Growth and Flowering of Lantana camara L. subsp. camara as Affected by Triapenthenol and Environmental Factors

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Abstract. The various concentration effects of the growth regulator triapenthenol (0, 43.75, 87.5, 175, and 350 mg/pot) on the growth and flowering of Lantana camara L. subsp. camara under different shading levels (0%, 28%, and 66%) were studied in 1997 and 1998 in a glasshouse in Attica, Greece. It was found that minimum temperature and photosynthetic photon flux density were the most important factors to plant growth. The growth index (GI) decreased as the regulator concentration increased while the number of flower heads per plant increased up to a maximum at the concentration of 87.5 mg triapenthenol per pot with a decrease afterwards, at all shading levels. The interaction between shading level and triapenthenol concentration significantly affected GI and flowering of lantana plants. The growth index of the control plants increased and the number of flower heads per plant decreased significantly at all concentration levels examined, as shading increased from 0% to 66%. Triapenthenol resulted in darker green foliage and at higher concentrations in some leaf distortion. The most attractive plants were produced with triapenthenol concentration of 87.5 mg/pot at the nonshaded plot; they were small with the greatest number of flowers. Chemical name used: \( (E)\)-\((RS)\)-1-cyclohexyl-4,4-dimethyl-2-(1H-1,2,4-triazol-1-yl)-pent-1-en-3-ol (tria penthenol).

Materials and Methods

The investigation took place from June to Nov. 1997 and 1998 in a glasshouse in Attica (lat. 37°48’20”N, long. 23°57’48”E), Greece. The experimental plant material was started from 16 to 18 cm mid-stem cuttings of lantana, each with one leaf pair. Eleven weeks later, rooted cuttings were placed in 1.1-L (14-cm top diameter) plastic pots (one cutting per pot) containing a white peat potting substrate (Klasmann-Deilmann GmbH, Germany). Plants were pruned to a height of 12 cm and transferred to a nonshaded glasshouse. After 4 weeks, the plants received a commercial liquid fertilizer containing trace elements (Comoples Fluid-Agrélor, Hellas Co., Athens, Greece), with 50 mL solution per pot (1 mL per liter of water, 5N–8P–10K). Ten days later the plants were pinched in the second internode from the tips; the experiments started 12 d later (on 24 and 20 June, for 1997 and 1998 respectively) when the new-developing stems had a length of ≈1 cm. No flower buds were present.

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relative humidity and PPF on plant GI change were evaluated by a step-wise multiple regression analysis technique in each treatment. The statistical analysis was conducted separately for each year of the experiments because the measured plant characteristics appeared statistically significant variation among 1997 and 1998, for a number of same treatments, probably due to the different environmental conditions between the 2 years.

Results and Discussion

During the second experimental period the plants presented greater increases to their GI changes and number of flower heads at all plots due to the more advantageous environmental conditions referred to higher values of PPF and temperature.

Significant differences to the changes of the GI and the total number of flower heads per plant among the various triapenthenol concentrations and shading levels were identified (Table 1). Concentration × shading level interaction was significant for both cases.

Treated plants with triapenthenol had smaller changes of GI (Figs. 1a and 2a) than the nontreated ones; this reduction may be attributed to the lower content of their biologically active gibberellic acids induced by triapenthenol application (Rademacher, 1991) compared to nontreated plants. According to Lürssen and Reiser (1987) triapenthenol inhibited gibberellin biosynthesis in vitro between ent-kaurene and ent-kaurenoic acid and may be interfered with both gibberellin and sterol metabolism in plants. Higher triapenthenol concentrations produced smaller plants at all shading levels.

However, the number of flower heads increased with increasing concentrations of triapenthenol up to 87.5 mg/pot, followed by a decrease at higher concentrations (Figs. 1b and 2b), indicating that a saturation point existed above which flowering was decreased. The regulator-treated plants produced more flowers than the nontreated ones which comes to conflict for gardenia treated with triapenthenol at 70, 140, and 280 mg·L⁻¹ (Chronopoulou-Sereli et al., 1998).

Increasing shading from 0% (R₁) to 28% (R₂) reaching 66% at R₃ plot caused generally no significant changes of GI for plants treated with the same concentration of the regulator. On the other hand, the GI of the nontreated plants was increased significantly (Tukey’s hsd test); this could be attributed to plants effort to avoid low light environments, a known feature of shade intolerant plants (Tang, 1997). An inverse relation between light intensity and plant growth parameters was also reported by Sim et al. (1997) on Campanula takesimana, Norcini et al. (1991) on Photinia fraseri and Svenson (1993) on Acalypha hispiliolae plants.

The number of flower heads was significantly decreased for the plants treated with the same concentration of the regulator while

| Source | df | 1997 | 1998 | 1997 | 1998 |
|--------|----|------|------|------|------|
|        |    | GI (cm) | No. of flowerheads | Mean square |      |
| S²     | 2  | 84.75*** | 123.43*** | 4941.70*** | 5066.10*** |
| CT     | 4  | 1370.27*** | 1789.84*** | 4538.56*** | 4043.46*** |
| S × CT | 8  | 41.87*** | 63.43*** | 101.51*** | 135.46*** |
| Error  | 75 | 0.90 | 0.82 | 5.34 | 6.44 |

Table 1. Analysis of variance for effects of shading level and concentration of triapenthenol on the growth index change (GI) and the number of flowerheads/lantana plant for the years 1997 and 1998.

*Significant at P = 0.001.

Fig. 1. Changes of growth index (GI) and number of flowerheads/lantana plant as a function of triapenthenol concentrations (0, 43.75, 87.5, 175, and 350 mg/pot), at the plots R₁, R₂, and R₃. Growth index = (height of tallest shoot + maximum diameter + perpendicular to maximum diameter)/3. Each value is the mean of six replicates. R₁obs, R₂obs, R₃obs, and R₁est, R₂est, R₃est are the measured and estimated GI (a) and flower (b) values, respectively for 1997.

Fig. 2. Changes of growth index (GI) and number of flowerheads/lantana plant as a function of triapenthenol concentrations (0, 43.75, 87.5, 175, and 350 mg/pot), at the plots R₁, R₂, and R₃. Growth index = (height of tallest shoot + maximum diameter + perpendicular to maximum diameter)/3. Each value is the mean of six replicates. R₁obs, R₂obs, R₃obs, and R₁est, R₂est, R₃est are the measured and estimated GI (a) and flower (b) values, respectively for 1998.
for the nontreated ones significant differences were found only between 0% and 66% as well as 28% and 66% shading (Tukey’s HSD test). The great reduction of flowering at R3 plot could be attributed to the strong light exclusion (Muzik, 1976).

The multiple regression analysis showed that minimum temperature and PPF were the most important factors in plant GI change for 1997 and 1998 respectively (data not shown), at all shading levels. Kamoutsis et al. (1998) reported that the maximum temperature was the most important factor in the development of gadenia.

Plants treated with triapenthenol exhibited darker green foliage than the nontreated ones consistent with previous studies (Lürssen and Reiser, 1987). Some leaf distortion was noticed in plants treated with the higher concentrations of the regulator. Kamoutsis et al. (1998) observed wrinkling on the leaves of Gardenia jasminoides treated with triapenthenol.

It is also interesting to note, that the more attractive plants were produced with triapenthenol at the concentration of 87.5 mg/pot at the nonshaded plot; they were small with the greatest number of flower heads, over three times the respective number of the nontreated ones at the same plot.

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