EFFECT OF GROWING MEDIA AND PLANT GROWTH RETARDANTS ON GROWTH, FLOWERING AND CHEMICAL COMPOSITION OF *Helianthus annuus* L. PLANTS

By

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B.Sc. Agric. Sci. (Ornamental Horticulture), Fac. Agric., Cairo Univ., Egypt, 2005

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APPROVAL SHEET

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Title of Thesis: Effect of Growing Media and Plant Growth Retardants on Growth, Flowering and Chemical Composition of *Helianthus annuus* L. Plants
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ABSTRACT

This study was carried out in the experimental nursery of the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, during the two successive seasons of 2007 and 2008. The aim of this study was to investigate the possibility of growing sunflower (Helianthus annuus L.) as a pot plant using different potting media and growth retardant treatments. The plants were grown in 25-cm pots filled with clay, clay+sand, clay+peat or sand+peat, and were treated twice with paclobutrazol as a soil drench at 1.5, 3.0, 4.5 or 6.0 mg a.i./pot, or with Pix as a foliar spray (mepiquat chloride) at 500, 1000, 1500 or 2000 ppm, in addition to an untreated control. The recorded results showed that using clay+peat gave the best results for all the tested vegetative growth and flowering characteristics. Also, plants grown in clay+peat had the highest contents of chlorophyll (a and b) in the leaves, total carbohydrates in leaves and roots, N in the leaves, stems and roots, as well as the highest P contents in the leaves and roots, and the highest K content in the leaves. In most cases, the different growth retardant treatments decreased plant height, whereas other vegetative growth characteristics (number of leaves, leaf area, plant fresh and dry weights) gave different results in the two seasons. The best control of plant height (i.e. the shortest plants) was achieved with using paclobutrazol at 6 mg a.i./pot (in the first season) or Pix at 2000 ppm (in the second season). Growth retardants also decreased flower diameter, but increased the fresh and dry weights of flower-heads. The paclobutrazol and Pix treatments also increased the leaf contents of chlorophyll (a and b) and total carbohydrates, but decreased the carotenoids content in leaves, and the total carbohydrates content in the stems. The N content in leaves was increased by paclobutrazol at 6 mg a.i./pot, and by all the Pix treatments (especially at 1000 ppm), compared to the control. Also, all paclobutrazol and Pix treatments increased the N content in stems and roots, as well as the K content in the leaves, stems and roots. In contrast, raising the application rate of paclobutrazol or Pix caused steady reductions in the P content in leaves. It was concluded that sunflower plants should be grown in clay+peat, and treated with paclobutrazol at 6.0 mg a.i./pot, or Pix at 2000 ppm.

Key words: Sunflower, *Helianthus annuus*, Paclobutrazol, PP-333, Pix, Mepiquat Chloride

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CONTENTS

INTRODUCTION

Sunflower (*Helianthus annuus* L., family: Asteraceae) is an ornamental annual plant that possesses a large inflorescence (flowering head). There are some 70-80 species of *Helianthus*, all native to the new world and the Americas. The term "sunflower" is also used to refer to all plants of the genus *Helianthus*, many of which are perennial plants. The leaves are mostly alternate, egg-shaped to triangular, and entire or toothed. The flower heads are 7.5-15 cm wide (some can reach 30 cm in diameter), have edible seeds, and are formed at the ends of branches. Ray flowers are yellow and disk flowers are reddish-brown. The plant is erect, coarse, tap-rooted, and mostly annual, with rough-hairy stems, 60 cm to 3 m tall. The plants need full sun, and grow best in fertile, moist, well-drained soil with a lot of mulch. Plants grow so rapidly that there is little reason to start seed indoors. Taller varieties should be sited in locations sheltered from strong winds. Sunflower is propagated by seeds, which are sown in early spring.

In general, sunflower is usually grown as a flowering annual for landscape purpose. However, the larger sunflowers can be a little too rangy and coarse for smaller gardens. The biggest sunflowers can be grown in the wildlife garden or behind the vegetable garden. Many of the small cultivars are good in masses in the flower bed or in the annual border with other bright colored flowers. Dwarf cultivars are good in containers, and all sunflowers are good and long lasting as cut flowers. Fast growing sunflowers are favorites with people, and children are fascinated by the bright colors of this easy-to-grow garden giant.

Previous studies have shown that sunflowers in the bud stage exhibit heliotropism, which explains why the flower heads follow the sun. At sunrise, the faces of most sunflowers are turned towards the east. Over the course of the day, they follow the sun from east to west, while at night they return to an eastward orientation. This motion is performed by motor cells in the pulvinus, a flexible segment of the stem just below the bud. As the bud stage ends, the stem stiffens and the blooming stage is reached [Putnam *et al*. (1978), and Pope *et al*. (2001)]. Sunflowers are supposedly allelopathic, their roots give off a chemical that inhibits the growth of other, nearby plants.

Sunflower seeds contain 35-40% oil. They are high in polyunsaturated fat and contain no cholesterol. The seeds are a good source of protein, starch and (especially) calories.

Flowering pot plants represent one of the most interesting and promising typologies of ornamental productions, and frequently new species or products are selected for marketing. The use of sunflower as flowering pot plant, thought quite unusual for this species, could represent a powerful innovation, also in view of the positive trend shown in the last years by the production of sunflower as cut flower. On the other hand, as for any new product, there is a lack of information about the cultivation technique and the appropriate technology for getting best results in producing high quality potted sunflower (Vernieri *et al*., 2003).

Several management practices are used for the production of pot ornamental plants, and among them the use of growth retardants (Bonacin *et al.*, 2006). Triazole salts are synthetic chemicals previously used in the production of horticultural crops as steroidal herbicides. Practically, these retardants are more effective than others, i.e. lower concentration or active ingredient levels are adequate to produce similar effects to higher concentration of other growth retarding chemicals (Law and Hamilton, 1989). Also, the physical and chemical composition of the potting medium used for the production of sunflower as a flowering pot plant may also have a considerable effect on the vegetative growth and flowering characteristics of the plant.

This study was conducted with the aim of investigating the effect of different potting media and growth retardants [Pix (mepiquat chloride) and PP-333 (paclobutrazol)] on the growth, flowering and chemical composition of sunflower (*Helianthus annuus* L.) cv. Sunrich Orange Summer plants. The information provided by this study may help in the successful production of *H. annuus* as a flowering pot plant.

REVIEW OF LITERATURE

1. Effect of growing media

a. Effect on vegetative growth

Devitt *et al.* (1991) found that using composted sewage sludge (at rates of 0, 7.5, 15, 30 or 60% by volume) to amend loamy sand, sandy-loam, or clay had a positive effect on size and growth rate of *Catharanthus roseus* cv. Bright Eyes plants grown in all 3 soils.

Hassan *et al.* (1994) investigated the effect of various growing media containing sand, clay, peatmoss, leaf mould, foam and peanut shells in different combinations on *Cupressus sempervirens* L. seedlings. They reported that vegetative growth was best in the medium containing sand + clay + foam (3:1:1), followed by media containing sand + clay + leaf mould (3:1:1), sand + peatmoss + leaf mould (3:1:1), sand + clay + peanut shells (3:1:1), and the control which consisted of sand + clay + peatmoss (1:1:1).

Lee and Ryu (1996) concluded that the best growth of poinsettias was observed in a substrate containing peat, paddy field soil and sand at a ratio of 4:4:2 by volume.

Yahya and Mohd (1997) grew annual ornamentals (zinnia, celosia, marigold and vinca) in different growing media comprising a range of percentages of coconut dust (coir) and tropical peat (100:0, 75:25, 50:50, 25:75, v/v and 100% peat). Plants grown in 100% peat were the shortest and accumulated the least amount of dry matter.

Mahros (1999) found that a clay + sand medium produced the longest and heaviest stems on *Polianthes tuberosa*.

Shujun *et al.* (2001) investigated the optimum composition of substrates for *Betula platyphylla*, and found that a mixed substrate of peat moss/ perlite/ vermiculite (3:3:3) gave the best plant growth.

Zubillaga and Lavado (2001) studied the effects of different proportions of compost in substrate mixtures on the growth and quality of *Petunia hybrida* and *Vinca sp*. Results showed that for petunia, plant height was highest in the substrate with 75% compost + 12.5% peat, 25% compost + 3.5% perlite, and lowest in peat + perlite. In vinca, plant height and aerial biomass were higher in substrates containing compost than in those without compost.

Barreto and Jagtap (2002) investigated the effect of coco-peat, peat, soilrite, perlite, vermicompost, compost and garden soil in various proportions on pots of gerbera cv. Sangria. They reported that vegetative growth was best in coco-peat alone.

Osman (2002) reported that growing *Nerium oleander* plants in clay increased plant height, whereas using a mixture of clay + sand + peatmoss increased number of branches and decreased stem diameter and root length.

Son and Chae (2003) mentioned that using sphagnum moss resulted in the best growth and flowering of *Spiranthes sinensis* pot plants, while sand and burnt chaff resulted in poor plant growth and was unsuitable for pot plant production.

El Attar (2006) investigated the response of *Ficus allii* cv. Green and cv. Variegata to growing media. The results indicated that using the mixtures of clay +sand + vermiculite, clay + peatmoss + perlite and clay +sand + peatmoss gave the tallest plants. Clay + peatmoss + perlite also gave the thickest stems of the cv. Green, whereas the thickest stems of cv. Variegata were obtained from the mixture of clay + sand + perlite. Using the mixtures of clay +sand + perlite and clay + peatmoss+ vermiculite increased leaf area in cvs. Green and Variegata, respectively. Using clay + peatmoss+ perlite and clay + peatmoss+ vermiculite increased the fresh and dry weight of leaves, stems and roots of both cvs.

Abdel Azeem (2006) investigated the response of *Ruscus hypoglossum* to seven potting media. The results indicated that plants grown in media containing peatmoss and / or vermiculite had the best vegetative growth compared to plants grown in other media. Plants grown in sand + peat (1:1 v/v) were taller, had thicker stems and larger leaves that those grown in the other tested media. Peatmoss produced higher numbers of branches and leaves per plant, and increased the fresh and dry weights of foliage and roots.

b. Effect on flowering

Devitt *et al.* (1991) grew *Catharanthus roseus* cv. Bright Eyes in three types of soil (loamy sand, sandy-loam, and clay) amended with composted sewage sludge at rates of 0, 7.5, 15, 30 or 60% by volume. Composted sewage sludge had a positive effect on size and number of flowers per plant in all 3 soils.

Rensburg *et al.* (1996) found that the yield of chrysanthemum cv. White Reagan was more pronounced in clay loam soil than in sandy soil.

Yahya and Mohd (1997) grew annual ornamentals (zinnia, celosia, marigold and vinca) in different growing media comprising a range of percentages of coconut dust (coir) and tropical peat (100:0, 75:25, 50:50, 25:75, v/v and 100% peat). Marigolds grown in media containing coconut dust produced more flowers than those grown in peat alone. The proportion of coconut dust in the medium did not affect the growth and flowering of vinca plants.

Mahros (1999) planted *Polianthes tuberosa* in pots containing clay alone, clay + sand (1:1 v/v) and clay + sand + peat moss (1:1:1, v/v). Bulbs of plants grown in clay soil recorded the earliest sprouting and flowering, produced the highest yield of flowering stalks and bulbs, and had the best inflorescence quality.

Maloupa *et al.* (1999) evaluated the performance of roses grown in perlite / zeolite mixtures at 100:0, 25:75, 50:50 and 75:25 (v/v) ratios. They found that plants grown on the 25:75 zeolite: perlite medium produced the highest total yield and the largest number of cut roses with a stem length >70 cm.

Klock-Moore (2000) stated that number of *Salvia splendens* flower spikes was significantly greater in substrates containing compost made from biosolids and yard trimmings than in substrates containing compost made from seaweed and yard trimmings.

Barreto and Jagtap (2002) on gerbera cv. Sangria, found that the flower quality, disc diameter and stalk length were superior in pots containing a combination of peat and vermicompost (1:1, v/v). On the other hand, the highest flower yield, with remarkable vase life, was produced by plants grown in coco-peat combined with either compost or vermicompost (1:1, v/v).

Osman (2002) on *Nerium oleander*, mentioned that using a mixture of clay + sand + peatmoss increased number of flowers, whereas adding sand to clay decreased fresh weight of flowers.

Son and Chae (2003) reported that sphagnum moss resulted in better flowering of *Spiranthes sinensis* than sand and burnt chaff.

Papafotiou *et al.* (2004) on *Euphorbia pulcherrima* cv. Peterstar, found that the bract number was significantly reduced only in case of 50% or more peat replacement by olive-mill wastes compost (OWC). Media with 50 and 75% peat replacement delayed the flowering, while plants in the medium with 25% peat replacement showed colour and flowered simultaneously.

c. Effect on chemical composition

Hassan *et al*. (1994) indicated that *Cupressus sempervirens* L. seedlings grown in a medium containing sand + clay + foam (3:1:1) had the highest branch N, P and K contents in the first season and the highest N content in the second season. Total carbohydrates content was highest in seedlings grown in a medium containing sand + clay + foam (3:1:1), and was lowest in a medium containing sand + peatmoss + leaf mould (3:1:1).

Saleh (2000) on *Ficus benjamina* "Starlight", indicated that a mixture of peatmoss + sand + clay resulted in higher total contents of chlorophylls a and b, N, P and K, but gave a lower concentration of carotenoids in the leaves, compared to growing the plants in peatmoss, peatmoss + sand and sand + clay.

Moghazy (2001) stated that a medium containing sewage sludge, farm waste and cement dust at 2:2:1 by volume gave the highest percentages of chlorophylls a and b, as well as total carbohydrates, N, P and K in leaves of *Beaucarnea recurvata*.

Osman (2002) reported that growing *Nerium oleander* in a mixture of clay + peatmoss increased pigments and phenols content in the leaves. Growing the plants in peatmoss increased total carbohydrates in leaves and branches, whereas using clay increased the carbohydrates content in the roots.

El Attar (2006) on *Ficus allii* cv. Green and cv. Variegata, indicated that using mixtures of clay + sand + vermiculite increased chlorophyll content in leaves of both cvs, while clay + peatmoss + perlite and clay +sand + vermiculite increased total carbohydrates in different parts of both cvs. Using clay + sand + perlite increased N content in both cvs, while clay +sand + peatmoss and clay + sand + vermiculite increased K content in both cvs.

Abdel Azeem (2006) indicated that leaf contents of chlorophyll a, b and carotenoids were increased in *Ruscus hypoglossum* plants grown in peatmoss and /or vermiculite (1:1, v/v), while sand or clay reduced leaf pigments content. The highest leaf contents of N, P, K and total carbohydrates were recorded in plants grown in peatmoss alone, or mixed with sand or vermiculite.