MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Open Access Journal of Agricultural Research
ISSN: 2474-8846

# Effect of Organic and Synthetic Mulches on Soil Temperature, Nutrient Availability and Yield of Squash

**Mondol ATMAI[1], Alam MJ[1]*, Naser HM[1], Salahin N[2], Alam MK[3], Akter M[1] and Ferdous AKMRH[4]**

[1]Soil Science Division, Bangladesh Agricultural Research Institute, Bangladesh
[2]Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Bangladesh
[3]Soil Science Division, Natural Resource management, Bangladesh Agricultural Research Council, Bangladesh
[4]Entomology Division, Bangladesh Agricultural Research Institute, Bangladesh

**Research Article**
**Volume 7 Issue 2**
**Received Date:** August 08, 2022
**Published Date:** August 18, 2022
DOI: 10.23880/oajar-16000292

***Corresponding author:** Md. Jahangir Alam, Soil Science Division, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh, Email: jahangirssd2013@gmail.com

## Abstract

The field experiment was conducted on squash cv. Bulam house at Central Research Farm, Bangladesh Agricultural Research Institute, Gazipur under AEZ-28 during rabi season of 2019-2020 and 2020-2021 to study the effect of organic and synthetic mulches on soil temperature, nutrient availability and yield of squash.The treatments were T1: control, T2: black polyethylene mulch, T3: white polyethylene mulch and T4: rice straw mulch. The experiment is laid out in a Randomized Complete Block Design (RCBD), where each treatment was replicated thrice. Data on growth and yield attributes of squash were collected during the crop growing season and after harvesting. Soil temperatures were differentially affected by the type of polyethylene mulch, with temperatures generally following the order: white polyethylene mulch>rice straw mulch>black polyethylene mulch. All plant growth characters, yield and yield contributing characters were superior with white polyethylene relative to grown without mulch (control). Treatment T3 (white polyethylene mulch) resulted in increased single fruit weight (kg) of squash than control. Fruit yield was also increased when grown in soil under white polyethylene mulch i.e. 37.6 tha-1. White polyethylene mulch had 282 % increase in yield per ha over control. The higher yield was associated with higher soil temperature in white polythene mulch compared to other mulches during crop growing period

**Keywords:** Mulching; Soil Moisture; Soil Temperature; Yield of Squash

**Abbreviations:** T: Treatment; AEZ: Agro-ecological Zone;
Kg: Kilo-gram; T: Ton; HA: hectare.

## Introduction

Squash is one of the most important cucurbitaceous vegetable crops. Squash belongs to cucurbitaceous family. Squash is a nutrient rich vegetable. If grown without reliable irrigation supply during the dry season they usually succumb to large yield losses. However, water use of the crops may be greatly lowered by mulching to conserve soil moisture. This can be an important practical aid in water and fertilizer saving and to minimize the cost of water and fertilizer fees for the resource poor farmers. Increased soil–water storage due to mulching could also help increase the availability of nutrients and uptake of nutrients by plant roots. The growth of the vegetable market even during the dry season and the improved nutritional awareness of people, have attracted farmers to bring greater areas under vegetable farming in winter season in plain areas of Bangladesh. However, dry weather during this season creates a condition of water scarcity for many crops requiring frequent irrigation. Several studies reported mulch to conserve soil moisture and improve crop yield.

Mulching, a beneficial practice for crop production, manipulates soil physical, chemical and biological properties [1]. Soil temperature can be regulated by mulch to a great extent which eventually influence release of nutrients, particularly, C and N. The difference in soil temperature between mulched and bare soil, plastic mulch transmits 85-95 percent solar radiation and raises day soil temperature (4.4-7.8 oC)[2]. Bhardwaj [3] stated that the plastic mulch played a vital role for increasing soil warmness in some in some areas for its cold weather. Aber and Melillo [4] stated that soil N transformations involve biological processes that are temperature dependent. Particular temperature controls net N mineralization and nitrification. Elevated temperatures dramatically accelerate decay. A rule of thumb is that decay rates double for every 18ºF increase in temperature. An understanding of temperature effects on decomposition can help to predict mineralization during crop growing period. Rates of C and N mineralization were insensitive to temperature between 3° and 9°C but increased by factors of 2 or more between 9° and 15°C. For example, mineralization of straw N at 7.2 and 22°C was about the same but at 37oC mineralized N appeared to be lost, possibly as gaseous N. Soil inorganic N content increased with increasing temperature, as did the native soil carbon loss. But these research results were reported mostly from works done in winter regions, what happens to temperature and nutrient release in the subtropical regions that has seasonal varied temperatures has not been studied yet. Environmental factors strongly influence the rate of soil organic matter decomposition, and temporal fluctuations in soil microbial biomass, soil enzyme activities and levels of available nutrients in the soil have been observed in a number of studies [5,6]. Roots have access to adequate oxygen and microbial activity is enhanced resulting in encouraged of plant growth [7]. Polyethylene mulches which can control the environmental factors have produced large increases in crop growth and yields from a variety of crops. Improved soil moisture status and increased soil temperatures can also affect soil fertility by influencing the biological activity in soils and, thus, mineralization rates. Thus, a mulching experiment under field conditions can measure temperature fluctuations and eventual changes in soil physico-chemical properties under different mulches. Therefore, this study was undertaken to determine the effects of different mulches on soil temperature and to observe the changes in soil moisture and trend of nutrient availability as governed by organic and synthetic mulches.

## Materials and Methods

### Description of the Study Area

A field experiment was conducted at Central Research Farm, BARI, Gazipur during 2019-2020 and 2020-2021.The experimental site located at the centre of the agro-ecological Zone of Madhupur tract (AEZ-28) at about 24° 23’ N latitude and 90° 07’ E longitude having a means of elevation 8.4 m above sea level. The soils belong to Chhiata series of the Grey terrace soils (Aeric Albaquept) onder the order of Inceptisols in the USDA Soil Taxonomy [8].

### Treatments and Experimental Design

There were four treatments i.e.T1: Control, T2: Black polyethylene mulch, T3: white polyethylene mulch and T4: Rice straw mulch. The experiment was laid out in randomized complete block design (RCBD) with 3 replications of each treatment.

### Description of the Experimental Materials

The crop was squash used in the experiment and the variety was Bulam house.

### Land preparation, fertilizer application and sowing

Experimental land was tilled with power tiller maintaining 6-8 cm depth and made plot size with 2 m x 2 m. In each plot fertilizer was applied at recommended dose i.e. NPKB @ of 230-80-150-0.3 kg ha-1 was used per STB BARC [9]. Cowdung @ 10 tons ha-1was applied during final land preparation. All PB, 1/2 K and 1/5 N was incorporated into soil before sowing. In each plot made two pits with 30cmx30cmx30cm size. Three seeds were sown in a pit on17 December of both 2019 and 2020 and finally kept single plant.


Copyright© Alam MJ, et al.

### Fertilizer Top Dressing and Intercultural Operations

The rest K was applied 25 days after seed germination and N was top dressed in four equal splits at 20 days interval after germination. After establishment of the seedlings, plants were mulched on 01 January, 2020 and 31 December, 2020 for both years. Irrigations were applied during fertilizer application with two extra irrigations. Two mulching and wedding operations were done.

### Soil Sampling and Analysis

The initial and final collected soil samples were dried at room temperature mixed thoroughly, grinded, sieved with a 2 mm sieve and preserved in plastic containers for subsequent laboratory analysis. Soil samples used were then analyzed for SOM, total N and available P. The SOM was determined by wet oxidation [10], total N by a modified Kjeldahl method [11] and total P by using the SnCl2 reduction method [12]. pH was determined through glass electrode pH meter method [13], K and S were determined through NH4OAC method [14] and turbidimetric method Sperber, 1948, respectively. Micronutrients were analyzed using atomic absorption spectrophotometer. Particle size distribution of the initial soil was analyzed by the hydrometer method [12] and the textural class was determined using the USDA texture triangle. The Bulk density of the soil samples were determined by core sampler method [15]. Moisture content was determined by gravimetric method [12]. Field capacity was done though pressure plate method. The initial results of some important soil physical and chemical properties are in Tables 1a & b.

| Soil depth | Bulk density | Soil Moisture content | Field capacity | Textural class |
|---|---|---|---|---|
| | (g $cm^{-3}$) | | | |
| 0-15 cm | 1.52 | 18.4 | 28.4 | Clay loam |

Initial soil physical properties (0-15 cm).

| Soil depth | pH | OM | Total N | K | P | B |
|---|---|---|---|---|---|---|
| (0-15cm) | | (%) | | meq 100 $g^{-1}$ | µg $g^{-1}$ | |
| Initial | 6.1 | 1.08 | 0.054 | 0.1 | 10 | 0.18 |
| Critical level - | | - | - | 0.12 | 10 | 0.2 |
| Interpretation | | Low | V. low | Low | Low | Low |

Chemical properties of the initial soil (0-15 cm)

**Table 1:** Physical and chemical properties of the experimental site during December, 2019.

### Data Collected

Soil samples for moisture content determination were collected from each plot, from sowing to harvesting of squash according to treatment. Soil temperature was also monitored. Fruits are harvested when they were still tender and of marketable size. The harvesting was started on 01 February 2021. Plant height, number of leaves plant-1, number of fruits plant-1, average fruit weight, fruit length and finally fruit yield.

### Weather Data

Monthly weather data was recorded during the crop growing period of 2019-2020 and 2020-2021 and were calculated monthly average weather data tabulated in the Tables 2 & 3.

| Month | Temperature (°C) | Evaporation (mm) | RH (%) | Wind Speed (km $h^{-1}$) | Sunshine hour | Rainfall mm | $ET_0$ mm/day |
|---|---|---|---|---|---|---|---|
| *December | 20.2 | 6.7 | 80 | 59 | 5.9 | 0 | 2 |
| January | 18.5 | 7.7 | 84 | 86 | 6.5 | 35 | 2 |
| February | 20.9 | 12.8 | 79 | 107 | 8.8 | 6 | 2.9 |
| *March | 23.5 | 13.7 | 78 | 157 | 5.8 | 0.3 | 3.4 |

*In December and March only the crop growing days were considered to calculate average monthly weather components

**Table 2:** Monthly weather data during the crop growing period of 2019-2020.


Copyright© Alam MJ, et al.

| Month | Temperature (°C) | Evaporation (mm) | RH (%) | Wind Speed (km $h^{-1}$) | Sunshine hour | Rainfall mm | $ET_0$ mm/day |
|---|---|---|---|---|---|---|---|
| *December | 20.1 | 6.8 | 87 | 58 | 5.7 | 0 | 2 |
| January | 19.2 | 8.4 | 84 | 84 | 5.9 | 0 | 2 |
| February | 21.8 | 14.8 | 75 | 107 | 7.7 | 0 | 2.9 |
| *March | 26.9 | 20.8 | 72 | 167 | 7.8 | 0 | 3.5 |

*In December and March only the crop growing days were considered to calculate average monthly weather components

**Table 3:** Monthly weather data during the crop growing period of 2020-2021.

### Data Analysis

After collection of data, it was tabulate in proper form and subjected to statistical analysis with the help of computer package tested with statistics 10.

## Results and Discussion

### Plant Height and Number of Leaves Plant$^{-1}$

White polythene mulch (67.6 cm) significantly gave the highest plant height than all other treatments and lowest plant height was obtained from no mulch plot (51 cm) (Table 4). For leaves plant$^{-1}$, white polythene mulch is identical to rice straw mulch but significantly higher to black polythene mulch and control. The increase in growth parameters was attributed to optimum temperature absorption through transparent mulch and increasing microbial activity resulting availability of nutrients as compared to control. The changes in soil temperature below PE mulch could be attributed to different manners of passing more sunlight and sunlight transfer to soil and also to heat accumulation during day and loss during night. Similar findings have also been obtained by Dean Ban, et al. [16].

| Treatment | Plant height (cm) | No. of leaves plant$^{-1}$ |
|---|---|---|
| $T_1$: Control | 51.0c | 52.8.3c |
| $T_2$: Black polyethylene mulch | 61.1b | 61.4b |
| $T_3$: White polyethylene mulch | 67.6a | 69.7a |
| $T_4$: Rice straw mulch | 61.3b | 65.6ab |
| Sig. levels | * | * |
| CV (%) | 6.2 | 6.4 |

*Significant at P≤0.05

**Table 4:** Effect of organic and synthetic mulches on growth characters of squash (2020-2021).

### Number of Fruits, Average Fruits Weight, Fruits Length and Diameter

Number of fruit and fruit length of squash under mulching were significantly increased (Table 5). Maximum fruit length, number of fruit and fruit diameter was observed in white polyethylene mulch treatment, whereas the minimum was noted in control (Table 5). The highest fruit length under white polyethylene mulch was due to higher soil temperature which might result in higher release of nutrients through mineralization for better growth of fruit, the reduction in evaporation losses of soil moisture caused by mulch cover. The above results were similar with those of Qin, et al. [17], Ansary and Roy [18] in bottle gourd. White polyethylene mulch was found to have significantly better effect on the extent of fruit set than other mulching materials tried. This mulch consistently increased higher fruit set than other mulch and no mulch. White polyethylene mulch might have provided more sunlight to soil and have inhibited escaping of heat finally increase soil temperature and pest-disease control. The present finding was in accordance with Bhardwaj [3] in vine crops like squash, cucumber. It was found that all treatments of mulching material significantly increased the average fruit weight (kg) of squash than control. Among all mulching treatments, maximum average fruit weight was recorded in treatment white polyethylene mulch. It appears that white polyethylene mulch might have induced favourable conditions conducive to attaining fruits with higher weight. The above results were in agreement with those of Aruna, et al. [19] in tomato and Angrej-Ali and Angej [20] in strawberry. It was found that all the treatments of mulching material were significantly increased the fruit yield of squash.


Copyright© Alam MJ, et al.

| Treatment | Number fruits plant$^{-1}$ | Average fruit weight(kg) | Fruit length | Fruit diameter |
|---|---|---|---|---|
| | | | (cm) | |
| $T_1$: Control | 5.1c | 0.84c | 28.9c | 6.1c |
| $T_2$: Black polyethylene mulch | 7.7b | 1.25b | 37.7b | 8.2b |
| $T_3$: White polyethylene mulch | 10.5a | 1.45a | 42.1a | 9.8a |
| $T_4$: Rice straw mulch | 9.6a | 1.29b | 38.4b | 8.9b |
| Sig. levels | * | * | * | * |
| CV (%) | 6.71 | 8.77 | 6.18 | 6.12 |

* Significant at P≤0.05

**Table 5:** Effect of organic and synthetic mulches on yield attributing characters of squash (2020-2021).

### Fruits Yield

Among all mulching treatments, maximum fruit yield was recorded in treatment white polyethylene mulch (Table 6) compare to other mulch and no mulch. Plants under polyethylene mulch (white polyethylene mulch) produced higher fruit yield because of better plant growth due to more sunlight, more absorption of soil temperature into soil, more microbial activity and more availability of nutrients. The above results were confirmed with those of Qin, et al. [17] in maize, Hallidri [21] in cucumber, Ibarra, et al. [22] in muskmelon.

| Treatment | Yield (2019-2020) | Yield (2020-2021) | Average yield | Yield increase over control (%) |
|---|---|---|---|---|
| | (tha$^{-1}$) | | | |
| $T_1$: Control | 9.25d | 10.4d | 9.82 | - |
| $T_2$: Black polyethylene mulch | 28.5c | 23.5c | 26 | 164 |
| $T_3$: White polyethylene mulch | 40.0a | 35.2a | 37.6 | 282 |
| $T_4$: Rice straw mulch | 35.0b | 30.7b | 32.5 | 230 |
| Sig. levels | * | * | - | - |
| CV (%) | 6.6 | 9.5 | - | - |

* Significant at P≤0.05

**Table 6:** Effect of organic and synthetic mulches on yield of squash.

### Soil Moisture

Mulch prevents soil water evaporation and thus helps retain soil moisture. The amount of moisture stored in the profile to a soil depth of 0-15 cm was significantly greater under black polyethylene over control (Table 7). Black polyethylene conserved the highest soil moisture and it was higher over all other treatments. White transparent sheet and straw mulch were found to be significantly superior over control. The reason for enhanced soil moisture storage under polyethylene and straw mulch may be attributed to significantly lesser evaporation from the soil surface. This study has shown that during December-March, when there is not much rainfall in the area, the soil moisture on the surface and the upper subsoil of un-mulched plots can be reduced from field capacity to wilting point or below, whereas the soil moisture in the mulched plot remains well above the wilting range. The result was in conformity with the findings of Ramakrishna, et al. [23] who reported that the amount of moisture stored in the profile to a soil depth of 90 cm was significantly greater under polythene and straw mulch over bare and chemically mulched soil. Singh and Kamal [24] also reported that black polythene mulch increase soil moisture reserve in soil and inhibits weeds growth


Copyright© Alam MJ, et al.

| Treatment | Soil moisture (%) (Data recorded before irrigation) | |
|---|---|---|
| | Jan-21 | Feb-21 |
| $T_1$: Control | 16.9c | 14.6b |
| $T_2$: Black polyethylene mulch | 21.4a | 18.7a |
| $T_3$: white polyethylene mulch | 20.6ab | 18.0a |
| $T_4$: Rice straw mulch | 19.4b | 17.6a |
| Sig. levels | * | * |
| CV (%) | 5.84 | 6.91 |

* Significant at P≤0.05

**Table 7:** Effect of organic and synthetic mulches on soil moisture of squash 2020-2021.

### Soil Temperature

A congenial temperature prevailed in the soil covered with black and white mulches for microorganism to remain active throughout the growing season (Table 8). All the mulched treatments had significantly higher temperature (p ≤0.05) at 0-15 cm soil depth compared to control treatment. Mean soil temperature under black polyethyene mulch and straw mulch was lower by 2oC compared to white polyethylene sheet (Table 8). Generally, highest soil temperature was recorded in white polyethylene mulch, followed by control. The prevention of direct contact of solar radiation alongside increased moisture content with the soil by the black polythene mulch and also organic mulches explains the low soil temperature under straw mulch. The high soil temperatures of polythene mulched plots observed in this investigation were in agreement with the results of Tegen, et al. [25]; Bhardwaj [3] & Melek and Atilla [26]. The present investigation shows that the polythene mulch offers better insulation than the other mulches and hence the increase in soil temperature. This employed for production of squash [27].

| Treatment | Soil temperature (°C) (Data recorded at11am; depth15cm) | | |
|---|---|---|---|
| | December-2020 | January-2021 | February-2021 |
| $T_1$: Control | 18.2 b | 19.1b | 21.5b |
| $T_2$: Black polyethylene mulch | 19.3b | 21.0a | 21.8b |
| $T_3$: White polyethylene mulch | 21.3a | 22.5a | 23.6a |
| $T_4$: Rice straw mulch | 19.2b | 19.2b | 20.6b |
| Sig. levels | * | * | * |
| CV (%) | 5.52 | 5.42 | 5.32 |

* Significant at P≤0.05

**Table 8:** Effect of organic and synthetic mulches on soil temperature of squash 2020-2021.

### Physical and Chemical of Post-Harvested Soil (After Two Years)

From the table found that, soil moisture, field capacity and bulk density of different mulches gave positive result compared to initial soil result (Table 9 a). In case of soil chemical properties pH and potassium more or less remain same but others properties were increased compared to initial soil chemical properties (Table 9 b).



Copyright© Alam MJ, et al.

| Treatment | Moisture content | Field capacity | Bulk density |
|---|---|---|---|
| | (%) | | (g cm$^{-3}$) |
| $T_1$: Control | 18.7 | 28.5 | 1.51 |
| $T_2$: Black polyethylene mulch | 20.3 | 30.4 | 1.49 |
| $T_3$: White polyethylene mulch | 20.1 | 30.5 | 1.48 |
| $T_4$: Rice straw mulch | 19.8 | 30.2 | 1.5 |
| Initial | 18.4 | 28.4 | 1.52 |

**Table 9a:** Physical properties of post-harvest soil (after two years).

| Treatment | pH | OM | Total N | K | P | B |
|---|---|---|---|---|---|---|
| | | (%) | | meq 100 g$^{-1}$ | µg g$^{-1}$ | |
| $T_1$: Control | 6 | 1.15 | 0.057 | 0.1 | 11 | 0.22 |
| $T_2$: Black polyethylene mulch | 6.1 | 1.25 | 0.061 | 0.1 | 12 | 0.24 |
| $T_3$: white polyethylene mulch | 6.2 | 1.23 | 0.06 | 0.11 | 13 | 0.25 |
| $T_4$: Rice straw mulch | 6.2 | 1.22 | 0.059 | 0.11 | 12 | 0.24 |
| Initial | 6.1 | 1.08 | 0.054 | 0.1 | 10 | 0.21 |

**Table 9b:** Chemical properties of post-harvest soil (after two years).

## Conclusion and Recommendation

White polythene mulch performed the best for yield of squash with congenial soil moisture, soil temperature and nutrient than other treatments. It is concluded that application of mulches over control (without mulch)is beneficial to farmers. Farmers can adopt white polythene mulch for production of pit crops like squash based on availability of mulch material and other priority criteria.

## Acknowledgement

The authors would like to give thank Soil Science Division, Bangladesh Agricultural Research Institute (BARI), Bangladesh, for its budgetary help and useful direction and Farm division for tillage and irrigation support in this study.

## References

1. Van Derwerken JE, Wilcox LD (1988) Influence of plastic mulch and type and frequency of irrigation on growth and yield of bell pepper. Horticultural Science USA 23(6): 985-988.
2. Reddy C, Avinashe H, Dubey N (2020) Effect of different Plastic Mulches on Vegetable Production: Review. International Journal of Innovative Research in Technology 7(6): 140.
3. Bhardwaj RL (2013) Effect of mulching on crop production under rainfed condition-A review. Agricultural reviews 34: 188-197.
4. Aber JD, Melillo JM (1991) Terrestrial Ecosystems. Saunders College Publishing, Philadelphia.
5. Ladd IN (1978) Origin and range of enzymes in soil. In: Burns RG (Ed.), Soil enzymes. Academic Press, New York, pp: 51-96.
6. Hatami S, Nourjou A, Henareh M, Pourakbar L (2012) Comparison effects of different methods of black plastic mulching and planting patterns on weed control, water-use efficiency and yield in tomato crops. International Journal of Agricultural Science 2: 928-934.
7. Parmar, HN, Polara ND, Viradiya RR (2013) Effect of mulching material on growth, yield and quality of watermelon (Citrullus lanatus thunb) Cv. Kiran. University Journal of Agricultral Research 1(2): 30-37.


Copyright© Alam MJ, et al.

8. Huq SMI, Shoaib JUM (2013) The Soils of Bangladesh. European journal of soil science 65(2).

9. BARC (Bangladesh Agricultural Research Council) (2018) Fertilizer Recommendation Guied. Bangladesh Agricultural Research Council, Farmgate, Dhaka, pp: 99.

10. Jackson ML (1973) Soil chemical analysis. Constable and Compani Limited, Prentice Hall of India Private. Limited, New Delhi, pp: 110-114.

11. Page AL, Miller RH, Kuny DR (1989) Methods of Soil Analysis. Part 2, 2nd (Edn.), American Society of Agronomy, Soil Science Society American Incorporation, Madison, Wisconsin, USA, pp: 403-430.

12. Black CA (1965) Method of soil analysis Part I and II, American Society of Agronomy, Madison, Wiscosin, USA, pp: 770.

13. Jackson ML (1962) Soil Chemical Analysis. New York: Prentice-Hall Incorporation.

14. Hanlon EA, Johnson GV (1984) Bray/Kurtz, Mehlich ill, AB/D and Ammonium Acetate Extraction of P, K, and Mg in Four Oklahoma Soils. Communication of Soil Science and Plant Analysis 15: 277-294.

15. Karim Z, Rahman SM, Ali MI, Karim AJMS (1988) Soil bulk density. A manual for determination of soil physical parameters. Soils and Irrigation Division, BARC.

16. Dean B, Zanic K, Dumicic G, Culjak TG, Ban SG (2004) The type of polythene mulch impacts vegetative growth, yield and aphid populations in watermelon production. Journal of Food, Agriculture and Environment 7(3-4): 543-550.

17. Qin S, Zhang Y, Wang J, Wang C, Mo Y, et al. (2022) Transparent and black film mulching improve photosynthesis and yield of summer maize in North China Plain. Agriculture 12(5): 719.

18. Ansary SH, Roy DC (2005) Effect of irrigation and mulching on growth, yield and quality of watermelon (CitrulluslanatusThunb.). Environment and Ecology 23(1): 141-143.

19. Aruna P, Sudagar IP, Manivannan MI, Rajangam J, Natarajan S (2007) Effect of fertigation and mulching for yield and quality in tomato cv. PKM-1. Asian Journal of Horticulture 2(2): 50-54.

20. Angrej Ali, Gaur GS (2007) Effect of mulching on growth, fruit yield and quality of strawberry (Fragaria x ananassaDuch.). Asian Journal of Horticulture 2(1): 149-151.

21. Hallidri M (2001) Comparison of the different mulching materials on the growth, yield and quality of cucumber (Cucumis sativus L.). Acta Horticulture 559: 49-54.

22. Ibarra L, Flores J, Diaz Perez JC (2001) Growth and response to plastic mulch and row covers. Scientia Horticulturae 87(1/2): 139-145.

23. Ramakrishna A, Tam HM, Wani SP, Long TD (2006) Effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. Field Crops Research 95(2-3): 115-122.

24. Singh AK, Kamal S (2012) Effect of black plastic mulch on soil temperature and tomato yield in mid hills of Garhwal Himalayas. Journal of Horticultural Forestry 4(4): 78- 80.

25. Tegen H, Mohammmad W, Yagzaw, Dessalegn (2015) Effect of mulching materials on soil temperature under polyhouse condition. Journal of Biology, Agriculture ND Healthcare 5(17): 164-168.

26. Melek E, Atilla D (2009) Effect of different mulch materials on plant growth, some quality parameters and yield on melon (Cucumis Melo) cultivation in high altitude environmental condition. Journal of Pakistan Botany 41(4): 1891-1901.

27. Suresh R, Ashok Kumar (2006) Effect of drip irrigation and mulch on pointed gourd in calcareous soil of north Bihar. Indian Journal of Soil Conscience 34(1): 83-88.



Copyright© Alam MJ, et al.