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A TRIAL FOR PRODUCTION OF THE DWARF YELLOW SAGE (*LANTANA CAMARA* L. CV. FLAVA)

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ABSTRACT: In order to produce small-sized, compact and attractive potted models from yellow sage (*Lantana camara* L. cv. Flava), a trial was carried out at the nursery of Hort. Res. Inst., Giza, Egypt during 2022 and 2023 seasons using the growth retardant paclobutrazol (PP-333) at concentrations of 0, 25, 50, 100, 150 and 200 ppm as foliar spray to run-off, twice with three weeks interval in a complete randomized design, replicated thrice. The control plants were sprayed with tap water. Results of this trial showed that a linear decrease in the means of different vegetative and root growth parameters occurred as a result of the progressive increase in PP-333 concentration to reach the minimum by 200 ppm PP-333 treatment, which gave the least records at all in the two seasons. However, 150 and 200 ppm PP-333 treatments were statistically at par with each other for some traits. Also, PP-333 at 25 ppm concentration significantly increased fresh and dry weights of roots over means of control and all the other PP-333 concentrations in both seasons. A similar trend was also obtained regarding No. heads/plant, head diameter, peduncle length and head fresh weight characters. As for No. florets/head at opening stage, it was significantly decreased in the 1st season by 100, 150 and 200 ppm PP-333 concentrations, while in the 2nd one, that was occured by only both 150 and 200ppm ones. After the full open of florets, a great number of these florets was fallen and means of their number/head were gradually decreased with increasing PP-333 concentration, leading finally to a great deformation for the flowering heads, especially by 150 and 200 ppm concentrations. Besides, concentrations of chlorophyll a, b and carotenoids were progressively increased as the concentration of PP-333 was increased, but the opposite was the right concerning the percentages of total soluble sugars. Hence, it can be proposed to repeat this trial again to restore the floret falling problem.

Keywords: growth retardant, paclobutrazol, vegetative and root growth, peduncle length, fresh weight

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INTRODUCTION

Increasing demand for flowering stunted pot-plants, requires us to search for the best new and unique models of these plants. Among these ornamentals that are of great suitable for such purpose may be the Yellow sage (*Lantana camara* L. cv. Flava) which belongs to Verbenaceae fam. It is a perennial, flowering hairy shrub, to 1.2-2.0 m height and form dense thickets, native to tropical America, but now it is distributed in various tropical and sub-tropical environments. In frost free climates, it can bloom all year round, especially when the soil is moist giving small tubular-shaped flowers in flat-topped

heads at the terminal of the stems. Plant as ornamental in a moderate greenhouse and out of doors in summer. Occasionally used medicinally in home remedies. Propagated by seed and also by soft-wood cuttings (Beckett, 1985; Brickell, 1997).

Using the plant growth retardants to limit stem elongation and produce a more branched, compact and floriferous pot-plant proper to decorate home, sunny terraces and small gardens is still the quick, easy and effective way. This truth was, previously documented by LiYun *et al*. (2004) on *Ixora duffii* cv. King Ixora, Grossi *et al*. (2005) on ornamental pepper (*Capsicum chinense* cv. Pitanga), Moraes *et al*. (2005) on ornamental tomato 468 BGH, Shahin *et al*. (2006) on *Rudbeckia hirta*, Jaleel *et al*. (2007) on *Catharanthus roseus*, YuQi and GuangHua (2007) on *Pyracantha fortuneana*, El-Bably (2008) on *Anisacanthus wrightii*, Mateus *et al*. (2009) on ornamental sunflower, Meijon *et al*. (2009) on azalea, Ochoa *et al*. (2009) on *Nerium oleander*, Wanderley *et al*. (2011) on ornamental sunflower, Banon *et al*. (2012) on chrysanthemum, Nicu and Manda (2013) on *Beloperone guttata* and *Plumbago capensis*, Ahmad *et al*. (2014) on sunflower, zinnia, impatiens, marigold and petunia, Shahin *et al*. (2014) on *Chrysanthemum carinatum*, Wanderley *et al*. (2014) on *Arundina graminifolia* orchid, Ahmad *et al*. (2015) on sunflower, zinnia, marigold and petunia, Brito *et al*. (2016) on ornamental sunflower, El-Sadek (2016) on *Hibiscus rosa-sinensis* cv. Yellow, Tawila (2018) on *Celosia cristata*, Zoorman and Karimi (2020) on *Euonymus japonious*, Guimaraes *et al*. (2021) on ornamental sunflower.

However, the current work is an attempt to produce picturesque, compact and wall-branched flowering specimens from yellow lantana plant chemically by growth retardant enough for local marketing in Egypt.

MATERIALS AND METHODS

A trial was conducted under the full sun of the nursery of Hort. Res. Inst., Giza, Egypt throughout 2022 and 2023 consecutive seasons to examine the role of paclobutrazol growth retardant at various concentrations in producing miniature, floriferous and attractive plants from potted yellow sage cv. Flava suitable for local marketing.

Thus, small and uniform seedlings of *Lantana camara* L. cv. Flava at a length of about 15.0 cm were transplanted on August, 15th for each season in 16-cm-diameter plastic pots (one seedling/pot) filled with about 2.3 kg of sandy loam soil. Some physical and chemical properties of the soil used in both seasons were determined and listed in Table (1).

After two weeks from transplanting (on 1st of September), the foliage of plants was sprayed with the aqueous solution of paclobutrazol (PP-333) till the solution was run-off at the concentrations of 0, 25, 50, 100, 150 and 200 ppm. Three weeks later (on September, 21st), the plants received the second spray of the growth retardant used at the same concentrations. The control plants were foliar sprayed with tap water. The experiment in the two seasons was set out in a complete randomized design, replicated thrice as every replicate contained five plants (Mead *et al*., 1993). The different agricultural practices required for keeping the plants freshness were done, as the usually gardener did.

At the end of each season (on November, 5th), the following data were recorded: plant height (cm), stem diameter at the base (mm), number of branches/plant, number of leaves/plant, leaf area (cm^2), root length (cm), as well as fresh and dry weights of top growth and roots (g). Besides, number of flowering heads/plant, head diameter (cm), number of

Table 1. The physical and chemical analysis of the soil used in the two seasons.

Particle size distribution (%)				S.P.	E.C. (dS/m)	pH	Cations (meq/l)				Anions (meq/l)		
Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
73.85	7.10	12.20	6.85	25.73	3.31	8.05	25.7	9.40	38.20	1.42	3.50	24.31	46.91

florets/head either at open stage or after the full open and head fresh weight (g) were also determined. In fresh leaf samples taken from the middle part of the plants, photosynthetic pigments (chlorophyll a, b. and carotenoids, mg/g f.w.) and the percentage of total soluble sugars were measured using the methods described by Sumanta *et al*. (1966) and Dubois *et al.* (1966), respectively.

Data were then tabulated and statistically analyzed using the Assistant Software program of Silva and Azevedo (2016), which was followed by the Duncan`s New Multiple Range t-Test (Steel and Torrie, 1980) for means comparison.

RESULTS

Effect of paclobutrazol treatments on:

1. Vegetative and root growth parameters:

As shown in Tables (2) and (3), a gradual decrement in the mean values of various vegetative and root growth traits was attained as a result of the progressive increment in concentration of paclobutrazol (PP-333) to reach minimum by 200 ppm PP-333 treatment, which gave the least values at all in the two seasons, with the exception of root length (cm) character (Table, 2) that was minimized by 150 ppm PP-333 treatment without significant differences compared to means acquired by 200 ppm one in both seasons. Also, the treatments of 150 and 200 ppm PP-333 were statistically at par with each other for stem diameter trait in both seasons and No. branches/plant in the first one. Likewise, PP-333 treatments at 100, 150 and 200 ppm recorded very close means of roots fresh weight in the second season and of roots dry weight in the first one without significant differences among themselves. Moreover, data presented in Table (3) exhibited that spraying the foliage of plants with PP-333 at 25 ppm significantly increased fresh and dry weights of roots (g) to the highest values over means of control and all other PP-333 concentrations in the two seasons.

2. Flowering parameters:

It is evident from data averaged in Table (4) that means of No. heads/plant, head diameter (cm) and peduncle length (cm) were linearly decreased with increasing PP-333 concentration to be the least by 200 ppm concentration relative to means scored by the other concentrations in the two seasons. Paclobutrazol at 150 ppm level also decreased values of head diameter and peduncle length to means clearly near to those of 200 ppm level. On the other hand, No florets/head at open stage was significantly decreased in the first season by 100, 150 and 200 ppm PP-333 concentrations to 32.00 florets/head without significant differences between the three concentrations, while in the second season means of this character were significantly decreased by only both 150 and 200 ppm concentrations to 33.10 and 32.00 florets/head, respectively with significant difference in between. However, after the full opening of the florets, a great falling for these florets was occurred and means of their number/head were gradually decreased as the concentration of PP-333 was increased compared to control in the two seasons, leading finally to a clear floral deformation for the flowering heads, especially by 150 and 200 ppm concentrations.

Similarly, the mean values of head fresh weight (g) showed a descending decrement with the progressive increment in PP-333 concentration to become minimal by 150 and 200 ppm bevels in both seasons. In the first season, control, 25 and 50 ppm PP-333 treatments achieved greatly near means of head fresh weight, whereas 100, 150 and 200 ppm ones significantly reduced these means to the least with very narrow differences among themselves. In the second season, however all PP-333 treatments decreased values of this attribute with various significance levels.

3. Chemical composition of the leaves:

From data listed in Table (5), it is obvious that a progressive increase in PP-333 concentration was accompanied by a linear one in concentrations of chlorophyll a, b and carotenoids (mg/g f.w.) to reach maximum by 200 ppm PP-333 treatment in the two seasons. The opposite was the correct regarding the

Table 2. Effect of paclobutrazol concentrations on growth traits of *Lantana camara* L. cv. Flava plants during 2022 and 2023 seasons.

PP-333 concentrations	Plant height (cm)		Stem diameter (mm)		No. branches per plant		No. leaves per plant		Leaf area (cm^2)		Root length (cm)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
0.00 ppm	61.76a	64.00a	10.00a	11.00a	6.73a	8.00a	74.50a	80.00a	48.76a	50.00a	38.10a	39.50a
25.00 ppm	55.00b	58.23b	8.50b	9.00b	6.00b	6.67b	58.33b	61.76b	43.20b	44.96b	32.65b	40.00a
50.00 ppm	43.68c	45.16c	8.00b	8.00c	4.00c	5.00c	45.00c	50.00c	38.51c	40.00c	29.00c	33.26b
100.00 ppm	38.10d	39.67d	6.50c	6.50d	3.31d	3.00d	36.73d	40.36d	32.64d	34.78d	26.95d	28.35c
150.00 ppm	32.51e	33.50e	5.33d	5.33e	2.00e	3.00d	32.10e	36.00e	27.33e	28.91e	24.10e	28.00c
200.00 ppm	26.33f	27.63f	5.00d	5.00e	2.00e	2.00e	28.50f	32.10f	20.10f	21.50f	25.00e	28.77c

There`s no significant differences among the means have the same letters according to DMRT at 5 % level.

Table 3. Effect of paclobutrazol concentrations on fresh and dry weights of *Lantana camara* L. cv. Flava top growth and roots during 2022 and 2023 seasons.

PP-333 concentrations	Top growth f.w. (g)		Top growth d.w. (g)		Roots f.w. (g)		Roots dry weight (g)	
	2022	2023	2022	2023	2022	2023	2022	2023
0.00 ppm	46.20a	50.36a	19.10a	20.18a	5.76b	6.13a	2.83b	2.97b
25.00 ppm	39.75b	41.92b	11.25b	12.10b	6.70a	6.34a	3.50a	3.50a
50.00 ppm	30.28c	33.00c	8.50c	8.86c	4.50c	4.72b	2.31c	2.36c
100.00 ppm	22.50d	24.89d	6.33d	6.58d	3.26e	3.51c	1.25d	1.30d
150.00 ppm	13.75e	14.91e	3.85e	4.15e	3.70d	3.38c	1.33d	1.27d
200.00 ppm	10.23f	11.50f	2.76f	2.90f	3.00e	3.26c	1.20d	1.07e

There`s no significant differences among the means have the same letters according to DMRT at 5 % level.

Table 4. Effect of paclobutrazol concentrations on flowering traits of *Lantana camara* L. cv. Flava plants during 2022 and 2023 seasons.

PP-333 concentrations	No. heads/plant		Head diameter (cm)		Peduncle length (cm)		No. florets/head at opening		No. florets/head after full opening		Head f.w. (g)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
0.00 ppm	22.33a	23.58a	3.90a	4.00a	6.25a	6.53a	34.00a	36.00a	31.30a	32.67a	0.61a	0.67a
25.00 ppm	18.76b	19.63b	3.21b	3.38b	5.50b	5.84b	34.31a	35.00a	28.00b	29.00b	0.57a	0.55b
50.00 ppm	16.00c	18.97c	3.00c	3.00c	5.21c	5.33c	34.00a	35.16a	25.50c	26.33c	0.52a	0.53b
100.00 ppm	14.10d	15.33d	2.81d	2.93c	5.00c	5.10c	32.00b	35.00a	23.21d	23.50d	0.46b	0.48b
150.00 ppm	12.50e	14.00e	2.80d	2.85d	4.50d	4.67d	32.00b	33.10b	21.78e	22.10e	0.42b	0.42c
200.00 ppm	8.36f	9.79f	2.63e	2.65e	4.43d	4.56d	32.00b	32.00c	18.73f	20.00f	0.40b	0.43c

There`s no significant differences among the means have the same letters according to DMRT at 5 % level.

Table 5. Effect of paclobutrazol concentrations on pigment and total soluble sugars concentrations of *Lantana camara* L. cv. Flava plants during 2022 and 2023 seasons.

PP-333 concentrations	Chlorophyll a (mg/g f.w.)		Chlorophyll b (mg/g f.w.)		Carotenoids (mg/g f.w.)		Total soluble sugars (%)	
	2022	2023	2022	2023	2022	2023	2022	2023
0.00 ppm	0.648	0.639	0.326	0.351	0.641	0.537	3.769	4.133
25.00 ppm	0.761	0.803	0.367	0.393	0.731	0.765	3.338	3.520
50.00 ppm	0.952	0.979	0.638	0.589	0.848	0.853	3.356	3.335
100.00 ppm	1.072	1.105	0.701	0.710	0.879	0.888	3.008	3.011
150.00 ppm	1.238	1.236	0.816	0.787	0.976	0.991	2.691	2.530
200.00 ppm	1.599	1.636	0.833	0.845	1.058	1.100	2.342	2.187

percentages of total soluble sugars (%), which were gradually decreased in response to the gradual increasing in PP-333 concentration. So, the least concentrations of such constituent were acquired in the first and second seasons by 200 ppm PP-333 level, and immediately followed by 150 ppm level.

According to the previous gains, it can be advised to repeat the current study either with other retardant or other concentrations to reveal a proper solution for the floret falling dilemma.

DISCUSSION

The growth reduction of paclobutrazol-treated plants, especially stem elongation may be attributed to its role in inhibiting the biosynthesis of gibberellins, consequently cell division and enlargement. In this regard, YuQi and GuangHua (2007) repeated that PP-333 at 500 mg/l reduced endogenous GA and IAA concentrations in the leaves of *Pyracantha fortuneana* plant but increased concentration of endogenous ABA. On ornamental tomato 468 BGH, Moraes *et al*. (2005) found that PP-333 up to 30 ppm as a foliar spray reduced plant height, internode length and leaf area, but applying it as soil drench at 16 ppm concentration increased stem diameter. Mateus *et al*. (2009) observed that PP-333 as substrate drench at 0.50, 0.75 and 1.0 mg/l decreased height of sunflower cv. Sunbright Supreme plants giving, more compact plants without any loss of their quality because diameter of their inflorescence was not affected. Besides, Ahmad *et al*. (2014) on potted sunflower, zinnia, impatiens, marigold and petunia, mentioned that PP-333 applied as drench or foliar spray at various concentrations reduced plant height and diameter, fresh and dry weights and total water use for all species. On containerized *Arundina graminifolia* orchid, Wanderley *et al*. (2014) declared that CCC at 2000, 4000 and 6000 ppm concentrations had no effect on the final height and No. shoots, whereas PP-333 at a concentration of 5 ppm was effective in controlling plant height and branching, but higher concentrations (10 and 20 ppm) were toxic to the plants. Brito *et al*. (2016) revealed that plant height, stem diameter, No. leaves and internodes, leaf area as well as fresh and dry weights of shoots, roots and capitulum of ornamental sunflower were significantly decreased when PP-333 was applied as substrate drench at 75 and 150 ppm, while applying it at 300 and 600 ppm reduced the height by 50 % without affecting biomass fresh and dry weights. Likewise, were the results of El-Sadek (2016) on *Hibiscus rosa-sinensis* cv. Yellow and Tawila (2018) on *Celosia cristata*.

The negative effects of Paclobutrazol and other growth retardants may be ascribed to their inhibiting impact on initiation of flower premordia by preventing formation of GA- and cytokinin-like substances in cells of some plant species (Nicu and Manda, 2013). In this concern, El-Bably (2008) pointed out that high concentration of PP-333 (30 ppm) significantly delayed flowering and decreased number and fresh and dry weights of florets in *Anisacanthus wrightii* ornamental plant. On *Chrysanthemum carinatum*, Shahin *et al*. (2014) decided that PP-333 at 100 ppm postponed the bloom and reduced No. inflorescences/plant, inflorescence peduncle and No. ray florets/inflorescence.

The worst negative effect of growth inhibitors is inducing the floral deformation. In this respect, Shahin *et al*. (2006) noticed that cycocel at 3000 ppm caused some deformatesn in the shape of *Rubeckia hirta* flower heads. Besides, Meijon *et al.* (2009) claimed that Alar 85 (daminozide) induced floral deformation in *Azalea japonica* "Blaauw`s Pink". YanHua *et al*. (2011) found that cycocel at 800 ppm was not suitable for dwarfing *Carmona microphylla* plants and showed the worst effect. On *Chrysanthemum carinatum* flowering winter annual. Shahin *et al*. (2014) observed that CCC at 2000 ppm distorted the ray florets.

Such phenomenon may be referred to toxicity caused by chemical retardants at the high concentrations. This fact was documented by Pinto *et al*. (2005) who indicated that cycocel at 2000 and 3000 ppm concentrations showed phytotoxicity

symptoms on *Zinnia elegans* cv. Lilliput plants. Similarly, Wanderley *et al*. (2014) clarified that PP-333 was effective on controlling growth of potted *Arundina graminifolia* orchids at 5 mg/l concentration, but higher ones (10 and 20 mg/l) were toxic and caused death to the new shoots.

However, PP-333 may play a vital role in improving some characters in plants, mainly increasing pigments and many other constituents in the leaves. This was emphasized by Grossi *et al*. (2005) who reported that "Pitanga" ornamental pepper plants sprayed with PP-333 at 30, 60, 90, 120 and 150 ppm had greener leaves than untreated ones. RongHua *et al*. (2012) concluded that spraying leaves of rose "Shijizhichun" with 700 ppm PP-333 or drenching its through roots with 300 ppm PP-333 increased chlorophyll content, improved the photosynthetic efficiency and activity of SOD and POD enzymes and sugars soluble content in the leaves. Nicu and Manda (2012) noticed that treating *Beloperone guttata* and *Plumbago capensis* plants with CCC at 3000 ppm gave the intensive colour of leaves and inflorescences. Likewise, Ahmad *et al*. (2015) demonstrated that PP-333 at 1.0, 2.0 and 4.0 mg/15.2-cm pot maintained darker green foliage for sunflower, zinnia and marigold potted plants. El-Sadek (2016) stated that *Hibiscus rosa-sinensis* cv. Yellow sprayed with 40 ppm PP-333 had higher concentrations of total carbohydrates, indoles and phenols, while 4 ppm PP-333 as drench increased chlorophyll a and b concentrations.

Despite our results exhibited the increased concentration of photosynthetic pigments in the leaves; due to spraying with PP-333, the concentration of total soluble sugars did not remarkably improve. This may be due to decreased number of leaves, consequently minimized surface area of photosynthesis system in the plan.

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محاولة لإنتاج اللانتانا كمارا الصفراء المقَزمة

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لكي ننتج نماذج صغيرة الحجم، مندمجة، رائعة الجمال من اللانتانا كمار الصفراء (*Lantana camara* L. cv. Flava)، أجريت هذه المحاولة بمشتل معهد بحوث البساتين، الجيزة، مصر خلال موسمي ٢٠٢٢ و ٢٠٢٣ مستخدمين مقَّزم النمو الباكلوبيوترازول (PP-333) بتركيزات: صفر، ٢٥، ٥٠، ١٠٠، ١٥٠ و ٢٠٠ جزء في المليون، رشاً على الأوراق حتى تساقط قطرات المحلول، مرتين بفاصل ثلاثة أسابيع في تجربة مصممة تصميماً عشوائياً كاملاً، وبتكرارات ثلاث. تم رش نباتات المقارنة بماء الصنبور. أوضحت نتائج هذه المحاولة انخفاض قيم متوسطات جميع قياسات النمو الخضري والجذري تدريجياً نتيجة للزيادة التصاعدية في تركيز الباكلوبيوترازول لتصل إلى أدنى القيم بمعاملة الباكلوبيوترازول ٢٠٠ جزء في المليون، والتي أعطت أقل القيم على الأطلاق في كلا الموسمين. إلا أن معاملتي الباكلوبيوترازول ١٥٠، ٢٠٠ جزء في المليون كانتا متقاربتين حسابيا (بدون فرق معنوى) في بعض الصفات. أيضاً، فإن الباكلوبيوترازول بتركيز ٢٥ جزء في المليون قد أحدث زيادة معنوية في الوزن الطازج والجاف للجذور أكبر من المتوسطات التي حققتها المقارنة ومعاملات الباكلوبيوترازول الآخرى بكلا الموسمين. ولقد أمكن الحصول على إتجاه مشابه فيما يتعلق بصفات: عدد النورات/نبات، قطر النورة، طول عنق النورة، والوزن الطازج للنورة. أما بالنسبة لعدد الزهيرات/نورة عند التفتح، فقد انخفض معنوياً في الموسم الأول بمعاملات ١٠٠، ١٥٠، ٢٠٠ جزء في المليون. بعد التفتح الكامل للزهيرات حدث تساقط كبير لهذه الزهيرات وانخفض متوسط عددها/نوره تدريجياً كلما زاد تركيز الباكلوبيوترازول مما أدى في النهاية إلى حدوث تشوه واضح للنورات (الروؤس) الزهرية، خاصة بتركيزي ١٥٠، ٢٠٠ جزء في المليون. إضافة إلى ذلك، فإن تركيزات كلورفيللي أ، ب والكارتينويدات قد زاد تصاعديا كلما زاد تركيز الباكلوبيوترازول، بينما كان العكس صحيحاً فيما يتعلق بالنسبة المئوية للسكريات الكلية الذائبة. وعليه، نقترح إعادة هذه المحاولة مرة أخرى بمقزمات وتركيزات جديدة، لعلاج مشكلة تساقط الزهيرات حتى يكون المنتج الجديد صالحاً للتسويق بقيمة جمالية أفضل.