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Effect of Tillers Cutting Height on Quality Production of Palmarosa (Cympopogon Martinii)

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Abstract
A study was conducted to assess the role of tiller height on quality production of palma rosa grass varieties. A field experiment consisting of two varieties (Wg-tejisar-I and Wg-tejisar-II) and four levels of cutting height (20, 25, 30 and 35 cm) in RCBD with three replications. There was tow harvesting time with in three months interval all parameters were taken during the course of field experiments. The first cycle data was taken three months later after planting. Even if no significant difference the effects of planting 20 and 35 cm height tiller on the two palmarosa verities have better plant height, number of leaves, number of tillers. The maximum weight of fresh biomass was harvested by planting WG-Tejsar-II variety with 20 cm long tillers (8.89 t/ha) which have no biomass difference with planting WG-Tejsar-I 20 cm long tillers (8.60 t/ha). The highest oil content recorded at the plot which contain WG-Tejsar-I variety with planting 30 long tillers (1.90 %) and planting WG-Tejsar-II variety with 35 cm long tillers (1.29 %) ranked first and second respectively. The recorded oil yield of planting 20 cm long tillers on the WG-Tejsar-I (109.92 kg/ha) and 35 cm with WG-Tejsar-II (90.44 kg/ ha) verities have higher essential oil as compare to planting 25 and 30 cm long tillers respectively. Excluding plant height and survival count all parameters were affected by varying the height of tillers in the time of the two cycle and the value indicated that planting 30 or 35 long tillers for the two palmarosa variety shows a good result in the second cycle relative to the rest of configured height levels. In conclusion planting 20 and 35 cm long tiller had good effect in all physical and quality parameter in the first cycle. Due to small increment of the value of each parameter in the second cycle at 30 and 35 cm long tiller as compare to the first cycle, planting WG-Tejsar-I with 20 cm or WG-Tejsar-II with 35 cm tiller long contribute good palmarosa production.
Keywords: Cymbopogon martinii, tillers, variety, cutting height, biomass, oil content and essential oil, survival count
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Introduction

Background and Justification

Aromatic (Aroma Producing) plants are those plants which produce a certain type of aroma. Their aroma is due to the presence of some kind of essential oil with chemical constituents that contain at least one benzene ring in their chemical configuration. Among the aromatic grasses, the genus Cymbopogon consists of about 100 species, distributed mainly in the tropical region of Africa and South East India. It was an indigenous plant found in large tracts in open dry scrub forests of India. Palmarosa is one of the perennial aromatic plants grown for its herbal and essential oil yield. It belongs to family Poaceae. Palma rosa is a hardy plant and can grow in varying altitude right from sea level. However, it does not withstand stagnant water (Takankhar et al., 2017).

The annual production of palmarosa in India is estimated to be 70-80 tones which are mostly obtained from wild sources (i.e. forests). Successful cultivation of palmarosa can also be done on problematic soils such as saline and alkali soils, poor fertile soils, sloppy lands and soils with high proportions of gravels and coarse sand (Takankhar et al., 2017). Palmarosa is cultivated both as rain fed and irrigated crop in several tropical and subtropical parts of India. It requires exposed sunlight and does not perform well under shady situations. Palmarosa prefers a well-drained soil (Smitha et al., 2015).

The chemical nature of aromatic substances may be due to a variety of complex chemical compounds. These plants have made a good contribution to the development of ancient Indian material medics. In recent years, there has been a tremendous growth of interest in plant-based drugs, pharmaceuticals, perfumery products, cosmetics and aroma compounds used in food flavors and fragrances and natural colors in the world. Essential oil from flower petals of Palmarosa is used for gargles in throat infection, Besides, palmarosa is beneficial for cardiovascular system, circulation, digestion, infection, nervous system and rashes (Lawrence et al.,2012) kin care, and beauty treatments (Reinhard et al., 2004). Palmarosa possesses various pharmacological activities such as antibacterial, anti-fungal and anti-inflammatory properties (Karkala et al., 2013). Its essential oil also used in perfumery industries.

In agricultural crops grown under rainfed condition; a number of agronomic practices have been developed to improve the quality production of palmarosa. It can propagate by through both seeds and tillers in our country, Palmarosa grown and its herb have been used for various purposes. It is one of the priority aromatic plants in Ethiopia and two varieties have been released so far. There were many factors that influence the agronomic

characteristics, biomass and EO yield of aromatic plant (Al-Ramamneh, 2009 and Sumran et al., 2009). However, so many factors affect production of Palmarosa among which planting height of slips /tillers/ during planting play great role. Besides, conducive planting height of slips /tillers/ used for planting was not fully studied in the country.

Objective:

- To assess the role of effect of tillers cutting height on quality production of palmarosa grass varieties.

Materials and Methods

Site description

The experiment has been conducted during 2019 in the research field of Wondogenet agricultural research center. Wendo genet is located at 7º 192 N latitude and 38º 382 E longitude with altitude of 1780 m a.s.l. the site receives mean annual rainfall of 1128 mm with minimum and maximum temperature of 11.47 and 26.51 ºC, respectively. The soil textural area of the experimental area was sandy loam with the pH of 7.2 (Abayneh et al. 2006). The Wg-tejisar-1 and Wg-tejisar-1, varieties which were adaptable to the experimental area were used as planting material.

Treatments and Experimental Design

The experiment was laid out in randomized complete block design in a factorial arrangement with three replications. Treatments will consist of four cutting heights (20, 25 30& 35 cm) and two palmarosa grass varieties (WG tejisar-I & WG-tejisar-II). Thus, there was 4 x 2 (8) treatment combination. The plot size was 3x3 m with area of 9 m2 and spacing of 60 cm between both plants and rows was maintained during the experiment resulting five rows and five plants per plot. Respective spacing of 1.5 m and 1 m was maintained between any two replications and plots respectively. Healthy slips from well grown clumps of palmarosa grass maintained at wondo Genet Agricultural Research Center were used for planting in well prepared experimental field. No fertilizer and chemical pesticide applied during experiment. All required cultural practices done as required. All agronomic practices of the experimental field were carried out uniformly whenever required.

To determine the yield and agronomic characteristics of palmarosa under planting different cutting height of tillers and palmarosa variety, plant height, number of leaves, number of tillers, fresh biomass (t/ha), oil content (%), essential oil (kg/ha) and survival count/1 m^2 of palmarosa were collected. Throughout the experimental period, each parameter was collected two times within three months interval starting from planting.

Table 1 Treatment combinations of the two Palma Rosa (WG-Tejsar-I and WG-Tejsar-II) and tillers cutting height.

No	Factor A (palmarosa variety)	Factor B (tillers cutting height)	Combination	Treatment code
1	WG-Tejsar-I	20 cm	WG-Tejsar-I + 20 tall	T1
2	WG-Tejsar-I	25 cm	WG-Tejsar-I + 25 tall	T2
3	WG-Tejsar-I	30 cm	WG-Tejsar-I + 30 tall	T3
4	WG-Tejsar-I	35 cm	WG-Tejsar-I + 35 tall	T4
5	WG-Tejsar-II	20 cm	WG-Tejsar-II+ 20 tall	T5
6	WG-Tejsar-II	25 cm	WG-Tejsar-II+ 25 tall	T6
7	WG-Tejsar-II	30 cm	WG-Tejsar-II+ 30 tall	T7
8	WG-Tejsar-II	35 cm	WG-Tejsar-II+ 35 tall	T8

Statistical Data Analysis

The data recorded in this study will be subjected to statistical analysis. The analysis of variance will be carried out using SAS software. Significance differences between treatment means will be delineated by least significance difference (LSD) test at 5 % level of significance.

Result and Discussion:

Plant Height

The first cycle data was taken three months later after planting. The longest plant recorded at the plot which contain WG-Tejsar-II variety with planting 20 cm taller tiller above the ground and next to that planting WG-Tejsar-I variety with 25 cm taller tiller and this shows the longest height as compare to the other treatment which was similar result with soil Smitha et al., 2015. Even if no significant difference the effects of planting 25 and 20 cm taller tillers on the two palmarosa verities have better plant height as compare to planting 30 and 35 cm taller tillers. So, planting the two palmarosa verities with the hieght of 25 cm taller tillers is the most advantageous from the other choice of tiller height. Generally, the average plant height at WG-Tejsar-II variety showed that the longest plant height as compare to WG-Tejsar-I variety at all height of tillers.

The second cycle data was recorded six months after planting and the plant height was not affected by varying the height of tillers but the value indicated that planting 35 taller tillers for WG-Tejsar-II variety and planting 30 taller tillers for WG-Tejsar-I variety shows the longest relative to the rest of configured height levels. Here the plant height of WG-Tejsar-II at the two-cycle for each levels of tillers height were uniform as compare to the variety of WG-Tejsar-I. In general, this result indicated that the plant height of palmarosa could not be affected by the number of tillers.

Table 2: Main effect of tillers cutting height on plant height, number of leaves and number of tillers at the first cycle.

No	Treatments	Plant height	Number of leaves	Number of tillers
1	WG-Tejsar-II+ 20 cm	41.51a	162.94b	44.99a
2	WG-Tejsar-II+ 25 cm	40.18ab	91.60dc	27.24bc
3	WG-Tejsar-II+ 30 cm	37.81ab	104.75c	35.97ab
4	WG-Tejsar-II+ 35 cm	37.00b	228.98a	36.75ab
5	WG-Tejsar-I+ 20 cm	38.56ab	107.50c	33.41b
6	WG-Tejsar-I + 25 cm	40.35ab	68.96ed	20.30cd
7	WG-Tejsar-I + 30 cm	37.44ab	40.50e	12.75d
8	WG-Tejsar-I + 35 cm	36.11b	69.67ed	21.28cd
LSD		**4.24**	**34.53**	**10.72**
Sig		**NS**	**	**
CV		**6.27**	**18.03**	**21.04**

Table 3: Main effect of tillers cutting height on plant height, number of leaves and number of tillers at the second cycle.

No	Treatments	Plant height	Number of leaves	Number of tillers
1	WG-Tejsar-II+ 20 cm	33.40a	80.09b	36.63ab
2	WG-Tejsar-II+ 25 cm	32.64a	74.04bc	28.38bc
3	WG-Tejsar-II+ 30 cm	31.64a	82.50b	33.85ab
4	WG-Tejsar-II+ 35 cm	34.92a	133.92a	49.33a
5	WG-Tejsar-I+ 20 cm	32.80a	76.83bc	36.02ab
6	WG-Tejsar-I + 25 cm	28.96a	48.42c	18.11c
7	WG-Tejsar-I + 30 cm	35.75a	76.83bc	48.17a
8	WG-Tejsar-I + 35 cm	33.80a	77.00bc	29.73bc
LSD		**8.02**	**31.23**	**15.64**
Sig		**NS**	**	*
CV		**13.91**	**21.96**	**25.50**

Number of Leaves

The analysis of first cycle data showed that significantly highest number of leaves was recorded by planting WG-Tejsar-II palmarosa variety with 35 cm taller tillers while the lowest number of leaves was recorded by planting WG-Tejsar-I palmarosa variety with 30 cm taller tillers. The highest number of leaves was showed by planting the variety WG-Tejsar-II and WG-Tejsar-I with 35 cm and 20 cm tall tillers respectively. On the other hand, the variety of WG-Tejsar- II have uniform leaf number than the variety of WG-Tejsar-I due to this planting 35 cm taller tillers for the two palmarosa makes advantageous to get a greater number of leaves.

The number of leaf six months later show significant effect on the number of leaves and the recorded value indicated that the variety WG-Tejsar-II has greater capacity to regenerate and bearing more number of leaves than the variety WG-Tejsar-I. Similar to the first cycle, the second time data record shows planting 35 cm taller tillers had an advantage to get more number of leaves for the two variety of palmarosa which was not significantly different from planting WG-Tejsar-I with 20 cm height.

Number of tillers

At the first cycle of harvesting significantly highest number of tillers was recorded by planting 20 cm taller tillers with the varieties of WG-Tejsar-II whereas the lowest number of tillers recorded from the plot which contains the treatment of WG-Tejsar-I with 30 cm taller tillers. The palmarosa variety was responsive for the number of tillers and the average number of tillers was grater at the variety of WG-Tejsar-II than the variety of WG-Tejsar-I.

For the second time data collection after six months the number of tillers have significant difference in different treatments and planting WG-Tejsar-I with 30 cm taller tillers have the highest number of tillers next to planting WG-Tejsar-II with 35 cm taller tillers. According to the recorded data in two cycle the number of tillers

could be influence the emerging tillers at the older and early stage. Even if inconsistence result of number of tiller due to tiller height, planting 30 or 35 cm taller plant have an advantageous than the other choice of tiller number to grow a greater number of tillers.

Fresh biomass

The highest yield of fresh biomass was harvested by planting WG-Tejsar-II variety with 20 cm taller tillers (8.89 t/ha) and planting WG-Tejsar-I 35 cm taller tillers (8.60 t/ha) was first and second respectively. The variety WG-Tejsar-II have a greater average biomass production as compared to the variety of WG-Tejsar-I and number of tillers combination. Even if no significant difference according to the first harvesting data the variety of WG-Tejsar-I shows slightly influenced due to the height of tillers than the variety of WG-Tejsar- II.

At the second cycle of data recording time planting of 35 cm taller tillers for the WG-Tejsar-II (5.23 t/ha) and planting of 25 cm taller tillers (1.59 t/ha) for the WG-Tejsar-I varieties of palmarosa showed that significantly highest and the lowest biomass production respectively. This indicated that the fresh biomass production was higher by planting 20 and 35 cm height tillers at the first cycle but higher 35 or 30 cm height in the second cycle harvesting. Generally, because of higher fresh biomass production at the first cycle, planting WG-Tejsar-II and WG-Tejsar-I varieties with 20 cm and 35 cm taller tillers had an advantage for a respective palmarosa variety. According to the analyzed data the fresh biomass of palmarosa at the second cycle could not be affected by the height of tillers and some weight fluctuating at the variety of WG-Tejsar-I as compare to WG-Tejsar-II, here is somewhat uniform and higher fresh biomass weight was recorded.

Table 4: Main effect of tillers cutting height on fresh biomass, essential oil and survival count at the first cycle.

No	Treatments	Fresh biomass in t/ha	Essential oil content in %	Essential oil yield kg/ha	Survival count
1	WG-Tejsar-II+ 20 cm	8.89a	0.69c	59.26b	0.94c
2	WG-Tejsar-II+ 25 cm	5.01bc	1.17b	62.30b	2.08abc
3	WG-Tejsar-II+ 30 cm	7.57ab	1.16b	85.02ab	1.67abc
4	WG-Tejsar-II+ 35 cm	7.22abc	1.29b	90.44ab	1.25bc
5	WG-Tejsar-I+ 20 cm	8.60ab	1.25b	109.92a	1.98abc
6	WG-Tejsar-I + 25 cm	6.95abc	1.04bc	72.27ab	2.29a
7	WG-Tejsar-I + 30 cm	3.51c	1.90a	66.25b	1.67abc
8	WG-Tejsar-I + 35 cm	4.91bc	1.21b	61.24b	2.50a
LSD		**3.77**	**0.43**	**41.29**	**1.15**
Sig		**NS**	**	**NS**	**NS**
CV		**32.69**	**20.41**	**31.11**	**36.61**

Table 5: Main effect of tillers cutting height on fresh biomass, essential oil and survival count at the second cycle.

No	Treatments	Fresh biomass in t/ha	Essential oil content in %	Essential oil yield kg/ha	Survival count
1	WG-Tejsar-II+ 20 cm	3.37b	1.00b	40.62c	0.94c
2	WG-Tejsar-II+ 25 cm	2.82bc	1.74a	48.09bc	2.08abc
3	WG-Tejsar-II+ 30 cm	3.13bc	1.64a	49.45bc	1.67abc
4	WG-Tejsar-II+ 35 cm	5.23a	1.47ab	74.06a	1.25bc
5	WG-Tejsar-I+ 20 cm	2.79bc	1.63a	43.96c	1.98abc
6	WG-Tejsar-I + 25 cm	1.59c	1.40ab	21.61d	2.29ab
7	WG-Tejsar-I + 30 cm	4.31ab	1.35ab	57.88b	1.67abc
8	WG-Tejsar-I + 35 cm	3.25b	1.36ab	45.00bc	2.50a
LSD		**1.57**	**0.59**	**13.76**	**1.153**
Sig		**	**NS**	***	**NS**
CV		**27.06**	**23.45**	**16.51**	**36.61**

Essential Oil content (%)

According to the first cycle data the heights oil content recorded at the plot which contain WG-Tejsar-I variety with planting 30 taller tillers (1.90%) and next to that planting WG-Tejsar-II variety with 35 cm taller tillers (1.29 %) shows the heights oil content as compare to the other treatment. The effects of planting 30 cm tillers on the WG-Tejsar-II verities have significantly better essential oil content as compare to planting 20, 25 and 30 cm taller tillers. Generally, the average oil content of WG-Tejsar-I variety showed that the better oil content as compare to WG-Tejsar-II variety.

The second cycle data was recorded six months after planting and the oil content was affected by the combined effect of plmarosa variety and planting height of tillers. The value indicated that planting 25 cm taller

tillers for the WG-Tejsar-II (1.74 %) and 30 cm taller tillers for the WG-Tejsar-II (1.64 %) varieties ranked first and second in oil content relative to the rest of configured tiller height respectively. Here the oil content of WG-Tejsar- I recorded for each planting height of tillers were uniform as compare to the variety of WG-Tejsar-II. The analysis indicated that the planting tiller height were not affected the oil content of WG-Tejsar-II at the second cycle of data collection. In general, the result indicated that the oil content of palmarosa could be affected by the planting height of tillers within three months growing time but above three months the oil content decreases as compare to the first harvesting time.

Essential Oil Yield (kg/ha)

The first cycle data was taken three months later after planting. The heights yield of oil recorded at the plot which contain WG-Tejsar-I variety with planting 20 cm tall tillers (109.92 kg/ha) and next to that planting WG-Tejsar-II variety with 35 cm taller tillers (90.44 kg/ ha) shows the heights yield of oil as compare to the other treatment. The yield of planting 20 cm taller tillers with the WG-Tejsar-I and 35 cm at WG-Tejsar-II verities have significantly higher essential oil as compare to planting other tillers height respectively. In addition, Tejsar-I verities was somewhat influenced by planting tillers with different height than WG-Tejsar-II variety. Generally, the average oil production of WG-Tejsar-II variety showed that the better volume as compare to WG-Tejsar-I variety.

The second cycle data was recorded after six months, the oil production was significantly affected by varying the height of tillers and the value indicated that planting 35 cm taller tillers for the WG-Tejsar-II (74.06 kg/ha) and 30 cm taller tillers for the WG-Tejsar-I (57.88 kg/ha) varieties ranked first and second in oil volume relative to the rest of configured tiller height respectively. Here the oil volume of WG-Tejsar-II recorded for each levels of tillers were uniform as compare to the variety of WG-Tejsar-I. On the other hand, the highest and the lowest oil volume were recorded at the variety of WG-Tejsar-II and WG-Tejsar-I respectively. In general, the combined effect of oil volume of palmarosa could be affected by the tiller's height at the two cycles harvesting time in addition to that the second cycle oil volume decreases as compare to the first harvesting time.

Survival count

The highest number of survived tillers were counted by planting WG-Tejsar- I variety with 35 cm taller tillers which have no survival difference with all palmarosa variety and cutting height except planting WG-Tejsar-II 20 and 35 cm taller tillers. On the other hand, the variety WG-Tejsar-I have a greater capacity to survive even as compared to the variety of WG-Tejsar-II. Even if no significant difference according to the first harvesting data the variety of WG-Tejsar-II was more influenced by the cutting height of tillers than the variety of WG-Tejsar- I.

At the second cycle of data recording time planting of 35 cm taller tillers for the WG-Tejsar-I and planting of 20 cm taller tillers for the WG-Tejsar-II varieties of palmarosa showed that the highest and the lowest survival count respectively. Similarly, to the first cycle the survival count was higher by planting 35 cm height tillers in the second cycle harvesting. Generally, because of similar survival count at the two cycle, planting palmarosa varieties with 35 cm taller tillers was better. According to the analyzed data the survival count of palmarosa could not be affected by the height of tillers however some fluctuating at the variety of WG-Tejsar-II as compare to WG-Tejsar-I.

Summery and Conclusion

Even if no significant difference at the first cycle of harvesting the effects of planting 25 and 20 cm long tillers on the two palmarosa verities have better plant height as compare to planting 30 and 35 cm taller tillers. Significantly maximum number of leaves was recorded by planting WG-Tejsar-II variety with 35 cm long tillers while the lowest number of leaves was recorded by planting WG-Tejsar-I variety with 30 cm taller tillers. Significantly highest number of tillers was recorded by planting 20 cm taller tillers with the varieties of WG-Tejsar-II whereas the lowest number of tillers recorded from the plot which contains the treatment of WG-Tejsar-I with 30 cm taller tillers. The maximum yield of fresh biomass was harvested by planting WG-Tejsar-II variety with 20 cm taller tillers (8.89 t/ha) and planting WG-Tejsar-I 20 cm taller tillers (8.60 t/ha) was first and second respectively. The heights oil content recorded at the plot which contain WG-Tejsar-I variety with planting 30 taller tillers (1.90%) and next to that planting WG-Tejsar-II variety with 35 cm taller tillers (1.29 %) shows the heights oil content as compare to the other treatment. The heights yield of oil recorded at the plot which contain WG-Tejsar-I variety with planting 20 cm tall tillers (109.92 kg/ha) and next to that planting WG-Tejsar-II variety with 35 cm taller tillers (90.44 kg/ ha) shows the heights yield of oil as compare to the other treatment.

The second cycle data was recorded six months after planting and the plant height was not affected by varying the height of tillers but the value indicated that planting 35 long tillers for WG-Tejsar-II variety and planting 30 long tillers for WG-Tejsar-I variety shows the longest relative to the rest of configured height levels. Similar to the first cycle, planting 35 cm taller tillers had significant advantage to get a greater number of leaves

for the two variety of palma rosa. The number of tillers had significant difference by planting WG-Tejsar-I with 30 cm long tillers had the highest number of tillers next to planting WG-Tejsar-II with 35 cm taller tillers. The fresh biomass production was higher by planting 20 cm height tillers (8.89 t/ha) and (8.60 t/ha) with WG-Tejsar-II and WG-Tejsar-I variety respectively at the first cycle but significantly higher at 35 (5.23 t/ha) and 30 cm (4.31 t/ha) height at the variety of WG-Tejsar-II and WG-Tejsar-I in the second cycle harvesting respectively. Because of higher biomass at the time of first cycle planting 20 cm height tiller had an advantage. Planting 25 cm long tillers for the WG-Tejsar-II (1.74 %) and 30 cm long tillers for the WG-Tejsar-II (1.64 %) varieties ranked first and second in oil content relative to the rest of configured tiller height respectively. The oil production was affected by varying the level of tillers height and the value indicated that planting 35 cm long tillers for the WG-Tejsar-II (74.06 kg/ha) and 30 cm long tillers for the WG-Tejsar-I (57.88 kg/ha) varieties ranked first and second in oil yield relative to the rest of configured tiller height respectively. In conclusion planting 20 and 35 cm long tiller had good effect in all physical and quality parameter in the first cycle but the above listed parameter at 30 and 35 cm long tiller had small increment. So, planting the tillers with 20 and 35 cm tall for WG-Tejsar-I and WG-Tejsar-II respectively contribute for a good palmarosa production.

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