 %	13.265	0.797	1.337

4.4 ROOT AND SHOOT STUDIES

4.4.1 Fresh weight of shoot (g)

From the Table 10 it could be revealed that highest average fresh weight of shoot (329.60 g) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior

over rest of the treatments. While lowest fresh weight of shoot (151.57 g) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

Table 10. Effect of various mulches on fresh and dry weight of shoot (g)

Sr. No.	Treatment	Fresh wt. of shoot (g)	Dry wt. of shoot (g)
1	**T_1** B-B. P. mulch	260.37	137.43
2	**T_2** S-B. P. mulch	329.60	143.97
3	**T_3** Y-B. P. mulch	151.57	60.80
4	**T_4** Rice straw	213.07	112.87
5	**T_5** Sugarcane trash	244.47	123.73
6	**T_6** Dry grass	205.87	111.07
7	**T_7** Control	172.50	70.67
	S. E ±	1.532	1.323
	C.D. at 5 %	4.722	4.077

4.4.2 Dry weight of shoot (g)

The data with regards to dry weight of shoot is presented in Table 7. There was significant difference among different treatments. The highest dry weight of shoot (143.97 g) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The

lowest dry weight of shoot (60.80 g) was recorded in treatment T_3 (Yellow-black polythene mulch).

4.4.3 Fresh weight of root (g)

Results pertaining to fresh weight of roots are recorded and presented in Table 11. The fresh weight of root was significantly influenced by different mulch treatments. The highest average fresh weight of root (77.20 g) was recorded in treatment T_2 (Silver- black polyethylene mulch) and was significantly superior over rest of the treatments, while lowest fresh weight of root (35.04 g) was recorded in treatment T_3 (Yellow-black polythene mulch), followed by T_7 (40.55 g) absolute Control.

Table 11. Effect of various mulches on fresh and dry weight of root (g)

Sr. No.	Treatment	Fresh wt. of root (g)	Dry wt. of root (g)
1	**T_1** B-B. P. mulch	67.40	27.37
2	**T_2** S-B. P. mulch	77.20	31.60
3	**T_3** Y-B. P. mulch	35.04	15.80
4	**T_4** Rice straw	51.30	20.90
5	**T_5** Sugarcane trash	54.21	21.50
6	**T_6** Dry grass	47.64	17.97
7	**T_7** Control	40.55	16.13
	S. E ±	2.263	0.446
	C.D. at 5 %	6.973	1.375

4.4.4 Dry weight of root (g)

Results pertaining to dry weight of root are recorded and presented in Table 11. The dry weight of root was significantly influenced by different treatments. The highest average dry weight of root (31.60 g) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments, however lowest dry weight of root (15.80 g) was recorded in treatment T_3 (Yellow-black polyethylene mulch), followed by T_7 (16.13 g) Control.

4.5 INCIDENCE OF PEST AND DISEASES

4.5.1 Per cent infestation of thrips and aphids

The data presented in Table 12 in respect of the infestation of thrips and aphids revealed significant differences due to the various treatments.

The data for different mulch treatments revealed that the highest infestation of thrips and aphids (1.73 and 1.10 % respectively) was observed in treatment T_7 (Control) and was significantly superior over rest of the treatments. The lowest infestation in thrips and aphids (0.27 and 0.34 % respectively) was observed in treatment T_2 (Silver-black polyethylene mulch), which is at par with treatment T_1 (0.50 and 0.40 %) (Black-black polyethylene mulch).

4.5.2 Disease incidence (%)

Results pertaining to disease incidence are recorded and presented in Table 12. The incidence of leaf curl disease was highest (4.43 %) in treatment T_7 (Control) and was significantly

superior over rest of the treatments. The lowest leaf curl incidence (0.67 %) was observed in treatment T_2 (Silver-black polyethylene mulch).

Table12. Effect of various mulches on pest and diseases incidence (%) on chilli

Sr. No.	Treatment	Incidence of thrips	Incidence of aphids	Incidence of leaf curl
1	**T_1** B-B. P. mulch	0.50	0.40	1.33
2	**T_2** S-B. P. mulch	0.27	0.34	0.67
3	**T_3** Y-B. P. mulch	0.77	0.43	3.37
4	**T_4** Rice straw	0.80	0.73	3.10
5	**T_5** Sugarcane trash	0.80	0.70	2.67
6	**T_6** Dry grass	0.83	0.73	3.33
7	**T_7** Control	1.73	1.10	4.43
	S. E ±	0.144	0.081	0.126
	C.D. at 5 %	0.444	0.251	0.389

4.6 QUALITY PARAMETERS

4.6.1 Leaf area (cm^2 $plant^{-1}$)

4.6.1.1 Leaf area at 45 days (cm^2)

The data presented in Table 13 regarding leaf area at 45 DAT revealed that there was significant effect due to various mulch treatments. The maximum leaf area (1764.99 cm^2 $plant^{-1}$) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The

minimum leaf area (1120.46 cm^2 $plant^{-1}$) was recorded in treatment T_3 (Yellow-black polythene mulch).

4.6.1.2 Leaf area at 90 days (cm^2)

The data presented in Table 13 in respect of leaf area per plant at 90 days after transplanting revealed significant differences due to the various treatments. The maximum leaf area (2565.37 cm^2 $plant^{-1}$) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The minimum leaf area (2034.86 cm^2 $plant^{-1}$) was recorded in treatment T_3 (Yellow-black polythene mulch).

4.6.1.3 Leaf area at 135 days (cm^2)

Results pertaining to leaf area are recorded and presented in Table 13. The leaf area was significantly influenced by different treatments. The maximum leaf area (2570.30 cm^2 $plant^{-1}$) was recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments. The minimum leaf area (1712.27 cm^2 $plant^{-1}$) was recorded in treatment T_3 (Yellow-black polyethylene mulch).

4.6.2 Chlorophyll content (mg/100 g)

The data presented in Table 13 in respect of the chlorophyll content of leaves revealed significant differences due to the various mulch treatments. The result indicated that the highest chlorophyll contain in leaves (2.83 mg/100 g) was

Table 13. Effect of various mulches on leaf area (cm^2) and chlorophyll (mg/100 g) content of chilli

Sr. No.	Treatment	Leaf area plant^{-1} (cm^2)			Chlorophyll Content in leaves (mg/100 g)
		45 days	90 days	135 days	
1.	**T_1** B-B. P. mulch	1623.10	2446.92	2403.73	2.45
2.	**T_2** S-B. P. mulch	1764.99	2565.37	2570.30	2.83
3.	**T_3** Y-B. P. mulch	1120.46	2034.86	1712.27	1.17
4.	**T_4** Rice straw	1439.27	2246.58	2008.09	2.20
5.	**T_5** Sugarcane trash	1472.91	2322.99	2014.73	2.32
6.	**T_6** Dry grass	1358.12	2135.31	1983.73	2.10
7.	**T_7** Control	1166.79	2036.01	1720.09	1.78
	S. E ±	3.130	4.379	17.635	0.042
	C.D. at 5 %	9.645	13.494	54.343	0.131

recorded in treatment T_2 (Silver-black polyethylene mulch) and was significantly superior over rest of the treatments under study. The lowest (1.17 mg/100 g) chlorophyll content was recorded in treatment T_3 (Yellow-black polyethylene mulch).

4.7 SOIL PROPERTIES

4.7.1 Soil pH

Results pertaining to soil pH which is presented in Table 14 revealed that the soil pH of the soil no significant difference was recorded by treatments under study. However, the highest pH of soil (7.34) was recorded in treatment T_5 (Sugarcane trash mulch) and lowest (7.30) soil pH was recorded in treatment T_3 (Yellow-black polyethylene mulch) and T_7 (Control). The soil pH of experimental plot before planting was (7.29).

4.7.2 Electrical conductivity (ds m^{-1})

The data pertaining to the electrical conductivity of soil is presented in Table 14.

The results were found to be non significant. The electrical conductivity of soil was highest (0.45 ds /m^{-1}) in treatment T_3 (Yellow-black polyethylene mulch), while lowest (0.41 ds/m^{-1}) electrical conductivity of soil was recorded in treatment T_5 (Sugarcane trash mulch) and T_7 (Control). The soil electrical conductivity of the experimental plot before planting was (0.40 ds /m^{-1}).

4.7.3 Organic carbon (%)

The results pertaining to organic carbon of soil are presented in Table 14.

The data with regards to organic carbon of soil was found to be non significant. However, the maximum organic carbon in soil (0.62 %) was recorded in treatment T_5 (Sugarcane trash mulch) and minimum (0.52 %) was recorded in treatment T_7 (Control). The soil organic carbon of the experimental plot before planting was (0.46 %).

4.7.4 Available N, P, K in soil (kg ha^{-1})

The data pertaining to available N, P, K in soil is presented in Table 14.

The result indicated that available soil N status showed no significant difference due to various treatments. The maximum available soil N status (182.10 kg ha^{-1}) was recorded in treatment T_2 (Silver-black polyethylene mulch), whereas minimum (173.90 kg ha^{-1}) was recorded in treatment T_7 (Control). The soil nitrogen of the experimental plot before planting was (176.66 kg ha^{-1}).

Further available soil P_2O_5 status was also found to be non significant. The maximum (34.06 kg ha^{-1}) available soil P_2O_5 status was recorded in treatment T_2 (Silver-black polyethylene mulch) and minimum (29.63 kg ha^{-1}) was recorded in treatment T_7 (Control). The soil P_2O_5 of the experimental plot before planting was (29.14 kg ha^{-1}).

The data with regards to the available soil K_2O status was also non significant. The maximum (294.27 kg ha^{-1}) available

Table No. 14 Effect of various mulches on soil nutrient status on chilli (After harvest)

Sr. No.	Treatment	Soil pH	EC (ds m^{-1})	Organic carbon (%)	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}
1.	**T_1** B-B. P. mulch	7.31	0.43	0.54	181.51	32.18	292.07
2.	**T_2** S-B. P. mulch	7.33	0.42	0.56	182.10	34.06	294.27
3.	**T_3** Y-B. P. mulch	7.30	0.45	0.55	175.07	29.79	286.67
4.	**T_4** Rice straw	7.31	0.44	0.59	177.77	30.40	291.50
5.	**T_5** Sugarcane trash	7.34	0.41	0.62	178.52	31.83	292.17
6.	**T_6** Dry grass	7.32	0.43	0.58	176.80	30.13	291.83
7.	**T_7** Control	7.30	0.41	0.52	173.90	29.63	287.57
	S. E ±	0.102	0.027	0.016	1.995	0.838	1.764
	C.D. at 5 %	N.S	N.S	N.S	N.S	N.S	N.S
	Initial analysis of soil	7.29	0.40	0.46	176.66	29.14	280.5

soil K_2O status was recorded in treatment T_2 (Silver-black polyethylene mulch), while minimum (286.67 kg ha^{-1}) was recorded in treatment T_3 (Yellow-black polyethylene mulch). The soil K_2O of the experimental plot before planting was (280.5 kg ha^{-1}).

4.7.5 Soil temperature (^0C)

4.7.5.1 Soil temperature (Morning)

The data pertaining to the mean soil temperature (Morning) as influenced by various treatments is presented in Table 15. The data revealed that there was significant difference in soil temperature (morning) due to various treatments. The maximum temperature (29.99 ^0C) was recorded in treatment T_1 (Black-black polyethylene mulch) and was at par with T_2 (29.04 ^0C) (Silver-black polyethylene mulch) and T_3 (28.52 ^0C) (Yellow-black polyethylene mulch) and significant over rest of the treatments. The minimum soil temperature (24.50 ^0C) was recorded in treatment T_7 (Control)

4.7.5.2 Soil temperature (Afternoon)

The data pertaining to the mean afternoon soil temperature as influenced by various treatments is presented in Table 15.

The data revealed that there was significant difference in soil temperature (Afternoon) due to various treatments. The mean maximum temperature (34.82 ^0C) was recorded in treatment T_1 (Black-black polyethylene mulch) and was at par with T_2 (34.07 ^0C) and significant over all other treatments. The minimum soil temperature (26.07 ^0C) was recorded in treatment T_7 (Control).

4.7.6 Soil moisture (%)

The data presented in Table 15 with respect to the soil moisture revealed significant differences due to the various treatments. The highest soil moisture (22.51 %) was recorded in treatment T_1 (Black-black polyethylene mulch) and was significantly superior to all other treatments. Minimum soil moisture (16.13 %) was recorded in treatment T_7 (Control).

Table No. 15 Effect of various mulches on soil temperature and soil moisture on chilli

Sr. No.	Treatment	Soil temp. (Morning) (^{0}C)	Soil temp. (Afternoon) (^{0}C)	Soil Moisture (%)
1.	**T_1** B-B. P. mulch	29.99	34.82	22.51
2.	**T_2** S-B. P. mulch	29.04	34.07	20.93
3.	**T_3** Y-B. P. mulch	28.52	33.27	20.13
4.	**T_4** Rice straw	26.25	29.60	18.60
5.	**T_5** Sugarcane trash	25.41	29.17	19.17
6.	**T_6** Dry grass	26.32	28.07	17.13
7.	**T_7** Control	24.50	26.07	16.13
	S. E ±	0.617	0.479	0.378
	C.D. at 5 %	1.902	1.533	1.164

4.7.7 Soil microflora (CFU/g)

4.7.7.1 Soil microflora (Fungi)

The results pertaining to the soil microflora (Fungi) of soil are presented in Table 16 and were found to be significant. However, the highest soil microflora (32.10 CFU × 10^{-5}/g) was recorded in treatment T_5 (Sugarcane trash) which was at par with treatment T_4 (Rice straw) (27.60 CFU × 10^{-5}/g) and lowest (20.10 CFU × 10^{-5}/g) was observed in treatment T_3 (Yellow-black polyethylene mulch).

4.7.7.2 Soil microflora (Bacteria)

The results pertaining to soil microflora (Bacteria) are presented in Table 16. The data with regards to soil microflora was non significant. However, the highest soil microflora

Table No. 16 Effect of various mulches on soil microflora (CFU/g) on chilli

Sr. No.	Treatment	Soil microflora (Fungi) (CFU × 10^{-5}/g)	Soil microflora (Bacteria) (CFU × 10^{-9}/g)
1.	**T_1** B-B. P. mulch	22.37	20.60
2.	**T_2** S-B. P. mulch	22.83	21.03
3.	**T_3** Y-B. P. mulch	20.10	19.33
4.	**T_4** Rice straw	27.60	27.90
5.	**T_5** Sugarcane trash	32.10	30.90
6.	**T_6** Dry grass	25.97	24.20
7.	**T_7** Control	21.90	22.97
	S. E ±	2.002	3.714
	C.D. at 5 %	6.006	N.S

(30.90 CFU × 10^{-9}/g) was recorded in treatment T_5 (Sugarcane trash mulch) while lowest (19.33 CFU × 10^{-9}/g) was noticed in treatment T_3 (Yellow-black polyethylene mulch).

4.8 Economics of different mulching treatments

The data in respect of economics of different mulching treatments in *summer* chilli is presented in Table 17. The total cost of cultivation was higher (Rs. 1,10,521 ha^{-1}) under T_2 (Silver-black polyethylene mulch) and the lower total cost of cultivation (Rs. 85,711 ha^{-1}) was obtained under T_7 (Control). The application of silver-black polyethylene mulch recorded the significantly highest net returns and B : C ratio (Rs. 2,49,029 and 3.25) and the lowest net returns and B : C ratio (1,30,499 and 2.24) was showed in yellow-black polyethylene mulch. Among the mulching treatments the higher gross returns (Rs. 3,59,550 ha^{-1}) was obtained under T_2 (Silver-black polyethylene mulch) and lower (Rs. 2,36,100) in T_3 (Yellow-black polyethylene mulch). It is indicated that the silver-black polyethylene mulch treatment was observed to be economically beneficial than other treatment. However, the organic mulches sugarcane trash mulch treatment found to be most profitable than other organic mulch treatments.

Table No. 17 Effect of mulches on cost of cultivation, net returns and B : C ratio of chilli

Treatment	Cost of cultivation (Rs.)					Marketable yield (t /ha)	Income		Cost : benefit ratio
	Common expenditure (Rs.)	Cost of mulching material (Rs.)	Cost of application of mulch (Rs.)	Cost of hand weeding (Rs.)	Total cost (Rs.)		Gross returns (Rs.)	Net returns (Rs.)	
T_1 B-B. P mulch	80021	24674	1920	-	106615	22.92	343800	237185	3.22
T_2 S-B.P. mulch	79871	28730	1920	-	110521	23.97	359550	249029	3.25
T_3 Y-B.P. mulch	80021	23660	1920	-	105601	15.74	236100	130499	2.24
T_4 Rice straw	81151	10000	3090	1900	96141	20.11	301650	205509	3.14
T_5 S. cane trash	81151	8750	3090	1900	94891	20.2	303000	208109	3.19
T_6 Dry grasses	81151	7500	3090	2280	94021	19.51	292650	198629	3.11
T_7 Control	81151	–	–	4560	85711	16.47	247050	161339	2.88
S. E ±								2763.3	
C.D. at 5 %								8515.3	

6. SUMMARY AND CONCLUSION

The present investigation entitled “Studies on effect of different mulches on growth and yield of chilli Cv. Phule Jyoti” was conducted during *summer,* 2013 at the Horticulture Farm, College of Agriculture, Kolhapur. The experiment was laid out in randomized block design with 7 treatments, replicated three times.

6.1 Summary

The important findings with regards to growth, flowering characters, shoot and root characters, yield contributing characters, quality parameters and different soil parameters of chilli crop in *summer* season are summarized here.

Maximum growth in respect of plant height was observed in silver-black polyethylene mulch (67.09 cm). Minimum (49.31 cm) plant height was observed in control at 135 DAT.

Maximum plant spreads in (E-W and N-S) were observed in silver-black polyethylene mulch (60.12 and 58.73 cm). While minimum plant spread in E-W direction was noticed in yellow-black polyethylene mulch (51 cm) and in N-S direction (51.07 cm) in control at 135 DAT.

Number of branches maximum in (21.42) was observed in silver-black polyethylene mulch. Minimum number of branches was noticed in yellow-black polyethylene mulch (13.57).

The minimum days to first flowering (46.00 days) was observed in silver-black polyethylene mulch and 50 per cent flowering was recorded under black-black polyethylene mulch

(67.67 days), while maximum days to first and 50 per cent flowering (53.33 and 76.67 days) in yellow-black polyethylene mulch.

Maximum (252.20) number of fruit per plant was observed in silver-black polyethylene mulch. While minimum (202.97) number of fruit per plant was observed in control.

The maximum fruit length and fruit girth (8.19 and 1.23 cm) was recorded in silver- black polyethylene mulch and minimum (7.10 and 0.82 cm) fruit length and fruit girth was recorded in the yellow-black polyethylene mulch.

The highest yield plant^{-1}, plot^{-1} and ha^{-1} (647.33 g, 31 kg and 23.97 t) was recorded in silver-black polyethylene mulch while lowest yield of fruit plant^{-1}, plot^{-1} and ha^{-1} (425.67 g, 20.41 kg and 15.74 t) was recorded in yellow-black polyethylene mulch.

The minimum number of days (66.00) for first picking was observed in black-black polyethylene mulch, which was closely followed by silver-black polyethylene mulch (66.33). Maximum number of days for first picking was recorded in yellow-black polyethylene mulch (73.33).

The maximum number of days for last picking was recorded in silver-black polyethylene mulch (161.33), while minimum number of days for last picking was recorded in control (135.00), which was closely followed by yellow-black polyethylene mulch (135.33).

The highest fresh weight of shoot and root (329.60 and 77.20 g) and dry weight of shoot and root (143.97 and 31.60 g) was recorded in silver-black polyethylene mulch while lowest

fresh weight of shoot and root (151.57 and 35.04 g) and dry weight of shoot and root (60.80 and 15.80 g) was recorded in yellow-black polyethylene mulch.

The lowest incidence of thrips, aphids and leaf curl (0.27, 0.34 and 0.67 %) was noticed in silver-black polyethylene mulch. The highest (1.73, 1.10 and 4.43 %) was observed in control.

The maximum leaf area per plant at 135 DAT (2570.30 cm^2) was recorded under in silver-black polyethylene mulch. The minimum leaf area per plant at 135 DAT (1722.27 cm^2) was recorded in yellow-black polyethylene mulch.

The highest chlorophyll content in leaves (2.83 mg/100 g) was recorded in silver-black polyethylene mulch and lowest (1.17 mg/100 g) was observed in yellow-black polyethylene mulch.

The results with regards to soil pH, electrical conductivity and organic carbon were non significant. However, available N:P:K was slightly increased as compared to initial available N:P:K in soil.

Maximum soil temperature in morning and afternoon (29.99 ^{0}C and 34.82 ^{0}C) was recorded in black-black polyethylene mulch and was closely followed by silver-black polyethylene mulch (29.04 ^{0}C and 34.07 ^{0}C). The minimum soil temperature in morning and afternoon (24.50 ^{0}C and 26.07 ^{0}C) was recorded in control.

The maximum soil moisture (22.51%) was recorded in black-black polyethylene mulch and minimum (16.13%) was recorded in control.

The highest soil microflora (Fungi) (32.10 CFU × 10^{-5}/g) was recorded in sugarcane trash mulch and lowest (20.10 CFU × 10^{-5}/g) was observed in yellow-black polyethylene mulch.

The results with regards to soil microflora bacteria was found to be non significant.

The highest net returns (Rs 2,49,029) and highest B : C ratio (3.25) was obtained in silver-black polyethylene mulch while the lowest (Rs. 1,30,499) and lowest B : C ratio was recorded in yellow-black polyethylene mulch.

6.2 CONCLUSION

- From the present investigation, it may be concluded that mulching in chilli had significant response on growth, yield, quality and profitability. Among the different mulches (organic and inorganic) silver-black polyethylene mulch sheet showed overall excellent performance in respect of growth characters and yield.
- The soil moisture and soil temperature was maximum in black-black polyethylene mulch followed by silver-black polyethylene mulch. The silver-black polyethylene mulch has reflective effect and reduces the incidence of sucking pests and diseases.
- The highest net returns and B : C ratio during *summer* season was observed in silver-black polyethylene mulch. Thus on account of higher yield potential and higher cost : benefit ratio, silver-black polyethylene mulch showed higher promise for *summer* chilli cultivation.

- Considering the overall performance the silver-black polyethylene mulch showed better performance during *summer* season for chilli cultivation.
- The above finding based on one year data and it seems worth while to continue exploration at different locations and different crops in this field in future for confirmation of the above findings.

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8. APPENDICES

Meteorological data recorded during period of investigation

Meteorological week	Temperature (ºC)		Relative humidity (%)		Rainfall (mm)	No. of rainy days
	Max.	Min.	Morn.	Even.		
1.	31.5	13.9	88	36	00.0	00
2.	30.9	11.8	87	42	00.0	00.0
3.	31.6	11.9	90	31	00.0	00.0
4.	31.4	12.3	88	30	00.0	00.0
5.	31.3	13.3	89	36	00.0	00.0
6.	31.0	14.4	94	36	00.0	00.0
7.	32.4	15.3	90	40	00.0	00.0
8.	33.7	14.3	84	29	00.0	00.0
9.	33.9	15.2	87	26	00.0	00.0
10.	35.5	18.0	87	25	00.0	00.0
11.	35.1	18.4	89	25	04.5	01
12.	35.1	16.8	83	22	00.0	00.0
13.	36.3	19.2	86	27	00.0	00.0
14.	36.9	17.8	82	21	00.0	00.0
15.	38.4	19.7	81	20	00.0	00.0
16.	35.7	17.7	84	26	00.0	00.0
17.	37.6	21.8	85	29	03.5	01
18.	38.1	21.9	83	32	00.0	00.0
19.	37.3	22.4	86	34	00.0	00.0
20.	35.8	22.6	84	42	00.0	00.0
21.	35.6	23.1	86	44	5.1	01
22.	34.2	22.6	90	47	41.6	03
23.	30.1	21.1	91	67	36.1	02
24.	27.3	21.2	88	83	64.4	04
25.	27.2	20.9	91	84	37.3	02

Different input prices used for calculating cost of cultivation

Sr. No.	Particulars	Rate (Rs.)
1.	Labour charges M/F	190 day^{-1}
2.	Bullock charges	600 day^{-1}
3.	Preparation cost per seedlings	1.5
4.	Urea	563 q^{-1}
5.	Single super phosphate	750 q^{-1}
6.	Murate of potash	1,675 q^{-1}
7.	FYM	1,500 t^{-1}
8.	Land revenue	480 ha^{-1}
9.	Tractor (Ploughing)	1,200 ha^{-1}
10.	Irrigation charges	1200 ha^{-1}
11.	Interest on fixed capital (6%)	15,000
12.	Rate of green chilli	15^{-1} kg

Sr. No.	Particulars	Quantity (kg/ha)	Rate (Rs.)
1.	Black polyethylene mulch	169	146^{-1} kg
2.	Silver polyethylene mulch	169	170^{-1} kg
3.	Yellow polyethylene mulch	169	140^{-1} kg
4.	Rice straw	5000	2^{-1} kg
5.	Sugarcane trash mulch	5000	1.75^{-1} kg
6.	Dry grasses	5000	1.50^{-1} kg

9. VITA

MR. MEHETRE YOGESH DATTATRAYA

A candidate for the degree of

MASTER OF SCIENCE (HORTICULTURE)

In

VEGETABLE SCIENCE

2014

Title of the Thesis	:	"Studies on effect of different mulches on growth and yield of chilli (*Capsicum annuum* L.) Cv. Phule jyoti"
Major Field	:	Horticulture

Biographical information

Personal	:	Born on 19th July, 1990 at Karjat, Tal. Karjat, Dist. Ahmednagar, Maharashtra state, India. Son of Shri. Dattataraya Dyneodev Mehetre and Sou. Sangita Dattataraya Mehetre.
Educational	:	Attended primary education at Zilla Parishad Prathamik Shala , Tal. Karjat, and secondary education at Mahatma Gandhi Vidhyalaya High School and higher secondary education Samarth Junior College, Tal. Karjat, Dist.

Ahmednagar, Maharashtra.

Completed B.Sc. (Agri). course at K.K.Wagh College of Agriculture, Nashik from 2008 to 2012 under Mahatma Phule Krishi Vidyapeeth, Rahuri.

Thesis for Master in Science (Horticulture) degree, in Vegetable Science is being submitted to the College of Agriculture, Kolhapur (Mahatma Phule Krishi Vidyapeeth, Rahuri).

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