STUDY ON USE OF MULCHES IN SUMMER GROUNDNUT (*Arachis hypoagea)* PRODUCTION

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ABSTRACT

A field trail was conducted to study the effect of different mulches on groundnut production. The experiment was laid out in six replications. The crop was watered with border irrigation method. During the trial the effect of mulches on soil and crop parameters were recorded. Soil temperature and soil moisture increased for the plants grown under mulch treatments. Temperature increased by 4 to 5^{o}C and moisture retained in the soil was increased by 14.83 to 33.54 per cent at 5 cm depth and 12.86 to 24.56 per cent at 10 cm depth as compared to bare soil treatment. The dry weight of weeds could be reduced 21 to 37.89 per cent over bare soil treatment. The yield of crop was increased by 38.88 per cent for plastic mulch treatments over bare soil (control). The biodegradable plastic mulch did not deteriorate throughout the crop season, but its strength was reduced and could be torn into pieces easily.

KEY WORDS: Bare soil, groundnut, mulch

INTRODUCTION

Groundnut is a rich source of energy due to its high oil and protein content. India accounts for 40% of the world area and 30% of the world output of the groundnut (Anonymous, 2010). However, the average yield is very low. The major groundnut growing states are Gujarat, Andhra Pradesh, Tamilnadu, Haryana and Maharashtra. In Gujarat, it is mainly grown in Junagadh, Bhavnagar and Jamnagar districts. Any material that is applied on the soil surface to check evaporation and improve soil water is called Mulch. Application of mulches results in additional benefits like soil conservation, moderation of temperature, reduction in soil salinity, weed control and improvement of soil structure. Plastic mulches are now available in different colours and thickness. The use of plastic mulch has become a standard practice for farmers. Black plastic mulch is the most commonly used synthetic mulch. However, plastic mulches have a negative impact on the environment. They are made from non-renewable resources and disposal usually involves taking the plastic to a wasteland which is expensive and also it persists for many years after disposal. Biodegradable mulch films, made from renewable resources, can be used. They are converted through microbial activity in the soil to carbon dioxide, water and natural substances; eliminating the need to pick up and dispose at the end of the season. Hence, this study was undertaken to determine the length of time the biodegradable mulch will last in the field, its effect on soil and crop parameters.

Chakravarti *et. al.* (2005) studied the efficacy of some bio-resources as mulch for

soil moisture conservation. They reported that water-hyacinth mulch conserved more soil moisture than the other mulches. Chen *et. al.* (2007) studied the effects of straw mulching on soil temperature, evaporation and yield of winter wheat. The results showed that the existence of straw on the soil surface reduced the maximum, but increased the minimum diurnal soil temperature. Rodriguez (2007) studied the effect of rice bran mulching on growth and yield of cherry tomato. The highest total fruit production (3.4 kg/plant) was obtained with the rice straw and bran treatment. Karaye and Yakubu (2007) studied the influence of intra-row spacing and mulch on weed growth and yield of garlic in Sokoto, Nigeria. Based on the results obtained, it was concluded that for optimum bulb yield in garlic, the intra-row spacing of 10 cm and 9 t/ha mulching rate should be adopted.

MATERIALS AND METHODS

The field experiment was conducted at the research and experimental farm, Department of Soil and Water Engineering, Junagadh Agricultural University, Junagadh. The experiment was laid out with four treatments (Normal plastic mulch - T_1, Bio-degradable plastic - mulch - T_2, Wheat Straw mulch - T_3 and bare soil - T_4) in six replications. The study was conducted in medium black soil for GG-6 variety of summer groundnut crop. The gross area of a treatment was (6 x 4.5) m and net area was taken (5 x 3.6) m. The area of a replication was (6 x 19) m, while that of whole plot was (13 x 59) m. The ultra thin sheet of 20 micron thickness and (7x1.2) m size with defined edges and shape based on the width of the bed was selected. The strips of 10 cm width were cut on the sheets so as to leave uncovered soil to irrigate the crop and also for easy pegs penetration in to the soil. The polyethylene sheets already prepared were spread in the field so that these are completely adhered to the soil surface. The edges of the film were properly buried on either side of the bed to make sure that the film didn't get blown away by the wind. The seeds of groundnut GG-6 were treated with Thirum at 3g/kg of seeds to check seed-borne diseases. Recommended dose of fertilizer (N_2: 25 kg/ha; P_2O_5: 50 kg/ha; K_2O: 0 kg/ha) was applied as a basal dose before sowing through DAP (108 kg/ha) and Urea (12 kg/ha). The seeds of groundnut were sown into the soil through the 10 cm wide strips that were cut on the polyethylene sheets. The spacing between rows and plant to plant was kept 30 cm and 10 cm, respectively. The irrigations were applied through Border irrigation system. Total seventeen irrigations were given to the crop before it was harvested. Weeding was done manually in all the treatments and weeds were collected in labeled polythene bags. The weight of each bag containing dry weeds was determined in g/m^2 using electronic weighing balance. Similarly, the number of weeds per square metre in each treatment was determined. For the measurement of crop parameters such as plant height, number of pods per plant and weight of pods per plant, ten (10) plants from each treatment of all the replications were selected randomly just after harvesting of the crop. To determine the plant population at initial and harvest stage, number of plants were selected from 1 sq .m area from all the treatments. To find out yield of crop, weight of pods of all replications for a particular treatment was measured and then using the following relationship yield of crop was worked out.

$$\textit{Yield}\ \text{of crop (kg/ha)} = \frac{\text{Yield (kg) from treatment} \times 10000}{\textit{Area}\ \text{of the treatment}\ (\text{m}^2)}$$

The yield of haulm was obtained in a similar way as that of pods. The weight of haulm obtained from all replications for a particular treatment was measured and the yield was worked out as

$$\text{Yield of haulm (kg/ha)} = \frac{\text{Yield of haulm (kg) from treatment} \times 10000}{\text{Area of the treatment (m}^2\text{)}}$$

To find out the moisture of the experimental plot, soil samples were collected from 50 mm and 100 mm depth using augur before irrigation each time and the soil moisture was determined on dry basis in percentage by Oven drying method. Soil temperature was recorded in degrees Celsius (^{0}C) at 13.00 hrs during the crop period at the time of collection of soil samples at soil surface, 50 mm and 100 mm depth with digital temperature indicator.

RESULTS AND DISCUSSION

Dry weight of weeds

The results indicated that dry weight of weeds was maximum (28.5 g/m^2) in bare soil (control) and in normal plastic, biodegradable plastic and wheat straw mulches was reduced by 21 %, 36.14 % and 37.89 %, respectively as compared to bare soil. The dry weight of weeds in normal plastic, biodegradable plastic and wheat straw mulch was found 22.5, 18.2 and 17.7 g/m^2, respectively (Figure 1).

Number of weeds

The number of weeds in bare soil treatment was higher (15/m^2) as compared to 13, 11 and 10 weeds/m^2 in normal plastic, biodegradable plastic and wheat straw mulch, respectively. Thus, the reduction in number of weeds in normal plastic, biodegradable plastic and wheat straw mulch was found 13.3 %, 26.6 % and 33.33 %, respectively as compared to bare soil treatment. The reason for less number of weeds in mulched treatments may be the unavailability of solar radiation to the weeds due to which their metabolic activities were reduced and the growth was checked as in absence of solar radiation the weeds were unable to do photosynthesis (Figure 2). Similar results are reported by Ramakrishna *et. al.* (2006).

Plant population at initial and harvest stage

The initial plant population/m^2 was recorded 51, 50, 49 and 50 for normal plastic, biodegradable plastic, wheat straw and bare soil treatment, respectively, while at the time of harvesting, it was found 49, 48, 48 and 46 for normal plastic, biodegradable plastic, wheat straw and bare soil treatment, respectively. Thus, plant population was decreased by 3.29 % in normal plastic, 4 % in biodegradable plastic, 2.09 % in wheat straw and 8 % in bare soil treatment. The reduction in number of plants during the crop period was more in bare soil treatment as compared to other treatments while the reduction in number of plants was minimum (2.09 %) in wheat straw mulch (Figure 3).

Plant height

The height of plants grown under normal plastic mulch was maximum (255.3 mm) followed by biodegradable plastic mulch (246 mm) and wheat straw mulch (239.7 mm). The height of plants grown in bare soil treatment was found minimum (187 mm). The reason behind may be the plants grown under normal plastic mulch and biodegradable plastic mulch treatment get more nutrients for their growth because of less number of weeds. Secondly, the plants in the mulched treatments get sufficient moisture while plants under bare soil are affected by burning injury due to less moisture availability (Figure 4).

Number of pods per plant

The number of pods per plant was highest (7.3) in case of biodegradable plastic, followed by wheat straw mulch (6.7), normal plastic mulch (6.0). The number of pods per plant was found minimum in bare soil treatment (4.8). The number of pods per plant in biodegradable plastic increased by 52.08 % while in wheat straw and normal plastic mulch treatments it increased by 39.58 % and 25 %, respectively as compared to bare soil (Figure 5).

Weight of pods per plant

The weight of pods per plant was highest (5.2 g/plant) in biodegradable plastic mulch followed by wheat straw (4.6 g/plant),

normal plastic mulch (4.4 g/plant) and bare soil (3.8 g/plant). The increase in the weight of pods per plant in biodegradable plastic mulch was highest (36.84 %) followed by wheat straw mulch (21.05 %) and normal plastic mulch (15.78 %) as compared with bare soil treatment. The reason for increase in weight of pods may be the availability of sufficient quantity of plant nutrients and soil moisture (Figure 6).

Weight of pods per plot

The weight of pods per plot was recorded 3100 g in both, normal and biodegradable plastic mulch treatments followed by wheat straw (3000 g/plot) and bare soil (2233 g/plot). The increase in weight of pods per plot was found to the tune of 38.82 % for normal plastic and biodegradable plastic mulch treatments and 34.34 % for wheat straw mulch as compared to bare soil treatment (Figure 7).

Yield of pods

The Yield of pods was recorded 1722.10 kg/ha for both normal and biodegradable plastic mulch treatments followed by wheat straw mulch (1666.5 kg/ha) and bare soil treatment (1240.7 kg/ha). The increase in yield of pods per hectare was found 38.88 % in case of normal plastic and biodegradable mulch treatments and 34.23 % for wheat straw mulch as compared to the yield obtained in bare soil treatment (Figure 8). Similar result has been reported by Dutta (2006).

Yield of haulm

Haulm obtained in normal plastic mulch was highest (8647.3 kg/ha) followed by biodegradable plastic mulch (7443.7 kg/ha), wheat straw mulch (6758.6 kg/ha) and bare soil treatment (6164.5 kg/ha). The increase in the yield of haulm was found 40.27 % for normal plastic mulch while in case of biodegradable plastic mulch and wheat straw mulch the increase in yield of haulm was found 20.75 % and 9.63 %, respectively, as compared to bare soil treatment (Figure 9).

Soil moisture

The soil moisture was calculated on dry basis. The results recorded for soil moisture at 5 cm depth indicate that highest (20.7 %) soil moisture was recorded for wheat straw mulch followed by normal plastic mulch (19.2 %) and biodegradable plastic mulch (17.8 %). The soil moisture was found minimum for bare soil treatment (15.5 %). Thus, the soil moisture retention at 5 cm depth was increased by 33.54 % for wheat straw mulch, 23.87 % for normal plastic mulch and 14.83 % for biodegradable plastic mulch as compared to bare soil treatment. Data recorded for 10 cm depth also showed that highest moisture retention (21.3 %) was in wheat straw mulch. At 10 cm depth, biodegradable plastic mulch retained higher moisture (20.6 %) than normal plastic mulch (19.3 %). The soil moisture was found minimum (17.1 %) for bare soil treatment. Thus, the soil moisture retention at 10 cm depth was increased by 24.56 % for wheat straw mulch, 20.46 % for biodegradable plastic mulch and 12.86 % for normal plastic mulch as compared to bare soil treatment. Higher moisture content was recorded at 5 cm depth as compared to 10 cm depth. Similar results have been reported by Pawar (2004). The reason for increase in soil moisture under mulching may be due to the reduced evaporation through soil surface and lesser transpiration through weed plants (Figure 10).

Soil temperature

From the results it was observed that soil surface temperature was highest (36.9^{o}C) for normal plastic mulch and biodegradable plastic mulch followed by wheat straw mulch (33.8^{o}C). The temperature at soil surface for bare soil treatment was recorded least (31.2^{o}C). Thus, it can be said that the temperature was higher for mulched treatment compared to bare soil treatment. The reason for increase in soil temperature at surface may be due to absorption of solar radiation by plastic mulch film which ultimately heats up the soil. Data of soil temperature obtained at 5 cm depth showed that maximum temperature (33.0^{o}C) was found under normal plastic mulch followed

by biodegradable plastic mulch (32.9°C) and bare soil treatment (31.0°C), the temperature was recorded minimum (29.3°C) for wheat straw mulch. At 10 cm depth, higher temperature (31.2°C) was observed for biodegradable plastic mulch followed by normal plastic mulch (31.0°C), bare soil treatment (30.0°C) and wheat straw mulch (28.2°C). Thus, it was observed temperature at 5 cm depth was higher than temperature at 10 cm depth. The reason for increased soil temperature at upper 5 cm layer may be due to absorption of solar radiation by black plastic mulch which ultimately heats up the soil. Similar results were recorded by Warner and Zandstra (2004) (Figure 11).

Mulch degradation

The biodegradable plastic mulch remained in the field for 112 days and it was observed that the film provided 100 % cover to the crop without showing any kind of holes or tears in the mulch film till the crop was harvested. However, the film could be torn into pieces easily which shows that the strength of the film during this period is reduced. The film may require more time for complete degradation.

CONCLUSION

The major conclusions drawn from the present study are:

- The dry weight of weeds was maximum (28.5 g/m^2) in bare soil (control). Whereas the dry weight of weeds in normal plastic, biodegradable plastic and wheat straw mulch was found 22.5, 18.2 and 17.7 g/m^2, respectively. The number of weeds in bare soil treatment was higher (15/m^2) as compared to 13, 11 and 10 weeds/m^2 in normal plastic, biodegradable plastic and wheat straw mulch, respectively.
- The plant population was decreased by 3.29 % in normal plastic, 4 % in biodegradable plastic, 2.09 % in wheat straw and 8 % in bare soil treatment.
- The height of plants grown under normal plastic mulch was maximum, followed by biodegradable plastic mulch and wheat straw mulch. The height of plants grown in bare soil treatment was found minimum.
- The number of pods per plant was highest in case of biodegradable plastic, followed by wheat straw mulch, normal plastic mulch. The number of pods per plant was found minimum in bare soil treatment.
- The weight of pods per plant was highest in biodegradable plastic mulch followed by wheat straw, normal plastic mulch and bare soil.
- The weight of pods per plot was recorded highest in both, normal and biodegradable plastic mulch treatments followed by wheat straw and bare soil.
- The Yield of pods was recorded highest for both normal and biodegradable plastic mulch treatments followed by wheat straw mulch and bare soil treatment.
- Haulm obtained in normal plastic mulch was highest followed by biodegradable plastic mulch, wheat straw mulch and bare soil treatment.
- Soil moisture at 5 cm depth was highest for wheat straw mulch followed by normal plastic mulch and biodegradable plastic mulch with lowest retention in bare soil. Data recorded for 10 cm depth also showed that highest moisture retention was in wheat straw mulch. At 10 cm depth, biodegradable plastic mulch retained higher moisture than normal plastic mulch with bare soil having a lowest retention.

- From the results it was observed that soil surface temperature was highest for normal plastic mulch and biodegradable plastic mulch followed by wheat straw mulch and bare soil. Data of soil temperature obtained at 5 cm depth showed that maximum temperature was found under normal plastic mulch followed by biodegradable plastic mulch and bare soil treatment, the lowest being for wheat straw mulch. At 10 cm depth, higher temperature was observed for biodegradable plastic mulch followed by normal plastic mulch, bare soil treatment and wheat straw mulch.
- Though, the yield of pods was same in both treatments – normal plastic mulch and biodegradable plastic mulch – the biodegradable mulch has another advantage of being environment-friendly and thus can be used further by ploughing back in the soil without any harm to the soil.

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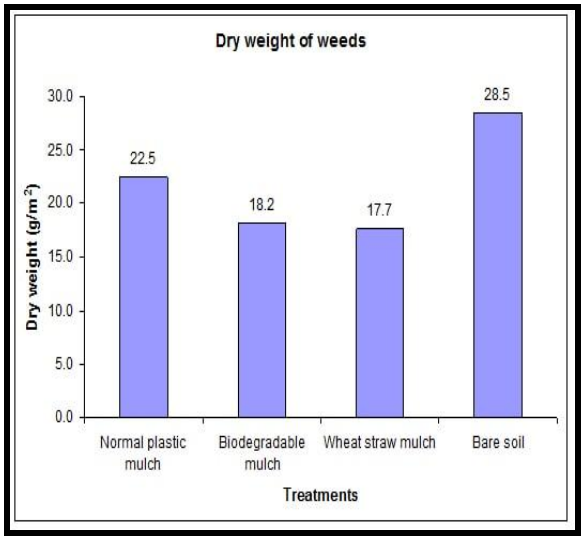

Figure 1: Dry weight of weeds under different mulching

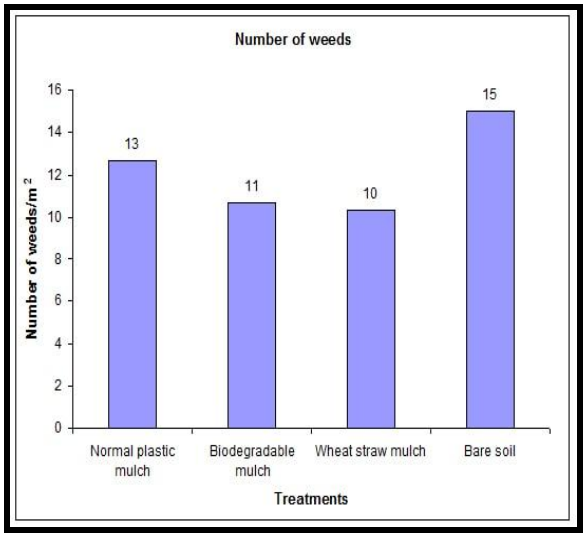

Figure 2: Number of weeds under different mulching

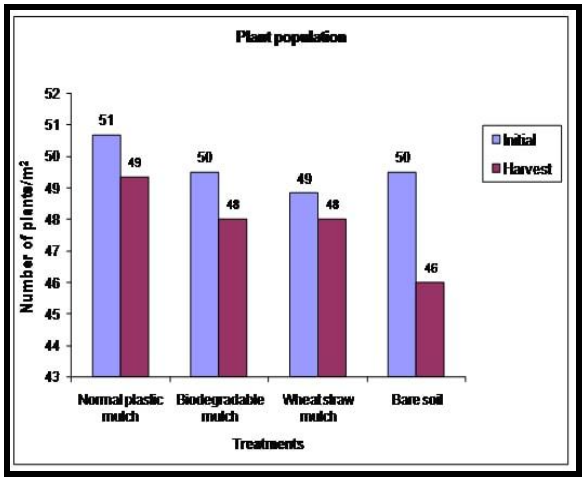

Figure 3: Plant population (Initial and at harvest)under different mulching

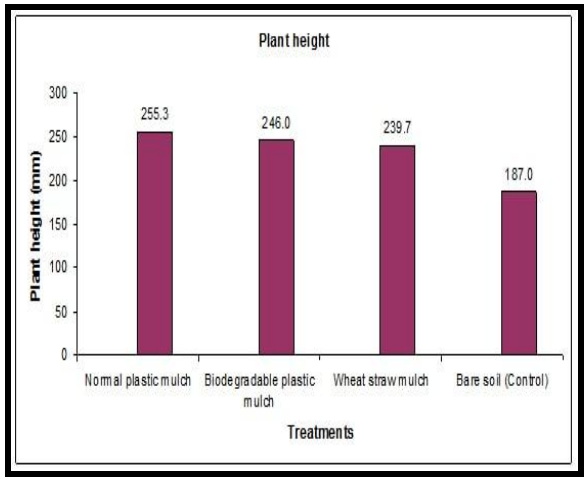

Figure 4: Plant height under different mulching

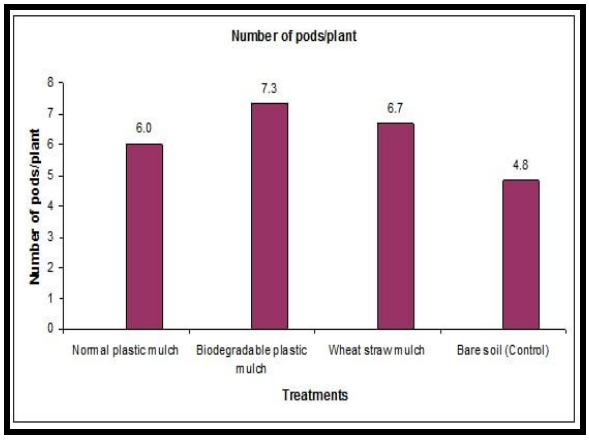

Figure 5: Number of pods per plant under different mulching

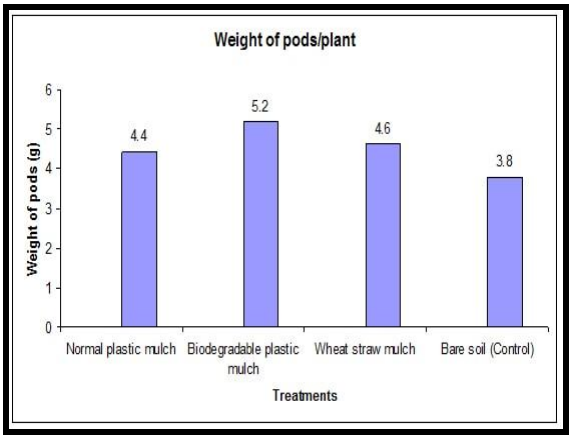

Figure 6: Weight of pods per plant under different mulching

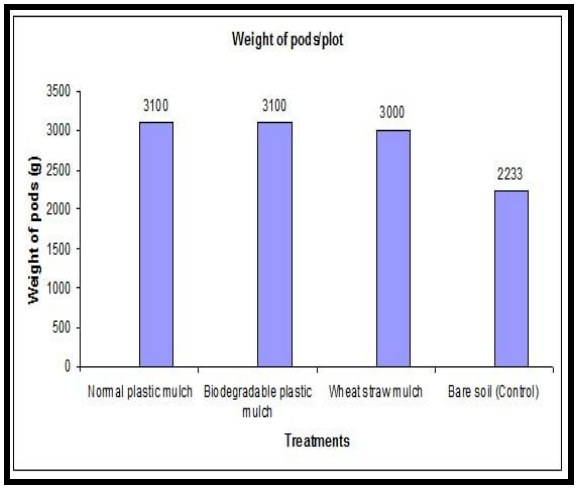

Figure 7: Weight of pods per plot under different mulching

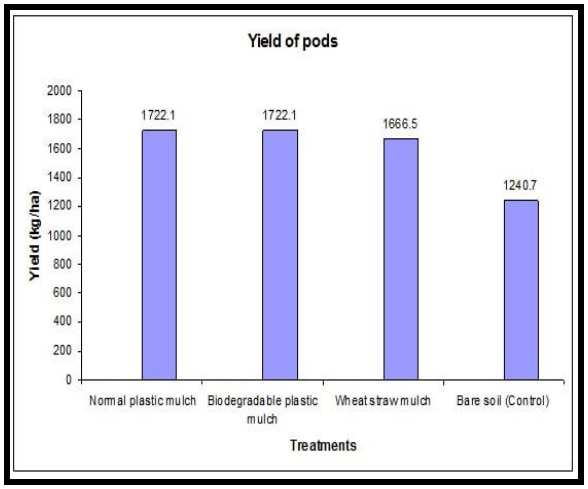

Figure 8: Yield of pods under different mulching

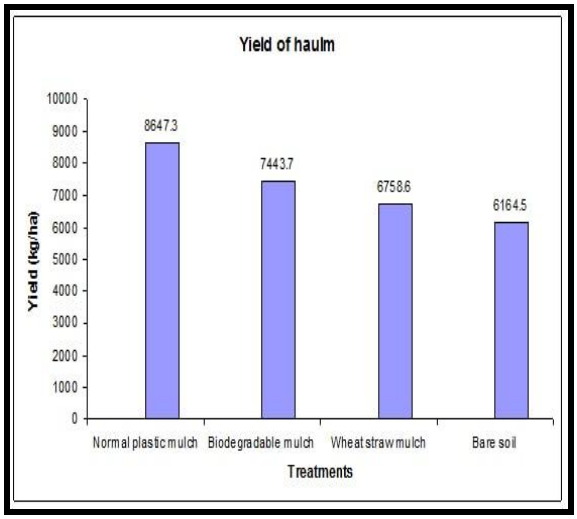

Figure 9: Yield of haulm under different mulching

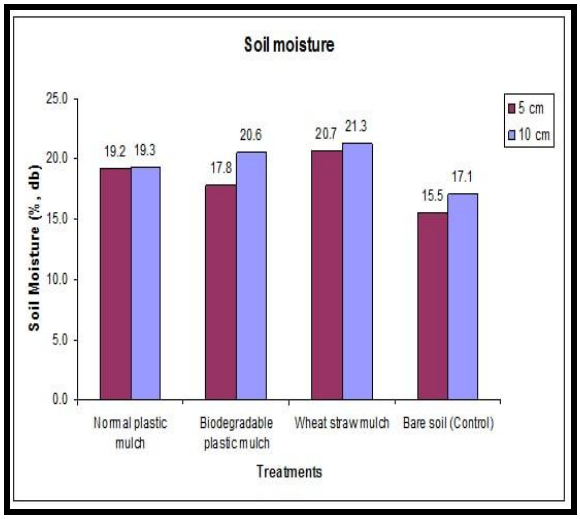

Figure 10: Soil moisture under different mulching

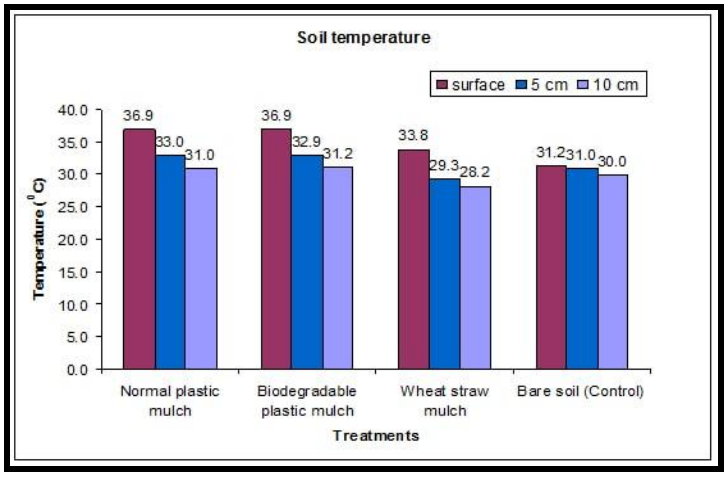

Figure 11: Soil temperature under different mulching

[MS received: November 11, 2016] *[MS accepted: December 17, 2016]*