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# Effect of Mulching on Soil Temperature and Its Impact on Seedling Emergence of Groundnut

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## ABSTRACT

Impact of soil temperature on seedling emergence of groundnut was studied in the Central Research Farm, BCKV, Gayeshpur, Kalyani during 2002-03. Soil temperature regulation was contributed by date of sowing and different types of mulching. Seeds of JL-24 variety were sown in replicated plots taking three dates of sowing (20.11.02, 06.12.02 and 23.12.02) as the main factor and mulching treatments (white polythene, lemongrass-straw, paddy-straw, forest leaves mulch and no mulch) as sub-factor. Seedling emergence (in percentage of total seeds sown) was calculated at 6, 8, 10, 12, 15 and 30 days after sowing. It was observed that irrespective of different mulching, seedling emergence of November sown crop was higher than December sown crops due to higher soil temperature. Seedlings of November sown crop emerged about six days earlier than late December sown crop. When mulch induced soil temperature was considered, irrespective of dates of sowing, it was observed that poly-mulch contributes the highest soil temperature as well as the seedling emergence. In case of forest-leaves mulch, seedling emergence percentage was relatively poor, which may be due to the relatively lower diurnal range of soil temperature. Study on diurnal range of soil temperature has shown that the range was the highest in poly-mulch, and the lowest for forest-leaves mulch.

**Key words:** Mulching, Soil temperature, Seedling emergence, Groundnut.

## Introduction

Soil temperature is one of the most important environmental factors for proper germination and emergence of any crop. The time of sowing has a direct influence due to existing soil temperature at that time and ultimately responsible for better crop stand and yield (Dixit *et al.*, 1992). During the winter season low soil temperature is a major factor limiting seedling emergence and its growth. The emergence of seedlings of various crops under different mulching conditions, which regulate soil temperature, were studied by several workers (Fraedrich and Ham, 1982; Ashworth and Harrison, 1983; Chung *et al.*, 1985; Parmar and Zode, 2002). In respect of groundnut, such studies were carried out mainly under laboratory conditions. The present study was carried out under field condition, wherein soil temperature regulation was manifested by the date of sowing and different types of mulching. The impact of different mulching treatments on soil temperature and its subsequent effect on seedling emergence of groundnut are discussed here.

## Materials and methods

***Study area:*** The field investigation was carried out from November 2002 to May 2003 at the Central Research farm, Gayeshpur, Bidhan Chandra Krishi Vishwavidyalaya, Nadia, West Bengal; situated at 22.57$^0$ N latitude and 88.20$^0$ E longitude with an elevation of 7.8 m above the mean sea level. The general slope of the area ranged between 0 and 3%, the relief being subnormal with slight to moderate runoff.

The study area comes under sub-tropical humid climate having moderate summer and mild winter. Generally the normal mean minimum air temperature does not fall below 9$^0$C in December January and the mean maximum temperature does not exceed 40$^0$C during April to May. The annual rainfall ranges between 1300 to 1700 mm of which 70% to 80% of rainfall is generally received during June to September.

***Field observations:*** Surface soil temperature was measured with the help of soil thermometer at a 5 cm and 15 cm depths in different mulching treatments [namely white polythene ($M_1$), lemongrass-straw ($M_2$), paddy-straw ($M_3$), forest leaves mulch ($M_4$) and no mulch condition ($M_5$)]. Diurnal variation of soil temperatures were recorded from 6 am to 6 pm at one-hour interval. Seedlings emergence were recorded at 6, 8, 10, 12, 15 and 30 days after sowing.

***Statistical analysis:*** Analysis of variance method (Gomez and Gomez, 1984; Panse and Sukhatme, 2000) was used for statistical analysis. The significance of difference for sources of variation was tested by error mean square by Fisher students 'F' test at probability level of 5%. For comparison of 'F' value and computation of CD at 5% level of

significance, Fisher and Yates tables were consulted.

## Results and discussion

### *Variation in soil temperature under mulching condition*

Variation in soil temperature were studied to observe the effect of mulching on soil temperature fluctuations. To nullify the effect of excess moisture content on soil temperature, observations were taken in post- to pre-monsoon seasons (November to May) and the data were used for the analysis.

The maximum value of soil temperature (32.0°C) was observed in case of poly-mulch ($M_1$). The second highest value of soil temperature (30.7°C) was observed in case of paddy straw mulch ($M_3$). In the case of other two mulches ($M_2$ and $M_4$) the soil temperature was around 30.5°C, which was slightly lower than that of paddy straw mulch (Fig. 1 and 2).

In the control treatment, soil temperature was lower than mulching condition particularly in the winter months, whereas, during rest of the observation period it was slightly higher than the straw mulches. It reveals that mulching induces higher soil temperature during winter and vice-versa; hence favourable soil temperature for seed germination and crop growth prevails in mulching treatments.

However, the soil temperature in the transparent polythene mulch ($M_1$) plots is always higher than without mulch plots. This may be due to polythene mulch intercepting some solar energy and preventing the rapid heat loss from warmed soil. In straw mulch treatments ($M_2$, $M_3$ and $M_4$) soil temperature was always lower than treatment $M_1$ due to prevention of direct heating from sun. In without mulch plot, soil temperature was positively correlated with the air temperature. Devi Dyal *et al.* (1991) observed similar results.

### *Diurnal variation in soil temperature under mulching condition*

Diurnal variations in soil temperature at 5 cm and 15 cm depths under various mulching treatments during pre-monsoon season are shown in figure 3 and 4. It was observed that diurnal range was highest in case of polyethylene mulch (8.0°C at 5 cm and 6.1°C at 15 cm depths, respectively). In case of forest leaves mulch the soil temperature range was lowest (5.1°C at 5 cm

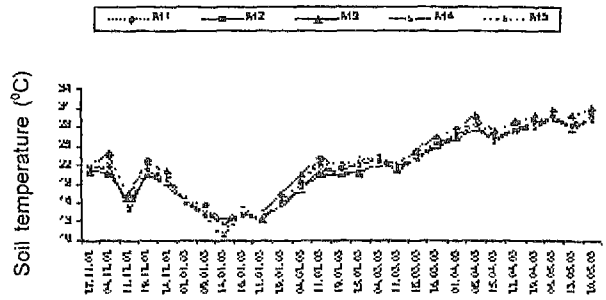


Fig. 1. Variation of soil temperature over the period of study (Depth : 5 cm)

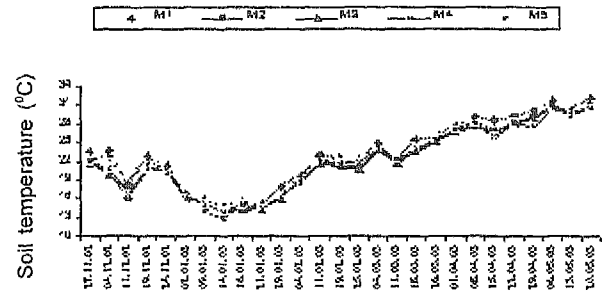


Fig. 2. Variation of soil temperature over the period of study (Depth : 15 cm)

and 4.5°C at 15 cm depths, respectively). It might be due to the fact that the polyethylene mulch creates greenhouse effect and hence, the highest range. On the other hand, straw mulche hinders the soil to heated up directly, hence the range is lower than control treatment. In all treatments, soil temperature reaches maxima at about 2 pm. Only in no-mulch condition at a depth of 5 cm, soil temperature maximum was observed at 1 pm. This may be due to the fact that mid-day solar radiation takes some time to heat up the mulches first and then the soil. Thus in control treatment, having no soil cover, soil temperature maxima was observed earlier. Under mulching condition, once the soil temperature maxima achieves, the soil temperature curve falls slowly towards minima due to conservation of heat energy to some extent.

### *Effect of sowing date and mulching on seedling emergence of groundnut*

Seedling emergence (% of total seeds sown) was calculated at 6, 8, 10, 12, 15 and 30 days after sowing and corresponding soil temperature recorded for each treatments (Table 1).

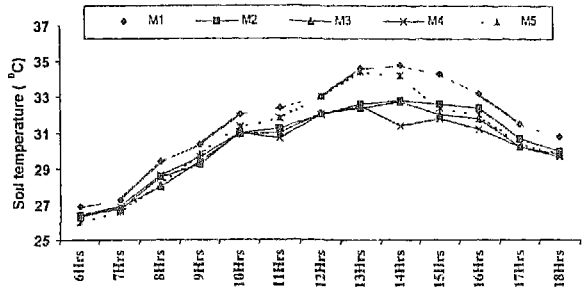


Fig. 3. Diurnal variation of soil temperature (Depth : 5 cm)

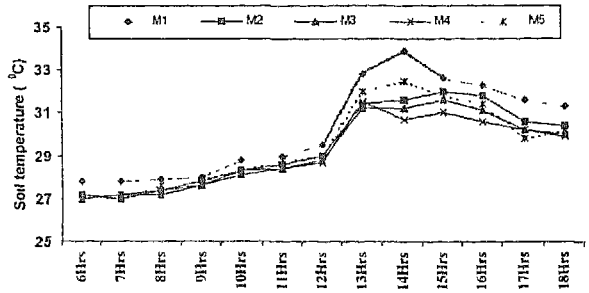


Fig. 4. Diurnal variation of soil temperature (Depth : 15 cm)

Table 1. Effect of sowing date and mulching on seedling emergence % of winter groundnut

| Treatment | Seedling emergence % | | | | | |
|---|---|---|---|---|---|---|
| | 6 days | 8 days | 10 days | 12 days | 15 days | 30 days |
| Sowing date | | | | | | |
| 20 November 2002 ($D_1$) | 21.45 (26.26) | 40.0 (38.81) | 55.55 (46.45) | 62.55 (52.67) | 66.75 (55.43) | 75.15 (61.29) |
| 06 December 2002 ($D_2$) | 13.2 (20.13) | 31.9 (34.14) | 43.15 (40.95) | 57.0 (49.75) | 64.90 (55.05) | 75.35 (61.70) |
| 23 December 2002 ($D_3$) | 00 (4.05) | 00 (4.05) | 00 (4.05) | 6.95 (14.55) | 19.30 (25.26) | 54.10 (47.37) |
| S.E.m ± | 1.989 | 1.267 | 1.857 | 0.941 | 2.232 | 2.089 |
| C.D. (P= 0.05) | 8.212 | 5.232 | 7.857 | 3.885 | 9.216 | NS |
| Mulching | | | | | | |
| Polyethylene mulch ($M_1$) | 22.0 (24.57) | 35.08 (32.35) | 47.25 (39.58) | 61.25 (52.16) | 68.08 (58.30) | 84.75 (69.38) |
| Lemon grass straw mulch ($M_2$) | 13.58 (18.57) | 27.0 (27.59) | 35.75 (32.75) | 48.00 (42.64) | 56.42 (48.88) | 75.08 (60.84) |
| Paddy straw mulch ($M_3$) | 11.92 (17.85) | 24.75 (26.29) | 30.58 (29.72) | 36.67 (35.19) | 47.33 (43.21) | 64.67 (53.83) |
| Forest leaves mulch ($M_4$) | 8.67 (15.12) | 20.75 (23.92) | 28.42 (28.48) | 37.75 (35.59) | 43.92 (40.67) | 58.67 (50.06) |
| Without mulch ($M_5$) | 2.42 (8.25) | 12.25 (18.19) | 17.50 (21.87) | 27.16 (29.41) | 35.84 (35.69) | 57.34 (49.82) |
| S.E.m ± | 1.321 | 1.138 | 1.354 | 2.022 | 2.200 | 2.126 |
| C.D. (P= 0.05) | 3.326 | 2.864 | 3.407 | 5.092 | 5.538 | 5.353 |

Please note: Days = Days after sowing, NS = Non significant, Figures in parenthesis are arcsine values.

As the effect of sowing date was concerned it was observed that the November sown crop ($D_1$) emerged earlier than December sown crop ($D_2$ and $D_3$). After six days 21% seedlings had emerged in case of $D_1$, whereas in case of $D_2$ only 13% seedlings had emerged. In case of $D_3$ seedling emergence started at 10 DAS, and at 12 DAS it was only 7%. The prevailing ambient soil temperature was the main cause of slow germination in treatment $D_3$.

After 30 DAS, the germination % of $D_1$ and $D_2$ were similar but that of $D_3$ was very much low compared to the previous two. Hence the study recommends November and early December sowing to get a good crop stand of winter groundnut. However, the early December sown crop ($D_2$) experienced comparatively lower temperature in its flowering to pegging stage than $D_3$, hence, the over all yield of $D_3$ was better than $D_2$. The result is in conformity with the findings of Dutta *et al.* (2000) that the favourable temperature and appropriate moisture helped in early germination and rapid growth of crop.

The effect of mulching on seedling emergence % showed significant at all the stages of observation. Seedling emergence % was highest in case of polyethylene mulch, which may be due to the prevailing higher soil temperature in this treatment. In case of forest-leaves mulch treatment, seedling emergence percentage was relatively poor, which may be due to relatively lower diurnal range of soil temperature. In all the mulching conditions the seedling emergence was higher than the control. The mulches induce high soil temperature, largely through stabilization by insulation and conserve soil moisture.

To find out the correlation between seedling emergence percentage and soil temperature, 15 days average soil temperature prior to the date of observation was considered. It was observed that seedling emergence percentage after 15 and 30 DAS were significantly correlated with surface soil temperature ($r = 0.63$ and 0.70, respectively). This result indicates that the higher soil temperature induces early and more seedling emergence.

## Conclusion

From the above discussion, it can be concluded that in the new alluvial zone of West Bengal November sown winter groundnut receives favourable soil temperature and ensures a good crop stand. Seedling emergence percentage and early emergence are positively correlated with soil temperature, which can be achieved by proper mulching. The diurnal variation of soil temperature shows considerable variation under different mulching treatments which also contributes to the seedling emergence.

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