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Micronutrient Content in Relation to Specific Leaf Area, Light Regime and Drenched-Applied Paclobutrazol in *Lantana Camara* L.

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ABSTRACT

Iron and manganese are essential microelements on plant growth but no information is known with regard to their content on *Lantana camara* L. subsp. *camara* (lantana) treated with drenched-applied paclobutrazol. Thus, the effects of drenched-applied paclobutrazol [0 (control), 40, and 80 mg l^{-1}] on leaf iron and manganese contents of lantana plants were investigated testing two light regimes, resulted from the establishment of different shading levels, 0% (daily light quantity of 27.8 mol m^{-2} d^{-1}) and 66% (9.4 mol m^{-2} d^{-1}) in a glasshouse in Attica, Greece. Possible correlations between the studied minerals contents (iron and manganese) and specific leaf area were examined. Analysis of variance showed that iron and manganese contents were affected by shading level, paclobutrazol, their interaction and paclobutrazol, respectively. Iron content increased significantly after treatments with paclobutrazol, compared to control, at full light environment (0% shading). Leaf manganese content presented no significant increase with the increasing paclobutrazol concentrations at 0% and 66% shadings. No significant differences were noted (dispensing control plants) on iron and manganese contents, when examining plants which were treated with the same paclobutrazol concentration, between the studied light environments. From the linear correlation analysis, manganese content exhibited a significant negative correlation with specific leaf area which was not shown by the iron content. The results of the present study could contribute to establishing iron and manganese sufficiency ranges on *L. camara*, especially after treatments with different light environments and paclobutrazol concentrations.

Key words: *Lantana camara*, Paclobutrazol, Shading, Iron, Manganese, Leaf Area.

INTRODUCTION

The genus of *Lantana* comprises ornamental plants with multipurpose uses such as the creation of flower beds, edgings and plant fences[1] which are characteristics of its noticeable position in landscape design[2]. Attractive flowering potted *Lantana camara* L. subsp. *camara* (lantana) plants have been reported after drenched applications with 40 and 80 mg l^{-1} of the growth regulator paclobutrazol (PBZ)[3]. However, no available information exists from literature on the iron (Fe) and manganese (Mn) content of the aforementioned plants, and therefore on their nutrition and subsequently their fertilization with regard to the aforementioned microelements.

Iron is among the most important micronutrients in plant nutrition[4], essential mainly for the young growing parts of plants[5]. Manganese, another essential micronutrient, is involved in several metabolic pathways of plants like photosynthesis[6]. To create and maintain as much as possible a high quality flowering aesthetic lantana plant after PBZ applications, proper fertilization is demanded[7] in both macro- and micronutrient levels.

Shading above plant canopies can alter light availability[8, 9] and environmental conditions, thus influencing plant nutrition[10]. Consequently, the present work aims mainly to investigate the hypothesis of the different Fe and Mn response of lantana plants to different drenched-applied PBZ concentrations and light regimes. Specifically, purpose of our research was the study of the possible effects of 40 and 80 mg l^{-1} PBZ on the leaf Fe and Mn of lantana plants under two light environments resulted from different shading levels (SLs), 0% and 66%. Additionally, an attempt was made to examine possible correlations between the examined micronutrients and lantana specific leaf area (SLA), an informative summary parameter on many aspects in plant metabolism[7], where plant nutrient elements play a key role.

MATERIALS AND METHODS

Lantana plants grown in a glasshouse in Attica (37°48´20´´N, 23°57´48´´E), Greece, were drenched with PBZ (Cultar, 250 g active ingredient l^{-1}, Zeneca, Wilmington, Delaware, USA) solutions of 0 (control), 40 and 80 mg l^{-1} at the rate of 100 ml per pot. At the same time, lantana plants were placed in two plots where different levels of photosynthetic flux density (PFD) were applied, providing two SLs, 0% and 66% according to Matsoukis *et al.*[3, 7].

At the end of the experimental period, 5 months after the beginning, 512 leaves, with no signs of senescence, from each PBZ treatment (consisted of eight plant-replicates) were collected from each SL. The collection of leaves was made from the second to ninth node of the four highest shoots of each plant and their SLA was calculated as described by Matsoukis *et al.*[7]. Sub-samples used for the determination of SLA were also used for the determination of Fe and Mn. Iron was analyzed as previously determined[11, 12] and the same procedure was followed for Mn.

The experiment was carried out according to the two-factor completely randomized design. The first factor had the two examined SLs and the second factor three levels, each corresponding to each applied PBZ concentration (including control). For the mineral element data, means were calculated for each experimental plant and studied variable and used for the analysis of variance (ANOVA). The two (out of eight) extreme means of each PBZ treatment were excluded from the data before the analysis. Due to the non significant interaction of the examined factors with regard to the Mn content, one-way ANOVA was performed to all individual PBZ treatments (comprising control) including both SLs. The means comparison, where appropriate, was made with the aid of the Tukey's HSD test. Additionally, in order to reveal possible relations between each of the studied mineral contents and SLA, a linear correlation (Pearson's) analysis was applied. Statistics was performed using SPSS version 8.0 for Windows and MS Excel 2007. Results were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

The values of important meteorological parameters of the experimental area have been previously determined[7]. The daily light quantity (DLQ) at 66% shading was lower by 18.4 mol m^{-2} d^{-1} compared to 0% shading (27.8 mol m^{-2} d^{-1}) while the mean daily maximum and minimum temperatures were higher to plot with 0% shading (30.4° and 17.5°, respectively). The mean daily relative humidity presented its higher value at 66% shading (70%) without noticeable differences between the shading levels. Both SL and PBZ treatment as well as their interaction affected leaf iron content (Table 1a), as did PBZ treatment on Mn content (Table 1b).

Iron content of lantana plants increased significantly in the cases of the plants treated with 40 and 80 mg l^{-1} PBZ in comparison with the control plants at the full light environment (Table 2a). These increased values (for 40 and 80 mg l^{-1} PBZ) exceeded the percentages of 75% and 71%, respectively. Similarly, leaf Mn content, in general, presented a rising course with the increasing PBZ concentrations irrespective of shading, however, no significant differences were established (Table 2b). Statistically, the greater value of Fe content in PBZ-treated plants (40 and 80 mg l^{-1}) in relation to control at the full light environment, could be attributed to actual changes in uptake and/or allocation of Fe inside the lantanas[13]. Matsoukis *et al.*[11] reported that Fe increased in lantana plants treated with similar sprayed PBZ concentrations (50 and 100 mg l^{-1}) at the same SLs as in our study. Increased leaf Fe and Mn contents have been reported in *Prunus persica* L. Batch trees after treatments with lower drenched-applied PBZ concentrations[10] than those of our study.

Comparing the Fe and Mn content of plants treated with the same PBZ concentration, between the examined light environments (Table 2a and b, respectively), it was found that no significant differences were ensured (except in control plants). The Fe and Mn contents of control plants increased (reaching almost a twofold value) and decreased (by almost 34%), respectively, with the lowering of DLQ, at 66% shading. As regards PBZ concentrations above 50 and 100mg l^{-1}, Fe and Mn contents increased and decreased constantly, respectively (Table 2a and b). It has been reported that the leaf Fe content of lantana increased after applications with 50 and 100 mg l^{-1} spray-applied PBZ as shading increased from 0% to 66%[11]. Also, decreased contents of Mn and Fe were reported in *Swietenia macrophylla* King leaves at 87% shading[14]. Literature, to our knowledge, provides no comparable studies on the effect of shading on leaf Fe and Mn content of drenched-applied PBZ-treated plants. This topic needs to be elucidated.

Table.1: Analysis of variance for (a) effects of shading level (SL) and paclobutrazol concentration (CPBZ) on leaf iron (Fe) and (b) effects of CPBZ on leaf manganese (Mn), on dry matter (DM) basis, of lantana plant

	Fe(a) (μg g-1 DM)			Mn(b) (μg g-1 DM)	
	df	**Mean square**		**df**	**Mean square**
SL	1	15773.21*	-	-	-
CPBZ	2	3748.12*	CPBZ	5	818.67*
SL × CPBZ	2	1923.43*	-	-	-
Residual	30	416.82	Residual	30	183.54

df: degrees of freedom; SL: 0% and 66%; CPBZ: 0, 40, and 80 mg l^{-1} (one-way analysis of variance for Mn in subtable b), ×: interaction, -: not applicable, *: significant at P<0.05.

Table 2: Effect of paclobutrazol (PBZ) concentration (CPBZ) on (a) leaf iron (Fe) and (b) manganese (Mn) content, on a dry matter basis (DM), of lantana plants at the examined shading levels (SLs)

CPBZ (mg l^{-l})	**Fe(a) (μg g^{-1} DM)**		**Mn(b) (μg g^{-1} DM)**	
	0% SL	66% SL	0% SL	66% SL
0	71.00±13.40[a] a[b] a[c]	141.99±12.64 a[b] b	80.00±15.10 a[c] a	52.90±4.71 a[b] b
40	124.80±35.06 b a[c]	149.90±19.76 a a	82.30±11.12 a a[c]	74.60±9.83 a a
80	122.10±16.50 b a[c]	151.60±16.43 a a	85.10±23.90 a a[c]	71.00±7.69 a a

CPBZ: 0, 40 and 80 mg l^{-1}. a:Mean of the treatment±standard deviation, n=6. b: In each column, separately for each examined variable and SL, entries with different letters indicate significant differences as regards to different concentrations of PBZ at P = 0.05 by Tukey's-HSD test. c: In each row, separately for each examined variable, entries with different letters indicate significant differences as regards to different SLs at P = 0.05 by Tukey's-HSD test.

From the results of the correlation analysis between the SLA and each of the examined variables it was found that only the Mn content exhibited a significant (P<0.05) negative correlation with SLA (r=-0.95) which may be justified by the fact that the increase of Mn content coincided, in most cases, with the decrease of SLA and vice versa. No correlation was apparent between Fe and SLA. It has been reported by most of the researchers that SLA[15] as well as plant biomass[16, 17] may be affected by nutrient uptake that is, macro- and micronutrients. Nevertheless, more research is required on the relationships between SLA and micronutrients taking into account the complexity of relations between the micro elements and between them and macro elements.

No visible deficiency symptoms were noticed on our experimental plants for Fe and Mn nutrients while on the other hand, no sufficiency ranges for the aforementioned elements are known, from literature, on *L. camara* plants. In conclusion, from the statistical evaluation of our findings, drenched-applied PBZ seems to affect plant nutrition of *Lantana*, with regard to Fe, only in the full light environment (0% shading). The results of the present study could aid towards the direction of establishing Fe and Mn sufficiency ranges on *L. camara*, leading to its appropriate fertilization trying different light environments and PBZ concentrations in proportion to the availability each time.

REFERENCES

1. Lorenzi H. and Mello-Filho L.E.D., As plantas tropicais de, The tropical plants of R. Burle Marx. Instituto Plantarum de Estudos da Flora Ltda; *Avenida, Brasil*, 504 p. (2001).
2. Naqvi S.A.R., Waseem R., Mahmood N., Hussain Z., Khan Z.A., Shahzad S.A., Yar M., Amin R., Bukhari S.A., Zahoor A.F., Javed S. and Hussain A.I., *Science Asia*, **39**: 340-345 (2013).
3. Matsoukis A.S., Chronopoulou-Sereli A., Dimopoulos I.D. and Kamoutsis A., *Canadian Journal of Plant Science.*, **81**, 761-764 (2001).
4. Vasconcelos M.W., Clemente T.E. and Grusak M.A., Front. *Plant Sci.*, **5**: 1-12 (2014).
5. Papadopoulos A.P. and Hao X., Interactions between nutrition and environmental conditions in hydroponics, In: Savvas D. and Passam H. eds, Hydroponic production of vegetables and ornamentals, Embryo Publications, Egaleo, Greece, 413-445 (2002).
6. Weiland R.T., Noble R.D. and Crang R.E., *Am. J. Bot.*, **62**: 501-508 (1975).
7. Matsoukis A., Gasparatos D. and Chronopoulou-Sereli A., *Chilean Journal of Agricultural Research*, **74**: 117-122 (2014).
8. Bargali K. and Bargali S.S., *J. Environ. Biol.*, **20**: 183-187 (1999).
9. Bargali K. and Singh S.P., *Tropical Ecology*, **36**: 237-247 (1995).
10. Pequerel, A., Monge E., Blanco A. and Val. J., *Acta Hortic.*, **448**: 169-175 (1997).
11. Matsoukis A., Chronopoulou-Sereli A. and Gasparatos D., *Acta Hortic.*, **813**: 615-622 (2009).
12. Gasparatos D., Roussos P.A., Christofilopoulou E. and Haidouti C., *Journal of Soil Science and Plant Nutrition*, **11**: 105-117 (2011).
13. Davis T.D., Steffens G.L. and Sankhla N., *Hortic. Rev.*, **10**: 63-105 (1988).
14. Gonçalves, J.F.D.C., Vieira G., Marenco R.A., Ferraz J.B.S., Junior U.M.D.S. and Barros F.C.F., *Acta Amazon.*, **35**: 23-27 (2005).
15. Karavin N., *Bangladesh Journal of Botany*, **42**: 301-306 (2013).
16. Bargali K. and Bargali S.S., *Current World Environment*, **10**: 494-499 (2015).
17. Bargali S.S., *Journal of Tropical Forest Science*, **7**: 383-390 (1995).