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Studies of microclimatic conditions in summer moong as influenced by different mulches

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सार — मूंग में सूक्ष्म जलवायुविक स्थितियों का अध्ययन करने के लिए 1990 में ग्रीष्म ऋतु के दौरान कृषि मौसम विज्ञान विभाग के अनुसंधान फार्म, हरियाणा कृषि विश्वविद्यालय, हिसार में मूंग को खेत में खरपतवार से ढककर उगाने का एक प्रयोग किया गया। प्रच्छन्न ताप ऊर्जा और युक्तियुक्त ताप ऊर्जा वास्तविक ऊर्जा के प्रमुख घटक थे। विभिन्न कृषि क्रियाओं के दौरान खरपतवार से ढकी काले रंग की पोलिथीन में प्रच्छन्न ताप ऊर्जा का उपयोग अधिक हुआ। जबकि काले रंग की पोलिथीन की तुलना में भूसे से ढकी सफेद पोलिथीन की मिट्टी में तापमान कम पाया गया।

ABSTRACT. A field experiment was conducted during summer season of 1990 at research farm of Department of Agricultural Meteorology, Haryana Agricultural University, Hisar to study the microclimatic conditions in moong with the use of mulches. Latent heat energy and sensible heat energy were the main components of net energy. Among the various treatments, the latent heat energy use was found higher in black polythene sheet mulch. Soil temperature values were low in straw and white polythene mulch than black polythene mulch treatment.

Key words — Phenophase, Treatment, Polythene mulching, Energy balance, Temperature, Microclimate.

1. Introduction

Moong has a considerable potential as a tropical legume crop. When grown during the summer (April-June) the crop experiences high water stress and supera-optimal soil temperature unless it is frequently irrigated. It has been reported in other crops also that sub-optimal soil water status and superoptimal soil temperature reduces root growth, water and nutrient uptake and grain yield (Harrison-Murray and Lal 1979). Mulching with straw offers a mean of moderating supera-optimal soil temperature, conserving moisture and increasing crop yield (Maurya and Lal 1981). Soil moisture stress in summer moong and excess thermal regime are the two most important factors that adversely affect the crop production. These adverse effects may be due to high temperature and increased evaporation. The uses of various mulches have been reported to result in lower evaporation losses, reduced soil temperature fluctuations by favourable modification of soil hydrothermal regime (Gupta and Gupta 1985). An attempt has been made to study the effect of various mulches and irrigation that modify the microclimatic conditions in summer moong.

2. Material and methods

A field experiment was conducted at the experimental farm of Department of Agricultural Meteorology, Haryana Agricultural University, Hisar (29° 10'N, 75° 46'E, 215.2 m asl) during summer season 1990 to study the effect of various mulches on microclimatic conditions. The moong crop (Var. K-851) was sown on 9 April with a spacing of 30 × 10 cm. The five treatments, *viz.*, T_1-straw mulch (sarson straw @ 5 tonnes/ha), T_2-black polythene sheet mulch, T_3-white polythene mulch, T_4-stress irrigation (one irrigation at flowering stage) + straw mulch (5 tonnes/ha) and T_5-control were given in 12 × 10 m plots in randomized block design with four replications. All the basic inputs were supplied as per package of practices of crop. Observations from 0700 to 1700 IST on net radiation (*Rn*) were recorded with net radiometer and soil heat flux plates (*G*) of Medoes and Co. Australia was used. The dry and wet bulb air temperatures were measured within and above the crop canopy at different heights at vegetative (40 days after sowing), flowering (48 days after sowing) and maturity (65 days after sowing). The data were analysed for the energy balance by energy balance-Bowen's ratio method (Bowen 1926) with the help of the following equations :

$$Rn = G + A + LE \quad (1)$$

where,

Rn — Net radiation (mW/cm^2)
G — Soil heat flux (mW/cm^2)

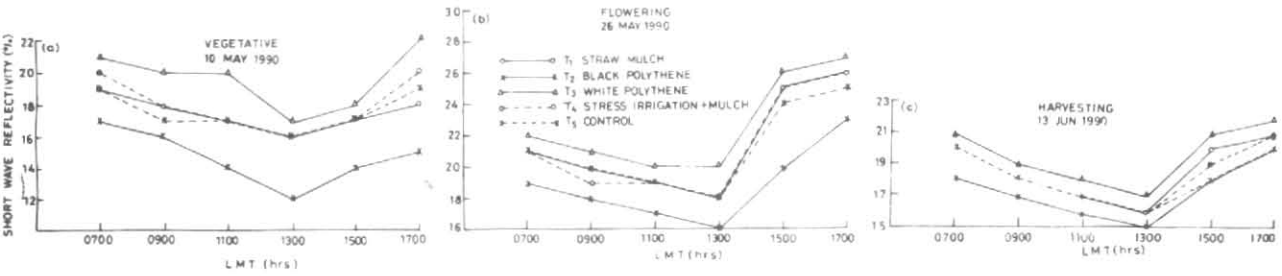

Fig. 1. Shortwave reflectivity over moong as influenced by various treatments at different phenophases

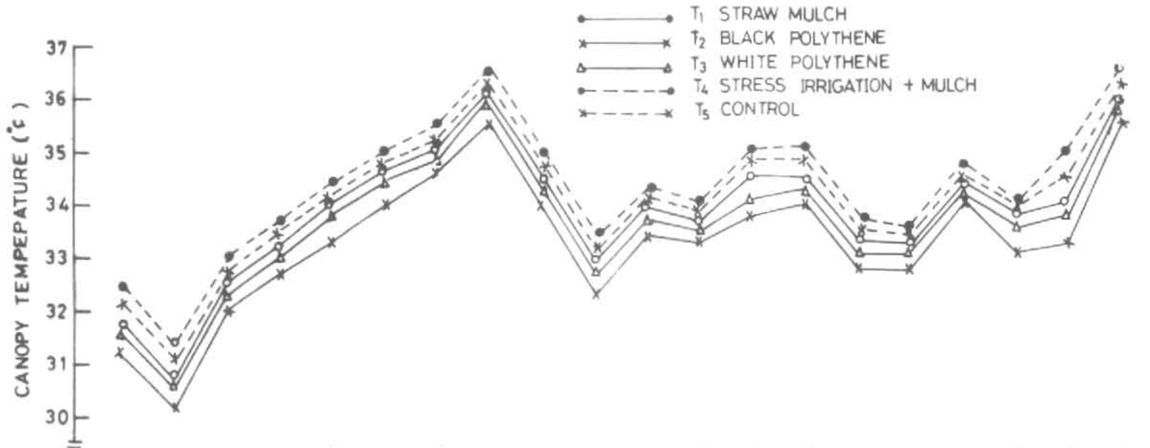

Fig. 2. Influence of various treatments on canopy temperature (1400 hrs)

A — Sensible heat flux (mW/cm^2)
LE — Latent heat flux (mW/cm^2)

$$LE = (Rn - G)/(1 + \beta) \qquad (2)$$

Bowen ratio, (β) = $0.66 \times (\Delta t/\Delta e)$

where,

Δt — Temperature gradient recorded between two heights

Δe — Vapour pressure gradient recorded between two heights

3. Results and discussions

3.1. *Energy balance components*

The daily total various energy parameters at different phenophases are presented in Table 1. More than 70 per cent of *Rn* was used as *LE*. The *LE* varied among treatments and phenophases. It varied from 72.7 to 80.1 per cent, 67.9 to 80.1 per cent and 67.7 to 76.3 per cent of *Rn* at vegetative, flowering and maturity stages respectively. The maximum *LE* was observed in T_2 treatment. The difference between *LE* at vegetative and flowering stage was less because of less difference in LAI in these stages. Sensible heat flux varied from 12.6 to 27.6 per cent indicating *LE* and *A* as the main share holders of net energy. Sensible heat flux variations were higher because of significant change in outgoing long wave radiations from different treatments. T_4 treatment used less radiation for *LE* and *G* among all the treatments. This may be due to higher sensible heat generated under stress conditions. The *LE* was observed in the order of $T_2 > T_3 > T_1 > T_5 > T_4$. The higher amount of *LE* in T_2 resulted in better crop growth, more leaf area, higher yield contributing parameters and higher dry matter production. The

TABLE 1

Energy balance components (mW/cm^2) over moong under different treatments at different phenophases

Treat-ment	Vegetative stage				Flowering stage				Maturity			
	Rn	*LE*	*A*	*G*	*Rn*	*LE*	*A*	*G*	*Rn*	*LE*	*A*	*G*
T_1	235.2	183.7 (78.1)	36.1 (15.3)	15.4 (6.6)	255.2	190.8 (74.8)	51.0 (19.9)	13.8 (5.3)	275.1	203.1 (73.8)	57.2 (20.8)	14.8 (5.4)
T_2	212.9	190.3 (80.1)	27.1 (12.6)	15.5 (7.3)	252.7	202.1 (80.1)	36.8 (14.4)	13.8 (5.5)	279.4	213.3 (76.3)	50.3 (18.0)	15.8 (5.7)
T_3	227.0	181.7 (80.0)	28.4 (12.6)	16.9 (7.4)	254.3	195.2 (76.9)	43.9 (17.1)	15.2 (6.0)	276.2	204.5 (74.0)	55.4 (20.1)	16.3 (5.9)
T_4	224.3	163.0 (72.7)	45.4 (20.2)	15.9 (7.1)	247.0	167.5 (67.9)	62.7 (27.4)	11.8 (4.7)	273.7	185.2 (67.7)	75.5 (27.6)	13.0 (4.7)
T_5	202.8	153.3 (75.6)	34.6 (17.1)	14.9 (7.3)	251.7	176.6 (70.2)	62.0 (24.6)	13.1 (5.2)	273.6	185.8 (67.9)	72.9 (26.6)	14.9 (5.5)

N. B. Figures in parentheses are per cent values of net radiation

T_1 = Straw mulch @ 5 tonnes/ha

T_2 = Black polythene sheet mulch

T_3 = White polythene mulch

T_4 = Stress irrigation + mulch

T_5 = Control

maximum seed yield was observed in the order of $T_2>T_3>T_1>T_5>T_4$. Similar type of results were reported by Rao (1986) and Singh (1988) in moong and raya crop respectively.

3.2. *Short-wave reflectivity*

The short wave reflectivity recorded in different treatments at various phenophases is presented in Fig. 1. In the morning and evening hours of the day, the reflected values were higher whereas, during noon hours these values were less. This may be due to direct sun rays falling on crop at noon time. However, during morning and evening hours higher values were recorded due to obliqueness of the sun rays. The highest values of reflectivity were recorded in T_3 treatment at all the growth stages. This may be due to white surface of polythene that reflects most of the radiation falling on the surface. T_2 treatment with black polythene resulted in lowest values of reflectivity due to more absorption of received radiation. Kumar (1985) and Rajegowda and Ratnam (1987) also reported similar results.

3.3 *Soil temperature variations*

Temperature variations were higher in 5 cm soil depth than 15 cm soil depth. In T_1 and T_3 treatments, soil temperature values were lower than other treatments throughout the growing season. In T_2 treatment, the temperature values in both the soil depths were higher. Therefore, it appears that black polythene has absorbed more radiation and generated higher sensible heat component as compared to control treatment. These variations in soil temperature do not function independently but they are governed by soil moisture also (Hundal and Dutta 1982). The mean soil variation over the different treatments was within ±2°C range over control treatment. The soil temperature manipulation by mulching resulted in higher yield in moong crop. Gurnah and Mutea (1982) also reported similar findings in different soil depths.

3.4. *Canopy temperature variations*

The canopy temperature has the direct bearing on soil moisture status and thus influenced the yield attributes. The canopy temperature in different treatments have been depicted in Fig. 2. The T_4 treatment showed the higher canopy temperature values due to stress condition because only one irrigation was applied in this treatment, whereas lower values of canopy temperatures were recorded in T_2 because of no-stress conditions. However, the differences of canopy temperatures between T_2 and T_4 treatment were observed to be maximum of 1.7°C at 64 days after sowing and a minimum of 0.8°C at 58 days after sowing.

4. Conclusions

(*i*) Among all the treatments, stress irrigation utilized less radiation in latent heat energy as well as energy used in soil heating.

(*ii*) The major portion of net energy was used in latent heat of evaporation at three growth stages in all the treatments.

(*iii*) The reflectivity values were higher in white polythene mulch treatment and were lower in black polythene mulch treatment.

(*iv*) Soil temperature variations were higher at 5 cm than 15 cm soil depth. In straw and white polythene treatments, lower temperature values were recorded throughout the crop season in comparison to control.

(*v*) The black polythene mulching resulted in improved growth and development of summer moong and significantly improved the yield and yield characteristics of crop.

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