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Relative efficacy of different mulch types on soil moisture conservation and performance of rainfed turmeric in an agroforestry system of Mizoram

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Abstract

A study was conducted to compare the relative efficiency of different types of mulch materials such as rice straw, weeds and subabul leaves applied at 6, 8 and 10 t/ha on the performance of rainfed turmeric and soil moisture conservation. Mulches significantly (P = 0.05) affected soil moisture retention and crop productivity. Results showed that application of mulches at 10 t/ha conserved more moisture and increased yield of turmeric. The soil moisture retention in the plots was in the order of rice straw > subabul leaf > weeds. Application of subabul mulch resulted in maximum yield of turmeric over other mulches. Quality of mulch was more effective than quantity in conserving soil moisture and increasing growth and yield of turmeric.

Key words : Moisture conservation, Mulching, Rainfed, Turmeric productivity.

Introduction

Turmeric (*Curcuma longa* L.) is a widely grown crop in Mizoram owing to its diverse use in the preparation of various dishes, ethno-medicines and herbal drugs. It is grown under shifting agriculture, traditional homestead garden and in agroforestry systems covering an area of about 287 ha with its annual production of 2,785 tonnes. Itsôproductivity can be increased by adopting improved package of practices, particularly *in situ* moisture conservation through mulching. Mulches have been found to increase soil moisture, improve water retention (Srinivas *et al.* 1990; Chovatia *et al*., 1992; Vanlalhluna and Sahoo, 2008) and increase fruit yield mainly due to increased soil moisture status (Chattopadhyay and Patra, 1992; Mage, 1982). Mulch materials are also well known to improve conservation of soil moisture during dry period (Haynes, 1980), help supply moisture to the root zones and thereby improve crop performance (Moitra *et al.,* 1994). The prevailing traditional ójhumô farming practice being unscientific, contributes to the loss of soil moisture and subsequent degradation of the sites. Therefore, there is a need for conserving soil moisture to avert moisture deficit during crop growth period. The present study has been undertaken to compare the relative efficacy of different mulches (both type and quantity) for moisture augmentation and to assess the role played by mulches for improving turmeric productivity in the hilly terrains.

Materials and Methods

The field study was conducted at Tanhril campus of Mizoram University located at 15 km south-west of Aizawl, the capital city of Mizoram and lies between 23°42' to 23°46' N latitude and 92°38' to 92°42' E longitude. The study was carried out during 2003 to 2006 on a 1-yr old *Gmelina arborea* based agroforestry plot using RBD (Randomized Block Design) involving 10 treatments [as three mulch types (rice straw, weeds, subabul leaves) and three mulch quantity (6, 8 and 10t/ha) and a control (without mulch)] replicated thrice resulting into a total of 30 subplots (size 2.5m x 2.5m) marked from the main plot for evaluating soil moisture retention and growth productivity of turmeric. Turmeric was planted in the sub-plots at a uniform spacing of 25cm x 35cm. Mulches were applied immediately after sowing of the crop. Three weedings were carried out during a cropping period in order to prevent the growth of weeds and improve crop growth. The first weeding was done in mid-June, the second weeding in mid-August and the last in the first week of October, prior to harvesting of turmeric every year and the experiment continued for three years. Chemical control measures and irrigation of any sort were not provided and the crop was raised purely under rainfed condition. Observations were recorded in respect of vegetative growth such as sprouting frequency; tiller height

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and average sprout height at monthly intervals. The average yield, finger number and finger size were recorded after harvest.

Soil moisture content was determined from the soil samples collected from 0-15 cm depth at a monthly interval, which were properly tagged and sealed in plastic packets before being brought to the laboratory for analysis. Soil moisture loss on drying to constant weight was determined for 100 gm of fresh soil. The soil moisture percent was expressed as percent fresh weight. Economics was found out by taking into account the existing market rate of the crop, mulch materials and cost of cultivation. The data were subjected to analysis of variance to see the effect of mulch materials on soil moisture conservation and growth and yield attributes of turmeric.

Results and Discussion

Growth

Plant height of turmeric increased with increasing rates of the application of mulch materials. Maximum height was recorded with 10 t mulch/ha, followed by 8 t/ha and 6 t/ha (Table 1). In general, increased number of sprouts and tiller frequency were observed with higher rates of mulch application. Similar findings were reported by Mohanty *et al.* (1990), Sharma *et al.* (2001) and Dinesh Kumar *et al.* (2003). The sprouting number and its frequency was in the order of subabul leaves mulch > rice straw > weeds. Similarly better growth of the tillers in the subabul leaves mulched plots could be related to the nitrogen supply of the rapidly decaying legume (subabul) leaves although the soil did not retain maximum moisture. More moisture was retained by rice straw mulch but it alone did not improve the growth.

Yield

Among the different mulches, subabul leaf mulch showed maximum turmeric yield, higher number of finger and better finger size over rice straw and weed mulches (Table 2). Quick decomposition of subabul leaves must have released some nitrogen to the soil favouring crop growth in the system. Further, maximum crop yield and finger number and better finger size were obtained with

Table 1: Plant height, tiller number, tiller frequency percent of turmeric as influenced by different treatments.

Mulch	2005 ï 2006	2004 ï 2005	2003 ï 2004	Mean
		Plant height/tiller height (cm)		
Quantity:				
6 t/ha	29.50	28.94	27.77	28.73
8 t/ha	30.89	30.27	29.27	30.14
10 t/ha	32.43	31.89	31.47	31.93
CD at 5%	3.94	3.97	3.75	
Quality:				
Rice straw	32.67	30.24	30.96	31.29
Weeds	30.68	28.67	29.42	29.59
Subabul leaves	34.49	31.90	32.80	33.06
CD at 5%	3.84	3.56	3.42	
		Sprout numbers		
Quantity:				
6 t/ha	1.17	1.14	1.14	1.15
8 t/ha	1.19	1.15	1.16	1.16
10 t/ha	1.23	1.16	1.17	1.18
CD at 5%	0.04	0.02	0.03	
Quality:				
Rice straw	1.18	1.16	1.17	1.17
Weeds	1.16	1.14	1.15	1.15
Subabul leaves	1.20	1.18	1.19	1.19
CD at 5%	0.03	0.02	0.02	
		Sprouting frequency percent		
Quantity				
6 t/ha	62.29	61.72	61.76	61.92
8 t/ha	63.86	62.95	62.99	63.26
10 t/ha	65.41	64.66	64.71	64.92
CD at 5%	2.95	2.86	2.85	
Quality				
Rice straw	64.62	63.23	63.67	63.84
Weeds	63.33	61.69	62.14	62.38
Subabul leaves	66.30	64.23	65.05	65.19
CD at 5%	2.21	2.15	2.32	

Table 2 : Turmeric yield, number of fingers and finger size as affected by different treatments

Mulch	2005 ï 2006	2004 ï 2005	2003 ï 2004	Mean
		Turmeric yield (t/ha)		
Quantity				
6 t/ha	7.79	7.14	6.15	7.02
8 t/ha	8.53	7.57	6.70	7.60
10 t/ha	9.08	8.25	7.18	8.17
CD at 5%	2.64	3.62	3.29	
Quality				
Rice straw	8.47	7.95	7.06	7.83
Weeds	7.69	6.57	5.68	6.65
Subabul leaves	9.04	8.44	7.29	8.26
CD at 5%	2.56	2.15	2.00	
		Number of fingers		
Quantity				
6 t/ha	6.33	6.22	6.13	6.22
8 t/ha	6.47	6.36	6.29	6.37
10 t/ha	6.58	6.51	6.41	6.50
CD at 5%	0.84	0.60	0.65	
Quality				
Rice straw	6.49	6.38	6.29	6.39
Weeds	6.31	6.20	6.11	6.21
Subabul leaves	6.58	6.51	6.42	6.50
CD at 5%	0.82	0.55	0.58	
		Finger size (cm)		
Quantity				
6 t/ha	6.65 x 6.26	6.27 x 6.14	6.23 x 6.11	6.38 x 6.17
8 t/ha	6.35 x 6.20	6.28 x 6.17	6.26 x 6.13	6.29 x 6.16
10 t/ha	6.52 x 6.31	6.39 x 6.23	6.38 x 6.18	6.43 x 6.24
Quality				
Rice straw	6.65 x 6.28	6.27 x 6.14	6.23 x 6.12	6.38 x 6.18
Weeds	6.22 x 6.16	6.18 x 6.12	6.17 x 6.11	6.19 x 6.13
Subabul leaves	6.71 x 6.30	6.30 x 6.23	6.28 x 6.19	6.43 x 6.24

10 t mulch/ha, followed by 8 t mulch/ha and 6 t mulch/ha (Table 2). Improved growth resulted in more finger number and better size per mother rhizome thereby depicting 10t mulch/ha as appropriate dose for bringing beneficial effects on crop productivity. Similar increase in turmeric yield have been reported earlier ((Mohanty *et al*., 1990, 1991; Dinesh Kumar *et al.,* 2003).

Soil moisture conservation

Soil moisture retention varied significantly (P = 0.05) with mulch types and quantity (Table 3). Among the mulch types the application of rice straw conserved more moisture than subabul leaves and weeds (Table 3). Higher moisture retention by rice straw over other mulches could be due to its slower rate of decomposition. The mulch quantity also significantly (P = 0.05) affected soil moisture retention; an increasing mulch rate increased moisture retention therefore moisture retention was in the order of 10 t mulch/ha > 8 t mulch/ha > 6 t mulch/ha. A higher rate of mulch application could have caused reduction in soil surface evaporation and weed intensity thereby facilitating more moisture retention and crop yield. Ross *et al.* (1985) have ascribed such a situation to thermal insulating and cooling effects.

Table 3: Soil moisture retention (%) as influenced by different treatments

Mulch	2005-2006	2004-2005	2003-2004	Mean
Quantity				
6 t/ha	39.73	20.26	7.16	22.38
8 t/ha	48.88	28.70	10.72	29.43
10 t/ha	59.95	37.31	16.74	38.00
CD at 5%	2.02	2.18	3.15	
Quality				
Rice straw	59.51	37.15	16.74	37.80
Weeds	39.46	20.35	7.94	22.58
Subabul leaves	49.73	29.08	9.58	29.46
CD at 5%	2.13	2.39	3.12	

Table 4 : Benefit: cost of turmeric as influenced by different treatments

Mulch	2005-2006	2004-2005	2003-2004	Mean
Quantity				
6 t/ha	1.95	1.79	1.54	1.76
8 t/ha	2.13	1.89	1.68	1.90
10 t/ha	2.27	2.06	1.80	2.04
Quality				
Rice straw	2.12	1.99	1.77	1.96
Weeds	1.92	1.64	1.42	1.66
Subabul leaves	2.26	2.11	1.82	2.06

Soil moisture in the present study increased gradually from May to July with the onset of rainfall and reached its peak between August to September and then declined (Fig. 1 and 2). This trend was seen for all the mulched plots. This was possibly related to the rate of decomposition of the vegetative mulch materials showing higher moisture retention during winter than summer months. Jiang Ping *et al.* (1997) advocated that mulching

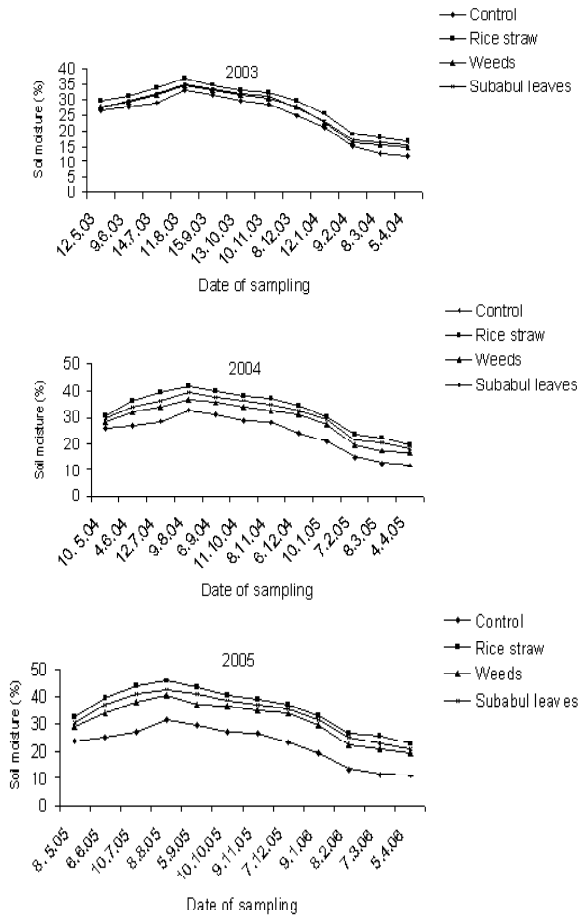

Fig.1 : Monthly soil moisture (%) under different mulch types during 2003-2005.

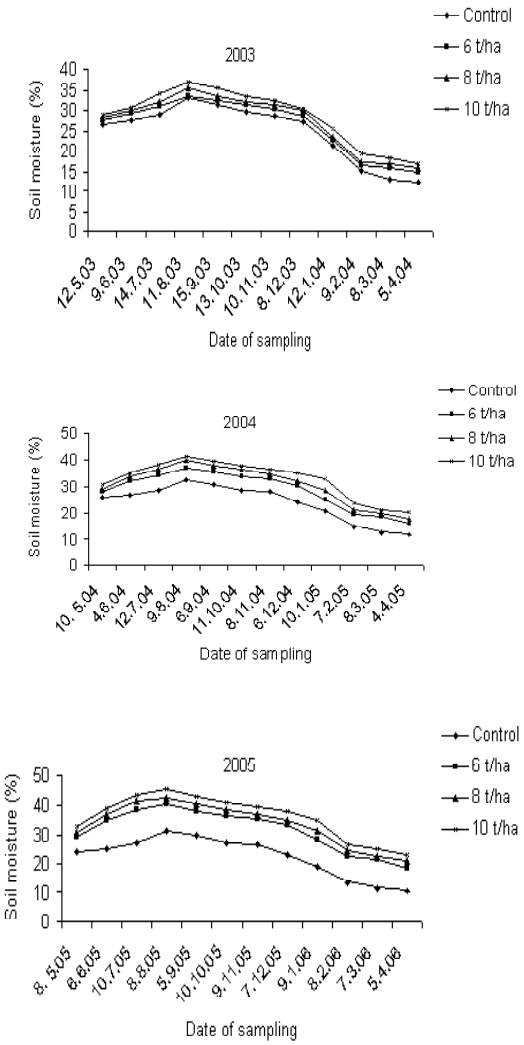

Fig.2 : Monthly soil moisture (%) under different mulch quantity during 2003-2005.

can reduce soil temperature in summer and increase in winter and hence the application of mulches in dried parts of the year can be more beneficial to the crop than the wet seasons.

Economics

Benefit: cost ratio was highest for the crop applied with 10 t mulch/ha and was most economical under subabul leaves than other mulches (Table 4). A higher yield with subabul leaves was the reason for its higher B:C ratio. The reduced management cost in the third year compared to first and second years also contributed to better B:C ratio suggesting the beneficial effect of the mulches to the soil over the years.

Conclusion

Our investigation revealed that moisture conservation is essential for better performance of turmeric. Mulching with subabul at 10 t/ha is best in maximizing the yield. Spreading the beds with locally available weeds (after weeding) could be an effective tool to enhance moisture conservation and productivity in the hilly terrain of Mizoram.

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