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RESEARCH PAPER

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Management of *Desmodium* for efficient Weed control and soil moisture conservation to improve production of Coffee *arabica* at Gera, Southwest Ethiopia

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ABSTRACT

The experiment was carried out at Gera, under the execution of Jimma agricultural Research center, with the impartial of controlling noxious grassy coffee weeds and soil moisture conservation to increase production of coffee Arabica in the case of Gera, south west Ethiopia. Arandomized complete block design (RCBD) with three replications was used. Treatments consisted of free growth Desmodium (not trimmed), recommended rate of NP, Desmodium trimmed once a year and used as mulch, Desmodium trimmed once a year and taken out, and Control (no fertilizer or Desmodium) and Desmodium trimmed once a year and half used as mulch the remaining taken out. Each experimental plot constituted of12 coffee seedlings planted at 2m by 2m spacing. Desmodium seed were sown (broadcasted) in the space between spaces of coffee tree at the time of sowing. Significant (P<0.05) variations were detected among treatments in terms of weed suppressing, soil moisture conservation and improving harvested mean annual coffee

yield. Accordingly, weed biomass, soil moisture and yield of coffee Arabica was affected by different dissmodium management practices employed. In general using Desmodium plant for controlling weed management is a best option, with Regard to low cost of establishment, suppressing weed and improving fertility status of the soil. Hence, from the different Desmodium management system Desmodium trimmed once a year and used as mulch was the superior one among treatments under Gera condition.
Keywords: Desmodium Management, Soil Fertility, Soil Moisture and Weeds Suppression.

INTRODUCTION

Coffee is one of the world's most popular beverages besides the most important traded commodity in the world after oil (Naidu *et al*., 2008). Among coffee tree species, Coffea arabica L. shows the highest economic importance, producing the consumers' most appreciated coffee drink (Nascimento *et al*., 2006). In Ethiopia, coffee accounts for 55% in the total export earnings and 25% of its population directly or indirectly depends for the livelihood on coffee business (Kruidhof *et al*., 2008).

Weeds cause quantitative and qualitative losses to agriculture products, such that these plants may be troublesome to coffee producers due to the interference on the tree growth and development and on fruits yield (Dias *et al*., 2008; Marcolini *et al*., 2009).In Ethiopia under high rain fall area due to weed computation yield loss reaches up to 65% as compared to weed controlled farms. In coffee plantations, weeds may also affect the macronutrients uptake (Ronchi *et al*., 2007) and they can be alternative hosts of coffee strains of *Xylellafastidiosa* which causes coffee leaf scorch (CLS), a serious disease of Coffee Arabica (Lopes *et al*., 2003).Weeds may constrain crops directly by competition, allelopathy and harvest impediment, or indirectly by pests and pathogens hosting (Radosevich *et al*., 1997).The degree of weed interference is determined by factors linked to crops (cultivar, spacing and density), to weed community (composition, density and distribution), to environment (soil, climate and management) and to the period of weed interference. The period that weeds coexist with crops, competing for limited environmental resources, is one of the most important factors affecting the degree of weed interference.

The coffee is very sensitive to weed competition for water, light and nutrients. Weeds can severely affect the growth of coffee plantation (Teasdale, 1999).Amongst all agronomic practices involved in coffee production; the weed management strategy/system is one of the most intensive in coffee bean production and critical to eco-friendly management ranging from two to five operations per year. The adopted weed management system in coffee plantations can have major effects on the soil environment; weed Control affecting physical, chemical and biological conditions, resulting in changes soil compressive behavior and load bearing capacity affecting yield potential in coffee plantations (Araujo *et al*., 2008; 2011).Appropriate weed management systems utilized between coffee rows would help inminimizing soil degradation by erosion (Carvalho *et al*., 2007), reducing compaction and improving soil workability (Araujo *et al*., 2008,2011). Desmodium plants utilized as cover crops residues can be left on the soil surface similar to a cereal stubble mulch to protect against evaporations and erosion (Faria*et al*., 1998). Ina newly developed orchard, Yang *et al*. (2007) observed that the application of herbicides and tillage favored soil erosion. Yang *et al*. (2007) pointed out that chemical and mechanical methods are the dominant weed control practices in many production systems due to its effectiveness, but noted on the other hand, that weed presence during the rainy season prevented soil erosion. Studies conducted in tropical conditions showed that mechanical and chemical methods for weed

control on coffee plantations had a great influence on the soil compaction state (Araujo *et al*., 2008, 2011), soil surface crust formation, erosion and coffee yield (Silveira *et al*., 1985).
To obtain good coffee yields, weeds must be controlled, regardless of the pruning system, degree of mechanization, or fertilization program. If weeds are neglected, amount of fertilizer can't help to bust production and productivity. Desmodium plant is among the important cover crop plants, in weed control, enhancing soil fertility, preventing soil erosion, using as a feed for animals and conserving soil moisture. Therefore, establishing Desmodium plant for newly established coffee plant farms can help as one of the best agronomic practices in weed control and soil moisture conservation. Noxious weeds, competent for nutrient and cause great yield loss in many crops, this can be managed using Desmodium cover crop. Generally, the plan has a number of advantages among which, soil moisture conservation, fixing nitrogen, reducing run off and used as livestock feed.

MATERIALS AND METHODS

The study was conducted at Gera on CBD resistant coffee variety. The experiment was laid out in a randomized complete block design with three replications. The treatments consisted of: free growth *Desmodium* /not trimmed, recommended rate of Nitrogen (N) and Phospurous (P), *Desmodium* trimmed once a year (used as mulch), *Desmodium* trimmed twice a year (taken out),and Control (no fertilizer or Desmodium) and *Desmodium* trimmed twice a year (used as mulch and the remaining taken out).
Desmodium were row drilled at seed rate of 5 kg ha^{-1} by mixing with sand or dry courser soil of 20 kg ha^{-1} inter and intra-raw between the coffee bushes 60 cm away from the main stem of the tree in all side in March/April, when the rain fall starts. The different rate of N fertilizer was applied as urea (46% N) on the respective experimental unit in three equal split (March/April, June/July and September). Recommended rate of P (63 kg/ha) were applied as triple supper phosphate (TSP) (46% P_2O_5 or 20% P) uniformly to coffee trees in all experimental unit in two equal split (March/April and September). Each experimental unit was consisting of 30 coffee trees. Except experimental variable other management practices were applied as recommended.

RESULT AND DISCUSSIONS

Coffee yield response data was collected for five consecutive crop seasons is presented in (Table 1). As a whole, lowest coffee yield was recorded during the first crop season. Accordingly yield variation among Desmodium management treatment was not significant. A relatively better coffee yield (377 kg/ha) was harvested from the control plot in the initial crop season. Significant coffee yield variation was noted during the subsequent crop season, (2011/12). Accordingly highest mean clean coffee yield was recorded from recommended fertilizer rate followed by Desmodium trimmed twice a year and used half as mulch and the remaining half taken out with mean value of 671 kg/ha (Table 1). Similar result reported that yield of coffee was significant influenced by the type and the management strategy of perennial cover crop (Hermann et al., 2008).
Highest (20.25 qt/ha) mean clean coffee yield was obtained during the third crop season. Though coffee yield variation was statistical non-significant among the treatments, highest (25.95 qt/ha mean clean coffee yield was obtained from the control plots followed by recommended fertilizer rate with mean value of 24.14 qt/ha. In contrast lowest (14.71 qt/ha) yield was obtained from free growth of Desmodium (not trimmed). This is due to the heavy competition of Desmodium with coffee trees for soil nutrients and other

environmental resources. Non-significant coffee yield variation was detected among the treatment during the fourth crop year. Consequently, the highest (17.77) lowest (10.62) qt/ha mean clean coffee yield was observed for recommended rate NP fertilizer rate and Desmodium trimmed once a year and taken out treatments, respectively (Table 2). This is because the prevailing poor return organic matter to the soil as a result of removal of Desmodum after trimming (Table 2).In the final crop season, coffee yield variation was not significant among the treatment. Accordingly, highest (17.39) and lowest (10.62) qt/ha mean clean coffee yield was obtained from recommended NP fertilizer rate and free growth Desmodium (not trimmed).

Table 1. Mean clean coffee yield as affected by Desmodium management practices at Gera.

Treatments	2010 /11	2011/12	2012/13	2013/14	2014/15	Over years mean (q/t ha^{-1})
	Clean Coffee (q/ha)					
Free growth Desmodium (not trimmed)	1.62	6.15^{ab}	14.70	15.17	10.62	9.65^{c}
Recommended rate of NP	3.55	8.09^{a}	23.61	17.77	17.39	14.08^{a}
Desmodium trimmed once a year and used as mulch	1.95	5.12^{b}	24.14	15.19	16.69	12.62^{a}
Desmodium trimmed once a year and taken out	2.46	5.96^{ab}	16.49	12.53	13.09	10.11^{c}
Control (no fertilizer or Desmodium)	3.77	5.78^{b}	25.95	16.27	17.81	13.91^{d}
Desmodium trimmed once a year and 50% used as mulch and the remaining taken out	2.11	6.71^{ab}	16.57	16.06	13.63	11.01^{c}
C.V (%)	**52.28**	**19.47**	**47.39**	**23.38**	**40.31**	**17.89**
LSD (0.05)	**245.02 (NS)**	**233.17**	**1745.6 (NS)**	**659.24 (NS)**	**1091.4 (NS)**	**280.88**

**Means with the same letter or are not significantly different, > at 5% probability level according to lsd test

The over years analysis revealed significant coffee yield variation among the treatment. Consequently, highest (14.08 qt/ha) mean coffee clean coffee yield variation was recorded under recommended NP fertilizer rate followed by Desmodium trimmed once a year and used as mulch with mean value of 12.62 qt/ha (Table 1). In contrast lowest (9.65 qt/ha) mean coffee yield was obtained from free growth/ un-trimmed Desmodium plot. This is most likely due to competition of Desomdium with coffee tree for soil nutrients among other during early period of coffee and Desmodium establishment.

Amount of weed obtained from each treatments have great variation. At the controlled plots across each year there was problem of weed. Whereas on Desmodium management part weeds out break from the Desmodium suppression was too small. Highest weed biomass (52.7 q/t ha^{-1}) was recorded from the control plot, whereas Desmodium trimmed twice a year and taken out has 91.36% weed suppressing effect over the control treatment. Thus, Desmodium intercropping within the space of coffee tree has a prodigious effect in controlling weed infestation in coffee field.

Table 2. Effect Weed dry biomass yield data (qt/ha) as affected by *Desomdium* management treatments at Gera.

Treatments	**Q/t ha^{-1}**
Weed dry biomass Qt/ha (over years)	
Free growth Desmodium (not trimmed)	11.19^{cb}
Recommended rate of NP	35.21^{b}
Desmodium trimmed once a year and used as mulch	6.30^{c}
Desmodium trimmed once a year and taken out	4.56^{c}
Control (no fertilizer or Desmodium)	52.76^{a}
Desmodium trimmed once a year and 50% used as mulch and the remaining taken out	5.18^{c}
C.V (%)	**33.49**
LSD (0.05)	**11.98**

****Means with the same letter or are not significantly different, > at 5% probability level according to LSD test**

The soil moisture content at the experimental site significantly ($p< 0.05$) affected due to the applied treatment (table.3). Higher soil moisture recorded from plot with Desmodium grown freely, however the lower the soil moisture was obtained from Desmodium trimmed once a year and 50% used as mulch. Thus, using Desmodium cover crop in coffee plantation is the best agronomic practice in conserving soil moisture especially for dry season of the year in line with reducing soil erosion at rainy season. Cover crops and cropping residues used in Conservation Agriculture systems serve as a protection for the soil surface against weather aggressions and water erosion, to maintain soil moisture, to suppress weed growth and to provide shelter and food for the soil biota (Blanchart et al., 2006).

Table 3. Effect soil moisture data (gm) as affected by *Desomdium* management treatments at Gera.

Treatments	Soil moisture (gm) over years mean
Desmodium grown freely (not trimmed)	77.72[a]
Recommended NP mineral fertilizer	74.00[a]
Desmodium trimmed once a year and used as mulch	73.62[a]
Desmodium trimmed once a year and taken out	71.88[a]
Control (no Desmodium and NP fertilizer)	60.37[b]
Desmodium trimmed once a year and 50% used as mulch	52.47[c]
CV %	**6.18**
LSD (0.05)	**7.68**

****Means with the same letter or are not significantly different, > at 5% probability level according to LSD test**

The inter-relationship between weed biomass, soil moisture and yield of coffee were affected by Dismodium cover crop (fig.1). However

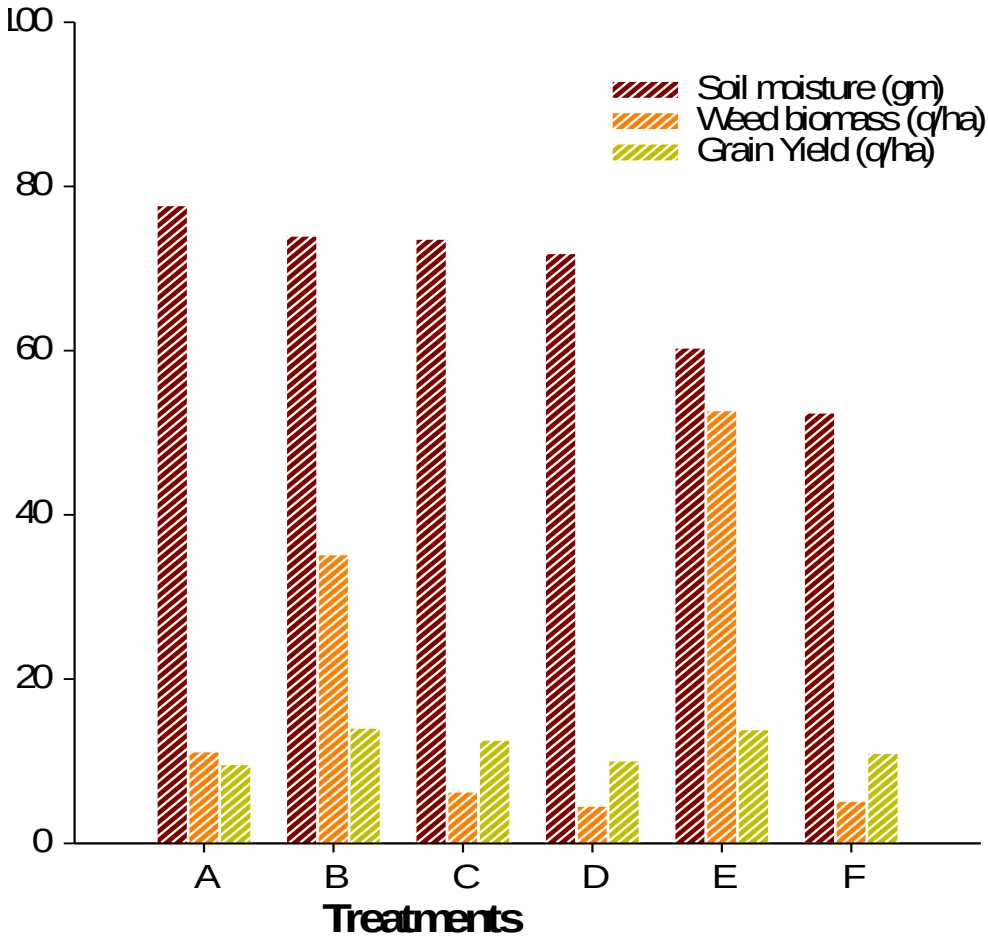

Figure 1. Effect of Desmodium management on soil moisture conservation, weed biomass and improving yield of Arabica coffee at Gera south west Ethiopia.

**where, Desmodium grown freely (not trimmed)(A),Recommended NP mineral fertilizer(B), Desmodium trimmed twice a year used as mulch (C), Desmodium trimmed twice a year and taken out (D),Control (no Desmodium and NP fertilizer) (E), Desmodium trimmed twice a year and 50% used as mulch (F)

CONCLUSION AND RECOMMENDATION

Using Desmodium plant for controlling weed management is a best option. With Regard to low cost of establishment, suppressing weed and improving fertility status of the soil. From the different Desmodium management system Desmodium trimmed once a year and used as mulch was better. As the table showed that maximum over years yield was obtained from recommended rate of NP fertilizer. But if we are considering cost of fertilizer and weeding cost there was big difference between recommended rate of NP and Desmodium trimmed once a year and used as mulch. But minimize heavy competition of Desmodium with coffee tree for soil nutrients, integrated use of inorganic fertilizer with Desmodium management system will better.

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