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Effect of clipping height on herb and oil content of Java citronella (*Cymbopogon winterianus*)

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ABSTRACT

An experiment was conducted during 1989–92 to determine the optimum clipping height of Java citronella (*Cymbopogon winterianus* Jowitt). Plants clipped at 30 cm-height showed significant increase in dry herbage and essential oil. However, further increase (40 cm) or decrease (5 cm) in the height reduced the yield of the 2 parameters. Leaf-area index was maximum at 30 cm clipping height, whereas oil content of herbage and dry weight and carbohydrate of roots were greater at higher heights used for clipping.

Harvest management of Java citronella (*Cymbopogon winterianus* Jowitt) is a destructive process, as it periodically removes some of the photosynthetic area of plants. The abrupt decrease in the photosynthetic activity generally reduces both top and root growth (Wagner, 1952). After cutting, a plant either utilizes its residual leaf area for photosynthesis or its carbohydrate reserve to support regrowth (Youngner, 1972). It is a perennial plant and its leaves are periodically removed for extraction of essential oil. As no definite information is available on the clipping height, an experiment was conducted to determine the optimum clipping height of this crop for increased production of herbage and oil.

MATERIALS AND METHODS

The field experiment was conducted during 1989–92 on the experimental farm of Regional Research Laboratory, Jorhat (26.44°N, 94.1°E and 96.5 m above the mean sea-level). It has a warm humid climate and the mean rainfall during the experimental period was 2,010 mm with major rainfall (87.6%) during April–September. The average minimum and maximum temperatures were 9.0°C and 33.3°C respectively. Experimental site was loamy sand. The soil had organic carbon 0.66%, and available N, P, K were 114.3, 39.3 and 131.7 kg/ha respectively. Average soil pH (up to 30 cm depth) was 4.1 (1 : 2 soil : water ratio, volume basis).

The treatments consisted of 8 clipping heights (5, 10, 15, 20, 25, 30, 35 and 40 cm) and were replicated 4 times in randomized block design. Each plot was of 27.0 m^2 and was raised 10 cm for easy drainage. One-third nitrogen (urea) of 60 kg/ha (Yadav *et al.*, 1984) and the entire quantity of P_2O_5 (80 kg/ha) and K_2O (30 kg/ha) were applied basal and the remaining N (120 kg/ha) was applied in 2 equal splits, 1 day after each

clipping. Same quantities of N, P and K were used in the second and third years. Planting was done in the first part of April with 30-cm-long rooted slips, 1 in each hill at a spacing of 75 cm x 75 cm. The herbage was clipped at intervals of 4 months each (total 9 clips in 3 years) and fresh weight of grass was recorded from net plot excluding the border rows. Essential oil content from fresh plant sample was determined in Clevenger's apparatus (Langenau, 1948). The oil density was determined to convert the volume yields into the respective weights. Herbage and oil yields were the total of all clipped biomass of each year, whereas oil content per clipping was the mean of 3 cuts. Two plant stumps from each treatment were cut randomly at ground-level for determining the essential oil content and different plant stumps were collected after each clipping.

Leaf area was estimated by an electronic portable area meter (LI-COR Model LI-3000, USA). Leaf-area index (LAI) was computed as a ratio of the leaf area divided by the plot area at the time of each clipping. The mean values of the 3 annual clips was considered as the LAI for each year. At the end of 3 years, the entire under-ground biomass of the randomly selected plants from each treatment was dug out by root-box method (Dabadghao *et al.*, 1973). After recording the root weight, these samples were analysed for total carbohydrates (Smith *et al.*, 1964).

RESULTS AND DISCUSSION

Dry herbage was highest in the second year in all the treatments. Plants clipped at 30 cm height produced maximum dry herbage, whereas at further higher (40 cm) or lower (5 cm) cuts it was significantly ($P = 0.05$) lesser in all the years (Table 1). A significant ($P = 0.05$) rise in LAI (5.8) was observed in a cut at 30 cm, but it was reduced to 0.8–1.02 at 5 cm clipping heights. The leaf-area index was also found less in clipping heights above 30 cm (Fig. 1).

Oil content in the aerial parts increased with an increase of clipping height

Table 1. Dry herbage, oil content and oil yield of *C. winterianus* as affected by of clipping height

Clipping height (cm)	Dry herbage (tonnes/ha)			Oil content (%)*			Oil yield (kg/ha)		
	I year	IIyear	III year	I year	II year	III year	I year	II year	III year
5	0.92	0.80	0.70	2.44	2.40	2.40	22.4	19.2	16.7
10	1.81	1.95	1.92	2.87	2.92	2.90	51.9	56.9	55.6
15	2.36	2.70	2.80	3.24	3.28	3.30	76.5	82.0	92.4
20	3.35	3.55	4.17	3.99	4.12	4.02	133.6	148.7	167.6
25	5.41	6.27	6.55	4.08	4.20	4.17	221.0	263.3	273.3
30	6.45	6.92	7.20	4.40	4.60	4.42	283.8	318.4	318.2
35	3.76	4.31	4.65	5.12	5.16	5.12	192.7	222.5	238.0
40	2.15	2.95	3.30	6.00	6.08	6.02	129.3	179.7	198.6
LSD (P = 0.05)	0.100	0.34	0.26	0.14	0.17	0.17	4.8	15.7	12.0

*Dry-weight basis

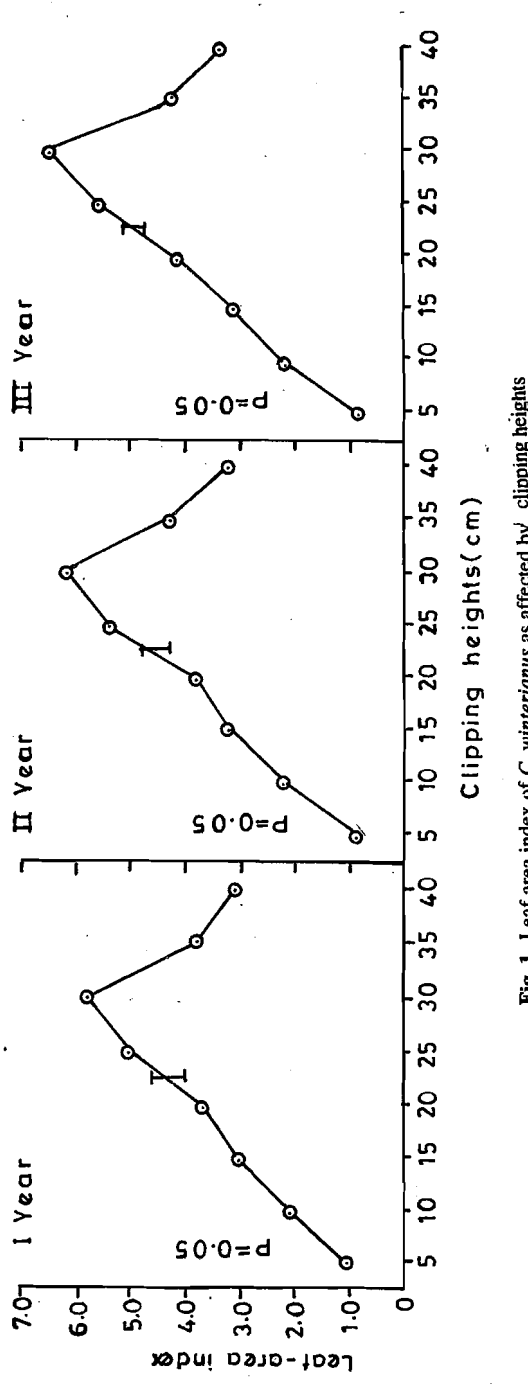

Fig. 1. Leaf area index of *C. winterianus* as affected by clipping heights

Table 2. Average annual oil contont of different stump heights (mean of three 4-monthly annual clippings) of *C. winterianus*

Stump height (cm)	Oil content*		
	I year	II year	III year
5	0.73	0.69	0.61
10	0.85	0.82	0.80
15	0.98	0.97	0.99
20	1.04	1.06	1.08
25	1.19	1.24	1.25
30	1.42	1.43	1.45
35	1.50	1.51	1.53
40	1.60	1.62	1.72
LSD (P = 0.05)	0.21	0.09	0.14

*Dry-weight basis

(Table 1). Likewise, oil content in the left-over stumps also increased (P = 0.05) with the increased stump height (Table 2). Oil yield increased significantly up to 30 cm clipping height and then declined sharply with further rise in cutting height (Table 1).

Dry-matter weight and carbohydrate content of the roots increased linearly with the rise in clipping height over the whole range of heights investigated (Fig. 2 a, b).

Java citronella has initial leg phase which perhaps is responsible for the low yield of herbage in the first clipping and ultimately gave poor yield in the first year (Prakash Rao and Rao, 1986).The drastic reduction in yield at lower clipping height (5–20 cm) may be attributed to the absence of foliage for photosynthetic activity. Under this condition, plants have utilized stored carbohydrate from the roots (Youngner, 1972). This has resulted in low dry-matter weight and carbohydrate content of the roots (Fig. 2). This is a normal phenomenon in plants which initiate new leaves for further

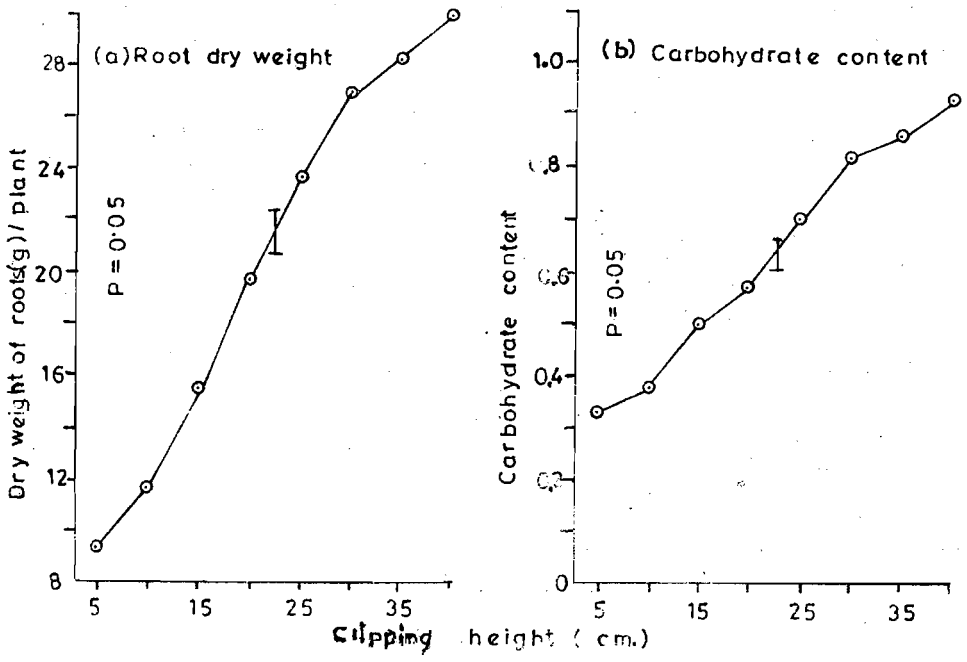

Fig. 2. Effect of clipping height on dry weight of roots (a) and carbohydrate content of roots (b) of *C. winterianus*

photosynthetic activity (May, 1960; Youngner, 1972). It is seen that clipping at 30 cm height removes large quantity of green biomass, keeping the stumps in the field with optimum green leaves just above the legule to help in regeneration. At this level of cut, the carbohydrate content and dry weight of roots were not appreciably affected unlike the low level cuts (Fig.2). Further, higher values (Fig.1) of leaf-area index indicated fast regeneration rate at 30 cm clipping (Osman and Abu Diek, 1982). The poor herbage yield in higher clipping heights was caused by low recovery of foliage in each clipping. The left-over stumps in higher cuts retained considerable amount of green material (7.2–10 cm above the legule) for photosynthetic activity. Hence there was no need for translocation of stored products of root after each clipping. Significant increase in dry matter and of root carbohydrate content at higher clippings confirms this view.

Plants clipped at 5–25 cm height include stumps in every harvest. This portion of the plant contains only 0.61–1.25% oil (Table 2). The less amount of oil in stumps may be due to the low photosynthetic activity in the lower portion of the plant. Guenther (1961) stated that lower cut in *C. winterianus* contains oil-free parts of the leaf blades, which when distilled diminish the yield of oil. On the other hand, plants clipped at higher levels contain mostly leaf blades which are rich in oil glands and are well-exposed to sunlight. These factors might have contributed in increasing the oil content in upper leaves. But the poor production of herbage in the higher clippings (35–40 cm) was not compensated by the higher recovery of oil. How-

ever, the combined effect of high herbage yield and good oil content at 30 cm clipping has boosted up the oil yield in this treatment.

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