Annals of Sri Lanka Department of Agriculture 2017. 19 (2): 128 - 137

EFFECT OF DIFFERENT MULCHING MATERIALS ON SOIL WATER, YIELD AND ECONOMICS OF FOUR BANANA VARIETIES ON NON-CALCIC BROWN SOILS IN THE LOW COUNTRY DRY ZONE OF SRI LANKA

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ABSTRACT

Mulching is a process or practice of covering the soil/ground to make more favourable conditions for plant growth, development and efficient crop production. Effects of different mulching materials on soil moisture availability, growth, yield and economics of four banana (*Musa* spp.) varieties (Seeni Kesel, Alu Kesel, Kolikuttu and Ambul Kesel) was tested using a split plot design with three replicates at the Regional Agricultural Research and Development Centre (RARDC), Aralaganwila during 2005/06 *Maha* to 2006 *Yala* seasons. The highest banana growth, yield and yield components were recorded by the treatment of rice straw followed by guinea grass. The lowest banana yield and yield components were recorded in no mulch treatment. The highest soil moisture availability was also recorded in straw mulch treatment followed by guinea grass treatment. The highest gross return, net return and cost-benefit ratio was also recorded in straw mulch treatment. Among the sub plot treatments, Ambul banana variety recorded the highest yield, but banana variety Kolikuttu recorded the highest gross return, net return and BC ratio. Based on the results, it can be concluded that application of recalcitrant mulches such as rice straw and guinea grass enhance the banana yield resulting higher net return and BC ratio.

Key words: Banana, Mulching, Soil moisture, Yield components, Growth, Yield

INTRODUCTION

The Banana (*Musa* spp.) is native to South East & South Asia and makes an important contribution to the international fruit industry. There is no other fruit in the world, which surpasses Banana & Plantains either in production tonnage or in trade volume in fresh form (FAO, 1995). Banana is the most widely consumed fruit in Sri Lanka, and is an attractive perennial

fruit crop for small farmers due to its high economic returns throughout the year. Currently, nearly 50,000 ha of lands are under banana cultivation in Sri Lanka, which is about 54% of the total fruit cultivation extent and the annual banana production is around 450,000 tons. Until recently, banana cultivation was limited to very small plots, but now large fields are being established. More and more rice farmers are switching to banana cultivation due to the high profit margin with less labour. At present, Banana productivity is only about 13 mt/ha. But, this amount is very low compared to that in major Banana growing countries of the world. However, this production can be increased up to 45-50 mt/ha by adopting good management practices.

A large extent of rainfed uplands is available in the eastern Dry zone of Sri Lanka under Non- Calcic Brown soil (NCB) without being used for any productive purpose as the rainfed uplands under NCB soil is marginally suitable for annual crop cultivation due to coarse textured soil and long dry spells in *Yala* season (Panabokke, 1996). Although, the use of mulching is long standing practice and much work is carried out to demonstrate the benefit of the use of different mulches, but, the adoption rate is very low. Therefore, this study was carried out to find out the effects of different mulching materials on soil moisture, growth, yield and economics of different banana varieties.

MATERIALS AND METHODS

The effect of four organic mulching materials namely Rice straw, Gliricidia (*Gliricidia sepium*) leaves, Guinea grass (*Panicum maximum*) and Ipil-Ipil (*Leucaena leucocephala*) leaves on soil moisture, growth, yield and economics of four banana (*Musa* spp.) varieties (Seeni Kesel, Alu Kesel, Kolikuttu and Ambul Kesel) was tested RARDC, Aralaganwila (DL_{2b} agro-ecological region) in a split plot design with three replicates. The area is having a uni-modal rainfall pattern with an average annual rainfall of about 1,100 mm. Soil of the area is moderately deep, well drained, Non Calcic Brown soils (*Haplustalfs*) (Panabokke, 1996). The texture of the soils of the experimental site was sandy loam with slightly acidic in reaction. Different mulching materials (Rice straw, Gliricidia leaves, Guinea grass lopping and

Ipil-Ipil leaves) were the main plot treatments, while banana varieties (Seeni kesel, Alu kesel, Kolikuttu and Ambul kesel) were the sub-plot treatments.

The experimental field was ploughed once with a tractor and made it to a fine tilth using a harrow. Banana suckers were planted in 2 m x 2 m spacing irrespective of the type of variety consisting four plants per sub plot (16 m^2) and sixteen plants per main plot (64 m^2) on 20th of July 2005. Mulching materials were applied uniformly (10 t/ha dry weight basis) half meter away from the base of the banana plants and covering the rest of the plot. Chemical fertilizer was applied at the rate of 300 kg/ha of urea, 320 kg/ha of muriate of potash and 340 kg/ha of triple super phosphate to all plants during planting. In addition organic manure (compost) was applied at the rate of 10 tons per hectare basis for all plants irrespective of treatment. Weeds were controlled manually. Other crop management practices were done according to the recommendation of the Department of Agriculture (Anon, 1990). Crop was maintained as rain-fed crop throughout the year. Crop growth was measured as number of leaves per plant and girth of the stem (ground level) at the time of the flowering. Fruit yield was measured as number of hands per bunch, fruits per hand, fruits per bunch, fruit length and bunch yield per hectare. Surface (0-15 cm soil depth) soil moisture content was measured 50 cm away from each plant at two months intervals using gravimetric method.

Economics of banana cultivation

Gross income of banana cultivation was calculated based on the product of weight of banana bunches (Economic yield) in each treatment and the market price of each banana varieties in year 2006.Cost of cultivation was calculated according to the actual cost of inputs (fertilizer etc.) used in the experiment and actual labour hours used in the experiment. Net income was calculated as the difference between gross income and cost of cultivation. Benefit: Cost ratio was calculated as the ratio between net income and cost of cultivation.

RESULTS AND DISCUSSION

There were total of 1,833.2 mm of rainfall received during the one year experimental period from July 2005 to June 2006. Higher amount of rainfall was received during the months of November and January (Figure 1).

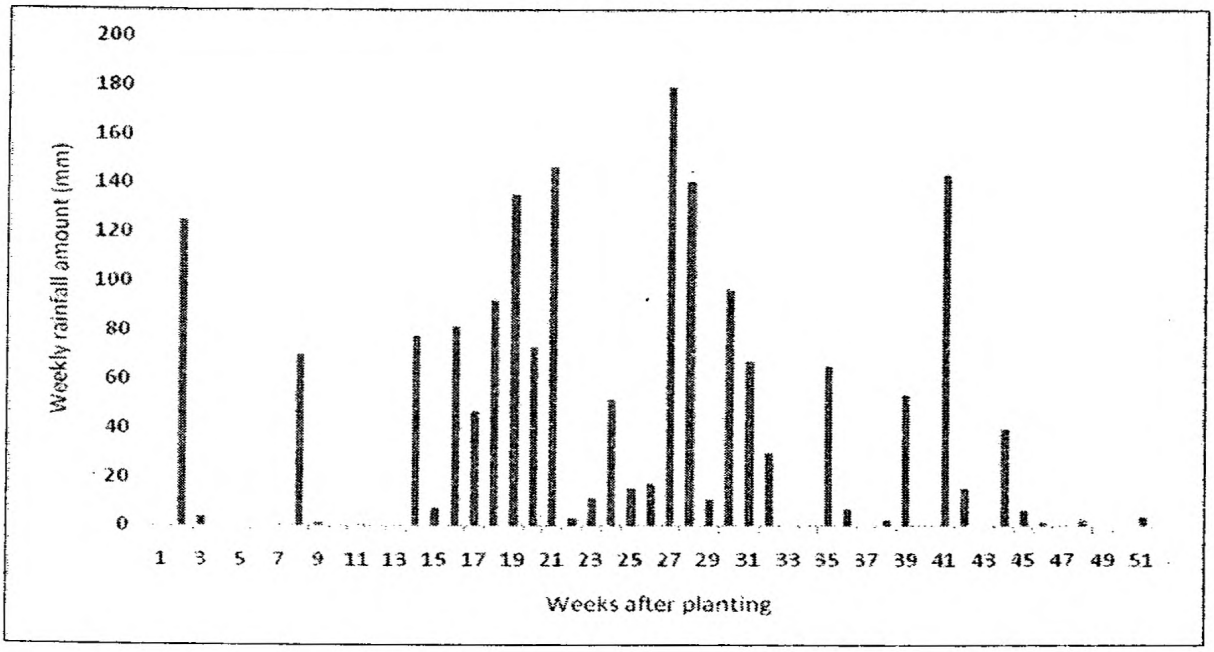

Figure 1. Weekly rainfall distribution during the experimental period.

Yield of Banana

Among the different mulching materials tested, Rice straw recorded the significantly highest number fruits per bunch and bunch yield. Both rice straw and guinea grass mulch recorded the highest number of hands per bunch and length of individual fruits. Rice straw, guinea grass and gliricidia mulch recorded the highest number of fruits per hand. Although, mulching materials of gliricidia and ipil-ipil might have contained much of the plant nutrient than rice straw and guinea grass rapid decomposing rate of gliricidia and ipil-ipil might have not performed the function of covering the soil against heavy rain and solar radiation leading to leaching of soil nutrients and loss of soil moisture. It might be the reason for lower banana yield under the treatments of gliricidia and ipil-ipil mulches. Among the banana varieties, both seeni kesel and ambul kesel recorded the significantly highest yield. However; only ambul kesel recorded the highest number of hands per bunch, fruits per hand and

number of fruits per bunch. Alu kesel recorded the significantly highest length of fruit.

Planting of banana without application of any mulching materials recorded very poor yield may be due to the leaching and bodily erosion of applied chemical fertilizer (especially TSP). In addition banana plants under no mulch treatment might have experienced the water stress during the dry period since crop was maintained as rain-fed crop (Table 3). Significantly lowest gravimetric soil moisture content throughout the growing season might have adversely affected the growth, yield and yield components of Banana (Table 1). In addition, since mulching materials cover the soil surface, ramification of banana roots might have stimulated. This may have resulted in increased nutrient uptake by the crop and increased bunch weights (Ruhigwa *et al.*, 1992). Highest banana yield under mulched treatments also reported due to the reduced soil erosion, temperature fluctuations, and improved weed control (Salau *et al.*, 1992). Interaction between mulching materials and banana varieties on yield and yield components of banana was not observed.

Growth parameters of Banana

Application of rice straw, guinea grass and ipil-ipil mulches recorded statistically similar number of leaves per plant of banana at the time of flowering. However, significantly highest girth of the stem of banana was recorded in the application of rice straw. Cultivation of banana without application of mulch recorded the lowest number of leaves per plant and girth of the stem. Organic materials used as mulch are biodegradable, and perform all the benefits to the soil (enhanced soil biological activity and improved chemical and physical properties of the soil) leading to the improved growth rate of banana plants (Murugan and Gopinath, 2001). Among the different banana varieties, Alukesel recorded the significantly highest girth of the stem. However, this may be due to the varietal differences of growth of the girth of plants.

Table 1. Effect of different mulching materials on yield and yield components of four banana varieties.

Treatment	# of hands	Fruits per hand	Length of fruit	# of fruits/bunch	Yield
Main treatments (type of mulch)					
M_1. Rice Straw	9.167a	15.717a	11.950a	136.167a	26.00 a
M_2. Gliricidia	8.000b	15.383a	9.608b	108.250c	15.15c
M_3. Guinea grass	8.750a	15.033ab	10.521a	120.917b	20.17 b
M_4. IpilIpil	7.333c	14.342b	9.175b	96.750d	14.81c
M_5. No Mulch	6.667d	13.142c	8.225c	83.250e	6.71d
S.Ed.±	0.244e	0.319	0.326	4.509	1.768
CD (p = 0.05)	0.572	0.748	0.763	10.559	4.416
Sub treatments (Banana variety)					
S_1. Seeni	9.000b	15.813b	8.780c	134.400b	18.38a
S_2. Alukesel	6.333c	12.213d	12.090a	72.200c	14.58b
S3. Kolikuttu	6.200c	13.447c	9.580b	75.467c	12.89b
S4. Ambul	10.400a	17.420a	9.133bc	154.200a	20.41a
S.Ed.±	0.280	1.369	0.358	5.077	1.42
CD (p = 0.05)	0.575	0.667	0.734	10.418	2.91
Interaction (MxS)					
S.Ed.±	0.627	1.491	0.800	11.352	3.18
CD (p = 0.05)	NS	NS	NS	NS	NS

Note: Means followed by the same letter are not significantly different at 5% probability level. M=main plot effect, S=subplot effect, CD= critical difference, S.Ed.± = standard error of deviation

Gravimetric soil Moisture Content

Significantly highest gravimetric soil moisture content of surface soil was recorded in the treatments of application of straw mulch and guinea grass. However, at the eight months after planting application of Ipil-Ipil was also recorded higher soil moisture content as the application of straw mulch and guinea grass. The recalcitrant nature of the straw might have shown some resistant to decomposition as well as it might have acted as a sponge and might have absorbed much of the rain water. It was also reported that straw mulch can be considered as an agronomic input with the potential to ameliorate stress by reducing evaporation of moisture from the soil and

increasing infiltration rate. While the season progress there was a declining trend of surface soil moisture content irrespective of the treatments.

Table 2. Effect of different mulching materials on growth indices of four banana varieties.

Treatment	Leaves/Plant	Girth of stem
Main treatments (type of mulch)		
M_1. Rice Straw	12.333a	36.667a
M_2. Gliricidia	10.583b	28.583c
M_3. Guinea grass	12.167ab	32.750b
M_4. Ipillpil	10.750ab	26.583d
M_5. No Mulch	8.833c	22.417d
S.Ed.±	0.728	1.193
CD (p = 0.05)	1.705	2.795
Sub treatments (Banana variety)		
S_1. Seeni	11.933b	27.600b
S_2. Alukesel	13.267a	34.800a
S3. Kolikuttu	9.400c	28.533b
S4. Ambul	9.133c	26.66b
S.Ed.±	0.558	1.518
CD (p = 0.05)	1.146	3.115
Interaction (MxS)		
S.Ed.±	1.249	3.394
CD (p = 0.05)	N/A	7.104

Note: Means followed by the same letter are not significantly different at 5% probability level. M=main plot effect, S=subplot effect, CD= critical difference, S.Ed.± = standard error of deviation

This may be due to the less amount of rainfall received at the 24th and 32nd weeks after planting (Figure 1). Lowest soil moisture status was recorded under no mulch treatment (control) throughout the seasons. The improved soil moisture regimes might have enhanced the growth of banana plants possibly through greater soil moisture and nutrient uptake (Table 2).Gliricidia and Ipil-Ipil mulches showed lower surface soil moisture content from the beginning of the measurements. This may probably be due to the higher decomposition rate of the Gliricidia and Ipil-Ipil leaves (De Costa, and Atapattu, 2001). It was

also observed that the majority of the applied Gliricidia and Ipil –Ipil mulches have decomposed within the first few weeks after application.

Among the sub plot treatments of banana varieties, significant variation of gravimetric soil moisture content was not observed throughout the experimental period except the significantly highest soil moisture content after 4 months of planting of banana variety ambul.

Table 3. Effect of different mulching materials on Gravimetric soil moisture percentage.

Treatment	Gravimetric soil moisture percentage			
	2 Months after planting	4 Months after planting	6 Months after planting	8 Months after planting
Main treatments (type of mulch)				
M_1. Rice Straw	16.4a	17.6a	9.5a	10.5a
M_2. Gliricidia	13.2b	14.7b	7.4b	8.3b
M_3. Guinea grass	17.1a	17.9a	10.5a	11.4a
M_4. Ipillpil	14.2b	14.8b	8.6b	8.7ab
M_5. No Mulch	10.1c	10.8c	5.3c	6.3c
S.Ed.±	0.91	1.02	0.81	0.97
CD (p = 0.05)	2.14	2.09	1.89	1.98
Sub treatments (Banana variety)				
S_1. Seeni	17.75	18.13b	10.42	11.36
S_2. Alukesel	17.21	18.42b	10.35	11.11
S3. Kolikuttu	18.36	17.86b	9.87	10.87
S4. Ambul	17.68	21.39a	10.66	11.86
S.Ed.±	0.71	1.24	1.16	0.96
CD (p = 0.05)	NS	2.54	NS	NS
Interaction (MxS)				
S.Ed.±	0.98	1.35	1.28	1.06
CD (p = 0.05)	NS	NS	NS	NS

Note: Means followed by the same letter are not significantly different at 5% probability level. M=main plot effect, S=subplot effect, CD= critical difference, S.Ed.± = standard error of deviation

Surface soil (0-20 cm) soil moisture retention % (m^3m^{-3}), at saturation 7.62; at field capacity 4.20; at permanent wilting point 2.53

Effect of Different mulching materials and varieties on economics of Banana cultivation

Among the mulching materials tested, application of rice straw mulch recorded the highest gross return, net return and B:C ratio (Benefit : Cost ratio) followed by application of guinea grass mulch. Lowest gross return, net return and Benefit: Cost ratio was recorded in the treatment of no mulch application and Benefit: Cost ratio was 7 times lower than application of straw mulch although the cost of production was the lowest. Banana variety Kolikuttu recorded the highest gross return, net return and Benefit: Cost ratio because it fetched the highest market price.

Table 4. Effect of different mulching materials on economics of banana cultivation.

Treatment	Yield (t/ha)	Gross Income (Rs)	Cost of Cultivation (Rs)	Net Income (Rs)	Benefit : Cost ratio
Main treatments (type of mulch)					
M_1. Rice Straw	26.00	1820000.00	424356.00	1395644.00	3.28
M_2. Gliricidia	15.15	1060500.00	443460.00	617040.00	1.39
M_3. Guinea grass	20.17	1412250.00	436245.00	976005.00	2.24
M_4. IpilIpil	14.81	1036700.00	451262.00	585438.00	1.29
M_5. No Mulch	6.71	469700.00	302354.00	167346.00	0.55
Sub treatments (Banana variety)					
S_1. Seeni	18.38	1102800.00	402810.00	699990.00	1.74
S_2. Alukesel	14.58	729000.00	418544.00	310456.00	0.74
S3. Kolikuttu	12.89	1546800.00	516360.00	1030440.00	2.00
S4. Ambul	20.41	1020500.00	413810.00	606690.00	1.47

Note: Price of banana was calculated according to the market price in year 2006; Seeni kesel, Rs. 60; Alu kesel, Rs. 50; Kolikuttu, Rs. 120; Ambul kesel, Rs. 50.

CONCLUSIONS

Based on the results of this study, it can be concluded that the application of straw mulch, guinea grass mulch is suitable to obtain higher banana growth and yield leading to higher income from banana cultivation mainly due to enhanced soil moisture availability to banana plants. Banana cultivation without application of mulches leading to poor soil moisture

availability to banana plants under rainfed conditions in Non-Calcic Brown Soils leading to low productivity and income from banana cultivation. The variety Kolikuttu performed well under straw and guinea grass mulching with higher economic returns.

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