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Influence of mulch on depletion pattern of *in situ* soil moisture in Rajma (Kidney Beans) crop system of Meghalaya

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ABSTRACT

In situ soil moisture is one of the constraints in crops production during the winter season when there is hardly any source of irrigation under a hilly terrain. A field trial was taken up to assess the *in situ* soil moisture depletion under two organic mulching materials, viz. maize stover and weed mulch. The performance of Rajma crop was studied under the influence of the organic mulch in the mid hill of Meghalaya. The percentage of emergence (79.75%) was found higher for weed mulch followed by maize stover mulch and un-mulch treatment. The soil moisture content and soil moisture stress were found to be within the acceptable range for weed mulch plot at two different monitored soil depths viz., 0-15 cm,16-30 cm. The depletion pattern of soil moisture was found rapid under un-mulch treatment (control) over organic mulch treatments. Within the organic mulch treatment, rapid depletion pattern was recorded for weed mulch over maize stover mulch. The economic yield and benefit cost ratio (BCR) recorded for Rajma cultivar "selection-9" was 2.52 t ha-1 and 1.45, respectively under weed mulching.

Key words: Organic mulch, Rajma, moisture depletion pattern, soil depth

INTRODUCTION

The Increase in agricultural productivity demands optimum utilization of natural resources like land and water. Mulching is one of the important practices in restoring moisture; among various mechanical and agronomic measures, to reduce soil erosion, increase *in situ* soil moisture storage and improve the productivity of crops (Bhatt and Rao, 2004). The practice of mulching has been widely used as a management tool in many parts of the world. However, the effect varies with soils, climate and kind of mulch materials used and the rate of application. The surface mulch favourably influences the soil moisture regime by controlling evaporation (Ramakrishna et al., 2006; Montenegro et al., 2013). To increase water availability to crops, it is necessary to adopt *in situ* moisture conservation techniques in addition to large scale soil and water conservation practices and various water harvesting measures (Lannotti, 2007; Chavan et al., 2010). Mulching can help to improve crop yield and optimize water use (Lamont, 1999; Parmar et al., 2013; Prasad et al., 2014 and Saikia et al., 2014). Mulches which are derived from plant material are called organic mulch, *viz*. grass, straws, leaves *etc* (Lannotti, 2007) and can be fruitfully utilized to retain moisture. A field trial was taken up to assess the *in situ* soil moisture depletion under two organic mulching materials, *viz.* maize stover and weed mulch with Rajma as a test crop at the mid hill of Meghalaya.

MATERIALS AND METHODS

A field trial was carried out during winter season (2015-16) at the experimental farm of the College of Postgraduate Studies, Umiam, which is located at Ri-Bhoi district, Meghalaya to study the

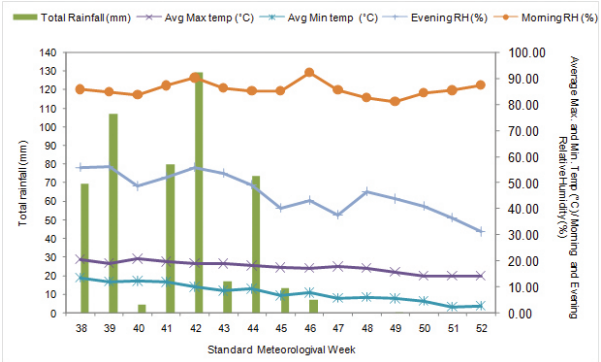


Fig. 1. Weekly variation of rainfall, temperature and humidity

soil moisture depletion pattern under organic mulch. The performance of a legume crop, Rajma cultivar "selection-9" was studied under the mulching practices. The experimental soil was sandy clay loam with PH of 4.83 and organic carbon (1.96%). The weekly rainfall (mm), average maximum and minimum temperature (^{0}C) and relative humidity (%) is shown in Fig. 1 and the weekly rainy day (day), pan evaporation (mm) and wind speed (km hr-1) is shown in Fig. 2. During the experimentation period, maximum weekly rainfall of 129.2 mm was received during the 42nd standard week (October), the total amount of 325.2 mm was received during the crop-growing season. The total number of rainy days recorded was 14; the highest number of rainy day occurred during the 39th standard meteorological week (5 days).

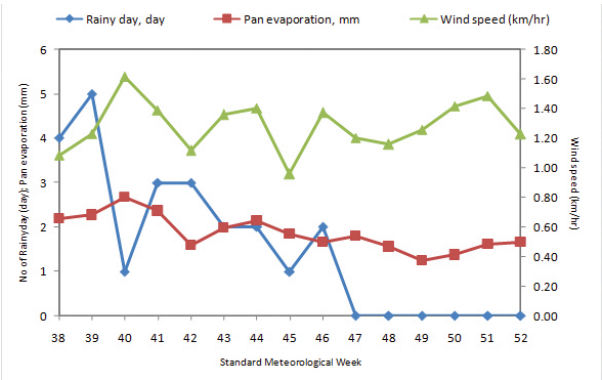


Fig. 2. Weekly variation of rainy days, pan evaporation and wind speed

To record the moisture stress developed at the 0-15 and 16-30 cm soil depth, tensiometers were also installed at the respective mulch and un-mulch plots. A calibration curve was prepared for the tensiometer prior to the installation and shown in Fig. 3.

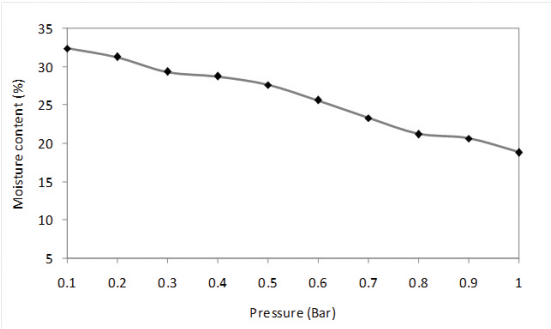


Fig. 3. Calibration curve of a tensiometer

A soil moisture characteristics curve was also prepared to know the moisture holding capacity of the soil. According to the prepared soil moisture characteristic curve soil moisture contents in Field capacity (FC) and Permanent wilting point (PWP) are 29.34% and 8.66%, respectively. The prepared curve is shown in Fig. 4.

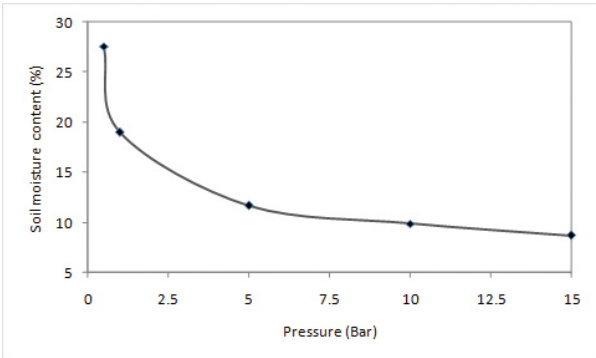


Fig. 4. Soil moisture characteristics curve

Mulching was applied @ 5 t ha^{-1} one day after sowing of the seed. The maize stover was chopped first and then spread over the plot. Standard agronomic practices were followed during crop growing period and the crop was harvested at maturity.

RESULTS AND DISCUSSION

Seed emergence

The emergence percentage for the Rajma varieties under different organic mulching is presented in Table 1. Weed mulch (79.75%) gave higher germination as compared to un-mulched (75.60%) indicating a better *in situ* soil moisture holding capacity by mulching practices. The results were well in agreements with the findings of Bonanno and Lamont, 1987; Sharma

and Acharya, 2000; Roy et al., 2010; Sharma et al., 2010; Nwokwu, 2014.

Table 1. Effect of mulching on emergence of Rajma

Treatments	Emergence percentage (%)
Un-mulch	75.60
Maize stover mulch	77.50
Weed mulch	79.75

Soil moisture depletion

The soil moisture values were recorded to determine the depletion pattern of soil moisture at two different depths, *i.e*., 0-15 cm and 16-30 cm for un-mulched and organic mulch treatment plots. The depletion status figures of un-mulching treatment at two depths are shown in Fig. 5 and 6, respectively. The weekly recorded data of *in situ* soil moisture is shown in the figure and the depletion status was found steady, however, the value of *in situ* moisture content recorded was found more at lower depth than at the upper layer. The same trend was observed for maize stover mulch and un-mulch treatment. Weed mulch showed better soil moisture retention as compared to maize stover mulch.

At the 15 cm depth the soil moisture fluctuation was recorded, where, the lowest was 10.98% at 84 days after sowing (DAS) and the highest value was 26% at 14 DAS. While at the 30 cm depth, the soil moisture status showed the highest value at 14 DAS as 32.15% and the lowest at 84 DAS as 15.64%. The weekly *in situ* soil moisture status for the maize stover mulch at 0-15 cm depth was found highest at 14 DAS (28.23%) and latter decreased; the lowest recorded value was at 84 DAS (11.91%); during the final stage of the crop. During a later stage of vegetative and pod formation, the *in situ* moisture was found higher and again it starts decreasing. While at 15- 30 cm depth the *in situ* soil moisture status of the maize stover mulch was found to be ranged between the lowest at 84 DAS (16.89%) and the highest at 14 DAS (31.23%). It may be noted that the *in situ* soil moisture depletion pattern was not steady as compared to un-mulch condition and the value of soil moisture was found higher at lower depth. It may be noted that the *in situ* soil moisture content was found more as compared to the other mulch treatments. The recorded soil moisture status for weed mulch at 15 cm depth was found to be lowest at 84 DAS (14.25%) and the highest value was observed at 14 DAS (29.87%). Whereas, at the 30 cm depth of weed mulching the soil moisture status were found to be ranged between the lowest of 19.24% at 84 DAS and the highest of 34.14% at 14 DAS. Similar findings were reported by Ahmed et al., 2007; Chavan et al., 2010; Parmer et al., 2013; Saikia et al., 2014.

Tensiometer observations

The tensiometer readings of the pressure gauge were recorded by the tensiometer installed in the un-mulched and organic mulched treatment field at two different depths, i.e., 15 and 30 cm are shown in the Fig. 7. The variation of tensiometer reading from 0 to 87 day of culture shows a steady increasing of soil moisture tension value as compared to the other two organic mulch treatments condition. The minimum value of soil moisture tension at 15 cm and 30 cm depth was recorded as 2.6 and 1.8 k pa, respectively.

For maize stover mulch treatment the soil moisture tension at 15 cm and 30 cm depth was 2.2 and 2 k pa, respectively. However, for weed mulch treatment the soil moisture tension at 15 cm and 30 cm depth was 1.9 and 1 kpa, respectively. The soil moisture tension values were found higher for the upper layer of soil depth as compared to the bottom layer, which indicates the availability of relatively more soil moisture at the bottom layer of soil for all organic mulch and un-mulch treatment plots. Similar trend in organic mulching treatments was also reported by Sinkevičienė et al., 2009; Chavan et al., 2010. The different between the high tension and lower tension is more at the top 15 cm depth (8 k Pa) at the end of the growing season, while (5 k Pa) was recorded at the 30 cm depth. Mulches reduce soil deterioration by preventing runoff and soil loss, minimize the weed infestation, increase the *in situ* soil moisture availability and reduce water evaporation (Sarangi *et al*., 2010). The *in situ* soil moisture depletion pattern was not found steady as compared to un-mulching condition and the value of soil moisture was found higher at lower depth, under

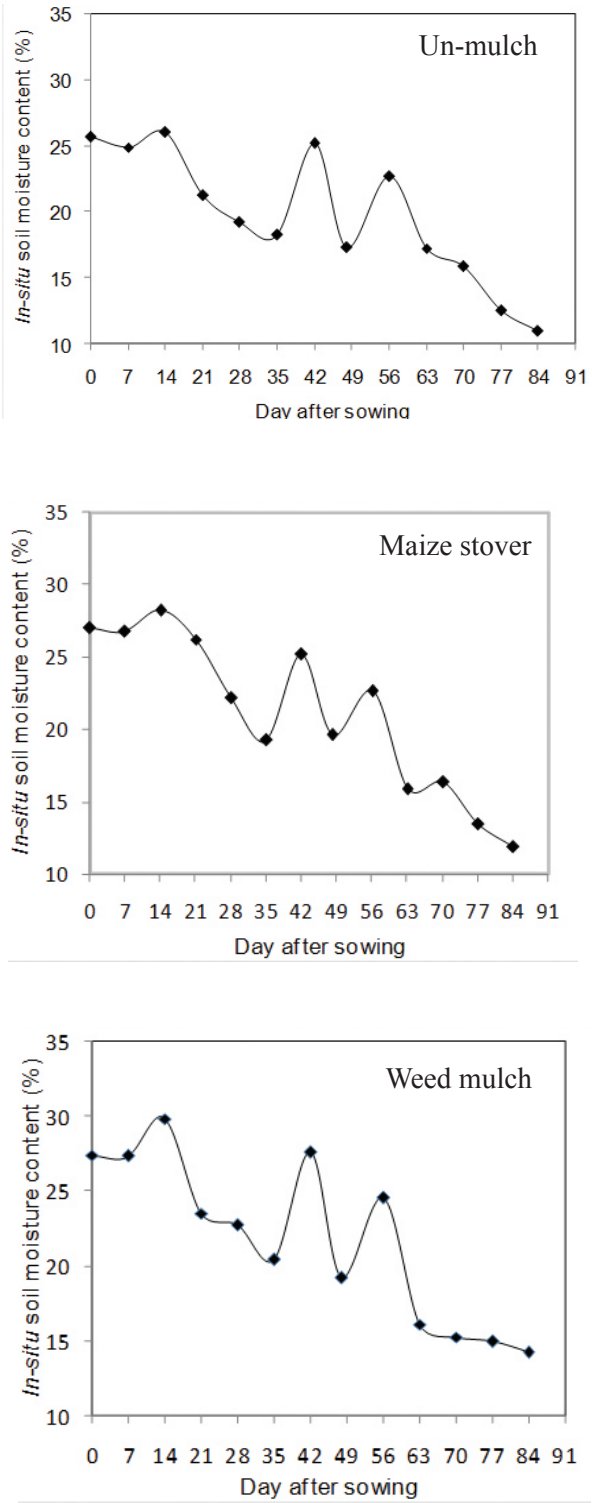


Fig. 5. Soil moisture content at 15 cm depth

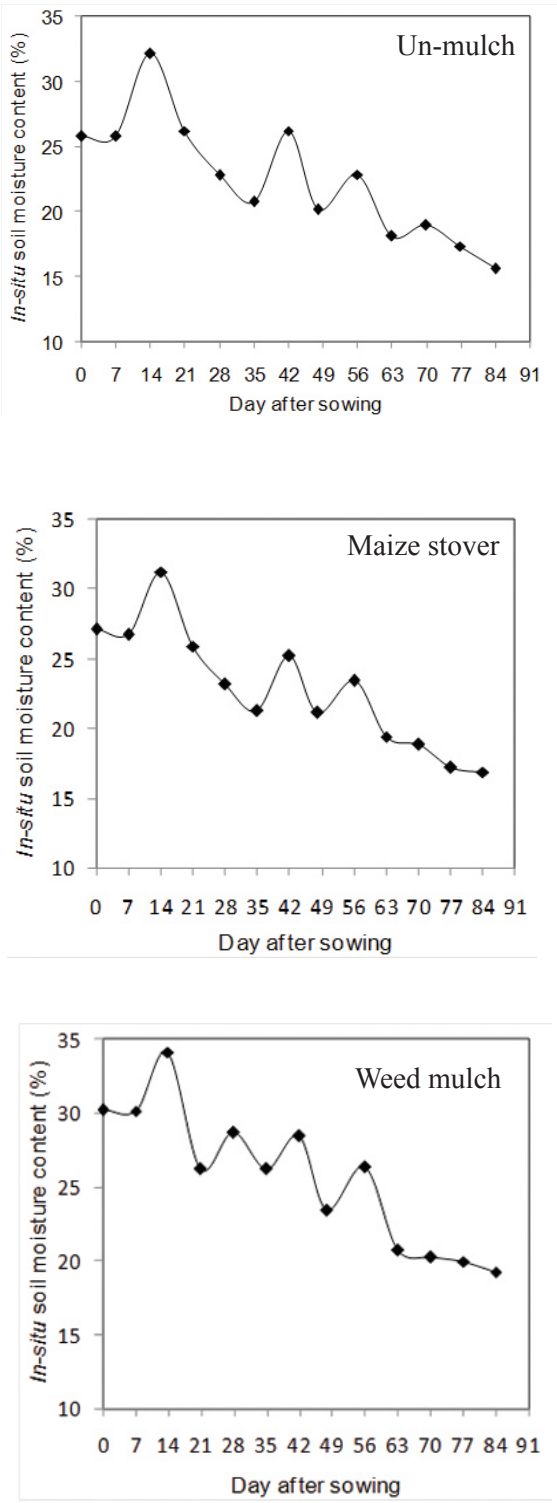
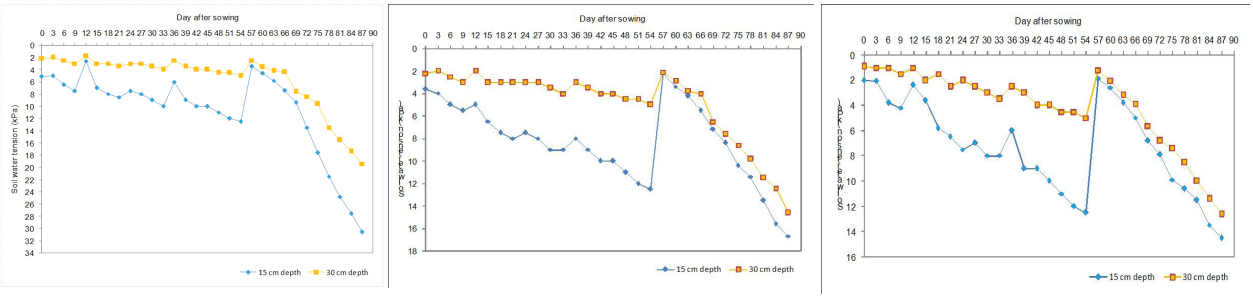


Fig. 6. Soil moisture content at 30 cm depth



a. un-mulch b. maize stover mulch c. weed mulch

Fig. 7. Variation of soil tension under condition

organic mulching and un-mulch condition. Similar findings were reported by Ahmed et al., 2007; Chavan et al., 2010; Parmar et al., 2013; Saikia et al., 2014. Weed mulch showed better soil moisture retention as compared to maize stover mulch.

Crop yield parameters

The organic mulching and the varieties selected for the field trial gave positive results on the yield parameters. The reductions in number of pods per plant may also be attributed due to abscission of flowers and pods (Malik et al., 2006) and or by the failure of fertilization due to the production of unviable pollens under moisture stress conditions under un-mulched plots (Ahmed and Suliman, 2010). Increasing the length of pod may be related with the age of the plant and its genetic characters as reported by Singh et al., 1994; Rashid and Hossain, 2014. Weed mulching treatment registered an increase in seed yield of Rajma. This was mainly due to availability of optimum soil moisture content at the seeds development stage, which enabled higher nutrient uptake, greater dry matter accumulation, more grains per pod and increased hundred seed weight. Better control of weeds under mulch which could have also favoured to increase the yield as reported by Barman et al., 2005; Chawla,2006; Chinnathurai et al., 2012.

CONCLUSION

Weed mulch is more effective in maintaining optimum soil moisture content at the seeds development stage, which enabled higher nutrient uptake, greater dry matter accumulation, more grains per pod and increased hundred seed weight. Better control of weeds under mulch which could have also favoured to increase the yield per plant. The soil moisture depletion was found rapid under un-mulch as compared to organic mulching. Hence, organic mulch can play a major role in maintaining *in situ* soil moisture and can be used by the farmers of the hilly regions to cultivate winter crop.

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