academicJournals

Vol. 12(38), pp. 2836-2843, 21 September, 2017
DOI: 10.5897/AJAR2017.12478
Article Number: 8AF313466051
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Effect of organic mulches and land preparation methods on soil moisture and sesame productivity

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Received 24 May, 2017; Accepted 20 June, 2017

Sesame (*Sesamum indicum* L.) is one of the exportable commodities in Ethiopia, though its productivity is threatened by moisture stress. This research aims to study effect of organic mulches and land preparation methods on sesame productivity and in-situ moisture conservation. The experiment was carried out in Humera, Western Tigray during 2015/16 growing season. The experimental design was factorial randomized complete block design with three replications. There were four type of organic mulches (rice straw, sorghum straw, sesame straw and "Sudan grass") compared with control (no mulching) and two land preparation methods (ridge and flat land preparation). Sesame, variety Setit-1 was used in the experiment. The organic mulching rate of application was 10 ton ha^{-1} and this was applied evenly to the soil immediately after emergence. Soil water content, phonological characteristics, yield and yield components of sesame were collected. Partial budget analysis was computed to evaluate the economic visibility of both factors. The data collected was analyzed with Genstat15 software and treatment showed that significant difference was subjected to mean comparison test. The analyzed results indicated that land preparation methods with organic mulching had significant effect on soil moisture content at different soil depth and grain yield. The highest yield (750 kg ha^{-1}) was recorded under flat land preparation with "Sudan grass" while the lowest yield (140 kgha^{-1}) was recorded under no mulch with flat land preparation methods. The economic analysis showed that flat land preparation with "Sudan grass" produces the highest net benefit (9,499 Birr) and marginal rate of return (223.3%). The overall result showed that investing 1.0 Birr on flat land preparation method mulched with "Sudan grass" earns 2.23 birr. Thus, using flat land preparation with "Sudan grass" as mulch could be an advantage to obtain highest yield and profit for the farmers in dry land areas.

Key words: Organic mulch, land preparation method, soil moisture, Sesame yield.

INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to *Pedaliaceae* family with a broad leaf and has an indeterminate flowering habit (Tashiro et al., 1991). Though there are shattering and non-shattering types, most sesame seed

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is produced with shattering varieties. Sesame is a crop that is adapted to deep soils which have a loamy texture, are well drained and good natural fertility. Regardless of having an optimal range of between 500 and 650 mm of water during its production phase (Grilo et al., 2013), sesame productivity is threatened by biotic and abiotic factors such as rainfall intensity and distribution on one side and insect pest on the other side; factors responsible for 0.35 - 4 t/ha yield reduction in sesame production (Gebregergis et al., 2016). Therefore, productivity could be attained through creating new cultivars with high yield potentiality as well as application of suitable cultural practices such as fertilization, in-situ water harvesting technique and weed control etc (El-Habbasha et al., 2007). Organic mulching has numerous benefits on soil physical, chemical and biological properties, and as a result increases water holding capacity through increasing infiltration and reducing evaporation. Mulches increased soil organic matter after decomposition and has resulted in mineralization and improvement in soil physical properties. Thus, this condition improves the number of pores and as result increase water holding capacity. Similarly, Ji and Unger (2001) reported that as the mulch decomposes, humus is added to the soil, which increases its water holding capacity. In other ways, soil water retention can be improved via reduction in evaporation. Similarly, Goitom et al. (2017) reported significant moisture retention due to application of organic mulching material. Moreover, De et al. (2005) and Adeniyan et al. (2008) found highest soil moisture content in plots mulched with water hyacinth and sunflower respectively. Soil evaporation reduction by 50% was modeled with 100% soil cover of the soil by organic mulch in Aqua Crop Water Productivity Model (Raes et al., 2009) and by 34 - 50% reduction in soil water evaporation as a result of crop residue mulching reported by Hatfield et al. (2001). Mulch conserve soil moisture and suppress weed growth, and as a result boost yield by 11.2% (Pandya and Rank, 2014). This research aims to evaluate the effects of land preparation methods with organic mulching on sesame productivity.

MATERIALS AND METHODS

Description of the study area

The field experiment was conducted in 2015 main growing season in Humera Agricultural Research Center (Table 1). The study area is found in northern Ethiopia bordered in the west by Sudan, north by Eritrea, south by the Amhara Regional State and in the east by Welkait-Tsegedie District. Humera, main town of Kafta Humera District, is found about 600 km west of Mekelle and situated between 13°14’ to 14°27´N and 36°27´ to 37°32´E.

Experimental design and treatments

In this research, factorial randomized complete block design with 10 treatment and three replications was used. Those treatments included land preparation method (flat bed and ridge) and organic mulch material (sesame straw, sorghum straw, rice straw, “Sudan grass” and control; that is, with no mulch). The gross plot size was 6 m^2 and the net plot size was 3.6 m^2. The distance between the plot and block was 1 m and 1.5 m, respectively. Sesame seed variety setit-1 was sown at row to row and plant to plant distance of 40 cm and 10 cm respectively. The field was tilled and supplied with 100 kg of NPS (19 N-38$P_2 0_5$ +7S) and 50 kg of urea fertilizer. The urea was applied in split form; 25 kg at sowing and 25 at flower initiation. In accordance with the methods adopted by Ramakrishna et al. (2006) and Ajibola et al. (2014), the rate of mulches used was 6 kg per plot which is equivalent to 10 ton/ha. Mulches were evenly applied immediately after emergence of sesame.

Land preparation

The experimental land was first prepared using tractor; thereafter, the different land preparation methods (ridge and flat) were prepared. Land preparation of the crop can either be in the furrows or on the ridges based on the expected soil moisture content required for a particular crop. Ridge and furrow land preparation method is a land preparation technique that has ridge, which is vital for moisture conservation. The ridges were raised and adjusted manually to a height of 20 cm after first plowing. The sesame seeds were then sown at ridges in order to reduce the influence of water logging. The soil surface of the study area is generally flat with slope range of 1 - 5% and is considered as control or check as it is the most common method used in the study area.

Yield and yield components

Number of branches per plant, number of capsules per plant and number of seed per capsule were counted from five randomly selected plants per plot and plant height was measured from five plants per plot. After harvesting, biomass was allowed to dry by setting the bundles upright until all capsules opened. Threshing was done by knocking the inverted bundles a few times until all seeds dropped from the capsules.

To determine the number of seeds per capsule, the seeds of three capsules (lower, medium and uppermost position on the plant) from each of five plants were counted. Seed weight per capsule was taken on fifteen capsules from the randomly tagged plants to determine thousand grain weights. Thousand seed weight were determined by counting 1000 seeds from each plot after sun drying. Seed yield of each plot was weighed in grams and converted to area basis to determine the yield per hectare in kg/ha.

Economic analysis procedure

This partial budget as described by Program (1988) was analyzed on grain yield of sesame crop in order to assess the costs and benefits associated with different treatment (land preparation method and organic mulching). Economic analysis was done using the market price for inputs at land preparation and for grain yield at the time the crop was harvested. All costs and benefits were calculated on hectare basis in Ethiopia Birr. Grain yield was adjusted down by 10% to minimize the effect of researcher-managed small plots as compared to the farmers managed plots.The dominance analysis procedure as detailed in Program (1988) was used to select profitability treatments from the range tested. The marginal rate of return (MMR) is calculated using Equation 3 by considering a pair of non-dominated treatments listed in the order of increasing net benefit. MMR denotes a return per unit of investment in the change of field management tested in the field research.

Table 1. Pre-sowing soil characteristics of the experimental site (Humera).

Soil characteristic		Value	Type
	Clay (%)	68	
Texture	Silt (%)	13	Clay
	Sand (%)	19	
Total-N (%)		0.04	Low
P (ppm)		2.78	
K (ppm)		62.8	
OM (%)		0.98	
CEC (meq/100 g soil)		30	
pH water (1:2.5)		8.45	Basic
EC water (mmohs/cm) (1:2:5)		0.16	Non saline

Source: Mekelle Soil Laboratory (2016).

The results of marginal analysis were further checked by the residuals which are residuals are calculated by subtracting the rate of return that farmers require (that is, the minimum of return multiplied by the total variable costs) from corresponding net benefits. Since the combination of field management treatments tested in this study is new to the farmers, 100% is considered as the change of their practice (Program, 1988). Following the analysis, treatments with highest residuals are recommended to farmers.

Gross benefit = Economical yield return × price (birr/kg) (1)

Net profit= Gross benefit – Total cost that vary (2)

$$MRR = \frac{change\ in\ NB}{change\ \ in\ TCV} \quad (3)$$

Where, MRR= is the marginal rate of return, NB= is net benefit ha^{-1} for each treatment, TCV= is the total variable costs ha^{-1} for each treatment.

RESULTS AND DISCUSSION

Soil moisture content during 15 days after sowing

Analysis of variance revealed highly significant difference (p<0.01) on soil moisture content during 15 days after sowing in the upper soil depth (0 - 0.2 m). Flat land preparation method with sorghum and ridge land preparation method with sesame conserved statistically similar soil moisture. There was also statistically similar result among flat land preparation method with sesame, ridge land preparation method with sorghum, flat land preparation method with "Sudan grass" and ridge land preparation with rice. The lowest soil moisture was conserved with ridge land without mulching. However, in the medium soil depth (0.21 - 0.4 m), insignificant (P>0.05) soil moisture was conserved among mulching with land preparation methods treatments. In the lower depth (0.41 - 0.6 m), highly significant difference (p<0.01) WAS shown among treatments. The highest soil moisture (20.7%) was conserved at flat land preparation method with "Sudan grass", even though statistically similar with ridge land preparation method with rice straw and ridge land preparation method with sorghum, while the lowest (11.2%) was conserved with flat land preparation method with no mulch statistically similar with ridge without mulch (Table 2). This period in sesame growth is known as vegetative (particularly seedling) (Langham, 2007). Thus, treatments that had conserved significant amount of soil moisture created favorable environment for escaping water stress in this sensitive stage (Silva et al., 2016). Moreover, El Harfi et al. (2016) reported sesame as very sensitive to water stress at seedling stage. The no mulch treated plot showed poor soil moisture conservation as compared to treated plots. This could be due to poor infiltration via impact of raindrop on soil physical characteristics or high evaporation rate.

Soil moisture content during 30 days after sowing

The analysis of variance did not show significant difference (p>0.05) on soil moisture content during 30 days after sowing at the upper depth (0 - 0.2 m). However, the highest soil moisture (25.6%) was conserved at ridge land preparation with sesame, whereas the lowest (17.9%) was conserved at flat land preparation method with no mulch (Table 2). Similarly, analysis of variance showed insignificant difference (p>0.05) on soil moisture among treatments in the medium soil depth (0.21 - 0.4 m). However, the highest soil moisture content was (25.3%) conserved at ridge sesame straw while the lowest (17.4%) was conserved at flat land preparation method with no mulch (Table 2). Besides, analysis of variance did not show significant difference (p>0.05) on soil moisture at lower depth (0.41 - 0.6 m); whereas, the highest soil moisture (28.1%) was conserved at ridge with rice while the lowest (18.2%) was conserved at flat land preparation method without mulch (Table 2). This period of growth in sesame is called vegetative (juvenile and pre reproductive) (Langham, 2007) and is in line with De et al. (2005) who reported the highest amount of water conserved in groundnut fields mulched with water hyacinth and the lowest under no mulch in the depth of 0.15 m during 30 days after sowing.

Soil moisture content during 45 days after sowing

Analysis of variance revealed highly significant difference (p<0.01) on soil moisture content at the upper depth (0 - 0.2 m) with the highest soil moisture (28.9%) conserved at flat land preparation method with sesame even though a statistically similar result was observed with flat land preparation method with "Sudan grass" and flat land preparation method with rice; whereas the lowest (17.4%) was conserved at flat land preparation method without mulch though statistically similar with ridge without mulch

Table 2. Effect of mulching and land preparation on soil moisture content at different soil depth and days after sowing.

Treatment	15 DAS (cm)			30 DAS (cm)			45 DAS (cm)			60 DAS (cm)			75 DAS (cm)		
	0 - 20	21 - 40	41 - 60	0 - 20	21 - 40	41 - 60	0 - 20	21 - 40	41 - 60	0 - 21	21 - 40	41 - 60	0 - 20	21 - 40	41 - 60
F. Sorghum	32.2^{a}	13.4^{de}	12.9^{cd}	$20.3^{c.e}$	21.3^{b}	22.4^{bc}	20.9^{de}	27.9^{cd}	28.9^{ab}	20.3^{bc}	$23.3^{b.d}$	22.9^{ab}	$36.4^{b.d}$	23.6^{de}	20.6^{e}
RF. Sesame	31.6^{a}	19.4^{ab}	16.8^{b}	25.6^{a}	25.3^{a}	25.9^{ab}	20.3^{de}	31.4^{ab}	30.5^{ab}	22.7^{a}	$21.2^{c.e}$	23.6^{ab}	33.9^{dc}	34.8^{a}	34.0^{b}
F. Sesame	28.5^{b}	$15.8^{b.e}$	16.0^{bc}	22.6^{bc}	24.0^{ab}	26.6^{ab}	28.9^{a}	33.0^{a}	32.0^{a}	22.8^{a}	26.8^{a}	26.7^{a}	34.1^{cd}	33.5^{ab}	39.8^{a}
RF. Sorghum	28.2^{b}	$16.6^{a.e}$	17.3^{ab}	$22.9^{a.c}$	23^{ab}	25.9^{ab}	$26.3^{a.c}$	31.1^{ab}	32.6^{a}	21.1^{ab}	$23.5^{b.d}$	23.9^{ab}	32.7^{d}	29.8^{c}	33.8^{b}
F “Sudan grass”	27.0^{bc}	$17.9^{a.c}$	20.7^{a}	$21^{b.d}$	23.8^{ab}	$23.8^{a.c}$	28.3a	31.9^{ab}	29.9^{ab}	18.5^{c}	24.8^{ab}	25.5^{ab}	40.7^{ab}	32.2^{abc}	31.2^{b}
RF Rice	26.2^{bcd}	$14.7^{c.e}$	18.4^{ab}	$23.1^{a.c}$	25.2^{a}	$23.9^{a.c}$	$23.6^{b.d}$	29.7^{bc}	27.1^{bc}	22.9^{a}	20.1^{e}	21.6^{b}	44.1^{a}	31.2^{bc}	33.4^{b}
F. Rice	24.5^{cd}	$17.3^{a.d}$	14.8^{bc}	21.1^{bcd}	22.5^{ab}	23.1^{bc}	26.5^{ab}	29.8^{bc}	29.4^{ab}	19.6^{bc}	$24.1^{a.c}$	23.8^{ab}	$39.7^{a.c}$	31.6^{bc}	26.8^{cd}
RF. ”Sudan grass”	23.4^{de}	20.3^{a}	$15.2^{a.c}$	23.4^{ab}	25.1^{a}	28.1^{a}	$21.8^{c.e}$	26.8^{cde}	29.9^{ab}	20.3^{bc}	20.6^{de}	21.7^{b}	$35.9^{b.d}$	31.4^{bc}	31.2^{b}
F. Control	21^{e}	12.8^{e}	11.2^{d}	17.9^{e}	17.4^{c}	18.2^{d}	17.4^{e}	24.1^{e}	23.9^{c}	18.8^{c}	18.3^{e}	24.3^{ab}	17.4^{f}	22.2^{e}	24.5d
RF Control	15.1^{f}	$14.7^{c.e}$	10.8^{d}	19.0^{de}	23.0^{ab}	21.3^{cd}	$22.6^{b.d}$	25.7^{de}	20.1^{d}	20.0^{bc}	19.9^{e}	22.4^{b}	26.9^{e}	25.4^{d}	28.1^{c}
CV (%)	6	12.6	12.3	7.4	7.9	9.3	10.4	5.8	6.9	5.3	7.5	9.1	9.1	5.5	5.2
LSD 0.05	2.7	3.5	3.3	NS	3.1	3.8	4.2	2.9	3.4	1.9	2.9	3.7	5.3	2.8	2.7

(Table 2). Similarly, soil moisture was highly influenced ($p<0.01$) by mulch and land preparation treatment in the medium soil depth (0.21 - 0.4 m). The highest soil moisture (33.0%) was conserved at flat land preparation method with sesame still statistically similar with flat land preparation method with “Sudan grass”; ridge land preparation method with sesame and Ridge land preparation method with sorghum; whereas the lowest (24.1%) was conserved at flat land preparation method with no mulch and presents a statistically similar influence with ridge land preparation method without mulch and ridge land preparation method with Sudan grass (Table 2). Moreover, the analysis of variance revealed significant difference ($p<0.05$) on soil moisture in the lower depth (0.41 - 0.6 m). On top of this, highest soil moisture (32.6%) was conserved at ridge land preparation method with sorghum even if it did not differ statistically as regards flat land preparation method with sesame, ridge land preparation method with sesame, flat land preparation method with “Sudan grass”, ridge with “Sudan grass”, flat land preparation method with rice and flat land preparation method with sorghum; whereas the lowest soil moisture (20.1%) was found in conserved ridge land preparation method without mulch (Table 2).

This period in sesame growth is known as pre reproductive (50% flowering) by Langham (2007). Those land preparation methods with mulch that conserved significant soil moisture kept delaying the flowering period by neglecting the negative effect of water stress. The “no mulch” land preparation method hastens the period of flower due to water stress.

Soil moisture content during 60 days after sowing

Analysis of variance revealed insignificant difference ($p>0.05$) on soil moisture at the upper soil depth (0 - 0.2 m) among treatments. However, the highest soil moisture (22.9%) was conserved at ridge land preparation method with rice while the lowest (18.5%) was conserved at flat land preparation method with “Sudan grass” (Table 2). However, the analysis of variance revealed highly significant difference ($p<0.01$) among treatments at the medium soil depth (0.21 - 0.4 m). The highest soil moisture (26.8%) was conserved at flat land preparation method with sesame even if statistically similar with flat land preparation method with “Sudan grass”, flat land preparation method with rice, ridge land preparation with sorghum and flat land preparation method with sorghum; whereas the lowest (18.3%) was conserved at flat land preparation method with no mulch (Table 2). All treatments did not show significant difference in the lower soil depth (0.41 - 0.6 m). The conserved soil moisture showed insignificant difference in all depths except in the medium soil depth (0.21 - 0.4 m). This growth period in sesame is known as reproductive stage by Langham (2007). The soil moisture conserved in this stage has a great role in converting the produced flower to capsule. In line with our observation, Adeoye (1984) reported high moisture content in a soil depth of 0.6 m, better water infiltration and reduced evaporation in plots mulched with grass.

Soil moisture content during 75 days after sowing

Analysis of variance revealed highly significant difference ($p<0.01$) on soil moisture at the upper soil depth (0 - 0.2 m). The highest soil moisture (44.1%) was conserved at ridge land preparation method with rice which is statistically similar with flat land preparation method with "Sudan grass" and flat land preparation method with rice; while the lowest (17.4%) was conserved at flat land preparation method with no mulch. The analysis of variance also revealed highly significant difference ($p<0.01$) on soil moisture content in the medium depth (0.21 - 0.4 m). The highest soil moisture (34.8%) was conserved at ridge land preparation method with sesame; though statistically similar with flat land preparation method with sesame and flat land preparation method with "Sudan grass", whereas the lowest (22.2%) was conserved at flat land preparation method with no mulch (Table 2). Moreover, the analysis showed highly significant difference ($p<0.01$) on soil moisture in the lower soil depth (0.41 - 0.6 m). The highest soil moisture (39.8%) was conserved flat land preparation method with sesame while the lowest (20.2%) was conserved flat land preparation method with no mulch (Table 2). Komla (2013) also reported high soil water content (15.3%) in sweet paper mulched with cocoa pod husk whereas the no mulch treatment conserved the lowest (7.7%) in dry season. Similarly, Adeniyan et al. (2008) again indicated higher soil moisture content on sunflower mulched plot as compared to control. This period in sesame growth is known as reproductive stage by Langham (2007). Those treatments that conserved significant soil moisture have a great role in grain filling.

Effect of mulching on agronomic trait of sesame

The analysis of variance did not reveal significant difference ($p<0.05$) on days to 50% flowering among treatment. However, the longest days to 50% flowering was noted in flat land preparation method with "Sudan grass" while the shortest days were noted in flat land preparation method with control. However, the analysis of variance revealed significant difference on days to 90% maturity. Days to 90% maturity taken at ridge with sesame remains statistically similar with flat land preparation method with sesame, ridge land preparation with "Sudan grass" and ridge land preparation with rice straw; whereas the lowest days were taken at flat land preparation method without mulch followed by ridge land preparation without mulch. This is due to role of mulch neglect as well as negative effect of stress.

Plant height

The analysis of variance showed highly significant difference on plant height among treatments. The maximum plant height (95.1 cm) was recorded at flat land preparation method with "Sudan grass" though statistically similar with flat land preparation method with sesame, while the lowest (49 cm) was recorded at flat land preparation method without mulching (Table 3). The maximum plant height measured at those treatments could be due to significant soil moisture conservation and reduced weed infestation. The non-mulch covered plot showed poor overall plant growth, a symptom that consistently occurred in flat land preparation without mulch. This result is in line with Amoghein et al. (2013) who noted tallest plant height in sunflower mulched with rye than no mulch plot. In addition, Ozkan and Kulak (2013) reported maximum (52 cm) and minimum sesame plant height (30 cm) at soil water content of field capacity (FC) and 0.25 of FC, respectively.

Stand per meter square

The analysis of variance revealed that there is highly significant difference on stand per meter square among treatments. The highest plant per meter square (23.4) was found to have survived at ridge with "Sudan grass" though statistically similar with ridge sesame and flat land preparation method with "Sudan grass"; meanwhile, the lowest (12.4) survived at flat land preparation method without mulch (Table 3). Those treatments which showed significant survival rate could be due to their soil moisture conservation efficiency, whereas the bare treatment showed poor survival rate especially as this is vivid with flat land preparation without mulch. The bare treatments also showed high cracking rate and the seedling of sesame which collapsed down to the cracked soil and were also highly suffering from moisture stress as a result of poor stand.

Number of capsule per plant

The analysis of variance revealed highly significant difference on number of capsule per plant among treatments. The number of capsule per plant (42.5) was recorded at flat land preparation method with sesame yet statistically similar with flat land preparation method with "Sudan grass", ridge "Sudan grass", ridge without mulch, ridge land preparation with sorghum and ridge land preparation with sesame, while the lowest (20) was recorded at flat land preparation method without mulch.

Table 3. Effect of mulching organic mulching and land preparation method on phenology, yield and yield component of sesame.

Treatment	DF	DM	Plants/m^2	Ph (CM)	NCPP	NSPC	1000 SW	Yield (kg/ha)
Flat with sorghum	40.7	93^{bc}	22.4^{ab}	81.1^{b}	29.6^{b}	42.0^{bc}	3.7^{ab}	400.5^{e}
Ridge and furrow with sesame	40.3	96.0^{a}	23.0^{ab}	80^{b}	33.0^{ab}	46.0^{a}	3.5^{ab}	596.7^{cd}
Flat with sesame	39.0	95.6^{a}	21.9^{b}	92^{a}	42.5^{a}	41.0^{cd}	3.6^{ab}	579.2^{cd}
Ridge and furrow with sorghum	41.3	94.6^{ab}	21.8^{b}	84.0^{b}	34^{ab}	44^{ab}	3.5^{ab}	700^{ab}
Flat with “Sudan grass”	43	92^{cd}	22.7^{ab}	95.1^{a}	41.3^{a}	46.3^{a}	3.8^{a}	750^{a}
Ridge and furrow with rice	40	95^{a}	21.7^{b}	78.1^{b}	30.5^{b}	41.0^{cd}	3.3^{c}	540.7^{d}
Flat with rice	41.0	92.3^{cd}	21.8^{b}	77.6^{b}	29^{b}	38.7^{d}	3.0^{d}	451.3^{e}
Ridge and furrow with “Sudan grass”	39.7	95.3^{a}	23.4^{a}	79.0^{b}	38^{ab}	42.3^{bc}	3.7^{ab}	640^{bc}
Flat with control	40.0	90.6^{d}	12.4^{d}	49.0^{d}	20^{c}	31.0^{e}	2.9^{d}	140.0^{g}
Ridge and furrow with control	39.7	91.6^{cd}	19.9^{c}	63.0^{c}	34.1^{ab}	39.0^{d}	3.7^{ab}	310.0^{f}
CV (%)	7.5	1.2	3.7	4.5	15.2	3.7	4.3	7.2
LSD0.05	NS	1.9	1.3	6.0	8.7	2.6	0.3	63.2

Those treatments that produce significant number of capsule per plant could be due to soil moisture conservation ability, while the bare treatment produce poor capsule which is in association with poor soil moisture conservation. Similar result was reported by Langham (2007) showing moisture stressed sesame plants did not form auxiliary flowers that produce capsule. Rice straw mulched treatment scored 1.7 times of pods/plant as compared with no mulched plot in groundnut (Ramakrishna et al., 2006).

Number of seed per capsule

The analysis of variance revealed highly significant difference (p<0.01) on number of seed per capsule among treatments. The highest number of seed per capsule (46.3) was noted at flat land preparation method with “Sudan grass” though statistically similar with ridge land preparation with sesame and ridge and furrow land preparation with sesame, while the lowest (31.0) was noted in flat land preparation method without mulch. Treatments that produced highest seed per capsule could be due to their good soil moisture conservation ability and this conserved soil moisture was essential in translocation of produced assimilate to the sink from the source. This is in line with Ozkan and Kulak (2013) who reported higher number of seeds per pod in sesame (47) under higher moisture content and the lowest (38) scored under water deficit level of irrigation. Moreover, Kim et al. (2007) reported that drought stress extremely reduced seed yield per plant in sesame.

Thousand seed weight

The analysis of variance revealed highly significant difference (p<0.01) on thousand seed weight among treatments. The highest thousand seed weight (3.8 g) was recorded at flat land preparation method with “Sudan grass” even if statistically similar with flat land preparation method with sorghum, ridge without mulch, ridge land preparation with “Sudan grass”, flat land preparation method with sesame and ridge land preparation with sorghum, while the lowest (2.9 g) was recorded at flat land preparation method without mulch followed by flat land preparation method with rice. Treatments that produce the highest thousand seed weight could be due to their good soil moisture conservation capacity which is essential for grain filling. The bare treatments produce the lowest thousand seed weight which could be due to poor soil moisture conservation affecting the overall growth and physiology of the crop. This result is in conformity with Kang et al. (2012) who found highest weight (11 g) from 100 soybean seed under bed land preparation with mulch while the lowest (10.5 g) was recorded under no mulch (flat sown). Similarly, Sinaki et al. (2007) noted that water stress reduce soybean seed weight from 3.3 to 3.1 g stating that exerting water stress on soybean decreased seed weight from 3.3 - 3.1 g.

Yield

The analysis of variance revealed highly significant difference (p<0.01) on yield among treatments. The highest yield (750kg/ha) was recorded at flat land preparation method with “Sudan grass” statistically similar with ridge and furrow land preparation with sorghum, while the lowest (140kg/ha) was recorded at flat land preparation method with no mulch. The highest yield produced at those treatments could be due to their significant effect on plant height, stand per m^2, number of capsule per plant, number of seed per capsule and thousand seed weight, while the bare treatment showed poor performance on yield component. This result is in line with Ajibola et al. (2014) who observed improved sesame yield (185 kg ha^{-1}) in plots mulched with elephant grass while the lowest yield (57 kg ha^{-1}) was recorded on control. Moreover, significant yield improvement with dry

Table 4. Dominance analysis of the combinations of land preparation method and organic mulching effect on sesame.

Treatment	TCV (Birr)	Gross benefit (Birr)	Net benefit (Birr)	Dominance (D)
F with no mulch	1,002	2,520	1,518	
F with sorghum straw	2,901	7,209	4,308	
F with sesame straw	3,050	10,425	7,375	
F with “Sudan grass”	4,001	13,500	9,499	
RF with no mulch	5,300	5,580	280	D
RF with sesame straw	5,944	8,123	2,179	D
F with rice straw	6,020	8,123	2,103	D
RF with sorghum	6,233	12,600	6,367	D
RF with “Sudan grass”	7,333	11,520	4,187	D
RF with rice	7,778	9,733	1,955	D

F = Flat; RF = Ridge land preparation method

Table 5. Marginal rate of return and residual analysis of the combination of land preparation method and organic mulch.

Treatment	TCV (Birr)	NB (Birr)	MRR (%)	Minimum rate of return (100% × TCV)	Residual	Rank in residual
F with no mulch	1,002	1,518	151.5	1,002	516	4
F with sorghum straw	2,901	4,308	146.9	2,901	1,407	3
F with sesame straw	3,050	7,375	2058.4	3,050	4,325	2
F with “Sudan grass”	4,001	9,499	223.3	4,001	5,498	1

F = Flat; TCV = total cost that vary; NB = Net benefit; MRR = Marginal rate of return.

grass mulch compared with no mulch was reported by Adesina et al. (2014). In contrast, Gruber et al. (2008) reported insignificant difference among mulch treated and non-treated plots on yield.

Among the 10 treatment combination tested, 6 treatments were dominated and excluded from the marginal analysis (Table 4). Irrespective of the mulching material used, all ridge and furrow dominated because of their non-profitability to the farmers. As compared to flat land preparation with no mulch, flat land preparation mulched with sorghum straw offered 146.9% marginal rate of return (Table 5). Also, flat land preparation mulched with sesame straw also gave MRR of 2058.4% when compared to its preceding treatment (that is, flat land preparation mulched with sorghum straw). Similarly, flat land preparation with “Sudan grass” mulch gave MRR of 223.3% Birr when compared with flat land preparation mulched with sesame.

This indicates that farmer can obtain extra 2.23 Birr by investing 1 Birr on flat land preparation with “Sudan grass”. This is also confirmed with residual analysis that indicates the highest profitability which can be gained with flat land preparation mulched with “Sudan grass”.

Conclusion

The current result investigated that land preparation method with organic mulching have influence on soil moisture content at different growth stage and yield of sesame as yield showed increment with mulch land preparation method as compare to bare. Flat land preparation method with Sudan grass had good soil moisture in different growth stage which resulted in better growth and yield. The economic analysis showed growing of sesame with flat land preparation is economically visible. This treatment was best for its net benefit (9,499 Birr), marginal rate of analysis (223.3%) and residual analysis (5,498 Birr), which ranked first compared to other treatments. The marginal rate of return showed that by investing 1 Birr on flat land preparation method mulched with “Sudan grass” we get 2.23 Birr. So application of flat land preparation with Sudan grass is vital for sesame grower in drier area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

Author acknowledge to Tigray Agricultural Research Institute, Humera Agricultural Research Center, Mekelle University and SBN project for providing the financial assistance and other facilities for the completion of this study. Author is also thankful to the colleagues who provided support during the study.

REFERENCES

Adeniyan B, Ojeniyi S, Awodun M (2008). Relative effect of weed mulch types on soil properties and yield of yam in Southwest Nigeria. J. Soil Nat. 2:01-05.

Adeoye K (1984). Influence of grass mulch on soil temperature, soil moisture and yield of maize and gero millet in a savanna zone soil. Samaru Journal of Agricultural Research (Nigeria).

Adesina J, Stewart S, Falase AO, Akinyemi JO, Adegbite GD, Alabi AA, Sliwa K (2014). Effect of Variable Rate of Poultry Manure on the Growth and Yield of Pepper (Capsicum annum) in South Western Nigeria. Academia Arena 6(1):9-13.

Ajibola A, Modupeola T, Adenuga A (2014). Effect of Different Weed Control Practices on Growth and Yield of Sesame in south-west Nigeria. Biol. Chem. Res. 31(2):1093-1100.

Amoghein MB, Tobeh A, Gholipouri A, Jamaati-e-Somarin S, Ghasemi M (2013). Effect of cover crop in control of weed density and some qualitative and quantitative characteristics of sunflower. Int. J. Agric. Crop Sci. 5(12):1318.

De P, Chakravarti AK, Chakraborty PK, Chakraborty A (2005). Study on the efficacy of some bio resources as mulch for soil moisture conservation and yield of rain fed groundnut *(Arachis hypogaea).* Archives of Agron. Soil Sci. 51(3):247-252.

El Harfi M, Hanine H, Rizki H, Latrache H, Nabloussi A (2016). Effect of Drought and Salt Stresses on Germination and Early Seedling Growth of Different Color-seeds of Sesame (*Sesamum indicum*). Int. J. Agric. Biol. 18(6):1088-1094.

El-Habbasha S, Abd El Salam M, Kabesh M (2007). Response of two sesame varieties (*Sesamum indicum* L.) to partial replacement of chemical fertilizers by bio-organic fertilizers. Res. J. Agric. Biol. Sci. 3(6):563-571.

Gebregergis Z, Assefa D, Fitwy I (2016). Insecticide Application Schedule to Control Sesame Webworm Antigastra catalaunalis (Duponchel) Humera, North Ethiopia.

Goitom T, Alemtsahay T, Berhanu A (2017). Effect of organic mulching on soil moisture, yield and yield contributing components of sesame *(Sesamum indicum* L.) Int. J. Agron. https://doi.org/10.1155/2017/4767509

Grilo JA, Azevedo PV (2013). Crescimento, Desenvolvimento E Produtividade Do Gergelim Brs Seda Irrigado Com Água Do Lençol Freático, Na Agrovila De Canudos, em ceará mirim (rn). Holos 2:19-33.

Gruber S, Acharya D, Claupein W (2008). Wood chips used for weed control in Organic Farming. J. Plant Dis. Prot. 21:395-400.

Hatfield JL, Sauer TJ, Prueger JH (2001). Managing soils to achieve greater water use efficiency. Agron. J. 93(2):271-280.

Ji S, Unger PW (2001). Soil water accumulation under different precipitation, potential evaporation, and straw mulch conditions. Soil Sci. Soc. Am. J. 65(2):442-448.

Kang J, Avtar S, MK (2012). Studies on growth and yield of soybean (*glycine max* l.) under different land preparation methods and fertility levels. Indian J. Legume Res. 35(3):265-267.

Kim KS, Park SH, Jenks MA (2007). Changes in leaf cuticular waxes of sesame (*Sesamum indicum* L.) plants exposed to water deficit. J. Plant Physiol. 164(9):1134-1143.

Komla AN (2013). Effect of Organic Mulch on Growth and Yield of Sweet Pepper *(Capsicum annuum L.)*, 2013, University of Ghana.

Langham DR (2007). Phenology of sesame. Issues in New Crops and New Uses, Janick & Whipkey, eds., ASHS Press, Alexandria, VA pp. 144-182.

Sinaki JM, Heravan EM, Ra AHS, Noormohammadi G, Zarei G (2007). The effects of water deficit during growth stages of canola (*Brassica napus* L.). Am. Eur. J. Agric. Environ. Sci. 4:417-422.

Ozkan A, Kulak M (2013). Effects of water stress on growth, oil yield, fatty acid composition and mineral content of *Sesamum indicum.* J. Anim. Plant Sci. 23(6):1686-1690.

Pandya P, Rank H (2014). Summer sesame response to irrigation methods and mulching. Res. Crops 15(4).

Program CE (1988). From agronomic data to farmer recommendations: an economics training manual. CIMMYT.

Raes D, Steduto P, Hsiao TC, Fereres E (2009). AquaCrop the FAO crop model to simulate yield response to water: II. Main algorithms and software description. Agron. J. 101(3):438-447.

Ramakrishna A, Tam HM, Wani SP, Long TD (2006). Effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam. Field Crops Res. 95(2):115-125.

Silva RTD Oliveira AB, Lopes MD, Guimarães MD, Dutra AS (2016). Physiological quality of sesame seeds produced from plants subjected to water stress. Rev. Ciênc. Agron. 47(4):643-648.

Tashiro T, Fukuda Y, Osawa T (1991). Oil contents of seeds and minor components in the oil of sesame, *Sesamum indicum* L., as affected by capsule position. Japanese J. Crop Sci. 60(1):116-121.