ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Effect of Khellinone Derivatives on Growth and Flowering of *Dianthus Chinensis* L. Plant.

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Manuscript Info

Manuscript History:

Received: 15 August 2015
Final Accepted: 22 September 2015
Published Online: October 2015

Key words:

khellinon derivatives, *Dianthus chinensis*, growth, flowering, chemical, constituents.

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Abstract

This study was carried out in the screen house of National Research Centre, Dokki, Giza, Cairo during two successive seasons (2011/2012 and 2012/2013). The aim of this work was to study the effect of foliar spray with different levels of khellinone dravatives 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one(**I**), 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl) pyridine-3-carbonitrile (**II**) and 7-(5-hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine-2,4(1*H*,3*H*)-dithione(**III**) at the concentrations of 50,100 and 150 ppm on vegetative growth, flowering and chemical constituents of *Dianthus chinensis* plant. Foliar application of all substances treatments 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl) propan-1-one.(**I**), 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4methoxyphenyl) pyridine-3-carbonitrile (**II**) and 7-(5-hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxy- phenyl)pyrido[2,3-*d*]pyrimidine-2,4(1*H*,3*H*)-dithione (**III**) significantly decreased plant height and root length compared with control plant. The highest values were obtained when application of 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one. (**I**) derivative at 100 ppm and 50 ppm of 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxy phenyl)pyridine-3-carbonitrile (**II**) and 7-(5-hydroxy-4,7-dimethoxy benzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine-2,4(1*H*,3*H*)-dithione (**III**) derivatives. Increasing the concentration of 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one (**I**) derivative led to increase the number of branches, fresh and dry weight of shoots. The high significant increased were obtained when the plants treated with 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxy-phenyl)propan-1-one (**I**) derivative at the concentration 150 ppm .Spraying the plants with 150 ppm of 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one(**I**), and 50 ppm of 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine3-carbo-nitrile(**II**) and 7-(5-hydroxy-4,7-dimethoxy benzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine-2,4(1*H*,3*H*)-dithione (**III**) derivatives significantly increased the number of flowers, fresh and dry weight of flowers (g/ plant) copared with control plants. Spraying the Dianthus chinensis plants with1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)-propan-1-one. (I) at the level of 150 ppm resulted in the highest values of chl a, chl b , carotenoids (mg/g F.W.) and total carbohydratesn percentage, while 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile(II) and 7-(5-hydroxy -4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine-2,4-(1*H*,3*H*)- dithione (III) substances spray, showed that the chl. a, chl. b exceeded as a result of spraying the plants with levels at 50 ppm.

Key Words: khellinon derivatives, Dianthus chinensis, growth, flowering, chemical, constituents.

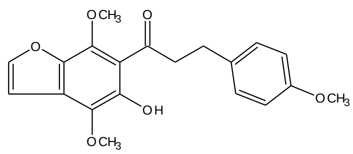
INTRODUCTION

These novel heterocyclic derivatives[1] which syntheized from naturaly occering source(Khelline), have a promising biological activity as anti-bacterial, anti-fungal and antimicrobial[2,3]. This fact promoted us to study their effect on *Dianthus chinensis* L. plant (growth, flowering and chemical constituents).

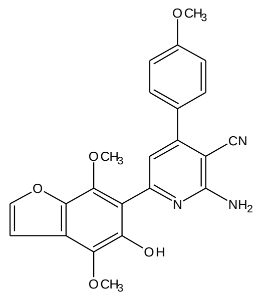
Dianthus chinensis L. (chinese carnation) is a glabra specie, originating from China, with highly branched stems, vigorous and knotty, with components which reach up to 40 cm high. The specie is used for cut flowers, for planting in parks and gardens and as potted plants for the interior decoration or ornamental. Chinese pink flowers are formed on many individual stems with one, or rarely two to three flowers per stem.Their flowers may be fringed solid or bicolor and red, pink, white, or purple in color. When used as bedding plants or pot crops, is treated as annuals, blooming the first year from seed. Annual carnations produce large double blooms on 45 cm (18 in) stems and are traditionally used as cut flowers. Both species provide a showy display of blooms in shades of red, pink or white[4]. The species has been used for over 3,000 years in Chinese herbal medicine and requires well-drained, neutral to slightly alkaline soil and full sun to partial shade. Like most Dianthus, it has a pleasant spicy, floral , clove-like taste and is ideal for decorating or adding to cakes[5,6,7]. The old leaves are crushed and used for clearing eyesight[8] . Dried aerial parts of *Dianthus chinensis* is used in Chinese herbal medicine to promote urination and menstruation, to break up blood stasis and to treat red, sore and swollen eyes[9] .

MATERIALS AND METHODS:

***Dianthus Chinensis* L.**



I



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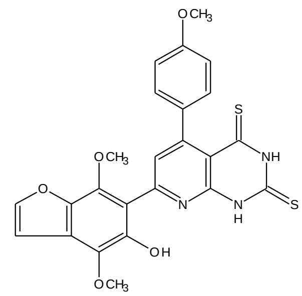


III

I: 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one.
II:2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile.
III:7-(5-hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine -2,4(1*H*,3*H*)-dithione.

This study were carried out in the screen house of National Research Centre, Dokki,Giza, Cairo during two successive seasons (**2011**/**2012** and **2012**/**2013**). Also, compounds **I** , **II**, and **III** were prepared and their structures were confirmed by the elemental analysis and different spectral data[1]. The aim of this work was to study the effect of foliar spray with different levels of Khellinone dravatives**:**1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)- propan-1-one(**I**), 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxy-phenyl)pyridine-3-carbonitrile(**II),** and 7-(5-hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)-pyrido[2,3-*d*]pyrimidine-2,4-(1*H*, 3*H*)-dithione (**III**) at the concentrations of 50,100 and 150 ppm on vegetative growth, flowering and chemical constituents of *Dianthus chinensis*. plant. seedlings were obtained from Egypt green farm ,Giza, Egypt**.** Seedlings (10 cm in length and carry 2 pairs of leaves) were individually transplanted at 15th of November in both seasons in a clay pots (30 cm diameter) filled with 10 Kg growing media consists of clay and sand at ratio of 1:1 (v/v).Each pot were fertilized twice with 1.5gm nitrogen as ammonium nitrate (33.5% N) and 1.0 gm potassium sulphate (48.5%K_2O) and Phosphorus as superphosphate (15.5% P_2O_4) were mixed with media befor transplanting at the rate of 3.o gm/pot. Thirty days later,transplants were sprayed with different concentrations of Khellinone dravatives: 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one(**I**), 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile (**II)** and 7-(5-hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine-2,4-(1*H*,3*H*)-dithione (**III**). in addition to the untreated plants (control) which were sprayed with tap water. Foliar application of 1-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one (**I)**, 2-amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile(**II)** and 7-(5-hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl) pyrido[2,3-*d*]pyrimidine-2,4(1*H*,3*H*)-dithione (**III**) was carried out two times of 15 days intervals, starting mid april in both seasons.The experiments were set in a Completely Randomized Design(CRD) with three replicates.Other agricultural processes were performed according to normal practice. The following data were recorded on 15 November 2012 and 2013 seasons: Plant height(cm),number of branches/plant ,root length(cm), fresh weight of shoot/plant ,dry weight of shoot/plant ,number of flowers/plant and fresh and dry weight /plant. Photosynthetic pigments: including chlorophyll (**a** , **b**) and carotenoids were determind as fresh weight(mg/g.) according to the procedure achieved by[10]. Total carbohydrates percentage were determined according to the method of [11].

Statistical Analysis:
The data were statistically analyzed for each season and compined analysis of the two seasons was carried out according to the procedure outlined by[12] .

RESULTS AND DISCUSSIONS:
Effect on Vegetative Growth:

Data presented in Table(**1**) indicate that foliar application of all substances treatments (**I**,**II** and **III**) on *Dianthus chinensis* plants significantly decreased plant height and root length compared with control plant.The highest values were obtained when application of (**I**) substance at 100 ppm and (**II** and **III**) substances at 50 ppm . The decrement of plant height were (9.44, 2.91 and 3.98%), respectively, while the decrement of root length were (16.17, 30.97 and 43.37%), respectively compared with untreated plants. Our results are in agreement with [13] on marigold,[14]on *Calendula officinalis*L. plant and [15]on *Schefflera arboricola* plants, they reported that foliar application of most paclobutrazol treatments significantly decreased plant height compared with control treatment .The decrease in plant height may be explained as triazol compound blocks the biosynthesis of the active gibberellin GA_1[16] so the morphological response to paclobutrazol is the reduction in internode length and this effect has been observed in herbaceous[17].The remarkable inhibition of plant height may be attribute to the effect of these growth retardants on gibberellins biosynthesis which are anti gibberellin, i.e. prevent the conversion of kaurene to kaurenoic acid which leads to the formation of gibbrellin[18 ,19] . Growth retardrdants tend to reduce the synthesis and action of auxins in plants through enhancing the activity of IAA-oxidase as well as reducing the rate transformation of tryptophan to IAA[20]**.**

Regarding the effect of growth retardants on number of branches, fresh and dry weight of shoots, from the previous results it could be noticed that spraying the plants with the different levels of (**I**,**II** and **III**) substances significantly increased these parameters except (**III**) substance at the concentratios of 100 and 150 ppm . Increasing the concentration of (**I**) substance led to increase the number of branches , fresh and dry weight of shoots. The high significant increased obtained when the plants treated with (**I**) substance at the concentration 150 ppm . The increments were (122.2, 107.5 and 135.8%), respectively compared with control plants. Increasing the concentration of (**I**) and (**III**) substances led to decrease these parameters. Application of (**II**) and (**III**) substances at the concentration of 50 ppm significantly increased number of branches, fresh and dry weight of shoots. The increments of (**I**) substance were (102.7, 76.6 and 101.0 %) , respectively compared with control plants, while the the increament of (**III**) substance were (100.0, 60.,67 and 74.14 %),respectively,compared with control plants. These results were in the same line of the findings of [21] on *Ocimum basilicum*, [22] on *Helychrysum bracteatum* [23] on *Euphorbia pulcherrima* plants,[24] on *Codaeium varigatum*, and [25] on *Jasminum sabac* plants.

The increase in the number of branches as a result of foliar application of growth retardants may be attributed to the high level of cytokinins, accompanied by reducing levels of indole action acetic acid and gibberellins which lead to inhibition of main stem apical dominance [26 , 20]

Effect on flowering:

Among the (**I**) derivative treatment,data presented in Table (**2**) found that increasing the concentrations highly significant increased the number of flowers, fresh and dry weight of flowers (g/plant) of *Dianthus chinensis* plants.The treatment of 150 ppm level of (**I**) substance induced these parameters as equal (94.2, 131.9 and 199.2%),respectively ,attributed to control plant. Data in Table (**3**) reveal that foliar application of (**II** and **III**) substances at 50 ppm treatments on *Dianthus chinensis* plants significantly increased number of flowers/plant, fresh and dry weight of flowers (g/plant) compared with control treatments.Foliar application of (**II** and **III**) substances at 50 ppm gave the highest significant increase in flowering growth compared with untreated plants. In support of these results, significant influence of growth retardants (paclobutrazol) in increasing number of flowers has been experimentally substantiated by [27,28] . Paclopultrazol at 20 mg/plant significantly increased number of flowers in the first and second flush and also total number of flowers/plant, however, fresh and dry weight of flowers/plant were found maximum with 40 mg paclopultrazol/plant drench followed by 20 mg/plant[26]. Also,[13]reported that Paclobutrazol at 10 mg/plant could be applied to enhance flowering.

Effect on Chemical Constituents:

Data in Table (**3**) showed that the chlorophyll **a**, **b** and carotenoids content increased as a result of growth retardants applications at the three levels (50, 100 and 150ppm). The obtained results cleared that spraying the *Dianthus chinensis* plants with(**I**) at the level of 150 ppm resulted in the highest values (chl**a** 1.31, chl**b** 0.92 and carotenoids 0.49 mg/g F.W.), respectively. Regarding the effect of (**II** and **III**) substances spray, data showed that the chl. **a**, chl. **b** exceeded as a result of spraying the plants with levels at 50 ppm and the highest values (1.29,0.60 and 0.40 mg/g) and(1.01, 0.57 and 0.36 mg/g), respectively.The former results were in harmony with the finding[29] on *Epipernnum aureum*[30] on Solanum capsicastrum cv. Melvinii, [31] on *Celosia argent* plants and [15] on *Schefflera arboricola* plants. It should be mentioned here that carotenoids provide photosynthetic system with a method of photoprotection by prevent the formation of free radical oxygen by quenching the triple states of the chlorophyll molecules [32]**.** In the present work the increase in photosynthetic pigments due to application of PP-333 might be attributed to more stimulation of stomatal regulation [33]**.**

Data presented in table (**3**) showed that foliar application of growth retardants increased the total carbohydrates percentage of the leaves of *Dianthus chinensis* plants compared with control plants.

On the other hand, no significant increase was found in carbohydrates percentage when treated plants with different levels of (**I**, **II** and **III**) substances. Application of 150 ppm (**I**) derivative significantly increased the carbohydrates percentage compared with control plants.The increment in total carbohydrates content may be attributed to the increase in photosynthetic process efficiency, which led to increase assimilation of leaf CO_2[34].This effect was previously found by [30] *Solanum capsicastrum* var. Melvinii , [35] on citrus and [15] on *Schefflera arboricola* plants.

Table(**1**): Effect of Khellinone derivatives on growth parameters of *Dianthus chinensis* L. during 2011/2012 & 2012/2013 season.

Characters / Treatments	**Plant height (cm)**	**Number of branches**	**Root length(cm)**	**Fresh weight of shoot (g)**	**Dry weight of shoot (g)**
control	25.40	12.00	17.50	17.80	455
50ppm(**I**)	17.20	21.00	10.17	26.93	7.08
100ppm(**I**)	23.00	24.67	14.67	33.08	9.80
150ppm(**I**)	21.23	26.67	12.17	36.94	10.73
50ppm(**II**)	18.00	24.33	12.08	31.44	9.15
100ppm(**II**)	15.64	22.33	10.17	28.96	8.31
150ppm(**II**)	13.94	20.33	9.50	25.28	6.85
50ppm(**III**)	15.30	24.00	9.91	28.60	8.06
100ppm(**III**)	13.82	14.00	8.50	21.38	5.56
150ppm(**III**)	11.06	1400	7.66	22.65	6.00
L.S.D. at 5%	1.44	3.17	0.56	4.05	1.88

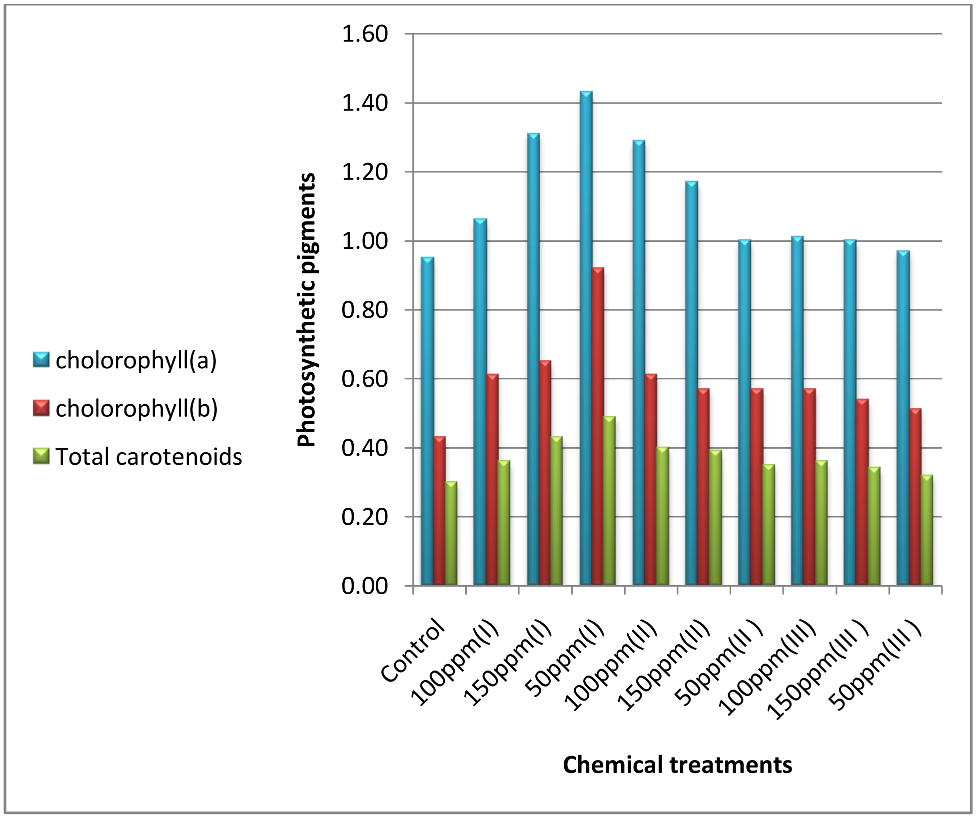
I: 1-(5-Hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one.
II:2-Amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile.
III:7-(5-Hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine -2,4(1*H*,3*H*)-dithione.

Table (**2**):Effect of Khellinone derivatives on flower parameters of *Dianthus chinensis* L. during 2011/2012 & 2012/2013 season.

Characters / Treatments	**Number of flowers**	**Fresh weight of flowers(g)**	**Dry weight of flowres (g)**
Control	17.33	7.82	1.21
50ppm (**I**)	24.00	15.33	2.65
100ppm (**I**)	27.67	16.83	3.32
150ppm (**I**)	33.67	18.14	3.62
50ppm (**II**)	29.00	15.31	2.92
100ppm (**II**)	27.33	15.25	2.85
150ppm (**II**)	23.00	13.11	2.25
50ppm (**III**)	24.00	15.33	1.99
100ppm (**III**)	22.00	12.00	1.94
150ppm (**III**)	19.33	11.98	2.77
L.S.D. at 5%	3.60	2.69	1.99

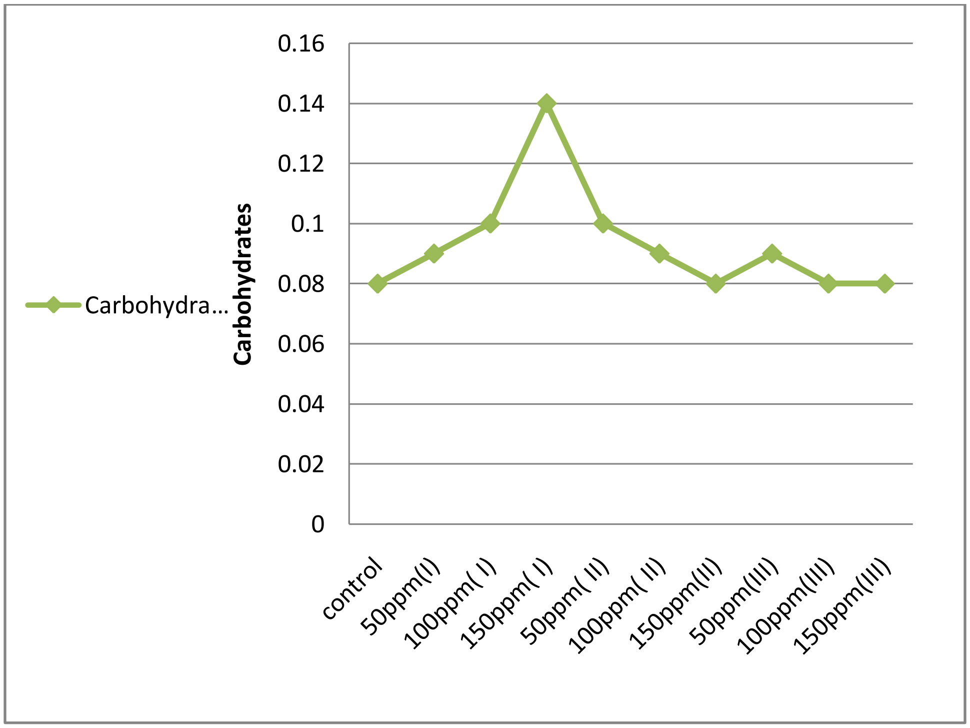
I: 1-(5-Hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one.
II:2-Amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile.
III:7-(5-Hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine 2,4(1*H*,3*H*)-dithione.

Fig (**1**): Effect of Khellinone derivatives on chlorophyll contents of *Dianthus chinensis* L. plant during 2011/2012 & 2012/2013 seasons.



I: 1-(5-Hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one.
II: 2-Amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile.
III: 7-(5-Hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine -2,4(1*H*,3*H*)-dithione.

Fig (**2**): Effect of Khellinone derivatives on total carbohydrates contents of *Dianthus chinensis* L. plant during 2011/2012 & 2012/2013 seasons**.**



I: 1-(5-Hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-3-(4-methoxyphenyl)propan-1-one.
II:2-Amino-6-(5-hydroxy-4,7-dimethoxy-1-benzofuran-6-yl)-4-(4-methoxyphenyl)pyridine-3-carbonitrile.
III:7-(5-Hydroxy-4,7-dimethoxybenzofuran-6-yl)-5-(4-methoxyphenyl)pyrido[2,3-*d*]pyrimidine -2,4(1*H*,3*H*)-dithione.

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