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Effect of Mulch on leaf growth and yield of Rape under overhead irrigation condititions of South East Lowveld of Zimbabwe

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ABSTRACT

Use of mulch is one of the most important practice which increases water use efficiency and ultimately productivity. A trial evaluating the effect of different organic mulches on growth and yield of rape and soil temperature was conducted in the South East Lowveld under irrigation during hot season. Two types of organic mulch materials with two different thickness per mulch were used. Treatments were maize stover at 15cm, maize stover at 10cm, dry grass at 15cm, dry grass at 10cm thickness and bare ground was used as a control for comparison. Soil temperature were measured at 0600, 1300 and 1800 hours at a depth of 5 cm. Results showed that maize stover at 10 and dry grass at 10cm significantly ($p<0.05$) increased plant height while leaf size, number of leaves and leaf yield were not increased by mulch type, mulch thickness and soil temperature leading to the observed results which were not significantly different ($p>0.05$).

INTRODUCTION

Rape (*Brassica nupus*) is a major leafy vegetable crop, and a source of income for a wide range of farmers. It is highly productive per unit area in a short period of time. In Zimbabwe rape is commonly grown in winter because it does best during this time. There is a huge over supply of this vegetable in winter and the selling price is not attractive to many producers. However, the production of rape in September is not productive because of the climatic condition of the south east lowveld of Zimbabwe. The south east lowveld falls under agro-ecological Region 5 and from September the temperatures will be too high for the production of exotic leafy vegetables such as rape as compared to other regions of Zimbabwe. High soil temperature can significantly and adversely reduce the potential yield of rape in the south east lowveld of Zimbabwe.

Moisture conservation measures can be important under such situations. Mulching has been advocated as an effective means for conservation of soil moisture. It works as an insulating barrier which checks evaporation from soil surface. Mulching is an agricultural and horticultural technique in which the use of organic materials such as plant residues-straw-hay and leaf with or without shallow tillage for the purpose of increasing soil productivity is involved. This technique is very important in preventing plant roots from heat, cold or drought. Mulching is an application of layer or covering material on the ground surface (Rowe-Dutton and Patricia 1957).

Mulch reduces the deterioration of soil by way of preventing the runoff soil loss, minimizes the weed infestation and controls the water evaporation. Thus it facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth of crops (Kurma et al., 1990). Research has shown that mulch provides many benefits to the crop production through soil and water conservation, enhances soil biological activity and improved chemical and physical properties of the soil (Cooper, 1973). However, Menezes et al., 1974 ; Chung, 1987 and Aliudin, 1986 reported that mulches conserved more soil temperature, enhances vegetative growth and yield contributing characteristics of garlic. Hatfield et al.,(2001) reported a 34-50 per cent reduction in soil water evaporation as a result of crop residue mulching. Mulch slows down evaporation and redues the irrigation requirement (Anonymous Commercial Flowers, 2003). (Chawl,a 2006), Khurshid et al., (2006) and Muhammad et al., (2009) stated the same results that mulching improves the ecological environment of the soil and increases soil water content. Mulches help to conserve soil moisture, lower soil temperature, smoother weeds, protect seedling from the impact of rain, hail and wind, reduce soil/pathogen innoculum splashing, and enhance beneficial microbial activity in the soil (Thurston, 1994).

MATERIALS AND METHODS

Sites

The experiments were conducted at Chiredzi Research Station on soil type called paragneis (Sand clay) in the South East Lowveld of Zimbabwe. The mean annual rainfall is 500mm with a seasonal range of 250-1000mm. The Natural Regions are a classification of the agricultural potential of the country from Natural Region I, which represents the high altitude wet areas to Natural Region V, which receives low and erratic rainfall averaging 500mm per annum.

Experimental procedures and treatments

The trial was set up in randomised complete block design (RCBD) replicated three times with five treatments. Plants were spaced 0.5m between rows and 0.3m between plants in a row. Two types of organic mulch materials with two different per much i.e. maize stover at 15cm (MST 15cm), maize stover at 10cm (MST 10cm), Dry grass at 15cm (DG 15cm), Dry grass at 10cm (DG 10cm), thickness and bare ground (BG) was used as treatments. Bare ground was used as a control treatment for comparison. Gross plots were 3m long (length) by 2m wide (width) each and the net plot area of 2.4m2 . Soil analysis was not done because of financial challenges. One rape variety (Rape Giant English) was used in this trial. Soil temperatures per treatment was recorded at 0600, 1300 and 1800 hours with the use of laboratory based thermometers at 5 soil depth. The three randomly selected plants were measured for plant height with a graduated meter ruler from the soil surface to the tip of the leaf at final harvest. Basal fertilizer compound at a rate of 400kgs/ ha was uniformly applied to all plots as basal application. Ammonium nitrate at a rate of 100kg/ha was uniformly applied to all plots as top dressing when the crop reached two weeks maturity from planting. The crop was again applied with ammonium nitrate at 100kg/ha to all plots uniformly at two weeks interval after harvesting. Organic mulch materials (maize stover and dry grass) at 15 and 10cm thickness per each mulch was applied to the crop four weeks from planting.

Crop establishment, measurements and management

Planting holes 50cm apart by 30cm were marked by hand hoes, giving a plant population of 66666.67/ha. Irrigation was applied at field capacity soon after planting. Plant heights at final harvest, number of marketable and non marketable leaves, fresh weight of marketable and non marketable leaves, leaf length and width and fresh leaf yield per hectare were determined. A net plot of 2.4m2 was used for determination of fresh leaf yield.

Statistical analysis

GenStart 14th Edition a statistical package was used to analyze data that was obtained from the experiments. Least Significant Difference (LSD) test was used to separate means at 5% probability.

RESULTS

Plant heights at final harvest

Plant height was significantly increased ($p<0.05$) by maize stover mulch (50.35) and dry grass applied at 10cm thickness (49.35) compared to

maize stover at 15cm thickness (44.10) (Table 1.) However, all the other treatments did not show significant differences.

Leaf size

There were no significant differences on marketable leaf length (44.31, 43.18, 43.18, 43.46 and 42.99) and width (17.78, 17.74, 17.91, 18.18, and 18.25) in all the treatments (Table 1.)

Number of marketable and non marketable leaves

There were no significant differences on number of marketable (351.7, 390.2, 377.2, 371.0 and 383.2) and non marketable (45.10, 57.80, 48.13, 58.23 and 73.10) leaves in all the treatments (Table 1.)

Fresh leaf yield of marketable and non marketable leaves

There were no significant differences on yield of marketable (73.67, 78.40, 75.43, 74.60 and 69.80) and non marketable (55.73, 60.31, 70.70, 77.88 and 83.67) leaves in all the treatments (Table 1.).

Effect of soil temperature measured at 5cm below soil surface

Results showed significant differences ($p<0.05$) on the effects of mulch materials on soil temperature measured at 5cm below soil surface at 0600 and 1300 hours resulting in significant differences (Table 2). Maize stover mulch at 15cm thickness (21.60c) had significant differences with maize stover mulch at 10cm (21.90c), dry grass mulch at 15 (22.800c)and 10cm mulch (24.6 0c) thickness and bare ground at soil temperature taken at 0600 hours. There were also significant differences between maize stover mulch at 15cm (23.30c) and bare ground (32.20c) on soil temperature taken at 1300 hours. However, soil temperature measured at 1800 hours showed no significant differences ($p>0.05$) as compared to bare ground treatment (Table 2).

DISCUSSION

The increased in plant height observed in this study on maize stover mulch at 10cm and dry grass mulch at 10cm thickness is in consistent with the findings of Mamkagh (2009), that covering the soil surface with mulch significantly increased plant height compared with bare soil, which might be due to the increased soil temperature (Tuli and Yesilsoy 1997).

The increase on plant height observed on maize stover mulch at 10cm and dry grass mulch at 10cm thickness compared to bare ground might be as a result of increased water use efficiency (Unger and Jones 1981). It is known that as the mulch decompose soil structure is improved and nutrients are released in the soil after decomposition and this might have caused the increase on plant height at the expense of leaf growth and yield.

Yield was not significantly increased by the application of mulch materials and the results disagree with the findings of Kurshid et al. (2006) ; Anikwe et al. (2007) ; Seyfi and Rashidi (2007) ; Essien et al. (2009) who observed that mulches not only conserved soil moisture and prevent soil erosion they also increased soil fauna and flora activities, suppressed weed and maintained high crop yields.

The low soil temperature observed under the mulch materials was a result of applying mulch on soil surface which lowers the soil temperature especially during the hottest hours as compared to bare ground. The results agreed with the findings of (Bhatt and Kheral 2006) ; Anikwe et al. (2007) ; (Sarka and Singh 2007) ; (Glab and Kuling 2008) who observed that, mulch provides a better soil environment and moderates soil temperature.

It was observed that by the time that the next irrigation was due, the unmulched plots had crusted at the top whereas it was still moist under mulched plots. This implied that mulched plots had greater soil moisture reserve in the surface layer than unmulched soil surfaces. Since irrigation is more expensive and time consuming for small holder farmers in the southeast lowveld of Zimbabwe, the application of organic mulch such as maize stover and dry grass may serve time and money and enhance nutrition and income generation among small holder farmers.

RECOMMENDATION

Maize stover and dry grass is recommended as mulch materials for rape production during hottest months. Small holder farmers are encouraged to use mulch in rape production since it conserve moisture, reduces frequency and serves time of irrigation in the southeast lowveld of Zimbabwe.

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Table 1: Response of rape (giant rape) to different organic mulch types and thickness on plant attributes and fresh yield of marketable and non marketable leaves under South East Lowveld conditions.

Treatment	Plant ht. at final harvest (cm)	Marketable leaf lengt h (cm)	Marketable leaf width (cm)	No of marketable leaves (000)	No of non marketable leaves (000)	Fresh leaf yield of marketable leaves (t/ha)	Fresh leaf yield of non marketable leaves (t/ha)
Maize Stover 15 cm	44.10[a]	44.31	17.78	351.7	45.10	73.67	55.73
Maize Stover 10 cm	50.35[b]	43.18	17.74	390.2	57.80	78.40	60.31
Dry Grass 15 cm	47.60[ab]	43.18	17.91	377.2	48.13	75.43	70.70
Dry Grass 10 cm	49.35[b]	43.46	18.18	371.0	58.23	74.60	77.88
Bare Ground control	47.90[ab]	42.99	18.25	383.2	73.10	69.80	83.67
Means	47.86	43.42	17.973	374.7	56.5	74.4	69.7
LSD	4.728	2.323	0.6350	53.04	50.29	18.04	34.21
SE	2.511	1.234	0.3373	28.17	26.71	9.58	18.17
CV%	5.2	2.8	1.9	7.5	47.3	12.9	26.1
P.Value	0.109	0.709	0.316	0.549	0.734	0.859	0.367

Table 2: : Effect of different organic mulch types and thickness on soil temperature measured at 5cm below soil surface at 0600, 1300 and 1800 hours .

Treatment	0600	1300	1800
Maize Stover 15 cm	21.60[a]	23.30[a]	24.90
Maize Stover 10 cm	21.90[b]	26.40[ab]	24.80
Dry Grass 15 cm	22.80[c]	29.30[ab]	27.33
Dry Grass 10 cm	24.63[c]	26.40[ab]	25.57
Bare Ground control	22.87[c]	32.20[b]	29.20
Means	22.360	27.52	26.36
LSD	0.2771	6.687	4.190
SE	0.1472	3.552	2.225
CV%	0.7	12.9	8.4
P.Value	<. 005	0.108	0.165

Disclosure statement

No potential conflict of interest was reported by the author.

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