Grass and Oil Yields from Lemon-grass and the Quality of Oil

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Introduction

Lemon-grass has been known for ages as one of the well known aromatic plants. And because of recent success in synthesizing vitamin A from β-ionone produced from the citral which is the main ingredient of lemon-grass oil the demand for lemon-grass oil has been increasing. The Izu Medicinal Plants Experiment Station is engaged in the research of tropical medicinal plants and since 1952 the study has been directed to various factors which control the yields in grass and oil and oil quality (mainly controlled by the citral content) of lemon-grass as basic research on the production of lemon-grass oil.

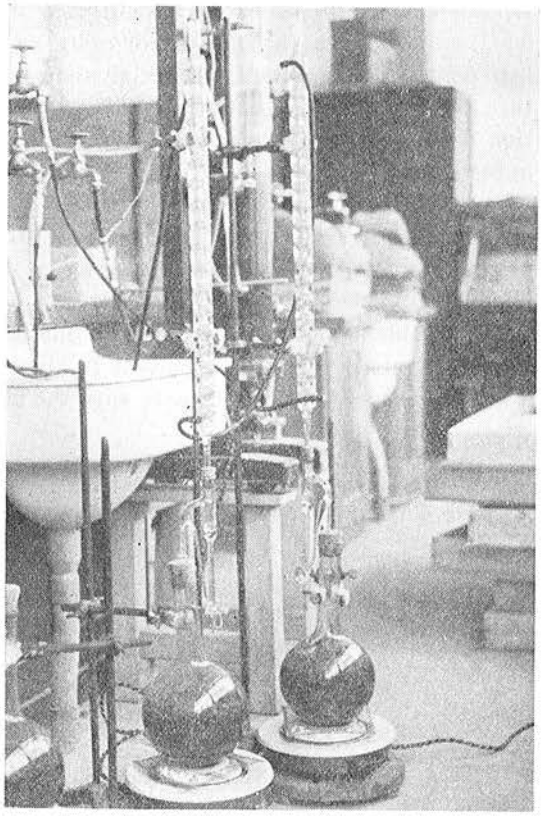

Fig. 1. Distillation of lemon-grass.

This paper intends to introduce the research findings obtained heretofore in outline. All the distillations in those researches were carried out in laboratory as shown in Fig. 1 by using oil determining apparatus made of glass and the citral content of oil was determined by hydoxylamine method.

Intrinsic factor of plant

1) Strain[1] The comparisons of 16 strains collected in Japan with respect to grass yield, oil yield and citral content revealed that the characteristics greatly differ by strains. And those 16 strains can be classified for the time being into 4 major strain groups by the said characteristics. Table 1 indicates grass yield, oil yield and citral content by the groups and the characteristics of each group can be outlined as follows.

Group 1 is the strain assumed as belonging to East Indian lemongrass (Cymbopogon flexuosus Stapf). It is comparatively low in grass yield but very high in oil content as well as in citral content of oil. Moreover, the weight of leaf blade is larger than that of leaf sheath in this strain and the strain greatly differs from other strains in that there is a small dif-

ference in both the oil content and citral content between leaf blade and leaf sheath.

Ohter 3 groups belong to West Indian lemongrass (C. citratus Stapf)

Group 2 is rather dwarf and although its grass yield is the lowest but the oil content of leaf is generally high, particularly the oil content in leaf blade is the highest among all groups. The citral content of oil is rather low in general. The number of strains belonging to this group is 5.

Group 3 is comparatively high in grass yield but is distinctly distinguishable from other groups in that the oil content of leaf is the lowest. Citral content of the leaf is comparatively high. 4 strains belong to this group.

Group 4 is the group belonging neither to the above 3 groups, and the grass yield is generally large as well as comparatively high in citral content . And from those points this group can not always be distinguished from the Group 3 but differs from other groups in oil content of leaf, and oil content of whole leaf is in the middle of Group 2 and Group 3. There are 6 strains belonging to this Group.

2) Portion of leaf[1] By dividing a leaf into the portions of blade and sheath and the study of relation between oil content and citral content of both portions reveals that the relations differ by strains as shown in Table 1. In Group 1 the difference is very small in both the oil content and citral content between the blade and sheath but it has been clarified that in other strains belonging to West Indian lemon-grass, although there are some differences, oil content in blade is always higher than that of sheath and contrariwise the citral content is always lower in blade than that of sheath.

3) Leaf age[2-4] The study on the relation between leaf age and oil content and citral content under the open field cultivation and hot house cultivation by using one strain belonging to Group 2 reveals that those relations considerably differ by temperature variations and by the portion of leaf. In the first place, under high temperature oil content is higher in young leaf and declines along with the advance in leaf age with respect to leaf blade. On the contrary, in leaf sheath oil content is lower in young leaf and higher in old leaf. On the other hand, oil content in both the blade and sheath declines when the temperature falls and in both cases the phenomenon is salient in young leaf. Accordingly, in open field cultivation a phenomenon is observed that along with the decline in temperature from the fall season, oil content of newly sprouting young leaf is lower than that of considerably aged leaf which has sprouted under high temperature period of summer and that a definite relation between leaf age and oil content becomes unrecognizable.

As for the relation between leaf age and citral content of oil, the seasonal variation practically has no influence and also no influence is witnessed in partial difference between the blade and sheath, and the trend has been recognized that citral content is always low in young leaf and it increases with the ad-

Table 1. Comparison of grass yield, oil content and citral content per hill of 2-years old lemongrass under open field cultivation among different strain groups. 1965.

Line groups No.	Grass yield			Oil content (on fresh leaf weight)			Citral content of oil		
	Total leaf (g)	Blade (g)	Sheath (g)	Total leaf (%)	Blade (%)	Sheath (%)	Total leaf (%)	Blade (%)	Sheath (%)
1	3.683	1.941	1.796	0.53	0.52	0.53	80.6	81.6	79.4
2	1.346～2.342	562～965	775～1.361	0.45～0.51	0.66～0.73	0.29～0.36	75.6～76.4	74.8～76.4	76.5～77.5
3	6.688～8.456	2.784～3.475	3.854～4.909	0.14～0.16	0.20～0.23	0.10～0.11	77.9～78.2	75.9～76.3	80.7～81.2
4	5.738～9.592	2.214～3.914	3.274～5.836	0.17～0.31	0.29～0.39	0.08～0.26	76.8～80.9	76.0～78.6	79.0～83.1

Fig. 2. Field cultivation of lemon-grass.

vance in age. However, it has been found that the difference in citral content by leaf age under high temperature is comparatively small.

Cultural conditions

1) Temperature[2-4] The impact of temperature has been observed from the seasonal variation in plant growth, oil content and citral content in open field cultivation or from the comparison of oil content and citral content between open field cultivation and hot house cultivation. And from the findings it is safe to assume that the plant growth is vigorous under high temperature in open field cultivation and not only the grass yield is high but both the oil content and citral content of oil are high. On the other hnad, the fall in temperature invites the lowering in plant growth, oil content and citral content; and under hot house cultivation oil content and citral content are generally higher; and from those findings high temperature increases not only the grass yield but both the oil content and citral content but low temperature invites the opposite influence. Accordingly, the attention should be directed to the fact that in temperate region as that of Japan the temperature is a very important environmental factor to control the plant growth, oil content and citral content of lemon-grass.

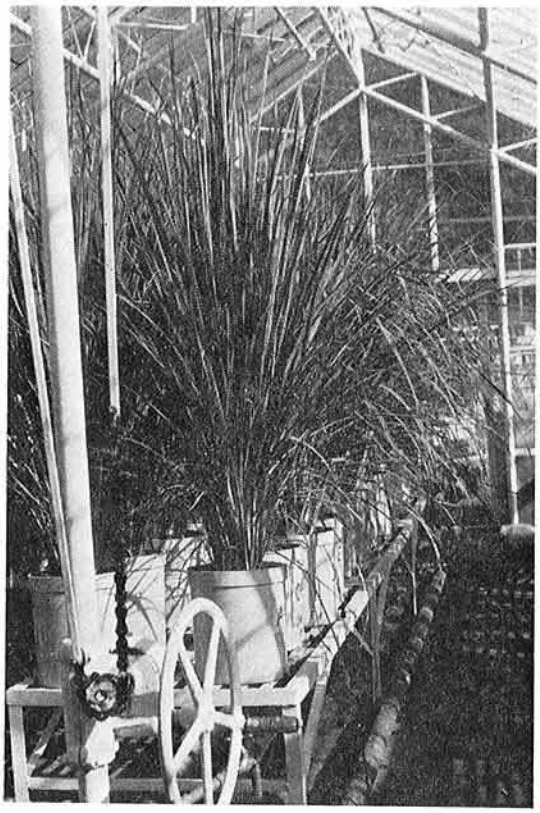

Fig. 3. Pot experiment of lemon-grass in hot house.

2) Light intensity[5] The study has been made on the impact of light intensity on plant growth of lemon-grass, oil content and citral content under different light intensity in hot house. The findings in general were: the influence of light on oil content and citral content is comparatively small and only in the case of extreme shielding of the light, there was a trend in slight decline in oil content. That which should be given a great attention with respect to the light intensity is its influence on grass yield. Even comparatively a slight shielding of light produces a strong tendency to inhibit the plant growth inviting the lowering of grass yield.

3) Soil moisture[6] By pot experiment in hot house 5 soil moisture plots have been established within the range of 100~25% moisture content, and thereby the study of plant growth, oil content and citral content have been carried out. And most important factor in soil moisture is its influence on plant growth or grass yield and it can be safely assumed that optimum moisture content in

soil is around 80%. On the other hand, it has also been recognized that drying and excessive humidity inhibit the growth and greatly lower the grass yield. Moreover, although the influence of soil moisture is not so much on oil content and citral content but under extreme drying and high humidity oil content tends to decline slightly.

In the cultivation of lemon-grass in tropical region the most important factor to control the plant growth has been recognized as the rainfall in general. And the findings from the above researches seem to endorse this concept.

4) Fertilizer[7] The results in 3 fertilizer elements experiments by using the soil of this Experiment Station have revealed the trends that the influence of the nitrogen is by far the salient. In the case of nitrogen deficiency not only the grass yield greatly declines but oil content of leaf declines slightly. On the other hand, citral content tends to increase slightly. However, this is assumed as mainly due to relative increase in leaf age caused by nitrogen definciency. Next, in the case of phosphate deficiency grass yield tends to considerably decrease, but practically no influence has been recognized in oil content and citral content. Moreover, practically no influence of potash has been recognized in all sectors.

Drying of leaves[8]

The results from the study of the change in oil content and citral content in case the leaves have been dried under the sun or in shade after the harvest it has been found that when the leaves have been dried under good weather without the leaves getting musty the yield of oil slightly increases within two, three days and interesting fact was that citral content of oil is always nearly 5% over the case when distilled immediately after the harvest. And under the drying with comparatively a cooler condition it has been found that such an increased citral content holds for more than a month. However, in case the leaves became musty under high temperature and humidity both the oil content and citral content violently decline, so the attention should be directed to this factor.

Distillation period

Distillation period has been divided into several stages from 15~20 minutes to 2~3 hours and the relation between the length of distillation period and oil yield and citral content has been studied and it has been found that oil yield per unit hour is by far the highest at early stage of distillation and as the distillation hours advance it declines rapidly, and that citral content of oil is high when distillation period is short and along with the prolongation of distillation period it declines. Accordingly, the citral is discharged at early stage of distillation. Furthermore, in this case, it has been clarified that oil yield relatively increases at early stage of distillation under the proper drying of leaves and that the time required for extracting total oil is somewhat shortened and such a citral content of oil by drying generally increases.

From the above research findings in the cultivation of lemon-grass and oil extraction first superior variety should be selected followed by rational cultivation, harvest, drying and distillation with due consideration to various factors stated above which control grass yield, oil content and oil quality.

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