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INTERAKSI ANTARA JUMLAH NITROGEN DAN CARA PANEN PADA PERTUMBUHAN DAN PERSENTASE MINYAK NILAM YANG DIHASILKAN PADA PANEN PERTAMA

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INTERACTION BETWEEN NITROGEN AND HARVESTING METHODS ON GROWTH AND YIELD OF PATCHOULI OIL PRODUCED AT FIRST HARVEST

ABSTRACT

Patchouli oil is one of major components in perfumery industries as well as incense. Its smell is heavy and strong due to the presence of its major component called patchoulol or patchouli alcohol. However, the production has not stabilized yet because of several factors including cultivation. Experiment was conducted from November 1999-May 2000. Patchouli cuttings were grown in randomized complete block design with four replications. Nitrogen rates for this experiment were 0, 45, 90, and 135 kg ha^{-1} and three harvesting methods which were three pairs of youngest leaves, 20 cm from the tip and by leaving 20 cm stubble from ground. Plant height and number of branches continued to increase significantly linear at higher N rates. There was significant interaction between N rate and harvesting method on wet and dry harvest mass. Effect of N on composite percentage differed for each harvesting method. The yield from three youngest leaves was higher than harvesting 20 cm from the tip and leaving 20 cm stubble from the ground for 45, 90, and 135 kg ha^{-1} respectively.

***Keywords*: patchouli oil, nitrogen level, harvesting method**

ABSTRAK

Minyak nilam merupakan salah satu komponen utama dalam industri parfum dan wangi-wangian. Aromanya yang berat dan kuat disebabkan oleh keberadaan komponen utamanya yang disebut dengan patchoulol atau patchouli alcohol. Sayangnya, produksi dari minyak nilam ini masih berfluktuasi dan salah satu penyebabnya adalah cara budi daya. Percobaan ini dilakukan di Bogor dari bulan November 1999-Mei 2000. Stek nilam ditanam dengan rancangan acak kelompok dengan 4 replikasi. Jumlah pupuk N yang digunakan adalah sebanyak 0, 45, 90, dan 135 kg ha^{-1} dengan tiga macam cara panen yaitu memanen tiga pasang daun termudanya, memanen 20 cm dari pucuk dan memanen dengan meninggalkan tanaman setinggi 20 cm dari tanah. Tinggi tanaman dan jumlah cabang meningkat secara nyata dan linier terhadap jumlah N. Terdapat interaksi nyata antara jumlah pupuk N dengan cara panen terhadap berat basah dan berat kering panen yang dihasilkan. Pengaruh N pada persentase minyak yang dihasilkan berbeda untuk tiap cara panen; persentase yang diperoleh dari panen tiga pasang daun termuda lebih tinggi dibandingkan dengan panen 20 cm dari pucuk dan meninggalkan tanaman 20 cm dari permukaan tanah untuk jumlah pupuk N sebanyak 45, 90, dan 135 kg ha^{-1}.

Kata kunci: minyak nilam, jumlah nitrogen, cara panen

I. INTRODUCTION

Patchouli oil has long been known as an important essential oil. The oil is produced from all parts of *Pogostemon cablin* plant. The major oil component is patchoulol or patchouli alcohol ($C_{15}H_{26}O$) (Figure 1). The (-)-patchoulol is responsible for the distinct smell of patchouli oil.

P. cablin belongs to Labiatae family and there are three species in Indonesia. These three species are

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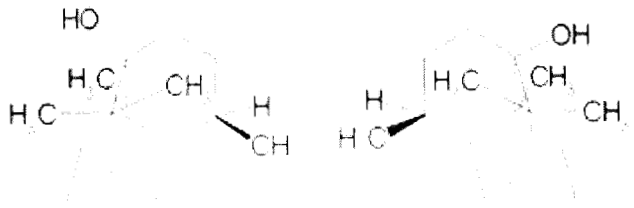

Figure 1 Patchoulol. The two optical isomers of patchoulol. Left: (+)-patchoulol. Right: (-)-patchoulol

P.cablin, *P. hortensis*, and *P.heneyanus*. From these, *P.cablin* is the most common to be cultivated because it has the best yield, oil quality and aroma (Laksamanahardja and Rusli 1985). Indonesia plays an important role in patchouli oil's production but this production has fluctuated (Lutony and Rahmayati 1994) due to several factors including cultivation.

Patchouli plant (Figure 2) is a bushy herb which may reach about two feet high. It enjoys tropical climate, however, the plant should be shaded in order to get the best growth. Suratman (1992) stated that urea at 300 kg ha^{-1} significantly increased plant height, number of branches and wet biomass of patchouli plant at 150 kg ha^{-1}. On the other hand, Pramono (1999) stated the opposite.

Figure 2 Patchouli (*Pogostemon cablin*)

There are several harvesting methods. First, part to be harvested should be three pairs of youngest leaves (Guenter *in* Tasma 1989). Second, part to be harvested should be the young leaves and branches or 20 cm from tip (Wikardi *et al.* 1990). Third, Moestafa (1992) stated that patchouli plant should be harvested by leaving 20 cm stubble from the ground.

The purposes of this investigation were (1) to find the effects of nitrogen on the growth of *P.cablin* and the yield of patchouli oil at first harvest, (2) to find the effects of harvesting method on the percentage of patchouli oil at first harvest, and (3) to find interaction between N and the harvesting method on the yield of patchouli oil at first harvest.

II. MATERIAL AND METHOD

The experiment was conducted at Bogor, West Java with altitude 246 above sea level, from November 1999 to May 2000.

The materials were cuttings of *P.cablin* Benth. var. Sidikalang, manure, urea, SP-36, and KCl. The cuttings were grown in randomized complete block design with four replications. Nitrogen rates for this experiment were 0, 45, 90, and 135 kg ha^{-1} and three harvesting methods, which were three pairs of youngest leaves, 20 cm from the tip, and by leaving 20 cm stubble from the ground. There were 10 samples for each combination. Means were separated when a significant F value was detected. Single degree of freedom orthogonal contrast was used to determine linear, quadratic, or cubic dependent variable response to N fertilizer.

Cuttings from Research Institute for Spice and Medicinal Crops aged 4 week after planting (WAP) were transplanted into polybag and manure at 10 tons ha^{-1} was added. Also, SP-36 and KCl at 100 kg ha^{-1} each and urea (according to treatment) at half dosage were applied. The remaining half dosage was applied at 12 WAP and plants were also pruned by leaving them 20 cm from the ground.

The plants were harvested at 24 WAP according to their treatments. Wet harvest mass was weighed then dried at 60°C for three days in a forced-air oven and weighed to determine the dry harvest mass. This dry mass was refined using water and vapor method. Fertilizers (same as transplanting) were applied after harvesting.

Plant height, numbers of branches, wet and dry harvest masses, and composite yield were determined. Plant height and number of branches interaction were determined one month after harvesting.

III. RESULT AND DISCUSSION

Plant Height

Plant height continued to increase significantly linear at higher N rates at 8-22 WAP (Tables 1, 2, and 4). Linear regression equation for plant height at 24 WAP was :

$$Y=36.42 + 0.09 X (R^2=0.89^{**}) \quad (1)$$

The lowest plant height was observed on plant without N fertilizer before and after harvesting (Tables 1, 2, 4, and 5). Without additional manure, media in polybag contained only 0.15% N. This condition did not support plant growth. Leiwakabessy (1988) stated that most plants absorb more N than other minerals. Therefore, plants with higher nitrogen until the level of nitrogen reached 135 kg ha^{-1} showed higher plant height since the more nitrogen was available, the more it supported the growth of the plants.

Table 1 F value for variables of plant height, number of branches, wet harvest mass and dry harvest mass

Age (WAP)	Variables	N rate	Harvesting method	Inter-action	Orthogonal contrast
4	Plant height	n	-	-	-
	Number of branches	n	-	-	-
6	Plant height	n	-	-	-
	Number of branches	n	-	-	-
8	Plant height	*	-	-	**
	Number of branches	n	-	-	-
10	Plant height	*	-	-	**
	Number of branches	*	-	-	**
12	Plant height	*	-	-	**
	Number of branches	*	-	-	**
14	Plant height	**	-	-	**
	Number of branches	*	-	-	**
16	Plant height	*	-	-	**
	Number of branches	*	-	-	*
18	Plant height	**	-	-	**
	Number of branches	**	-	-	**
20	Plant height	**	-	-	**
	Number of branches	**	-	-	**
22	Plant height	**	-	-	**
	Number of branches	**	-	-	**
24	Plant height	**	-	-	**
	Number of branches	**	-	-	**
	Wet harvest mass	**	**	*	-
	Dry harvest mass	**	**	*	-
26	Plant height	**	**	*	-
	Number of branches	**	*	*	-
28	Plant height	**	**	n	**
	Number of branches	**	**	n	**

*) significant (linear for orthogonal contrast) at 5% error level
**) significant (linear for orthogonal contrast) at 1% error level
n) not significant

Table 2 Plant Height at 4-24 WAP

Age (WAP)	N rates (kg ha^{-1})			
	0	45	90	135
	---------- cm ----------			
4	23.86	22.34	23.87	25.06
6	24.03	22.67	24.27	25.56
8	25.03a	24.79a	27.31ab	28.92b
10	27.14a	28.72a	30.83ab	32.96ab
12	29.29a	32.64ab	33.90b	35.89b
14	20.88a	24.29b	23.56b	24.78b
16	24.98a	29.46b	29.08b	30.73b
18	28.39a	33.80b	33.73b	36.38b
20	30.11a	37.37b	37.61bc	40.91c
22	34.74a	41.58b	42.15b	46.48c
24	34.95a	42.66b	44.26c	48.61d

Number followed with different alphabet at same rows differed significantly according to DMRT at 5% error level

Table 3 Number of branches at 4-24 WAP

Age (WAP)	N rates (kg ha^{-1})			
	0	45	90	135
4	1.31	1.32	1.33	1.37
6	1.32	1.33	1.36	1.40
8	1.66	2.31	2.49	2.39
10	2.14a	3.13ab	2.99ab	3.42ab
12	2.61a	3.85b	3.98b	4.28b
14	2.31a	3.06b	3.30b	3.34b
16	2.58a	3.74b	3.74b	4.14b
18	2.91a	4.00b	4.19b	4.46b
20	3.11a	4.38b	4.63b	4.82b
22	3.42a	4.95b	5.47b	5.42b
24	3.45a	5.28b	5.83b	5.91b

Number followed with different alphabet as same rows differed significantly according to DMRT at 5% error level

Table 4 Refined Dry Harvest Mass, Patchouli Oil Volume and Percentage at Four N Rates and Three Harvesting Methods

N rates (kg ha^{-1})	Refined dry harvest mass (g)	Patchouli oil volume (ml)	Percentage of Oil Yield (%)
	----- Harvesting three pairs of youngest leaves -----		
0	27.99	0.20	0.71
45	58.22	0.55	0.94
90	67.37	0.50	0.74
135	80.76	0.70	0.8
	---------- Harvesting 20 cm from tip ----------		
0	60.71	0.50	0.82
45	146.22	1.05	0.72
90	127.36	1.00	0.78
135	185.12	1.50	0.81
	- Harvesting by leaving plants 20 cm from ground -		
0	38.68	0.35	0.90
45	187.32	1.30	0.69
90	227.40	1.60	0.70
135	299.88	1.70	0.57

There was significant interaction between N rate and harvesting method. Plants at 0 kg N kg ha^{-1} and harvested 20 cm from tip showed lowest plant height; however plants at 135 kg N ha^{-1} and harvested their three youngest leaves showed highest plant height at

26 WAP (Table 5). The result was obtained because this harvesting method caused minimum height loss and as a result the plants were able to recover soon. Plant recovery was observed at 28 WAP (Table 6).

Table 5 Interaction between N Rate and Harvesting Method

N rates (kg ha^{-1})	Harvesting Methods		
	Harvesting three pairs of youngest leaves	Harvesting 20 cm from tip	Harvesting by leaving 20 cm stubble from ground
	-------Wet harvest mass (g/plant)--------		
0	6.82a	11.66ab	8.40a
45	11.88ab	24.19bc	35.12c
90	12.21ab	31.64c	36.36c
135	15.57ab	35.11c	49.12d
Mean	11.06a	25.65b	32.24c
	--------Dry harvest mass (g/plant)------		
0	1.22a	2.33ab	1.68a
45	2.16ab	4.57bc	6.69c
90	2.17ab	5.79c	6.17c
135	2.69bc	6.17c	9.37d
Mean	2.06a	4.71b	6.16b
	---------Plant height at 26 WAP (cm)--------		
0	25.91bc	18.11a	20.42ab
45	33.11d	25.69bc	21.10ab
90	32.55d	29.73cd	22.34ab
135	42.43c	26.84bc	23.89abc
Mean	33.50b	25.09ab	21.94a
	----------Number of branches at 26 WAP-------		
0	3.12ab	2.47a	2.57a
45	4.12bcd	4.23bcde	3.62ab
90	5.12cd	5.36de	3.92bc
135	5.46c	4.32bcde	4.18bcd
Mean	4.45b	4.09ab	3.58a

Number followed with different alphabet for each variable differed significantly according to DMRT at 5% error level

Table 6 Plant Height and Number of Branches After Harvesting (28 WAP)

Treatments	Plant height (cm)	Trunk count
N rates (kg ha^{-1}):		
0	22.11a	3.07a
45	27.40ab	4.44b
90	29.03b	5.34b
135	31.86b	5.38b
Harvesting methods :		
Harvesting by leaving 20 cm stubble from ground	22.37a	3.92a
Harvesting 20 cm from tip	26.01a	4.73a
Harvesting three pairs of youngest leaves	34.42b	5.03a

Number followed with different alphabet at the same columns differed significantly according to DMRT at 5% error level

Number of Branches

Number of branches continued to increase significantly linearly at higher N rates at 10-28 WAP (Tables 1, 3, and 4). Linear regression equation for number of branches at 24 WAP was

$$Y = 4.09 + 0.01 X ((R^2=0.57^{**}) \quad (2)$$

The lowest number of branches was observed on plant without N fertilizer before and after harvesting (Tables 3, 4, and 5). The result went in line with the plant height where the increase in the level of N also increased the number of branches until the level reached 135 kg N ha^{-1}.

There was significant interaction between N rate and harvesting method. Plants at 0 kg N kg ha^{-1} and harvested 20 cm from tip showed lowest number of branches; however those at 135 kg N ha^{-1} and harvested on their three youngest leaves showed highest number of branches at 26 WAP (Table 5). This result was obtained because the harvesting method caused minimum loss to the whole plants and there were not many branches cut. Therefore, they were able to recover sooner.

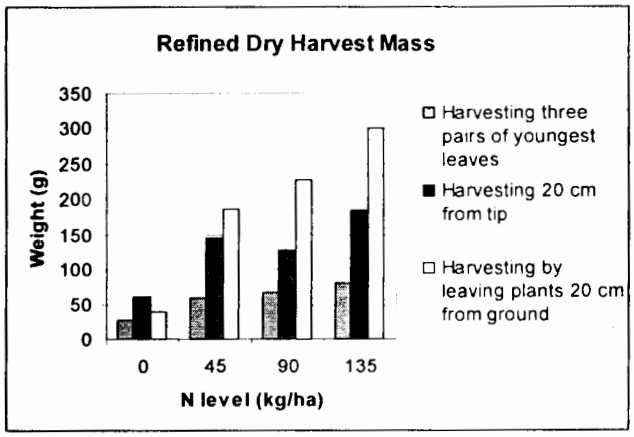

Figure 3 Refined Dry Harvest Mass

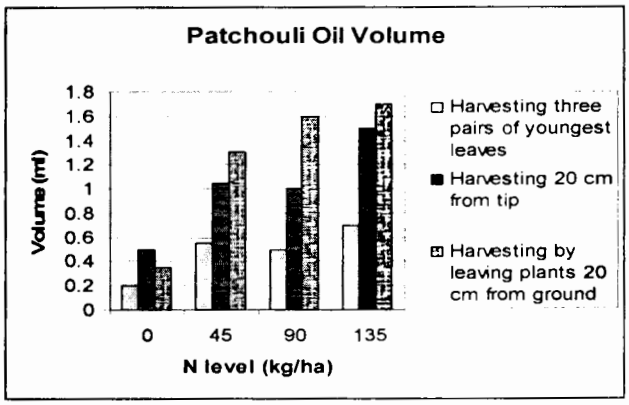

Figure 4. Patchouli Oil Volume

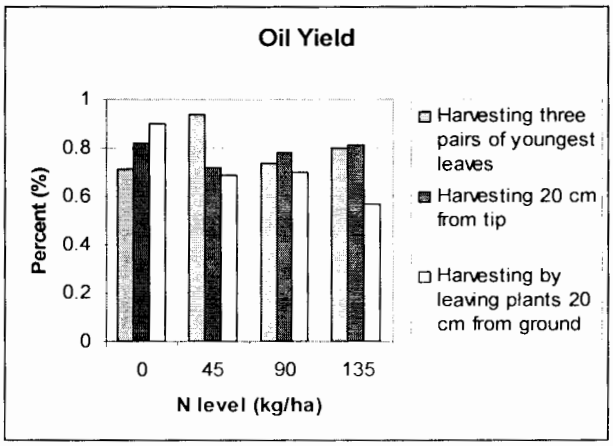

Figure 5. Percentage of Oil Yield

Wet and Dry Harvest Mass

There was significant interaction between N rate and harvesting method on dry and wet harvest masses. Plants at 135 kg N ha^{-1} and harvested by leaving them 20 cm from the ground showed the highest wet and dry masses (Tables 1 and 5, Figure 3). Leiwakabessy (1988) stated that high amount of N causes protoplasm forming which contain more water. Increasing dry harvest mass was considered due to increasing assimilation at higher rate of N. The more parts of plants taken at harvesting, the higher the weight was.

Yield of Oil

The plants with the highest N level gave the highest oil volume for all three types of harvesting methods, while those with no N gave the lowest for all the types of harvesting methods (Table 4, Figure 4). The percentage of oil yield from three youngest leaves was greater than harvesting 20 cm from tip and leaving 20 cm stubble from the ground for 45, 90, and 135 kg N ha^{-1} (Table 4, Figure 5). All parts of patchouli plants contained oil but the leaves contained more than root and branches (Guenter *in* Nuryani and Sutjihno, 1994).

For harvesting by leaving plants 20 cm from ground, the result showed that percentage continued to decrease at higher N rates and dropped at the lowest point when the N rate was at the highest (Table 4, Figure 5). Even though the higher N rates caused the more branches formed and harvested, Irfan (1989) stated that an increase of trunk leave ratio cause a decrease in the oil yield. Therefore, the result of this study was in line since the oil yield was decreasing as the trunk leave ratio increasing.

For harvesting 20 cm from tip, the N rate did not seem to affect the oil yield since it remained constant for different N rates. For harvesting three youngest leaves, plants at 0 kg N ha^{-1} showed the lowest yield (Table 4, Figure 5).

IV. CONCLUSION

Before harvesting, plant height and number of branches continued to increase at higher N rates. There was also significant interaction between N rate and harvesting method on the dry and wet harvest masses. Plants with the highest N level and harvested by leaving them 20 cm from the ground showed the highest masses. However, the oil yield (percentage) was higher when the three pairs of youngest leaves were harvested, except for the plants which did not receive N treatment. After harvesting there were different responses of plant height and number of branches (26 WAP), wet and dry harvest mass and composite percentage to N rate for each harvesting method.

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