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BRIEF COMMUNICATION

Application of gibberellin to *Pogostemon cablin* plants: growth, photosynthetic pigment content and oil yield

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Abstract

Foliar application of gibberellin (GA_3) to patchouli (*Pogostemon cablin* Benth.) increased the plant height, number of nodes per plant, leaf fresh mass and photosynthetic pigment contents. The content of chlorophyll (Chl) *b* increased faster than that of carotenoids (Car), Chl (*a+b*) and Chl *a*. This was reflected in a decline in Chl *a/b* and Chl (*a+b*)/Car ratios. There was a GA_3 concentration dependent variation in the number of branches, leaves, total leaf area, and leaf area index. These growth parameters decreased over control values up to 250 g(GA_3) m^{-3} and increased at 500 g(GA_3) m^{-3} concentration. The patchouli oil yield varied from 2.4 to 2.6 % of the leaf dry mass.

Key words: carotenoids, chlorophyll, leaf area, patchouli

GA_3 application induces an increase in leaf production in different plants (Rappaport 1980, Bishnoi and Krishnamurty 1992, Mishra 1992, Misra and Misra 1992), with a few exceptions (Monselase and Halevy 1962). Reduction in Chl content after GA_3 application has been reported in barley (Misra and Misra 1992), wheat (Misra and Biswal 1980), peach trees (Monge *et al.* 1994), honey suckle (Kwak and Kwak 1990) and pepper (Aloni and Pashkor 1987). The most prominent effect of GA_3 on leaves is the retardation of leaf senescence and autumnal yellowing (Brian *et al.* 1959, Fletcher and Adedipe 1972, Goldthwaite 1988, Misra and Misra 1989, 1991).

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Table 1. Changes in growth of patchouli plants sprayed with different concentrations of GA_3. The data are mean ± S.E. of five separate experimental pots.

Plant growth parameters	GA_3 [g m^{-3}] 0 (control)	10	100	250	500
Plant height [cm]	38.600± 2.800	40.300± 3.200	42.900± 2.600*	44.100± 3.500*	44.600± 4.000*
Nodes per plant	8.100± 0.600	8.300± 0.800	8.000± 0.600	9.200± 0.700*	9.000± 0.800*
Inter-nodal length [cm]	4.770± 0.350	4.860± 0.400	5.300± 0.320*	4.850± 0.420	4.990± 0.440
Branches per plant	4.600± 0.200	2.100± 0.200*	2.400± 0.300*	4.000± 0.300*	5.400± 0.400*
Leaf fresh mass (3^{rd} leaf) [mg]	980.000±82.000	1076.000±115.000*	1153.000±101.000*	1285.000±136.000*	1192.000±124.000
Green leaves per plant	41.000± 3.000	34.000± 4.000*	34.000± 3.000*	35.000± 4.000*	44.000± 4.000*
Yellow leaves per plant	4.000± 0.400	4.000± 0.300	4.000± 0.400	5.000± 0.400*	4.000± 0.300
(% total leaves)	8.900	10.500	10.500	12.500	8.300
Total leaves per plant	45.000± 3.000	38.000± 4.000*	38.000± 3.000*	40.000± 5.000*	48.000± 4.000*
Leaf area (3^{rd} leaf) [cm^2]	36.800± 4.100	33.600± 3.800*	39.200± 4.500*	34.800± 3.200	40.200± 4.300*
Total leaf area [m^2 $plant^{-1}$]	0.151± 0.021	0.128± 0.014*	0.148± 0.013	0.132± 0.018*	0.193± 0.022*
Leaf area index	1.680± 0.230	1.420± 0.160*	1.650± 0.150	1.470± 0.200*	2.140± 0.240*

*The data significantly different from the control value ($P < 0.05$, Students 't' test)

Table 2. Changes in leaf pigment contents of GA_3 treated patchouli plants. Each data represents mean ± S.E. of five separate experimental pots. Figures in the paranthesis represent percentage [%] of control values.

Pigment content	GA_3 [g m^{-3}] 0 (Control)	10	100	250	500
Chl *a* [g kg^{-1}(f.m.)]	0.51± 0.05 (100)	0.73± 0.06* (143)	0.82± 0.09* (160)	1.12± 0.08* (220)	1.04± 0.09* (204)
Chl *b* [g kg^{-1}(f.m.)]	0.25± 0.04 (100)	0.45± 0.05* (180)	0.63± 0.06* (252)	0.76± 0.05* (300)	0.70± 0.06* (280)
Chl *a*+*b* [g kg^{-1}(f.m.)]	0.76± 0.08 (100)	1.18± 0.14* (155)	1.45± 0.12* (191)	1.87± 0.15* (246)	1.74± 0.17* (229)
Car [g kg^{-1}(f.m.)]	0.22± 0.04 (100)	0.36± 0.05* (164)	0.47± 0.05* (214)	0.64± 0.07* (291)	0.58± 0.06* (264)
Chl *a* [mg m^{-2}]	147.00±11.00 (100)	227.00±20.00* (154)	278.00±18.00* (189)	304.00±36.00* (207)	352.00±24.00* (239)
Chl *b* [mg m^{-2}]	70.00± 4.00 (100)	142.00±15.00* (203)	214.00±12.00* (301)	202.00±20.00* (284)	235.00±22.00* (331)
Chl *a*+*b* [mg m^{-2}]	217.00±19.00 (100)	369.00±42.00* (170)	493.00±46.00* (227)	506.00±75.00* (233)	587.00±41.00* (271)
Car [mg m^{-2}]	62.00± 4.00 (100)	112.00± 9.00* (181)	159.00±14.00* (256)	174.00±15.00* (281)	196.00± 2.00* (316)
Chl *a*/*b* ratio	2.10± 0.20	1.60± 0.20*	1.30± 0.10*	1.50± 0.20*	1.50± 0.20*
Chl/Car ratio	3.40± 0.40	3.30± 0.40	3.10± 0.30*	2.90± 0.30*	3.00± 0.40*

*The data significantly different from the control value ($P < 0.05$, Students 't' test)

However, several plant species respond to GA_3 application by accelerated senescence *e.g. Phaseolus* (Halevy and Wittwer 1965), wheat (Misra and Biswal 1980), *Lonicera japonica* (Kwack and Kwack 1990), rice (Misra and Misra 1991) and *Prunus persica* (Monge *et al.* 1994). With respect to the variations of leaf growth and pigment content to GA_3 application Bishnoi and Krishnamurti (1992) suggested that the effects of GA_3 on leaves differ from species to species. Therefore I tested the effect of GA_3 application on the growth, photosynthetic pigment contents and oil yield of patchouli plant.

Patchouli (*Pogostemon cablin* Benth. cv. Johor) stem cuttings were collected from the Indian Institute of Horticultural Research, Bangalore. 10 cm long stem cuttings with six leaves were treated with 0.2 kg m^{-3} indole butyric acid by quick dip for rooting in sterile sand in the laboratory. The rooted cuttings were transplanted after 2 weeks of rooting to the pots containing a mixture of sand, soil and manure in proportion of 2:1:1, respectively. After 2 months, the plants were sprayed with a GA_3 solution (10 cm^3 per plant) containing the surfactant *Labolene* 1 % v/v. The GA_3 concentrations were 10, 100, 250 and 500 g m^{-3}. The control plants were sprayed with 10 cm^3 of an aqueous solution of 1 % v/v *Labolene* only. The hormonal treatment was repeated 3 times at 1 month intervals. The plant growth was measured 165 d after stem cutting. The foliage developing from the buds occupying during the treatment period the 3rd basipetal nodal position from the apex was used as the experimental sample for leaf area, photosynthetic pigment analysis and patchouli oil estimation as described by Misra (1995).

The application of GA_3 to patchouli plants increased the plant height, number of nodes, the inter-nodal length and leaf fresh mass over the control (Table 1). The number of branches per plant, green leaf number, total leaf number, and leaf area index decreased over control, at 10 - 250 g(GA_3) m^{-3}, but they increased at 500 g(GA_3) m^{-3} concentration (Table 1).

The chl *a*, chl *b*, chl (*a*+*b*) and car contents increased after GA_3 application over control values (Table 2). chl *b* accumulated most fast (up to 330 % of the control) followed by car, chl *a*+*b* and chl *a*, both per fresh leaf mass or leaf area. The chl *a*/*b* and chl/car ratios decreased in GA_3 treated plants (Table 2).

The patchouli oil yield remained at 2.3 - 2.5 % of leaf dry mass during all GA_3 treatments. The control value for oil yield was 2.4 ± 0.2 %. Although the oil yield showed little change with treatments, the projected yield estimate, taking into account total number of leaves, leaf mass and leaf area, is that plants treated with 500 g(GA_3) m^{-3} have a potential for a significantly higher amount of patchouli oil yield in the field conditions.

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