Journal of
Plant Sciences

ISSN 1816-4951

Academic
Journals Inc.

www.academicjournals.com

Journal of Plant Sciences 2 (1): 96-101, 2007
ISSN 1816-4951

Study on Weed Flora and Their Influence on Patchouli (*Pogostemon cablin* Benth.) Oil and Patchoulol

J.J. Mahanta, M. Chutia and T.C. Sarma
Regional Research Laboratory (CSIR), Jorhat-785006, Assam, India

Abstract: Experiments were conducted to study the weed flora and its influence on the yield of oil and Patchoulol by co-distillation of fresh Patchouli leaves with weed biomass at different proportions (0, 5, 10, 15 and 30%) during 2004-05 and 2005-06. The survey of weeds commonly growing in patchouli plantation was made and a total of 17 weed species were recorded. *Alternanthera sessile*, *Cynodon dactylon* and *Oxalis corniculata* exhibited 100% frequency in both the years. *A. sessile*, *C. dactylon* and *O. corniculata* had highest density during 1st year and the density of most of the weed species increased during 2nd year except *C. dactylon* and *A. sessile*. Co-distillation of fresh Patchouli leaves with weeds at the rate of 0, 5, 10,15 and 30% yielded 0.70, 0.67, 0.65, 0.50 and 0.43% oil, respectively. It was observed that the oil yield decreased gradually with the increase in weed biomass. However, the percentage of patchoulol showed a different behaviour. It decreased at 15% (53.7) and 30% (50.4) and increased at 5% (56.5) and 10% (63.8) treatments. The oil extracted with weed biomass imports a weedy odour, which may decrease its commercial value.

Key words: Co-distillation, oil yield, Patchouli, Patchoulol, weed , weedy odour

Introduction

Pogostemon cablin Benth. (Patchouli) belonging to family Lamiaceae, a native to South East Asia, is long been used as a moth repellent. It is a perennial, bushy plant grows up to 1 m (3 feet) high, with a sturdy, hairy stem and large, fragrant, furry leaves, about four inches long and five inches across. It has whitish flowers tinged with purple. The word is derived from Hindustan word patch meaning green and ilai meaning leaf. Patchouli oil has a rich musky-sweet, strong spicy, herbaceous smell and dark orange or brownish colored viscous liquid. Because of its oriental notes and its strong fixative properties, it is one of the most important essential oil utilized in the perfumery, flavour and cosmetic industries for manufacture of soaps, detergents, deodorants etc. (Akhila and Tewari, 1984; Maheshari *et al*., 1993; Sarma and Sarma, 2003). Newly distilled oil has a fresh green slightly harsh aroma. As the oil ages, it mellows considerably becoming sweeter and balsamic. Nikiforov *et al*. (1988 and 1989) proved that (-)-patchoulol was the predominant odor component of patchouli oil by using chiral phase gas chromatography combined with a sniffing-technique.

Patchouli is grown mainly in Indonesia, Malaysia, China, Brazil and India. Various natural and controllable factors could affect the yield and quality of oil such as soil heterogeneity (Sugimura *et al*., 1990), quality of planting material (Sharma, 1999) and cultivation practices (Sarma and Kanjilal, 2000).Weeds are constant component of agro-ecosystem and alternative control methods have been used to control them in different crops (Powell and Justum, 1993). Due to wider gap during the initial plantation, the weeds become dominant in field (Yadav *et al*., 1981). However many seeds of exotic species are introduced in new regions by accident and some of them may settle

Corresponding Author: T.C. Sarma, Regional Research Laboratory (CSIR), Jorhat-785 006, Assam, India
Tel: 0376-2370121, 0376- 2372572 Fax: 0376- 2370011

and become component of the natural flora (Maillet and Lopez-Garcia, 2000). Weeds compete with crop plants for light, water and nutrients. Weed management practice significantly increased the yield attributes and yield over the control (Sharma *et al*., 2002). Some of the grass species grow in close proximity to the base of the plants and often their branches and leaves get intermingled with branches of the crop. During harvest such weeds get mixed with the crop and distilled along with crop biomass. Therefore, an experiment was conducted to study the weed flora under plantation and its effect on combined distillation of patchouli leaves and weed biomass on the yield of oil and patchoulol.

Materials and Methods

Experimental Site

Trials were conducted at Regional Research Laboratory, Jorhat (Assam) during 2004-2006. The area is located at 96.5 msl. and the climate is worm humid. Annual average rainfall is about 2000 mm and rainy season began in early part of April and continues till October. The maximum temperature does not exceed 40°C and winter temperature does not fall below 5°C. The soil of the experimental field is sandy loam in texture and acidic (pH 5.5) in reaction. The field was thoroughly ploughed and harrowed before making experimental plots. Patchouli cuttings were planted in mid February 2004 and regularly irrigated to ascertain optimum survivability.

Field Layout

The experiment, having two treatments comprising of weed free plots (weeded manually) and weed infested plots (weeds were allowed to grow), was laid out in a randomized block design having four replications. Plot size was 10×10 m and each plot was separated by 1.5 m. Patchouli cuttings were planted at intra-row spacing of 60 cm apart. Two weeks before plantation, N 25, P_2O_5 50 and K_2O 50 Kg ha^{-1} along with 8 tons of well rotten compost was basally applied. The remaining 75 Kg N was applied in equal three split doses after each harvest as side dressing.

Sampling Procedure and Data Analysis

Sampling was made from randomly selected plots using 1 m^2 quadrate for 5 times $plot^{-1}$. Weed species were separately counted from each quadrate and identified. To eliminate the influence of field edges on survey, sampling was made inside the field. Frequency and density of each weed species were determined and calculated according to Odum (1971).

$$\text{Frequency (\%)} = \frac{\text{Number of surveyed areas where a species occurred}}{\text{Number of total surveyed areas}} \times 100$$

$$\text{Density (plants m}^{-2}\text{)} = \frac{\text{Total number of each species}}{\text{Total surveyed area}}$$

Ecological analysis of the weed flora was carried out to determine the relative frequency and density using the equation provided by Wirjahadja and Panch (1975).

$$\text{Relative frequency (\%)} = \frac{\text{Frequency value for one weed species}}{\text{Total frequency of all weed species}} \times 100$$

$$\text{Relative density (\%)} = \frac{\text{Density of one weed species}}{\text{Total density of all weed species}}$$

Weeds were collected from the plots and its dry weight (t ha^{-1}) was recorded.

Hydro-Distillation

Fully-grown Patchouli plants were harvested and weeds were collected separately. Specific proportion of weed biomass was mixed with patchouli leaves at the rate of 5, 10, 15 and 30% along with a control (weed free) for hydro distillation in Clevenger's apparatus for 16 h. Extraction of oil was repeated for 10 times for each treatment and average data were presented in Table 3. Weed biomass alone was also distilled to ascertain the presence or absent of any oil.

GC Analysis

The patchoulol of oil was determined by gas chromatography method. A Chemito model 3865 GC with FID and a Hewlett Packard HP 3395 data integrator was used for the analysis. The constituents in the oil were separated in a packed glass column (2 mm id×2 M length) of 15% SE 52 on gas chrom Q, 80/100 mesh.

Results and Discussion

Weed Frequency

A total of 17 weed species were growing in patchouli plantation and enumerated in Table 1. The frequency of weed species ≥ 75% were *Oxalis corniculata* (100%), *Cynodon dactylon* (100%), *Alternanthera sessile* (100%), *Ageratum conizoides* (95%), *Spilanthes oleraceae* (85%) and *Amaranthus spinosus* (75%) during 1st year (2004-2005). In 2nd year (2005-2006), the frequency of majority of weed species was increased. The frequencies were 100% in case of *A. conizoides*, *A. sessile* and *Oxalis corniculata* followed by *C. dactylon* (98%) and *A. spinosus* (80%)

Weed Density

The weed density of 3 species was ≥ 10 plants m^{-2} during 1st year. *C. dactylon* exhibited the highest density (21 plants m^{-2}) followed by *O. corniculata* (18 plants m^{-2}) and *A. sessile* (12 plants m^{-2}). It was observed that the density of most of the weed species increased during 2nd year except *C. dactylon* (9.5%) and *A. sessile* (16.7%)

The high number of weed species might be attributed to the fact that patchouli provides poor shading during initial stage and take longer time (29-32 days) to attain its full growth, which gave the weeds an advantage to become well established. The earlier the weed emerges prior to crop, the more time it has to established and compete (Chapman, 2000).

Relative Frequency

Table 2 shows the relative frequency of various weed species indicates the rate of occurrence of weed was relatively higher during 1st year than 2nd year. Patchouli was predominately invaded by *A. conizoides*, *O. corniculata*, *C. dactylon*, *S. oleraceae* and *A. sessile*. The decrease in relative frequency in the 2nd year might probably due to increase in plant growth providing shade.

Relative Density

In patchouli plots only 3 weed species occurred at relative density ≥ 10% in 2004-2005. (Table 2) of these *C. dactylon* produced the highest density relative to *O. corniculata* and *A. sessile*. In 2nd year relative density of *Portulaca quadrifida* observed to be increased from 1.94% in 1st year to 10.84% in 2nd year, while that of *O. corniculata*, *C. dactylon* and *A. sessile* decreased considerabily. The relative density of *A. conizoides*, *Cyperus prolifer*, *Mimosa pudica* and *Mikania macrantha* was also fairly increased during 2005-2006, which might be attributed to their higher growth rate.

Oil yield and GC Analysis

The oil yield and chemical profile of patchouli oil were reported in detail earlier (Lawrence, 1976, 1981, 1990, 1995; Akhila and Nigam, 1984). Weed biomass did not yield any oil. Whereas, presence

Table 1: Enumeration of weeds in patchouli plantation, their frequency and density

	Frequency (%)		Density (plants m^{-2})	
Weed species	2004-05	2005-06	2004-05	2005-06
Ageratum conizoides Linn	95	100	3	21
Alternanthera sessiles R.Br.	100	100	12	10
Amaranthus spinosus Linn	75	80	6	10
Crassocephallus crepidioides Benth	65	70	5	7
Cuphea hyssipifolia Kunth	45	59	7	13
Cymbopogon nurdus (Linn.)	25	45	3	12
Cynodon dactylon Pers	100	98	21	19
Cyperus prolifer Lam	40	28	1	13
Justicia simplex D.Don	35	49	2	7
Mikania macrantha Kunth.	10	41	3	34
Mimosa pudica Linn.	10	33	2	28
Oxalis corniculata Linn	100	100	8	32
Oxalis martiana Zucc	70	65	5	12
Portulaca oleracea Linn	45	72	2	4
Portulaca quadrifida Linn	30	29	2	44
Scoparia dulcis Linn	30	65	3	42
Spilanthes oleraceae Murr	85	70	8	51

Table 2: Relative frequency and density of weed species during 2004-2005 and 2005-2006

	Relative frequency (%)		Relative density (%)	
Weed species	2004-2005	2005-2006	2004-2005	2005-2006
Ageratum conizoides Linn	9.89	8.89	2.91	5.17
Alternanthera sessiles R.Br.	10.42	8.89	11.65	2.46
Amaranthus spinosus Linn	7.81	7.12	5.82	2.46
Crassocephallus crepidioides Benth	6.77	6.23	4.85	1.72
Cuphea hyssipifolia Kunth	4.67	5.25	6.79	5.42
Cymbopogon nurdus (Linn.)	2.60	4.00	2.91	2.95
Cynodon dactylon Pers	10.42	8.72	20.39	4.68
Cyperus prolifer Lam	4.16	2.49	0.97	3.20
Justicia simplex D.Don	3.64	4.36	1.94	1.72
Mikania macrantha Kunth.	1.04	3.65	2.91	8.37
Mimosa pudica Linn.	1.04	2.93	1.94	6.89
Oxalis corniculata Linn	10.42	8.89	17.47	7.88
Oxalis martiana Zucc	7.29	5.78	4.85	2.95
Portulaca oleracea Linn	4.67	6.40	1.94	0.98
Portulaca quadrifida Linn	3.12	2.58	1.94	10.84
Scoparia dulcis Linn	3.12	5.78	2.91	10.34
Spilanthes oleraceae Murr	8.85	8.01	7.77	12.56

Table 3: Yield of oil and patchoulol as affected by co-distillation under different treatments

Treatment	Oil yield (%)	Difference % over control	Patchoulol (%)	Difference % over control
Fresh leaves (control)	0.70	-	54.9	-
Fresh leaves+ weeds (5%)	0.67	4.28	56.5	+2.90
Fresh leaves+ weeds (10%)	0.65	7.14	63.8	+16.21
Fresh Leaves+ Weeds (15%)	0.50	28.57	53.7	-2.18
Fresh Leaves + Weeds (30%)	0.43	38.57	50.4	-8.19
SEm±	0.04	-	0.78	-
CD at 5%	0.10	-	1.60	-

+ indicates increase, - indicates decrease

of weed during co-distillation contributed additional biomass to the patchouli leaves. Therefore, increase proportions of weed co-distilled with patchouli resulted in decrease of oil progressively. The oil yields were 0.70, 0.67, 0.65, 0.50 and 0.43% at 0, 5, 10, 15 and 30% weed treatments, respectively. Co-distillation with different proportions of weed biomass showed a variation in patchoulol content, which were 54.9, 56.5, 63.8, 53.7 and 50.4% at 0, 5, 10, 15 and 30% weeds treatment, respectively (Fig. 1). It was observed that patchoulol was gradually increased up to 10% weed-patchouli mixture showing maximum of 63.8% at 10% and then gradually decreased showing minimum of 50.4% at 30% (Table 3). Variation in patchoulol content may be due to interaction with water-soluble chemicals

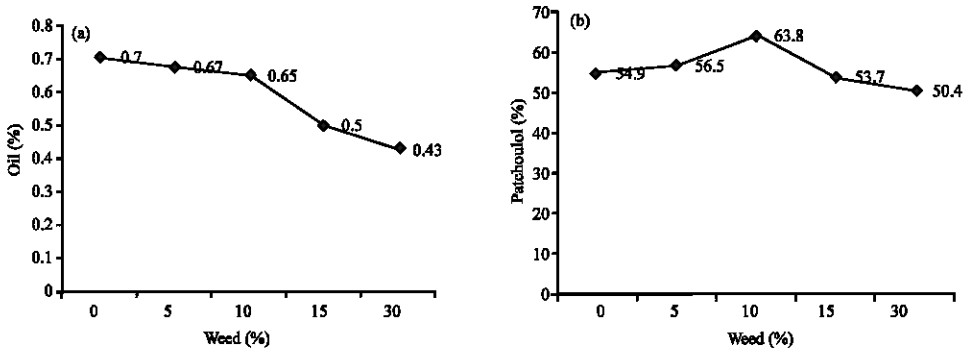

Fig. 1: Effect of co-distillation of patchouli and weed on oil and patchoulol

released by weed species into distillation water during co-distillation. Similar results were also reported by Rao *et al.* (2005) on rose scented geranium sp. Although, the weeds did not yield any oil, it imports a weedy odour to the distillation water as well as patchouli oil comparing to the control (Kaul *et al.*, 1997).

Conclusion

It is imperative that the quality of patchouli oil is based on higher percentage of patchouli alcohol (patchoulol) and odour profile. Proper care should be taken to avoid mixing of weed with patchouli during distillation as it imparts weedy odour and decrease oil yield.

References

Akhila, A. and M.C. Nigam, 1984. GC-MS analysis of the essential oil of *Pogostemon cablin* (Paychouli oil). Fitoterapia, 55: 363-365.

Akhila, A. and R. Tewari, 1984. Chemistry of patchouli oil: A review. CROMAP, 6: 38-54.

Chapman, B., 2000. Effect of weed in wheat. Top Document. Agricultural Food and Rural Development, pp: 25.

Kaul, P.N., B.R.R. Rao, A.K. Bhattacharaya, K. Singh and C.P. Singh, 1997. Effect of partial shade on essential oils of three geranium (*Pelargonium* species) cultivar. Indian Perfumer, 41: 1-4.

Lawrence, B.M., 1976. Progress in essential oils- Patchouli oil. Perfum. Flavor., 1: 20.

Lawrence, B.M., 1981. Progress in essential oils- Patchouli oil. Perfum. Flavor., 6: 73-76.

Lawrence, B.M., 1990. Progress in essential oils- Patchouli oil. Perfum. Flavor., 15: 76-77.

Lawrence, B.M., 1995. Progress in essential oils- Patchouli oil. Perfum. Flavor., 20: 72-73.

Maheshari, M.L., K.T. Vasantha, N. Sharma and K.P.S. Chandel, 1993. Patchouli-an Indian Perspective. Ind. Perfum., 37: 9-11.

Maillet, J. and G.C. Lopez, 2000. What criteria are relevant for predicting the invasive capacity of a new agricultural weed? The case of invasive American species in France. Weed Research, 40: 11-26.

Nikiforov, A., L. Jirovetz, G. Buchbauer and V. Raverdino, 1988. GC-FTIR and GC-MS in odour analysis of essential oils. Mikrochim. Acta, 2: 193-198.

Nikiforov, A., L. Jirovetz and G. Buchbauer, 1989. Synthesis of tertiary alcohol carbamates. Liebigs Ann. Chem., 5: 489-491.

Odum, E.P., 1971. Fundamentals of Ecology. W.B. Saunders Company, Philadelphia, pp: 574.

Powell, K. and A.R. Jutsum, 1993. Technical and commercial aspects of bio control products. Pest. Sci., 37: 315-321.

Rao, B.R.R., P.N. Kaul, K. Singh, G.R. Mallavarapu and S. Ramesh, 2005. Influence of Co-distillation with weed Biomass on yield and chemical composition of Rose- Scented Geranium (*Pelargonium* species) Oil. J. Essential Oil Res., 17: 41-43.

Sarma, P.C. and P.B. Kanjilal, 2000. Effect of planting time and row spacing on growth yield and quality of Patchouli (*Pogostemon patchouli* Benth). Adv. Plant Sci., 13: 201-204.

Sarma, A. and T.C. Sarma, 2003. Patchouli oil recovery and effect of leaf ageing. Indian Perfumer, 47: 151-154.

Sharma, N., 1999. Coservation of Patchouli (*Pogostemen patchouli*) through *in vitro* methods. Ind. Perfum., 43: 19-22.

Sharma, R.P., P. Singh and P.L. Maliwal, 2002. Effect of weed management and phosphrous level on yield and qualiy of Indian mustard (*Brassica juncea*). Ind. J. Agric. Sci., 72: 461-463.

Sugimura, Y., Y. Ichikawa, K. Otsuji, M. Fujita, N. Toi, N. Kamata, R.M. Del Rosario, G.R. Luingas and G.L. Taga, 1990. An- Cultivarietal comparison of patchouli plants in relation to essential oil production and quality. Flavour and Fragrance J., 5: 109-114.

Wirjahadja, S.D. and J.Y. Pancho, 1978. Weed survey method and vegetation analysis. Biotrop. Tech. Bull., 4: 20.

Yadav, R.L., R. Mohan and D.V. Singh, 1981. Requirement of weed free period for optimum herb and oil yield of Java citronell. Ind. Perfum., 25: 47-52.