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Variation in oil and its major constituents due to season and stage of the crop in Java citronella (*Cymbopogon winterianus* Jowitt.)

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Abstract

Variations in citronella oil and its major constituents due to seasonal changes and stage of the crop were studied for three years under the climatic conditions of Jorhat, Assam. Rainfall, temperature, sunshine and relative humidity have cumulative effect on the oil yield and its major constituents namely, citronellal, citronellol and geraniol. Post monsoon months were seemed to be favourable, contributing higher oil yield. Citronellal content was higher during September (44.3%) and October (45.7%). It was observed that light rainfall (100 to 200 mm), moderate temperature (20-30^{0}C), sunshine hours of 5 to 6 hours and high humidity (90-95%) were the favourable meteorological parameters for higher oil yield and citronellal content in citronella oil. Growing period or stage of crop growth also had profound effect on the oil yield and citronellal content. Older crop with highly matured leaves found to yield higher oil and less citronellal. Alcohol content in citronella oil was not affected by seasonal variation. However, total alcohol percentage was found to reduce, while aldehyde percentage increased.

Key words: citronellal, citronellol, crop growth stage, *Cymbopogon winterianus*, geraniol, seasonal variation.

Introduction

The highly valuable oil of Java citronella (*Cymbopogon winterianus* Jowitt.) is aromatic in nature and has wider application in perfumery industry (Malwatkar *et al.* 1984). Though the crop is very hardy, its ecological demand has to be studied for obtaining better yield and quality of oil (Sarma 1997). Influence of seasonal variations in essential oils and their components of *Siparuna quianensis* was reported by Machado *et al.* (2001). Volatile leaf oils and various components of lemon changed significantly during ripening as well as due to seasonal changes (Ahmed *et al.* 2001). Milos *et al.* (2002) studied the seasonal variations in essential oil composition of *Cupressus sempervirens* and found that there were notable differences in the amounts of several compounds during different months of the year. It is important to know the requisite parameters leading to higher yield of oil and its major component – citronellal. Therefore, the present study was made to observe the effect of different seasons and growth stages of the citronella on the variation of oil and its major components in citronella oil.

Materials and methods

The experiments were carried out at Regional Research Laboratory, Jorhat (Assam) during 1998 to 2000. Citronella plantation was maintained in a plot of 2 ha for the purpose of harvesting leaves to distill oil. Crop was maintained as rainfed and distillation of oil was done at monthly intervals from January to December for 3 years to observe monthly variation in the recovery of oil and its major components. Meteorological data like rainfall, temperature, sunshine hours and relative humidity for the cropping period were obtained from Tea Research Association, Tocklai, Jorhat (Table 1). Distillation of oil was done with the help of Cleavenger's apparatus using freshly harvested leaves of citronella. Oil samples were analysed by Gas Liquid Chromatographic method for citronellal, citronellol and geraniol contents. Apart from monthly observations, variation of oil and its major components were also recorded during four different seasons namely, spring, summer, autumn and winter. Distillation of oil was done in the month of March, June, September and December for respective seasons. In another experiment, to study effect of growth stages of the crop on such variations, the data were recorded at the age of 30, 45, 60, 75, 90, 105 and 120 days after planting. In all cases recovery of oil and its major components, samples were replicated 4 times.

Results and discussion

Variations in oil yield and its major components like citronellal, citronellol and geraniol were compared against monthly meteorological parameters (four seasons and seven growing stages).

Monthly variation

Java citronella shows good deal of variations in oil content and its major components like citronellal, citronellol and geraniol in different months (Table 2). Comparing the data of oil recovery and its major components with the monthly meteorological parameters, it might be summarised that moderate rainfall, temperature and high humidity along with maximum sunshine hours have cumulative effect on oil content. Light rainfall (100 to 200 mm), moderate temperature (20–30°C), sunshine hours (5 to 6 hours) and high humidity (90–95%) were favourable conditions for synthesis of citronellal (aldehyde) in citronella. However, cool and humid weather with maximum sunshine hours favoured the production of citronellol and geraniol (alcohols) in the oil.

Light, temperature, nutrients, water etc. have effect on the physiology, growth and development of plant species and their production. Malwatkar *et al.* (1984) and Sarma (1997) observed seasonal variations in oil and its

Table 1. Metereological data during the cropping period (average of 3 years)

Month	Rainfall (mm)	Temperature (°C)		Sunshine hours	Relative humidity (%)	
		Maximum	Minimum		Morning	Evening
January	20.85	22.34	9.38	6.15	96	57
February	32.40	23.96	11.90	6.24	94	54
March	78.15	27.50	15.45	6.75	91	53
April	190.60	28.65	19.15	9.90	92	62
May	275.68	29.94	21.85	5.12	92	69
June	331.50	31.54	24.21	4.54	93	74
July	384.01	32.19	24.65	4.78	93	73
August	340.70	32.98	24.74	5.14	95	74
September	253.84	31.20	24.10	9.01	95	73
October	117.50	29.35	21.04	5.75	96	71
November	28.43	26.33	15.32	6.17	96	64
December	12.36	23.34	10.70	6.10	96	60

Table 2. Citronella oil and its major constituents during different months

Month	Oil (v/w %)				Citronellal (%)				Citronellol (%)				Geraniol (%)			
	1998	1999	2000	Avg.	1998	1999	2000	Avg.	1998	1999	2000	Avg.	1998	1999	2000	Avg.
Jan	1.02	1.05	1.07	1.04	39.5	40.0	40.1	39.8	18.6	18.5	18.7	18.6	23.5	23.4	23.5	23.4
Feb	1.03	1.05	1.05	1.04	39.6	39.8	40.0	39.8	18.5	18.4	18.6	18.5	23.6	23.5	23.7	23.6
Mar	1.03	1.10	1.15	1.09	40.1	40.5	40.3	40.3	18.4	18.4	18.5	18.4	23.4	23.5	23.6	23.5
Apr	1.01	1.15	1.17	1.11	40.2	40.3	40.1	40.2	17.9	18.0	18.2	18.0	23.4	23.4	23.5	23.4
May	1.00	1.10	1.15	1.08	40.0	40.1	40.0	40.0	18.2	18.1	18.1	18.1	23.1	23.2	23.1	23.1
Jun	1.00	1.12	1.17	1.09	40.0	40.0	40.1	40.0	18.4	18.3	18.3	18.3	23.6	23.5	23.5	23.5
Jul	1.01	1.13	1.19	1.11	40.2	40.3	40.4	40.3	18.5	18.5	18.4	18.4	23.8	23.7	23.6	23.7
Aug	1.17	1.21	1.30	1.22	41.5	40.8	41.5	41.2	17.8	17.8	17.9	17.8	22.9	23.0	23.4	23.1
Sep	1.24	1.40	1.40	1.34	44.7	43.6	44.6	44.3	17.7	17.9	17.8	17.8	22.8	22.8	23.0	22.8
Oct	1.28	1.45	1.45	1.39	45.8	45.7	46.0	45.8	17.6	17.9	17.7	17.7	22.4	22.6	22.7	22.5
Nov	1.30	1.43	1.46	1.39	42.0	44.5	45.1	43.8	17.2	18.0	18.2	17.8	23.1	23.4	23.1	23.2
Dec	1.20	1.25	1.28	1.24	40.3	41.2	42.0	41.1	18.4	18.5	18.5	18.4	23.4	23.3	23.4	23.3
CD 0.05	0.03	0.04	0.04	-	0.1	0.2	0.2	-	0.5	0.6	0.5	-	0.7	0.7	0.6	-

Table 3. Citronella oil and its major constituents during four seasons

Season	Oil (v/w %)				Citronellal (%)				Citronellol (%)				Geraniol (%)			
	1998	1999	2000	Avg.	1998	1999	2000	Avg.	1998	1999	2000	Avg.	1998	1999	2000	Avg.
Spring (March)*	1.12	1.14	1.18	1.14	40.8	40.6	40.9	40.7	18.4	18.5	18.6	8.5	23.5	23.6	23.4	23.5
Summer (June)	1.04	1.08	1.09	1.07	41.6	41.7	41.5	41.6	18.3	18.4	18.5	18.4	18.5	23.4	23.3	23.3
Autumn (September)	1.35	1.40	1.48	1.41	45.7	45.6	45.4	45.5	17.6	17.7	17.7	17.6	22.7	22.8	22.8	22.7
Winter (December)	1.25	1.35	1.40	1.33	42.1	42.0	41.8	41.9	18.4	18.5	18.5	18.4	23.3	23.4	23.3	23.3
CD 0.05	0.03	0.04	0.04	-	0.5	0.5	0.6	-	0.6	0.7	0.7	-	0.4	0.5	0.5	-

* Month in which oil was analyzed

Table 4. Citronella oil and its major constituents at different stages of crop growth (average of 3 years)

Stage of the crop (days after planting)	Oil (%)	Citronellal (%)	Citronellol (%)	Geraniol (%)	Total aldehyde and alcohol (%)
30	0.95	47.1	16.7	22.6	86.4
45	0.98	47.0	16.8	22.7	86.5
60	1.08	46.5	17.3	22.7	86.5
75	1.25	45.8	17.5	23.4	86.7
90	1.40	45.0	18.3	23.6	86.9
105	1.42	43.1	19.5	23.8	86.4
120	1.45	42.8	20.0	23.8	86.6
CD(P=0.05)	0.23	0.5	0.7	0.7	-

aldehyde contents of citronella and recorded that aldehyde content was higher during post monsoon period. The quality of citronella oil is dependent on its citronellal content. Higher the aldehyde, better is the quality. Guenther (1948) reported that moderate rainfall was beneficial for good quality oil. In North East India, September and October months are having similar weather and produced desired quality oil. Months with very dry spells or with high rainfall and with only few days of sunshine produced oil with lower aldehyde content even under irrigated conditions (Guenther 1961).

Seasonal variation

Seasonal variations in oil and its aldehyde content were significant (Table 3). Maximum recovery of oil (1.41%) was recorded during autumn season (September-November) and minimum (1.07%) during summer season (June-August). Aldehyde (citronellal) content was also maximum (45.5%) during September. Alcohol content increased during the dry season (citronellol – 18.4% and geraniol – 23.5%). Similar observations were also recorded by Ganguly (1978) and reported increase in oil and citronellol content during dry season, while citronellal and geraniol remained unaffected by the season.

Variation due to stage of crop growth

Oil of citronella was extracted during a growing period of 4 months at an interval of 15 days where first sample was taken after 30 days after planting (Table 4). A very contrasting result was observed. With the increase in the age of the crop, oil recovery was increased while citronellal content decreased. On the other hand, alcohol content increased with the decrease of aldehyde. It may be concluded that tender leaves contain higher aldehyde as compared to old leaves. One month old crop with tender leaves showed synthesis of more aldehyde as compared to other leaves. As the interval of harvest was increased, aldehyde content decreased in citronella oil. However, usually citronella is harvested at an interval of two months or so and in such cases, aldehyde content in oil may not be disturbed due to age factor. Similar results were observed by Gupta (1973) and Sarma (1997).

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