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Effect of rice (*Oryza sativa*) straw mulching on the performance of rapeseed (*Brassica campestris*) varieties in rice–rapeseed cropping system

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ABSTRACT

An experiment was conducted at Meghalaya, during 2006–08 to study the effect of rice straw mulching on growth, yield attributes and yield of different rapeseed (*Brassica campestris* L.) varieties, namely 'M 27', 'TS 38' and 'Sikkim Sarson'. The plant height of rapeseed increased by 7.2% at harvest due to rice straw mulching @ 5.0 tonnes/ha over the non-mulching and it was highest (96.88 cm) in 'TS 38'. Lower values (–2.9°C) of canopy air temperature difference were recorded in the mulch treatment than under control (–2.3°C). Mulching resulted in storage of 2.0% more soil moisture in the root zone of the crop over the unmulched control, indicating better microclimate for crop growth and development. Leaf area index was higher in 'TS 38' and in mulching treatment. Number of siliquae/plant (24.6%), seeds/siliqua (17.6%) and seed yield (35.4%) increased due to mulching over the non-mulching. The varieties differed significantly with respect to 100-seed weight and it was highest (0.37 g) in 'TS 38'. Highest seed yield was obtained in 'TS 38' (1.51 tonnes/ha), followed by 'M 27' (1.46 tonnes/ha) and significantly superior over the 'Sikkim Sarson' (0.97 tonnes/ha).

Key words: Canopy-air temperature difference, Mulching, Paddy Straw, Rapeseed

In the mid-hills (800–1 300 m above mean sea level) of Meghalaya rice (*Oryza sativa* L.) – rapeseed/toria (*Brassica campestris* L.) is the most prevalent cropping system. The productivity of post-rainy season crop is very low because of moisture deficits during critical periods of crop growth, as much of the rainfall received during the monsoon season is lost as runoff from the hilly terrain. Since rice is grown widely in this region, a huge quantity (~ 8 million tonnes) of straw is produced. Keeping aside half of the straw produced for the domestic uses as cattle fodder, 4 million tonnes of paddy straw would be available for recycling in the cropping system (Hazarika *et al*. 2006). Mulch is a good option for rice residue management under upland condition, especially with reduced or no tillage. Mulch can increase yield, water- use efficiency and profitability, while simultaneously decreasing weed pressure. Through proper mulching, the problems of surface evaporation and soil moisture deficit in dry season can be solved to a great extent. A review of the available literature reveals the paucity of information on the response of winter *(rabi)* season crops, like rapeseed to mulching and suitable rapeseed varieties for the mid-hills of north-eastern region. Keeping these facts in view, an experiment was conducted to study the effect of mulching on performance of different rapeseed varieties in rice – rapeseed cropping system at Meghalaya under rainfed situation.

MATERIALS AND METHODS

A field experiment was conducted at the research farm of ICAR Research Complex for NEH Region, Umroi Road, Umiam, Meghalaya, India during winter (*rabi*) seasons of 2006–07 and 2007–08 under rainfed conditions. The Institute farm is located at 25°302` N latitude and 91°512` E longitude with an elevation of 980 m above mean sea level. The soil was silty clay loam in texture (22.6% sand, 45.0% silt and 32.4% clay), medium in available N (290 kg/ha) and high in available P (45 kg/ha) and K (320 kg/ha). The *p*H and organic carbon content of the soil were 4.95 and 2.33%, respectively. The field experiment was laid out in a factorial randomized block design with 3 replications. Six treatments were formed with 3 varieties of rapeseed ('M 27', 'TS 38' and 'Sikkim

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Sarson') in combination with and without mulching. The preceding crop was 'RCPL 27' (120 days) rice. After harvest of rice crop, the straw collected was used for mulching the succeeding rapeseed crop. Farmyard manure was applied to the entire experimental area uniformly @ 5.0 tonnes/ha 15 days before sowing crop. No other chemical fertilizer was applied to the crop.

Rapeseed varieties were sown in last week of October continuously in line at a row-spacing of 60 cm and thinned 1 week after germination to spacing of 15 cm plant-to-plant. For mulching, rice straw was spread uniformly over the soil @ 5.0 tonnes/ha (air dry basis) after thinning. The gross plot size was 8.0 m × 4.5 m. The weather was dry due to evaporation (76.4 mm) exceeding rainfall (24.4 mm) during the active crop growing period (December and January). Observations on plant growth (height and leaf area index), soil moisture (gravimetric), yield and yield-attributing characters were recorded using the standard procedure. The temperature (canopy and air) and leaf area index were recorded using a hand held infrared thermometer and digital plant canopy imager (Model CI-110), respectively. The canopy-air temperature difference was calculated to compare the effect of mulching over the non-mulching. The varieties 'M 27' and 'TS 38' matured in 98 days, while 'Sikkim Sarson' took 10 days more to mature. Data obtained from the experiment were statistically analyzed using analysis of variance technique as per the procedure given by Gomez and Gomez (1984). The interaction between variety and mulching treatments were found non-significant for all the characters studied.

RESULTS AND DISCUSSION

Plant height

There was a significant effect of mulching as well as varieties on plant height. Averaged over varieties, mulching with paddy straw increased the plant height of rapeseed at all stages. When compared with control, there was 8.9, 8.3 and 7.2% increase of plant height due to mulching of paddy straw at 30 and 60 days after sowing and at harvest, respectively. The findings corroborate with those of Pramanik and Nawaz (2007). Highest plant height at harvest was recorded in the 'TS 38' and other 2 varieties were at par.

Canopy-air temperature difference

Canopy-air temperature difference is a measure of plants response to stress conditions. No positive value of canopy-air temperature difference was observed in the experiment, which might be attributed to the abundance of residual soil moisture as the crop was sown immediately after retreating of the monsoon rains (Fig 1). Higher values were observed at 60 days after sowing for all the varieties owing to reduction in soil moisture due to consumptive use. The mulching treatment exhibited lower values of canopy-air temperature difference (–2.9°C) than non-mulching treatment (–2.3°C) 60 days after sowing indicating better preservation of soil moisture and micro-climate due to use of mulches. Goswami and Saha (2006) reported the beneficial effect of rice straw mulching in regulating the soil temperature, conserving soil moisture and saving the crop from weed infestation.

Soil moisture status

The soil moisture status on gravimetric basis up to 30 cm layer of soil was higher in mulched treatment as compared to when no mulch was used. There was 2.0 and 1.7% higher soil moisture storage in 0–15 and 15–30 cm depth of soil respectively. The varieties did not have any influence on soil moisture status. In general, the soil moisture status was in an increasing order from top layer to 45 cm soil depth. Mohanty *et al.* (2002) observed a 2.8% increase in soil moisture content in the top 20 cm soil depth due to rice straw mulching over the control. The higher soil moisture content below the mulches might be due to reduction in soil surface evaporation and weed intensity (Shirgure *et al*. 2003).

Table 1 Performance of rapeseed varieties and effect of mulching on its growth, yield attributes and seed yield and soil moisture status (mean data of 2 years)

Treatment	Plant height (cm)			Leaf area index		Yield attributes and seed yield				Soil moisture (% dry weight) in different soil layers at flowering		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Siliquae/ plant	Seeds/ siliqua	100-seed weight (g)	Seed yield (tonnes/ha)	0–15 cm	15–30 cm	30–45 cm
'M 27'	57.17	87.15	92.65	0.91	1.16	90.00	17.67	0.33	1.456	21.80	23.95	25.56
'TS 38'	57.00	87.86	96.88	1.18	1.24	97.00	17.00	0.37	1.511	22.35	22.86	25.43
'Sikkim Sarson'	48.03	88.32	92.47	0.72	0.92	59.00	20.16	0.33	0.968	20.97	23.92	26.19
CD (*P*=0.05)	2.50	2.49	3.61	0.21	0.22	11.50	NS	0.008	0.140	NS	NS	NS
Non-mulching	51.75	84.27	90.72	0.88	1.01	73.00	17.00	0.34	1.114	20.70	22.72	25.50
Mulching	56.38	91.28	97.27	0.99	1.20	91.00	19.56	0.34	1.508	22.71	24.42	25.95
CD (*P*=0.05)	2.04	2.03	2.95	NS	0.18	9.39	2.45	NS	0.114	1.63	0.88	NS

DAS, days after sowing

Leaf area index, yield attributes and yield

Mulching did not influence the leaf area index at early (30 days after sowing) growth stage, however at 60 days after sowing there was increase in leaf area index in mulching, due to better preservation of the soil moisture and availability to the plant for optimum vegetative growth. The leaf area index was highest in 'TS 38', followed by 'M 27' and 'Sikkim Sarson'. The treatments had a significant influence on the number of siliquae/plant. Due to mulching there was an increase in number of siliquae from 73 to 91/plant. Highest numbers of siliquae (97) were observed in 'TS 38' while the same was 59 in 'Sikkim Sarson'. Number of seeds/siliqua was influenced due to mulching. It increased from 17 to around 20 due to mulching with rice straw. Mulching had no significant effect on the 100-seed weight, however, the varieties differed significantly in this character. It was highest (0.37 g) in 'TS 38', which was higher over other varieties 'M 27' (0.33 g) and 'Sikkim Sarson' (0.33 g).

Highest seed yield (1.511 tonnes/ha) was obtained in 'TS 38' which was at par with 'M 27' (1.456 tonnes/ha) and significantly superior over the'Sikkim Sarson' (0.968 tonnes/ha). Mulching had a significant effect on seed yield of rapeseed varieties. There was 35.4% increase in seed yield due to mulching over non-mulched control. Rautaray (2005) reported that the mean response of *rabi* crops (potato, tomato, radish, pea, toria, lentil, gram and coriander) in rice-based cropping system to mulching (rice straw @7.5 tonnes/ha) was significant with 16% increase in yield. In rice–linseed (*Linum usitatissimum* L.) cropping sequence, normal tillage with rice straw mulching @ 3.5 tonnes/ha applied just after linseed sowing, recorded significantly higher seed yield over without mulch treatment (Kalita *et al*. 2005).

The importance of organic mulching, like rice straw @ 5.0 tonnes/ha is better realized in terms of their positive effect on improving soil moisture status and maintaining a congenial micro-climate for better growth and development of the rapeseed crop. Mulching improved the growth, yield attributes and seed yield of rapeseed and thereby this practice could sustain the productivity of a rice–rapeseed cropping system in the mid-hills of north-eastern hills region. It can also be concluded that the 'TS 38' rapeseed is significantly superior over other varieties.

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