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Effect Of Different Mulch Application On Soil Moisture Conservation, Growth And Grain Yield Of Beans Under Semiarid Of Rain Fed Fersiallitic Soil Conditions In Eastern Of Rwanda

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Abstract – There are several studies of the use of different mulches in crop production, but there is little work of their use with beans (Phaseolus vulgaris L.). Beans are word's most important vegetables for consumption especially in sub-Saharan countries. Already sub-Saharan countries are suffering from a great water stress and large food scarcity. To achieve the sustainable agriculture each and every drop from rainfall should be well managed but unfortunately a huge amount of rainfall water is wasted. This study was carried out to determine the effect of different mulch application on soil moisture conservation; growth and grain yield of beans under semiarid of rain fed fersiallitic soil condition in eastern of Rwanda. In the experiment a control (no mulch) was also included. The study indicated that mulching materials greatly affected the growth and yield of beans on fersiallitic loam soil than control at (P<0.05).The obtained results showed that soil treated with mulches conserved moisture at root zone level. The soil moisture increased 11.05% which showed the significant benefits of mulching. When growing beans in Eastern of Rwanda it is recommended to apply mulches in order to maximize growth and yield. They are also recommended for soil moisture conservation.

Keywords – Mulching, *Phaseolus Vulgaris,* Conservation, Soil Moisture, Yield.

I. INTRODUCTION

The common bean (Phaseolus vulgaris) is one of the most important vegetable crops widely consumed in eastern Africa, including Rwanda, Democratic Republic of Congo (DRC) and Uganda (Asare-marafo, 2016), beans have small inner edible grains which have a high preferable human consumption role as they are high in protein, fibre, phosphorus, iron, vitamin B1 and have no cholesterol(Kwambe, Masarirambi, Wahome, & Oseni, 2015). Beans are tolerant of heat and drought conditions and produce well on marginal soils and they are grown over a wide range of climatic zones. Different studies have been done to investigate the impact of climate variability on environment; the results show that there is an impact of climate change on yield of crops like beans due to increased temperature and limited rainfall. Here rain-fed farming should be interfered with different agricultural conservation techniques in order to improve soil status and plant health which could contribute to environmental and economic benefits(Kader, Singha, Begum, Jewel, & Khan, 2019).Mulching develop a protective strength in a significant way to reduce the erosion of top soil

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means that it protects the soil from agents as causal of erosion, feedlot wastes (manure)-required to control wind erosion(Sharma & Bhardwaj, 2018). (Rahma, Warrington, & Lei, 2019) revealed that applying mulch always reduced water losses as compared to a bare soil without mulch and thereby helps in reducing runoff and soil loss(Vashisht, 2016). Previous review indicated that there is a difference in soil moisture for mulched and un-mulched bare soil or control, The control shows the lowest soil moisture content compared to the other treatments(Kwambe et al., 2015)

The present study deals with the discussion of the effect of different mulch application on soil moisture conservation, growth and grain yield of beans.

II. Material And Methods

The study was carried out at Nyagatare dry valley near the town of Nyagatare district located in Eastern province, close to Rwanda's International borders with both Uganda and Tanzania. Its location lies about 168.7 kilometers by road North-East of Kigali the Rwanda's capital and largest city. The coordinates of the town are: 1° 18' 0.00"S, 30° 19' 30.00"E (Latitude:-1.3000; Longitude: 30.3250).

The Nyagatare Soils are fersiallitic oxisol loams, pH of 5.8-6.5 with 30% clay, 3.2% organic matter; it experiences small quantity of rains around 827mm and hot temperatures. It is characterized by two main seasons: Season A (September to January) and season B (February to May), the monthly distribution of the rains varies from one year to another, which is very weak and very unpredictable to satisfy the needs in agriculture and livestock. Between these rainy periods comes dry periods where the shorter is between September-January and a longer between February-May. The temperature varies between 15°c to 30 °c depending on the location.

The study was set up as a Randomized complete Block design (RCBD), four (4) Treatments each with three (3) replicates were established for the study; Rice straw, beans straw, cut grass and Un-mulched bare soil, the grasses were cut into pieces with a pang at 0.0 2 m long.

The plot size of each mulching treatment was10 m^2 means (4×2.5) m^2, the area of each planting catchment is (4×10) m^2, ridge furrow of 1:1 ratio, ridge height of 0.15 m, the distance between treatments was 0.5 m. The plot were prepared to fine using hoes before planting, with a ridge width of 0.6m, mulching with organic residues was done at planting time at a thickness of 0.05 m; a hoe was used to open the holes for easy seed emergence and a cropping pattern of 0.10 m between crops and 0.20 m in row spacing to attain target population of 480, 000 plants per hectare. The Planting stations were measured and marked using a tape measure and 2 seeds per hole were sown at a depth of 0.05m and 0.30m depth of the main root zone through visual observation of the wetting front in soil. Manual Weeding was done to remove unwanted grasses by using a hand hoe when needed during the time of the study. Mulching materials were laid before sowing and the application of fertilizers were avoided. The study commenced on September 25, 2019 the date of sowing for Season A and being harvested December 15, 2019, the Season B commenced March 03, 2020 and being harvested on May 25, 2020.

1.1.1 Soil sampling, data collection and Analysis

The three soil samples at depths 0–10, 10–20, and 20–30 cm were corrected, placed in sterile plastic sealing bags and transported to the laboratory and at the end the soil moisture characteristics were determined and recorded accordingly. Sampled fresh weight was weighed and dried in oven for 24 hours at 105∘ C (Kwambe et al., 2015).

$$Soil\ moisture\ content\ (\%) = \frac{\text{Fresh soil weight} - \text{Dry soil weight}}{\text{Dry soil weight}} \times 100$$

Beans (*Phaseolus vulgaris*) were used as experimental crop during this experiment. These are local varieties most used by farmers taking 75-90 days from sowing to harvesting. Five plants were randomly selected to test crop parameters include: Number of leaves, stem diameter, crop height, leaves diameter, total plant weight and total grain weight. The stem diameter, leave diameter were measured by using the ruler, plant height was measured using a measuring tape, number of leaves by counting, the total plant and grain weight were measured using a calibrated electronic balance. All the data analysis will be done using SPSS software package (version 20.0) (IBM Corporation, Armonk, New York) and the data will be subjected to Two-way of variance (ANOVA) with the least significant difference test at $P < 0.05$.

III. RESULTS AND DISCUSSIONS

Moisture content variation

Mulching has influenced the soil moisture content in mulched lands than bare soil, the highest amount of moisture has seen after two weeks of the date after planting due to reduced evaporation and due to water from rainfall. The findings have shown the difference in soil moisture contents with the variation of time from two weeks after planting to eight weeks after planting (Kwambe et al., 2015). The plots treated with mulches have shown the appropriate moisture than un-mulched plots, as mulches improve soil moisture retention capacity(Pinamonti, 2000).

At the end of experiments the results have shown that there were no significance in the mean moisture contents along mulched treatments, but the indicated differences between moisture data under different treatments including control have confirmed the influence of mulching on soil moisture contents. the earlier studies confirmed how the application of straw mulches resulted in higher soil moisture content than control(*In the Graduate College*, 1987)

Table1: The study of weekly moisture Content variation by treatments

Treatments	Stats	Two weeks	Four weeks	Six weeks	Eight weeks
T1 (Rice Straw)	Mean	23.433	26.544	25.333	24.399
	P50	26	28.6	23.6	23.1
	Variance	16.670	29.185	37.148	26.705
	SD	4.083	5.402	6.095	5.168
	Min	17.800	19.000	19.200	19.210
	Max	26.600	32.300	35.000	32.000
	CV	0.174	0.204	0.241	0.212
	N	9	9	9	9
T2 (Beans straw)	Mean	21.000	26.767	22.467	24.433
	P50	21.500	27.100	19.800	27.400
	Variance	2.460	20.845	18.518	26.483
	SD	1.568	4.566	4.303	5.146
	Min	19.000	20.800	19.400	17.500
	Max	23.000	31.900	28.400	28.500
	CV	0.075	0.171	0.192	0.211
	N	9	9	9	9
T3 (Cut grass)	Mean	20.967	25.683	22.067	25.100
	P50	21.200	27.500	21.400	22.500
	Variance	6.595	22.221	12.275	24.988
	SD	2.568	4.714	3.504	4.999
	Min	17.700	19.000	18.400	20.500
	Max	24.000	30.050	26.700	31.900

	CV	0.122	0.184	0.159	0.199
	N	9	9	9	9
T0 (Bare soil)	Mean	22.233	25.078	22.700	25.311
	P50	22.100	26.900	23.800	26.300
	Variance	27.163	36.284	29.318	22.586
	SD	5.212	6.024	5.415	4.752
	Min	15.900	16.900	15.000	19.200
	Max	28.900	31.200	28.600	30.400
	CV	0.234	0.240	0.239	0.188
	N	9	9	9	9
Total	Mean	21.908	26.018	23.142	24.811
	P50	21.750	27.250	22.450	24.650
	Variance	13.154	25.280	23.930	23.197
	SD	3.627	5.028	4.892	4.816
	Min	15.900	16.900	15.000	17.500
	Max	28.900	32.300	35.000	32.000
	CV	0.166	0.193	0.211	0.194
	N	36	36	36	36

Table2. Analysis of Variance (ANOVA) of weekly Moisture Content records (Two way)

ANOVA Two way (MC- 2 weeks)						
Soil moisture	Source	Partial SS	DF	MS	F	P>F
MC- 2 weeks	Model	456.8075	11	41.5280	278.4	0.0000
	Treatments	37.2875	3	12.4292	83.32	**0.0000[a]**
	Depth	148.655	2	74.3275	498.28	**0.0000[b]**
	Treatments X Depth	270.865	6	45.1442	302.64	**0.0000[c]**
	Residual	3.58	24	0.1492		
	Total	460.3875	35	13.1539		
Number of Obs		36		R^2		**0.9922**
Root MSE		0.386		Adj R^2		0.9887
ANOVA Two way (MC- 4 weeks)						
Soil moisture	Source	Partial SS	DF	MS	F	P>F
MC- 4 weeks	Model	878.5124	11	79.8648	305.54	0.0000

	Treatments	16.5030	3	5.5010	21.05	**0.0000[a]**
	Depth	115.0460	2	57.5230	220.07	**0.0000[b]**
	Treatments X Depth	746.9635	6	124.4939	476.28	**0.0000[c]**
	Residual	6.2733	24	0.2614		
	Total	884.7858	35	25.2796		
Number of Obs		36		R^2		**0.9929**
Root MSE		0.511		Adj R^2		0.9897
ANOVA Two way (MC- 6 weeks)						
Soil moisture	Source	Partial SS	DF	MS	F	P>F
MC- 6 weeks	Model	828.7475	11	75.3407	205.47	0.0000
	Treatments	59.4875	3	19.8292	54.08	**0.0000[a]**
	Depth	360.365	2	180.1825	491.41	**0.0000[b]**
	Treatments X Depth	408.895	6	68.1492	185.86	**0.0000[c]**
	Residual	8.8	24	0.3667		
	Total	837.5475	35	23.9299		
Number of Obs		36		R^2		**0.9895**
Root MSE		0.606		Adj R^2		0.9847
ANOVA Two way (MC- 8 weeks)						
Soil moisture	Source	Partial SS	DF	MS	F	P>F
MC- 8 weeks	Model	804.5671	11	73.1425	239.35	0.0000
	Treatments	5.8149	3	1.9383	6.34	**0.0025[a]**
	Depth	673.4410	2	336.7205	1101.9	**0.0000[b]**
	Treatments X Depth	125.3113	6	20.8852	68.34	**0.0000[c]**
	Residual	7.3341	24	0.3056		
	Total	811.9013	35	23.1972		
Number of Obs		36		R^2		**0.991**
Root MSE		0.553		Adj R^2		0.9868

a, b, c correspond to statistical significance difference at 5% level of significance

Yield of beans of mulched and non- mulched land

The illustrated table presented the effect of mulching on number of leaves, steam diameter, height, leaves diameter, total plant weight, total grain weight.

Table3. Descriptive analysis of agronomic parameters by treatments

Treatments	Stats	Number of leaves	Steam diameter, Cm	Height, cm	Leaves diameter, cm	Total Plant weight, gm	Total grain weight, gm
T1 (Rice Straw)	Mean	18	0.893	1.5	7.98	102.167	56.233
	P50	18	0.9	1.5	7.94	101	56.2
	SD	1	0.021	0.020	0.203	3.403	2.150
	Min	17	0.87	1.48	7.8	99.5	54.1
	Max	19	0.91	1.52	8.2	106	58.4
	CV	0.056	0.023	0.013	0.025	0.033	0.038
	N	3	3	3	3	3	3
T2 (Beans straw)	Mean	17.667	0.867	1.473	8.067	101.667	55.833
	P50	18	0.88	1.49	8.1	102.5	55.5
	SD	0.577	0.081	0.047	0.153	1.893	1.528
	Min	17	0.78	1.42	7.9	99.5	54.5
	Max	18	0.94	1.51	8.2	103	57.5
	CV	0.033	0.093	0.032	0.019	0.019	0.027
	N	3	3	3	3	3	3
T3 (Cut grass)	Mean	17.667	0.903	1.507	7.843	103.167	56.333
	P50	18	0.89	1.51	7.93	100.5	56
	SD	0.577	0.032	0.015	0.605	6.429	2.616
	Min	17	0.88	1.49	7.2	98.5	53.9
	Max	18	0.94	1.52	8.4	110.5	59.1
	CV	0.033	0.036	0.010	0.077	0.062	0.046
	N	3	3	3	3	3	3
T0 (Bare soil)	Mean	16.667	0.870	1.167	7.167	81.233	39.867
	P50	17	0.89	1.22	7.3	76.8	38.4
	Variance	2.333	0.002	0.042	0.103	226.443	22.773
	SD	1.528	0.044	0.205	0.321	15.048	4.772
	Min	15	0.82	0.94	6.8	68.9	36
	Max	18	0.9	1.34	7.4	98	45.2
	CV	0.092	0.050	0.176	0.045	0.185	0.120
	N	3	3	3	3	3	3

Total of the experimental site	Mean	17.5	0.883	1.412	7.764	97.058	52.067
	P50	18	0.89	1.49	7.915	100	55
	SD	1	0.045	0.174	0.483	11.951	7.798
	Min	15	0.78	0.94	6.8	68.9	36
	Max	19	0.94	1.52	8.4	110.5	59.1
	CV	0.057	0.051	0.123	0.062	0.123	0.150
	N	12	12	12	12	12	12

Number of leaves

The highest number of leaves of 19 has found in plot treated with rice straw, the lowest number of 15 in control, the difference in number of leaves has counted after harvesting. These findings are in accordance with(Sadek, Youssef, Solieman, Abdul, & Alyafei, 2019) who reported that mulching has significantly influenced the number of leaves.

Table4: One way ANOVA for the significance of number of leaves by treatments

Studied Parameters	Treatments (I)	Multiple Comparisons (J)	Mean Comparison (I-J)	Std Error	Sig.
Number of leaves	T1 (Rice Straw)	T2 (Beans straw)	0.33333	.81650	0.998
		T3 (Cut grass)	0.33333	.81650	0.998
		T0 (Bare soil)	1.33333	.81650	0.527
	T2 (Beans straw)	T1 (Rice Straw)	-0.33333	.81650	0.998
		T3 (Cut grass)	0.00000	.81650	1.000
		T0 (Bare soil)	1.00000	.81650	0.769
	T3 (Cut grass)	T1 (Rice Straw)	-0.33333	.81650	0.998
		T2 (Beans straw)	0.00000	.81650	1.000
		T0 (Bare soil)	1.00000	.81650	0.769
	T0 (Bare soil)	T1 (Rice Straw)	-1.33333	.81650	0.527
		T2 (Beans straw)	-1.00000	.81650	0.769
		T3 (Cut grass)	-1.00000	.81650	0.769

*. The mean difference is significant at the 0.05 level.

Stem diameter

The findings have shown that mulching has not significantly affected the steam diameter among mulched treatments; the difference in data has shown the difference between mulched and bare soils. The same results have confirmed by(Kwambe et al., 2015)

Table5: One way ANOVA for the significance of steam diameter by treatments

Studied Parameters	Treatments (I)	Multiple Comparisons (J)	Mean Comparison (I-J)	Std Error	Sig.
Stem Diameter	T1 (Rice Straw)	T2 (Beans straw)	0.02667	0.04062	0.980
		T3 (Cut grass)	-0.01000	0.04062	1.000
		T0 (Bare soil)	0.02333	0.04062	0.990
	T2 (Beans straw)	T1 (Rice Straw)	-0.02667	0.04062	0.980
		T3 (Cut grass)	-0.03667	0.04062	0.921
		T0 (Bare soil)	-0.00333	0.04062	1.000
	T3 (Cut grass)	T1 (Rice Straw)	0.01000	0.04062	1.000
		T2 (Beans straw)	0.03667	0.04062	0.921
		T0 (Bare soil)	0.03333	0.04062	0.946
	T0 (Bare soil)	T1 (Rice Straw)	-0.02333	0.04062	0.990
		T2 (Beans straw)	0.00333	0.04062	1.000
		T3 (Cut grass)	-0.03333	0.04062	0.946

*. The mean difference is significant at the 0.05 level.

Plant heights

There were significant (P<0.05) in plant heights between 3 mulched plants and un-mulched plants after harvesting, the highest plant height of 1.52 m was obtained from planted mulched with rice straw, the lowest height was obtained from control plants. The findings have shown that Mulching has significant influence on plant heights in mulched plants, also reported by (Kwambe et al., 2015).

Table6: One way ANOVA for the significance of plant height by treatments

Studied Parameters	Treatments (I)	Multiple Comparisons (J)	Mean Comparison (I-J)	Std Error	Sig.
Plant Height	T1 (Rice Straw)	T2 (Beans straw)	0.02667	0.08660	1.000
		T3 (Cut grass)	-0.00667	0.08660	1.000
		T0 (Bare soil)	0.33333*	0.08660	0.025
	T2 (Beans straw)	T1 (Rice Straw)	-0.02667	0.08660	1.000
		T3 (Cut grass)	-0.03333	0.08660	0.999
		T0 (Bare soil)	0.30667*	0.08660	**0.039**
	T3 (Cut grass)	T1 (Rice Straw)	0.00667	0.08660	1.000
		T2 (Beans straw)	0.03333	0.08660	0.999
		T0 (Bare soil)	0.34000*	0.08660	**0.023**
	T0 (Bare soil)	T1 (Rice Straw)	0-.33333*	0.08660	**0.025**

		T2 (Beans straw)	-0.30667*	0.08660	**0.039**
		T3 (Cut grass)	-0.34000*	0.08660	**0.023**

*. The mean difference is significant at the 0.05 level.

Leaves diameter

Several studies reported that mulching affect the plant growth especially leaves diameter(Id et al., 2019).However, the present studies that mulching can increase the growth of red beans including a change in leaves diameter. There is no significance difference among the treatments treated with different mulches but a slight difference in diameter compared to control treatments. The highest value of 8.2 cm was found in plots treated with cut grass while the lowest 6.8 cm was found in control. The same report that mulching improves steam diameter has made by(Bhardwaj, 2013)

Table7: One way ANOVA for the significance of leaves diameter by treatments

Studied Parameters	Treatments (I)	Multiple Comparisons (J)	Mean Comparison (I-J)	Std Error	Sig.
Leaves diameter	T1 (Rice Straw)	T2 (Beans straw)	-0.08667	0.29819	1.000
		T3 (Cut grass)	0.13667	0.29819	0.997
		T0 (Bare soil)	0.81333	0.29819	0.125
	T2 (Beans straw)	T1 (Rice Straw)	0.08667	0.29819	1.000
		T3 (Cut grass)	0.22333	0.29819	0.964
		T0 (Bare soil)	0.90000	0.29819	0.082
	T3 (Cut grass)	T1 (Rice Straw)	-0.13667	0.29819	0.997
		T2 (Beans straw)	-0.22333	0.29819	0.964
		T0 (Bare soil)	0.67667	0.29819	0.237
	T0 (Bare soil)	T1 (Rice Straw)	-0.81333	0.29819	0.125
		T2 (Beans straw)	-0.90000	0.29819	0.082
		T3 (Cut grass)	-0.67667	0.29819	0.237

*. The mean difference is significant at the 0.05 level.

Total plant weight

The total plant weight of red beans was influenced significantly due to different mulching treatment. The highest plant weight (110.5 g) was produced by cut grass mulch treatments and the lowest (68.9 g) was found from control treatments where no mulch material applied. The same results that mulching affect positively the total plant weight were reported by(*127-132.pdf*, n.d.)

Table8: One way ANOVA for the significance of total plant weight by treatments

Studied Parameters	Treatments (I)	Multiple Comparisons (J)	Mean Comparison (I-J)	Std Error	Sig.
The total plant weight	T1 (Rice Straw)	T2 (Beans straw)	0.50000	6.86711	1.000
		T3 (Cut grass)	-1.00000	6.86711	1.000
		T0 (Bare soil)	20.93333	6.86711	0.079

	T2 (Beans straw)	T1 (Rice Straw)	-0.50000	6.86711	1.000
		T3 (Cut grass)	-1.50000	6.86711	1.000
		T0 (Bare soil)	20.43333	6.86711	0.087
	T3 (Cut grass)	T1 (Rice Straw)	1.00000	6.86711	1.000
		T2 (Beans straw)	1.50000	6.86711	1.000
		T0 (Bare soil)	21.93333	6.86711	0.064
	T0 (Bare soil)	T1 (Rice Straw)	-20.93333	6.86711	0.079
		T2 (Beans straw)	-20.43333	6.86711	0.087
		T3 (Cut grass)	-21.93333	6.86711	0.064

*. The mean difference is significant at the 0.05 level.

Total grain weight

The total grain weight was affected by mulching positively the same as total plant weight. The highest total grain weight was recorded from treatments with mulching(Fetri, Ghobadi, Ghobadi, & Mohammadi, 2015).The current study has shown the increment in grain weight due to mulching than control, the same results were found by (Vashisht, 2016)

Table9: One way ANOVA for the significance of total grain weight by treatments

Studied Parameters	Treatments (I)	Multiple Comparisons (J)	Mean Comparison (I-J)	Std Error	Sig.
The total grain weight	T1 (Rice Straw)	T2 (Beans straw)	0.40000	2.46892	1.000
		T3 (Cut grass)	-0.10000	2.46892	1.000
		T0 (Bare soil)	16.36667*	2.46892	**0.001**
	T2 (Beans straw)	T1 (Rice Straw)	-0.40000	2.46892	1.000
		T3 (Cut grass)	-0.50000	2.46892	1.000
		T0 (Bare soil)	15.96667*	2.46892	**0.001**
	T3 (Cut grass)	T1 (Rice Straw)	0.10000	2.46892	1.000
		T2 (Beans straw)	0.50000	2.46892	1.000
		T0 (Bare soil)	16.46667*	2.46892	**0.001**
	T0 (Bare soil)	T1 (Rice Straw)	-16.36667*	2.46892	**0.001**
		T2 (Beans straw)	-15.96667*	2.46892	**0.001**
		T3 (Cut grass)	-16.46667*	2.46892	**0.001**

*. The mean difference is significant at the 0.05 level.

IV. Conclusion And Recommendation

In the present study, the soil moisture content has improved varying with weeks after sowing. Different mulches rice straw, beans straw; cut grass improved the soil moisture retention capacity. Excessive competition has not only compelled us to produce more but also to produce quality fruits for sustaining in the international market. Apart from improving the moisture, mulching

increased the production of red beans. In these days farmers are recommended to make use of this innovative technique that helps them conserve moisture while producing more. This will also go a long way in the world achieving food security sustainably.

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CONFLICT OF INTEREST

The author of this article declares that there is no conflict of interest related to this publication manuscript.

REFERENCE

[1] *127-132.pdf*. (n.d.).

[2] Bhardwaj, R. L. (2013). EFFECT OF MULCHING ON CROP PRODUCTION UNDER RAINFED CONDITION - A REVIEW Organic mulches : Organic mulches are derived. *Agri. Reviews*, *34*(3), 188–197. https://doi.org/10.5958/j.0976-0741.34.3.003

[3] Fetri, M., Ghobadi, M., Ghobadi, M., & Mohammadi, G. (2015). *Effects of Mulch and Sowing Depth on Yield and Yield Components of Rain-Fed Chickpea (Cicer arietinum . L).* *11*(4), 1063–1072.

[4] Id, B. Q., Liu, Y., Sun, X., Li, S., Wang, X., Xiong, K., … Zhang, H. (2019). *Effect of various mulches on soil physico — Chemical properties and tree growth (Sophora japonica) in urban tree pits*. 1–12.

[5] *In the Graduate College*. (1987).

[6] Kwambe, X. M., Masarirambi, M. T., Wahome, P. K., & Oseni, T. O. (2015). *The effects of organic and inorganic mulches on growth and yield of green bean (Phaseolus vulgaris L .) in a semi-arid environment*. 81–89. https://doi.org/10.5251/abjna.2015.6.3.81.89

[7] Pinamonti, F. (2000). *Compost mulch effects on soil fertility , nutritional status and performance of grapevine*. 239–248.

[8] Rahma, A. E., Warrington, D. N., & Lei, T. (2019). International Soil and Water Conservation Research Ef fi ciency of wheat straw mulching in reducing soil and water losses from three typical soils of the Loess Plateau , China. *International Soil and Water Conservation Research*, *7*(4), 335–345. https://doi.org/10.1016/j.iswcr.2019.08.003

[9] Sadek, I. I., Youssef, M. A., Solieman, N. Y., Abdul, M., & Alyafei, M. (2019). *Response of Soil Properties , Growth , Yield and Fruit Quality of Cantaloupe Plants (Cucumis melo L .) to Organic Mulch*. *7*(9), 106–122.

[10] Sharma, R., & Bhardwaj, S. (2018). *Effect of mulching on soil and water conservation -A review Effect of mulching on soil and water conservation -A review*. (December 2017). https://doi.org/10.18805/ag.R-1732

[11] Vashisht, B. B. (2016). *Effect of mulches on maize crop yield , soil loss and water transmission properties under rainfed Shivaliks of Punjab Effect of mulches on maize crop yield , soil loss and water transmission properties under rainfed Shivaliks of Punjab*. (January 2009).