Determining the impact of mulching practice on the early survival and subsequent growth performance of newly transplanted coffee seedlings

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Paper presented on 2018 IACO Annual Meetings
African Coffee Scientific Conference, Hotel Nomad, Libreville, Gabon, 20 to 21 November 2018

1. Introduction

- Ethiopia gave the world *Coffea arabica*, the species that produces most of the coffee we drink today.
- Today, the country is the largest Arabica coffee producers and exporters in Africa.
- But the effects of climate change like higher temperatures and less rainfall could take a toll on the country's ability to farm this treasured crop.
- Recent study forecasted that, Ethiopia could lose from 39 to 59% of its current coffee-growing areas to climate change by the end of this century (NPR, 2017).

1. Introduction … Cont'd

- The usual limiting factor due to climate change in most coffee growing parts of Ethiopia is moisture stress.
- The most traditional farmer depends entirely on rainfall as a source of moisture.
- However, recently frequent drought of varying degrees have been experienced.
- This has made the necessary for the farmer to get the best out of the varying rainfall amount and distribution.
- Thus, incorporating mulching in the farming definitely encouraged to maximize the available soil moisture.

1. Introduction …Cont'd

- But, coffee production is challenged by shortage of best recommended agronomic practices like mulching.
- Coffee farming in Ethiopia appeared to be lacking suitable farming practices such as mulching and/ or irrigation, which required for growing coffee (Moat *et al*., 2017).
- Hence, one of the most important methods of moisture conservation is use of mulches.
- The use of mulches in coffee farms has been on the increase over the years especially during the first few years after transplanting of the seedlings (Addo, 2013).

1. Introduction …Cont'd

- Hararghe is the areas known for the best quality coffee (Harar coffee) producing region in eastern Ethiopia, which is currently highly influenced by climate change.

- It is a moisture deficit area where the tradition of using different mulching materials such as grass, maize straw, sorghum straw, banana leaves, coffee husk and etc are not well adapted by coffee growers.

- This is due to the lack of best recommended mulching materials with its appropriate application practices for the areas.

1. Introduction … Cont'd

- As a result, in the areas early survival of transplanted coffee seedling is becoming the most limiting factor for coffee producers.

- Thus, scientific studies are required to determine the precise outcomes and benefits of on-farm interventions for better coffee production and productivity in coffee growing areas of Hararghe.

- Therefore the experiments were conducted with the objective:
  - ✓ To identify effective mulching materials and their optimum application thickness for newly transplanted coffee seedlings under Hararghe conditions.

2. Materials and Methods

- The experiment was conducted at Mechara Agricultural Research Center on-station and Sakina on-farm.
- The experiments at both locations were made up of four mulching treatments (Maize stover at 5 & 10cm; and vetiver grass at 5 & 10cm mulching thicknesses).
- These treatments were compared with the usual soil mulching as a farmers' practices & no-mulch treatments.
- The treatments were arranged in RCBD of 3 replications.
- Coffee seedlings of *Mechara-1* variety were used as a planting seedling materials.

2. Materials and Methods …. Cont'd

- The coffee seedlings were transplanted to the field at 6-8 true leaf stage.
- The mulching materials were applied at end of September (termination of rainfall & start of dry period) and they were kept under the seedlings until the commencement of early *belg* rain (end of March).
- The Survival rate, Soil moisture content, Moisture stress score, weed population and early growth performances of the seedlings were tested.
- The collected data were subjected to ANOVA using GenStat 15th edition.

3. Results and Discussion

Application of mulching effect on seedling survival rate

- At both location the mean survival rate of the seedlings is significantly different (Table 1).
- The seedlings were survived more with the combined mean 95% in vetiver grass at 5cm mulching thickness followed by that of 10cm thickness (Table 1).
- The seedlings were less survived in farmer practice/soil mulch and no mulch (Table 1).
- The combined means survival rate was also significantly different (Table 1).

Table 1. Effect of mulching materials and thicknesses on mean survival rate of newly transplanted coffee seedlings across locations

Treatment	Survival rate (%) by location		
	Mechara	Sakina	Mean
Maize stover mulch 5cm thickness	96.7a	75.8ab	86.3abc
Maize stover mulch 10cm thickness	94.3ab	75.0ab	84.6abc
Vetiver grass mulch 5cm thickness	98.3a	90.8a	94.6a
Vetiver grass mulch 10cm thickness	98.0a	81.7ab	90.0ab
Soil mulch (farmer practice)	87.8bc	73.3ab	80.6bc
Without mulch (control)	85.3c	66.5b	75.9c
Mean	93.4	77.1	85.3
LSD (5%)	6.4	21.2	12.3
CV%	3.8	15.1	7.9

Means with the same letters are non-significant (P<0.05)

3. Results and Discussion … Cont'd

Effect of mulching practices on soil moisture content

- Mean analysis of variance for soil moisture content resulted statistically significant differences across the experimental locations (Table 2).

- The mean maximum 14.3% at Mechara & 18.7% at Sakina with combined mean of 16.5% moisture content were recorded for soils of coffee seedlings mulched with vetiver grass at 5cm mulching thickness (Table 2).

- The mean minimum soil moisture were recorded with unmulched treatments at both location (Table 2).

Table 2. Soil moisture content as affected by mulching materials and thicknesses under newly transplanted coffee seedlings at Mechara ARC on-station and Sakina on-farm

Treatment	Soil moisture content (%) by location		
	Mechara	Sakina	Mean
Maize stover mulch 5cm thickness	11.0b	13.3b	12.1bc
Maize stover mulch 10cm thickness	11.4b	15.5ab	13.3b
Vetiver grass mulch 5cm thickness	**14.3a**	**18.7a**	**16.5a**
Vetiver grass mulch 10cm thickness	11.9b	15.9ab	13.7b
Soil mulch (farmer practice)	9.9c	**11.1b**	10.8c
Without mulch (control)	**7.3d**	12.9b	**9.8c**
Mean	11.0	14.6	12.7
LSD (5%)	1.31	5.3	2.6
CV%	6.6	20.3	11.4

Means with the same letters are non significant.

3. Results and Discussion … Cont'd

Effects of mulching application on moisture stress score

- The response of coffee seedling under different mulching type and thickness to mean moisture stress shows significant different ($P<0.05$) at both locations.
- The least pooled mean (1.5 out of 5) score of moisture stress across locations were recorded from coffee seedlings mulched with vetiver grass at 5cm and 10cm mulching thicknesses (Table 3).
- However the highest (2.3) combined mean of moisture stress score values was recorded from the soil mulching/ farmers practice (Table 3).

Table 3. Effect of mulching materials and thicknesses on moisture tolerance for newly transplanted coffee seedlings at McARC on-station and Sakina on-farm

Treatment	Mechara on-station	Sakina on-farm	Mean
Maize stover mulch 5cm thickness	1.8bc	2.6b	2.2b
Maize stover mulch 10cm thickness	1.6ab	2.7b	2.2b
Vetiver grass mulch 5cm thickness	**1.3a**	**1.6a**	**1.5a**
Vetiver grass mulch 10cm thickness	**1.4ab**	**1.5a**	**1.5a**
Soil mulch (farmer practice)	1.8bc	**2.8b**	2.3b
Without mulch (control)	**2.2c**	**2.3b**	**2.1b**
Mean	1.66	2.17	1.74
LSD (5%)	0.4	0.6	0.4
CV%	13.7	15.7	11.2

Means with the same letters are non significant.

3. Results and Discussion … Cont'd

Application of mulching practice on Weed suppression

- The mean values of weed species and density across locations and their combined mean showed statistically significant differences ($P<0.05$) among the mulching treatments (Table 4).
- The lowest weed density (3) was recorded due to the application of maize stover at 10cm and the highest (42) weed was counted from the unmulched plot (Table 4).
- This shows that, the maize stover mulch significantly reduced weed infestation compared to vetivar grass and the control plot without mulch.

Table 4. Mean total weed density and weed species emerged as affected by different mulching materials and thicknesses at Mechara ARC and Sakina on-farm

Treatment	Weed Species			Weed Density		
	Mechara	Sakina	Mean	Mechara	Sakina	Mean
Maize stover mulch 5cm thickness	2.3a	1.6ab	2ab	5.3a	6.3a	5.8a
Maize stover mulch 10cm thickness	2.0a	0.3a	1.2a	3.0a	**2.7a**	**2.8a**
Vetiver grass mulch 5cm thickness	4.0ab	2.3ab	3.2bc	12.0a	4.0a	8.0a
Vetiver grass mulch 10cm thickness	5.7bc	3.0bc	4.3cd	15.3a	7.7ab	11.5a
Soil mulch (farmer practice)	6.7bc	5.0cd	5.8de	**34.7b**	19.3bc	27b
Without mulch (control)	7.0c	6.0d	6.5e	**41.7b**	21.3c	**31.5b**
Mean	4.6	3.0	3.8	18.7	10.2	14.4
LSD (5%)	2.9	2.1	1.8	17.6	12.1	10.3
CV%	34.4	37.6	26.2	51.8	37	39.5

Means with the same letters are non significant.

3. Results and Discussion … Cont'd

Application of mulching effects on early growth performance of coffee seedlings

- Statistically significant difference ($P<0.05$) have been observed across locations on all early growth parameters of the coffee seedling (Table 5).
- At both location the highest mean plant height, girth, canopy diameter & number of primary branches were recorded in vetivar grass at 5cm thicknesses (Table 5).
- The lowest growth performance of the seedlings were observed under the control treatments (no mulch and soil mulch/farmer practice).

Table 5. Early growth performance of newly transplanted coffee seedling as affected by mulching materials and thicknesses at end of experimental period at both locations

Treatment	Mechara on-station				Sakina on-farm			
	PH (cm)	Girth (mm)	NPB	CD (cm)	PH (cm)	Girth (mm)	NPB	CD (cm)
Maize stover mulch 5cm thickness	81.7abc	18.1ab	20.3abc	75.4ab	80.7ab	17.1bc	20.3a-c	75.4ab
Maize stover mulch 10cm thickness	91.9ab	19.6ab	23.9ab	73ab	90.6a	18.3bc	22.9a	73ab
Vetiver grass mulch 5cm thickness	**97.1a**	**21.1a**	**26.4a**	**91.1a**	**90.4a**	**23.4a**	**24.4ab**	**85.4a**
Vetiver grass mulch 10cm thickness	85.2abc	20.3ab	21.1abc	79.3ab	91.9a	19.6ab	21.1ab	84.9a
Soil mulch (farmer practice)	77.2bc	17.1ab	18.5bc	66.7b	73.9b	15.4bc	18.5bc	66.7ab
Without mulch (control)	**70.7c**	**14.9b**	**15.4c**	**57.3b**	**74.0b**	**14.9c**	**15.4c**	**60.6b**
Mean	84.0	18.5	20.9	73.8	83.6	18.1	20.4	74.3
LSD (5%)	18.2	5.1	7.0	23.4	14.5	4.4	5.3	22.9
CV%	12	15.1	18.3	17.4	9.5	13.1	14.4	17.0

Means with the same letters are non significant

PH=Plant height; NPB; number of primary branch; CD=Canopy diameter

4. Conclusion and Recommendations

- The combined mean results of this study indicated that seedling survival rate, soil moisture content, moisture stress score, seedling growth performance and weed were significantly influenced by application mulching practices.

- Application of mulching vetiver grass at 5cm thickness gave high rate of survival by keep significant amount of soil moisture which resulted for good moisture stress and best growth rate for seedlings compared to farm under no mulch.

- Thus, under drought prone areas improved soil moisture conservation, and reduced soil temperature, weed infestation and leaching of nutrients provided by mulching might have contributed to the high survival and early growth rate of the coffee seedlings.

4. Conclusion & Recommendation ... Cont'd

- All tested parameters except weed population were shows best under the mulching of vetivar grass at 5cm thickness.
- However the weed population was highly suppressed by maize stover at 10cm thickness compared to all others.
- In general with this study it was confirmed that, mulching of newly transplanted coffee seedling is very important for the survival and best early growth performance during dry period in area like Hararghe.
- Thus, from this study the adoption of the application of locally available mulching vetiver grass at 5cm thickness could be recommended.

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