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EFFECT OF GROWTH AND YIELD PERFORMANCES OF MUNGBEAN (*VIGNA RADIATA* L.) UNDER DIFFERENT MULCHING PRACTICES

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ABSTRACT

Research was conducted at the Parasankulum located in Vavuniya district, to study the effect of growth and yield performances of mung bean (*Vigna radiata* L.) under different mulching practices during the period of February to May 2016. Three different mulching treatments such as live mulch with sun hemp (T_1), dry mulch ie paddy straw mulch (T_2) and No mulch (T_3) were tested in randomized complete block design with four replicates. Size of each plot was 3.5 m x 2 m and mung bean sowing was done by hand at a depth of 2 cm and thinned out at 5-7 days after germination. The soil properties, plant growth, yield components, dry weight of weeds and their counts were recorded. The data were analyzed by using SAS 9.1 package. In weed composition and biomass, both were lowest in the live mulch treatment than other treatments. In growth parameters, there was a significant difference between mulched treatments and no mulched treatment, but there was no significant differences among the mulched treatments. The yield components of mung bean significantly different among treatments and highest yield was observed in live mulch. The live mulched treatment produced the highest 1000 grain weight (89.43 g) in comparison to the no mulched treatment (86.43 g). Significant yield increase was observed in live mulched treatment (1.86 tons /ha) compared to the other treatments. Profit from live mulched treatment also the highest than other treatments. Mulched treatments produced highest yield compared to no mulched treatment. Among mulched treatments, the live mulch produced the highest yield. Therefore, live mulch was the best mulch than straw mulch in weed suppression, crop yield and profit.

KEYWORDS: Dry mulch, live mulch, mung bean, mulching, yield.

INTRODUCTION

Pulses are annual leguminous crops which are used for both food and feed. In addition to their food value, pulses also play an important role in cropping systems because of their ability to produce nitrogen and thereby enrich the soil (FAO, 1994). From prehistoric times, mung bean cultivation spread over to many countries especially in tropical and subtropical Asia and it is native to India and central Asia (Vavilou, 1926). From the historical times, the pulses have been an important group of field crops in Sri Lanka. Mung bean has become an important commercialized crop at present in Sri Lanka. Presently they occupy a prominent place in the cropping patterns encountered mainly in the dry and intermediate zones of the country due to their wide ecological adaptability. It is successfully cultivated in the districts of Anuratdhapura, Pollannaruwa, Vavuniya, Kurunegala, Puttalam, Killinochchi, Mullaitivu, Batticaloa and Jaffna (Ranawake *et al*., 2011). The choice of pulses as an important component of the cropping patterns in Sri Lanka has been based on nutritional and economic considerations. Pulses are cheaper than animal protein sources (Akinbode, 2011) and per capita consumption of pulse is around 0.89 kg/year. However, only 50 % of our national requirement is produced in the country In Sri Lanka the green gram was cultivated to the extent of 5230 ha and production was 7440 mt in 2015 *Yala* and 6035 ha and 7975 mt in 2015/2016 *Maha*, respectively (Department of Census and Statistics, Sri Lanka,2016).

Improved and proper management practices such as proper weed control, pest control, irrigation, fertilization etc. are very important to increase the productivity from the land. Weeds competing with the desired plants for the resources that a plant typically needs, namely, direct sunlight, soil nutrients, water ,space for growth(to a lesser extent), providing hosts and vectors for plant pathogens, giving them greater opportunity to infect and degrade the quality of the desired plants (en.wikipedia.org/wiki/Weed). Weed management is one of the most important crop management concerns of farmers to increase productivity. Apart from reduction of crop yield, weeds contaminate and taint farm product to

reduce their market values and change their end use. 34.3 % to 89.8 % losses caused by the uncontrolled growth of weeds in the productivity of different crops (Mukhopadhyay, 1991). Weed management were born to increase productivity by removing competition. It is well-established that weeds cause most injury to crops during certain crop growth stages and control during this period is especially important (Singh and Singh, 1994). Therefore, proper weed control is an important management practice that has to done in proper way and proper time to reduce the weed population and to improve the crop productivity.

Mulching is the process or practice of covering the soil to make more favorable conditions for plant growth, development and efficient crop production (eagri.tnau.ac.in/eagri50/AGRO103/lec17). The term "mulch" means 'covering of soil'. Mulching is really nature's idea and is an effective method of manipulating crop growing environment to increase yield and improve product quality by controlling weed growth, ameliorating soil temperature, conserving soil moisture, reducing soil erosion, improving soil structure and enhancing organic matter content (Opara-Nadi, 1993; Hochmuth *et al.*, 2001; Awodoyin and Ogunyemi, 2005). Soil mulching with organic material is one method of soil water protection and also helps maintain a constant soil temperature within the root system of crops (Awal and Khan 2000, Sinkevičienė *et al.*, 2009, Samaila *et al.*, 2011). Plastic or straw mulch is an efficient practice, which can alter water distribution between soil evaporation and plant transpiration (Raeini-Sarjaz and Barthakur, 1997). Prasad and Kumar, (2008) also stated that mulching is mainly used for soil enrichment and weed suppression. It also helps in moisture retention, temperature modification, soil texture, pest and disease protection and appearance.

Even though, there are several research studies available in the world related to effect of mulch on weed control and yield performances in pulse crops, but few studies are available about influence of mulch on growth and yield performance of mung bean in Sri Lanka especially in Kilinochchi. Therefore, by considering this gap the study was carried out with the main objective of evaluating the growth and yield performance of the mung bean under different mulching practices.

Main objective

Evaluate the growth and yield performance of the mung bean under different mulching practices.

Sub objectives

1. Compare the growth and development of mung bean under different mulching practices with the standard management practices.
2. Evaluate the yield components of mung bean under different mulching practices.
3. To analyses the economic benefits of different mulching.

MATERIALS AND METHODS

A field experiment was carried out at Parasankulum located in Vavuniya district of the Northern Province of Sri Lanka belongs to the agro-ecological region of Low Country Dry Zone (DL_{1e}) during the period of February to May to evaluate the effect of different mulching practices on growth and yield performances of mung bean (*Vigna radiata*.L). Mung bean (*Vigna radita* L,) variety MI-6 was selected for this study. Because, variety MI-6 is suitable to cultivate both *Yala* and *Maha* seasons in the drier areas, it is tolerance to heat and yellow mosaic virus, big seed size and also having high yield potential (1.8 tons/ha). An experiment was conducted in Randomized Complete Block Design (RCBD) with three treatments and four replicates. The plots were made with the size of 3.5 m x 2 m.

Table 1: Layout of the field.

T_1R_1	T_2R_1	T_3R_1
T_2R_2	T_3R_2	T_1R_2
T_3R_3	T_1R_3	T_2R_3
T_1R_4	T_2R_4	T_3R_4

Table 2: Different mulch treatments and their treatment codes.

Treatments	Treatment code
Live mulch (Sun hemp)	T_1
Dry mulch (Paddy straw)	T_2
No mulch (Control)	T_3

Land was prepared by ploughing and harrowing to make the soil as fine tilth condition. Mung bean seeds were planted at spacing of 30 cm × 10 cm. Then seeding was done by hand at a depth of 2 cm and covered by soil. Thinning out was done 5-7 days after germination. All other management practices were carried out according to the recommendation made by the Department of Agriculture (http://www.agridept.gov.lk/index.php/en/crop-recommendations/988). Mulch treatments were applied one week after germination of seeds. For live mulch sun hemp was seeded 1 week after planting of green gram and 3 weeks after planting it was cut and placed it in between the green gram row as live mulch at the rate of 60 kg/ha. For dry mulch paddy straw was applied at the rate of 2 kg/m^2 1 week after sowing of mung bean. Pod colour change is an indication of harvesting time. Pods were harvested when the pod colour changed to green to black. Three pickings were done at one week interval from first picking.

Measurements

a) Soil parameters

Soil pH (1:5 soils: distilled water) using a pH meter, EC and soil organic matter were estimated prior to

commencement of the experiment (Anonymous, 1970).

b) Weed composition
Land area was marked with 25 cm × 25 cm permanently. From such area, weed samples were collected 3rd and 6th weeks after crop germination by uprooting the weeds. Weed count, fresh weight and oven dry weight of weeds were recorded. For oven dry weight, weed samples were kept in oven at 85 °C until get constant dry weight.

c) Plant growth parameters
Plant height and canopy width were taken at weekly intervals.

d) Yield parameters
Number of flowers per plant, number of pod per plant, pod length, number of seeds per pod, number of seeds per plant, 1000 grain weight and the total yield were recorded.

Data Analysis

The ANOVA was performed using the GLM procedure of the SAS computer software package.

RESULTS AND DISCUSSION

Results of the effect of different mulching practices on growth and yield performances of mung bean economic benefits with yield variation were given below.

1. Soil Parameters

Table 3: PH, Electrical Conductivity (EC) and organic matter content of soil of field site.

Soil Characteristics	Values	Interpretation
PH (1:2.5 Soil:Water)	7.5	Neutral
EC (dSm^{-1}) – (1:5 Soil:Water)	0.09	Non Saline
Organic Matter (%)	2.42	Medium

The cultivated soil is non saline which is having neutral pH and medium organic matter content. This soil is ideal for mung bean cultivation.

2. Weed Composition

Broad leaves and grasses were observed in the field. Broad leaves such as *Amaranthus hybridus* L., *Tridax procumbens* and grasses such as *Isachne globosa*, *Oryza* sativa were observed in the field site. Grasses was prominent weeds compared to broad leaves in all treatments. Abouziena *et al*. (2014b) reported that rice straw, sawdust, clover weed and cogon grass mulch treatments significantly reduced the total dry weight of onion weeds at 45 days after transplanting. They also stated that broad-leaved weeds were more susceptible than grassy weeds to mulching treatments.

Weed Population m^{-2}

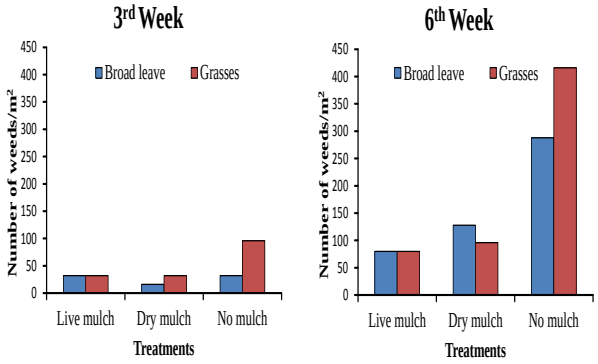

Figure 1: Weed population m^{-2} at 3rd and 6th weeks after planting of mung bean.

The lowest weed population was observed in dry mulch and live mulch 3rd and 6th week after planting, respectively. The highest weed population was observed in no mulch treatment. Both live and dry mulch treatments suppress the weed growth compare to no mulch. Chattha *et al*. (2007) stated that the magnitude of yield losses in mung bean caused by weeds depends mainly on the weed species and their densities.

3. Dry Weight of Weeds (gm^{-2})

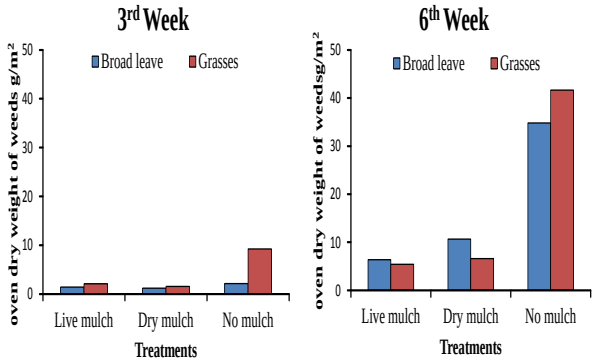

Figure 2: Dry weight of weeds (gm^{-2}) at 3rd and 6th weeks after planting of mung bean.

In 3rd weeks after germination, dry weight of grasses was higher compared to broad leaves and 6th weeks after germination, dry weight of broad leaves was higher than grasses. This may be due to number of leaf development and expansion of canopy was increased in broad leave weeds in 6th weeks compared to grasses. Weed population and dry matter accumulation by weeds significantly influenced by mulch treatments (Mahajan *et al*., 2007). Weed control efficiency varied with different mulch treatments. Awodoyin and Ogunyemi (2005) have reported that the weed control efficiency of different types of mulch in cayenne pepper production ranged from 27 % to 97 %. Awodoyi Ogbeide and Olufemi Oluwole (2007) also stated that the weed control efficiencies of the mulches ranged between 91 % and 100 % in tomato.

4. Soil Temperature

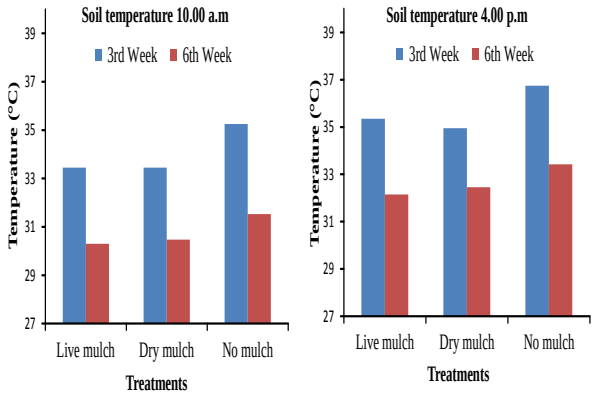

Figure 3: Morning and evening soil temperature of the field at 3rd and 6th weeks after planting of mung bean.

There was a significant difference in soil temperature with different time period in the mulch treatments. The same trend of temperature variation was observed in both time periods. Soil temperature increased from morning to evening in treatments due to increased light intensity increased surface temperature during day time. The lowest soil temperature was observed in live and dry mulch treatments. This could be due to the prevention of direct contact of solar radiation with the soil surface by the live mulch and dry mulch. This result agreed with the studies of Mahajan *et al*. (2007), he stated that the temperature differences between the Mulched and no mulched soil were considerably less after plants developed a complete ground cover. Mulching can significantly affect the soil micro-climate such as soil temperature and moisture content (Ghosh *et al*. 2006) and hence grain yield and yield components. Sinkevičienė *et al*. (2009) stated that all organic mulches caused a significant reduction of soil temperature. Many authors reported that a slower increase in soil temperature under mulches and also lower fluctuations of soil temperature in the plant growing period contribute to the better growth and development of plants (Schonbeck and Evanylo 1998, Olasantan 1999, Kęsik and Maskalaniec 2005, Dahiya *et al*., 2007, Sinkevičienė *et al*., 2009). In turn, some authors claim that natural organic mulch eventually breaks down and becomes a part of the soil and a source of plant nutrients (Bond and Grundy 2001, Gruber *et al*. 2008), which as a result improve plant growing conditions.

5. Plant Height

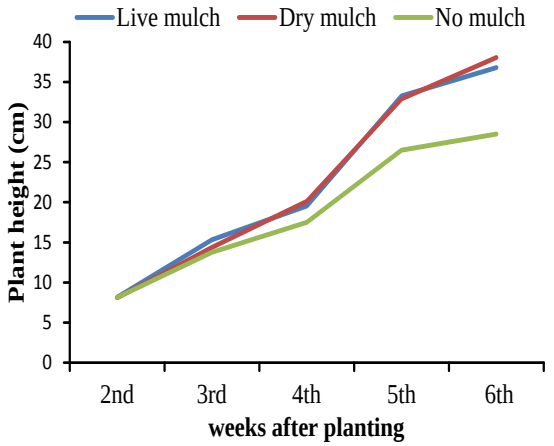

Figure 4: Plant height of mung bean with different mulching treatments and control at weekly interval.

There was no significant difference in plant height among Mulched and no mulched treatments up to 2nd week. Thereafter, there was a significant difference in plant height in Mulched and no mulched treatments. But among mulched treatments, there was no significant difference. The growth performance of plant showed more or less the same trend in mulched treatments compared to no mulch treatment. This result clearly indicated that the mulching has beneficial effect on plant height by suppressing the weed population. This finding was also recorded by Awodoyin *et al*. (2007). Iftikhar *et al*. (2011) stated that mulch material had significant effect on plant height. The highest chilli plant height was noted in rice straw mulch followed by sugarcane bagasse mulch and wheat straw mulch. The lowest plant height was recorded in control plants. Okra plants on grass mulched plots recorded significant height than the control plants at fruit set (Norman *et al*., 2011). Sawdust mulch increased hot pepper plant height more than the control (Norman *et al*., 2011).

6. Canopy Width

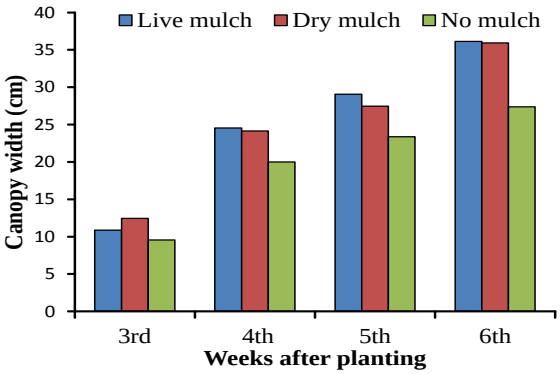

Figure 5: Canopy width of mung bean with different mulching treatments and control at weekly interval.

There was a significant difference in canopy width between mulched treatments and no mulched treatment at weekly interval. But there was no significant difference among mulched treatments. This may be due

to, the mulch prevents evaporation of water from the soil surface and canopy width of plants plays a major role in weed suppression. Wider plant canopy reduces the light interception by weeds thereby reduce the competition of weeds against crops. At the same time, water moves from deeper soil layers to the topsoil by capillary rise and vapour transfer, thereby keeping the topsoil water content relatively stable (Wang *et al.*, 1998; Li *et al.*, 1999). Baumhardt and Jones, (2002) and Zhang *et al.* (2009) also stated that mulching is regarded as one of the best ways of improving water retention in the soil and reducing soil evaporation. Capsicum plants grown on plots mulched with lantana leaves and grass mulches maintained higher canopy width compared to plants on unmulched plots (Thakur *et al.*, 2000). Mulching has also been found to increase canopy width of lettuce plant compared with unmulched plants (Moniruzzaman, 2006). Increased hot pepper canopy size was observed on sawdust mulch compared to the control (no mulch) (Norman *et al.*, 2011).

The increase in growth parameters was attributed to sufficient soil moisture near root zone and minimized evaporation loss due to mulching. Similar findings have also been obtained by Dean Ban *et al.*(2004) Ansary and Roy (2005) in wateremelon, Al-Majali and Kasrawi (1995) in muskmelon, Hallidri (2001) in cucumber, Alemayehu-Ambaye and Joseph (2002) in melon.

7. Number of Pods/Plant

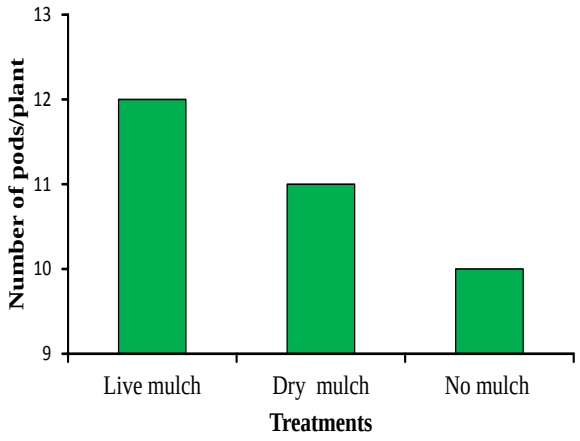

Figure 6: Number of pods/plant of mung bean with different mulching treatments and control at harvest.

The number of pods/plant was significantly differed between the treatments. The highest pod number was observed in the live mulched and the lowest was in the no mulched treatment.

8. Average Pod Length

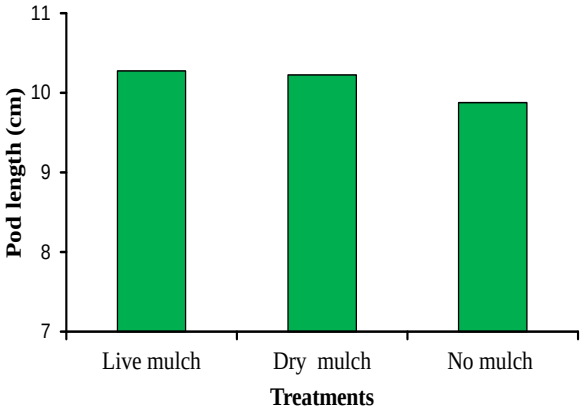

Figure 7: Average pod length of mung bean with different mulching treatments and control at harvest.

The average pod length is one of the important parameter in yield determination. The highest pod length was recorded in the live mulched treatment followed by dry mulched treatment. The lowest pod length was produced in no mulched treatment.

9. Number of Grains/Plant

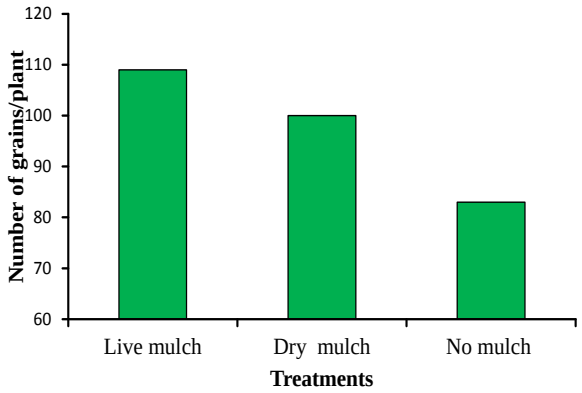

Figure 8: Number of grains/plant of mung bean with different mulching treatments and control at harvest.

Number of grain per plant varied with different mulched treatments. The highest number of grains were produced in live mulched treatment. Live mulched obtained from sun hemp which belongs to the family of fabaceae, it has nitrogen fixing ability and it is used as green mulch. Therefore, soil fertility can be improved and this could be the reason for increased number of grain per plant in live mulched treatment.

10. Thousand grain weight

Thousand grain weights was significantly differed among mulched treatments and no mulched treatment. But there was no significant different among mulched treatments. The live mulched treatment produced the highest thousand grain weight (89.43 g) in comparison to the no mulched treatment (86.43 g).

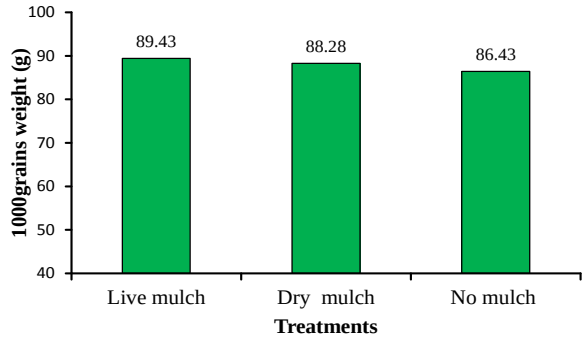

Figure 9: Thousand grain weight of mung bean with different mulching treatments and control at harvest.

11. Yield (t/ha)

There was a significant different in yield between mulched and unmulched treatments and there was no significant different among mulched treatment. The reason may be the contribution from mulch was significant in conserving soil moisture and adding organic matter to the soil. Among the benefits of mulches, the use of mulch regulates surface radiation, promotes vegetative growth and productivity, controls weeds, decreases water loss by evaporation, and facilitates harvesting.

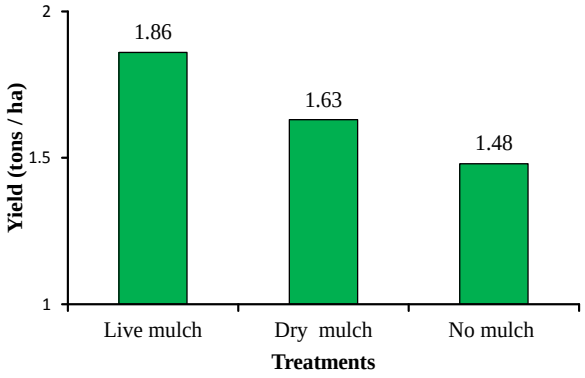

Figure 10: Yield of mung bean with different mulching treatments and control at harvest.

Mulching can affect the temperature and moisture content of the soil (Li *et al*., 1999; Acharya *et al*., 2005) and directly influence the grain yield of crops (Ramalan and Nwokeocha, 2000; Li *et al*., 2001 a, b). Straw mulching systems can conserve soil water and reduce temperature because they reduce soil disturbance and increase residue accumulation at the soil surface (Baumhardt and Jones, 2002; Zhang *et al*., 2009). Un-mulched (control) treatment plots plants showed lower growth and yield, because of higher weed growth, lowest soil moisture conservation and poor temperature amelioration, required by the crop performance (Awodoyin *et al*., 2005). Tolk, *et al*. (1999) and Liu *et al*. (2002) concluded that mulching increases soil moisture and nutrients availability to plant roots, in turn, leading to higher grain yield. Bunnaa *et al*. (2011) reported that mulching of rice straw at 1.5 t/ha improved mung bean crop establishment from 72 to 83 %, reduced weed biomass from 164 to 123 kg/ha and increased yield from 228 to 332 kg/ha. Siddique *et al*. (2004) also reported that mulching with rice straw recorded significantly higher mung bean yield over the no mulching treatment. There are several reports indicating that the mulching can improve crop yields (Kamara, 1981; Simpson and Gumbs, 1986; Gupta, 1989). In general, a higher seed yield was attained with mulching.

Table 4: Comparison of yield components between treatments.

Comparisons of mulch treatments with no mulched treatment	Differences between means of yield components				
	No of pod/ plant	Pod Length (cm)	No of grain /plant	1000 grain Weight (g)	Yield (t/ha)
T_1-T_3	12^a	10.28^a	109^a	89.43^a	1.86^a
T_2-T_3	11^a	10.23^a	100^a	88.28^a	1.63^a
T_3	09^b	09.88^b	83^b	86.43^a	1.48^b

There were significant differences in number of pods/plant, pod length, number of grain/plant and yield between mulched treatments and un-mulched treatment. Among mulched treatments there were no significant differences in number of pods/plant, pod length, and number of grain/plant. But there was no significant difference in 1000 grain weight in all treatments.

Table 5: Economic benefits of the different mulches in hectare.

Treatments	Gross income (Rs)	Total cost for mulching (Rs)	Net profit (Rs)
Live mulch	334800.00	19000.00	315800.00
Dry mulch	293400.00	16000.00	277400.00
No mulch	266400.00	-	266400.00

Among the treatments, the highest net profit was obtained from live mulch by using sun hemp and the lowest net profit was in un-mulched (control) treatment.

In weed composition and biomass both were much lowest in the live mulch treatment than other treatments. The growth and yield performance of green gram also highest in the live mulch treatment than other treatments. Profit from live mulch also the highest than other treatments. Therefore, the live mulch was the best mulch than dry mulch in weed suppression, crop yield and profit. Most organic mulches have some fertilizer value and are good soil conditioners when worked into the soil. They improve both the physical and chemical properties of soil. Organic matter incorporated into the soil improves water-holding capacity, nutrient availability, and aeration of the soil (Bilalis *et al.*, 2003). Organic mulches also improve water use efficiency (WUE) indirectly. As mulch decomposes, humus is added to the soil, which increases its water holding capacity (Paul *et al*., 1997). A mulch layer prevents weed seedling growth by inhibiting light penetration to the soil surface. Lower weed prevalence significantly improves WUE (Ossom *et al*., 2001). Xu *et al.* (2009) stated that straw mulching (wheat straw after harvesting the ears) significantly depressed weeds, increased soil microbial quantity and activity, avoided powdery mildew and increased pumpkin fruit yield. Abouziena *et al*. (2014b) stated that the application of sawdust mulch, rice straw, clover weed and cogon grass mulches produced a higher onion bulb yield over unweeded by 127, 118, 152% and 123%, respectively. All mulch plant species examined at 1.5 t ha^{-1} markedly reduced growth and dry weight of weeds by 60-100 % and 70-100 %, respectively (Khanh *et al*., 2005). Covering soil under mandarin trees with cattail or rice straw mulch (two layers) gave 85 % to 98 % weeds control (Abouziena *et al*., 2008). Wien *et al*. (1993) and Jain *et al*. (2000) reported that yield components increasing under straw mulch residue.

CONCLUSION

The highest plant growth and yield was observed in live mulched treatment by using sun hemp followed by dry mulched treatment. The lowest plant growth and yield was observed in unmulched treatment. Mulching increased the growth and yield of mung bean through modification of the crop growing environment by reducing weed infestation, soil moisture depletion and ameliorating soil temperatures. Among mulched treatments, live mulch is more effective in the control of weed infestation, growth and yield parameters of mung bean compared to straw mulch. Therefore, live mulch by using sun hemp was the best mulched treatment to grow mung bean.

Suggestion

Other natural mulches (dead leaves and coir dust) can also be used and experiment can be repeated for both Maha and Yala seasons to get consistency.

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