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Flower yields of pot marigold (*Calendula officinalis* L.) plants as effected by flowering durations and number of harvests

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Abstract

Pot marigold (*Calendula officinalis* L.) is a medicinal plant used in pharmaceutical and cosmetic industries since ancient times. Today, as well as folk medicine, active ingredients are widely used medicines and pharmaceuticals. Flowers are quite rich in various active ingredients. Flowering durations of pot marigold is greatly influenced by available climate conditions. In this study, fresh and dry flower yields were investigated under ecological conditions of Samsun province. It was observed that flowering continued for about 4 months from the beginning of July until the end of October. A total of 24 harvests were performed throughout the vegetation period. Flower yields increased from the first harvest till the 10th harvest and then a decrease was observed in flower yields through the end of vegetation. The total fresh flower yield was calculated as 328.6 kg/da and dry flower yield was calculated as 56.68 kg/da. The average number of flowers per plant was calculated as 49.11.

Keywords: *Calendula officinalis* L., harvest time, fresh flower yield, dry flower yield

Introduction

Pot marigold (*Calendula officinalis* L.) belonging to *Asteraceae* family has a quite widespread from North America to Asia. Egyptians, Greeks and Arabs have grown pot marigold as an ornamental plant in their gardens and it has been for medicinal purposes since 12th century (Khalid and Silva, 2012) [1]. Pot marigold plants have quite long flowering period, resistant to cold weather and it possible to the flowers from spring to winter. Besides being an ornamental plant, active ingredients make it a significant medicinal plant. Chemical studies revealed various essential oils, carotenoids, flavonoids, terpenoids, coumarins, quinines, carbohydrate, oil, amino acid, and various minor compounds for pot marigold plants (Muley *et al.*, 2009) [2]. With these active ingredients, wound healing, antibacterial, antifungal, anti-inflammatory, antioxidant, immune-stimulant, spasmolytic, anti-carcinogenic effects have been reported in previous studies (Khalid and Silva, 2012; Bashir *et al.*, 2006; Kuppast and Nayak, 2006; Leach, 2008, Varlijen *et al.*, 1989; Efstratios *et al.*, 2012) [1,3-7]. Pot marigold is commonly seen landscapes of Turkey and it is used in folk medicine for various purposes. For instance, in an ethno-botany study carried out around the Uşak University, the tea made of dried pot marigold flowers used to heal liver and gallbladder diseases, stomach diseases, gastritis and ulcer treatment and the cream made from the flowers was used for psoriasis, eczema and fungal diseases like dermatologic disorders (Deniz *et al.*, 2010) [8].

Pot marigold is also known with local names of aynisafa, orange pot marigold, Ox-eye and common pot marigold and grow is almost every part of the country. Plants flower from the beginning of July until winter (70-120 days). Flowers are harvested through defloration and new flowers are formed after the harvest. In other words, continuous flower harvest is possible as long as climate conditions are available. There aren't any studies about flower development and yield of pot marigold plants in Samsun province. Therefore, present study was conducted under ecological conditions of Samsun province to investigate flowering durations, fresh flower yields per harvest and dry flower yields of pot marigold plants and ultimately to put forth the flower yield potential for a growing season of the plants.

Material and Method

Pot marigold (*C. officinalis* L.) seeds used in this study were supplied from Zeytinburnu Merkezefendi Medicinal Plants Garden.

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Experiments were conducted over the experimental fields of Ondokuzmayıs University Bafra Agricultural Research Center. Experimental soils had sandy-loam texture with a pH of 8.1, CaCO₃ content of 21.48%, organic matter level of 1.41%. According to long-term climate data for Samsun province, average maximum temperature is 27.0°C, average minimum temperature is 3.9°C, annual average temperature is 14.4°C and annual average precipitation is 733 mm (Anon., 2016) [9].

Seeds were sown into viols in April 2015 to grow seedlings under greenhouse conditions. In a previous study carried out in Serbia, 40, 50, 60 and 70 cm row spacings were tested in 4 pot marigold cultivars, despite insignificant differences between flower yields of different row spacings, 40x10 cm was recommended for the greatest flower yield (Crnobarac *et al.*, 2009) [10]. In present study, 40x20 cm plant density was preferred. Pot marigold seedlings were planted over 5 meter long 6 rows at 40x20 cm plant density in 3 replications. Average of replications was taken and flower yield per decare was calculated. Half of nitrogenous fertilizer (as to have 10 kg/da nitrogen) was applied at planting (24th of May) and the other half was applied after the first flower harvest. Two of being after fertilizer applications, a total of 5 irrigations were performed. Mechanical weed control was practiced 3 times. Fungicide or insecticide treatments were not performed.

Flower harvest was initiated on 10th of July and continued until the end of October. A total of 24 harvests were performed. In each harvest, plant heights and fresh flower weights were measured and flowers were placed over drying benches. Flowers were dried under shade, dry flower weights were measured and used to calculate dry flower yield per decare.

Result and Discussion

The first harvest was performed on 10th of July and a total of 24 harvests were performed. Until the 19th harvest, harvests were performed twice a week in 3-4 day intervals (Monday-Thursday). In a previous study with 10 kg/da NPK treatments in autumn and 10 kg/da urea treatments in spring, 14 harvests were performed and the greatest yield (642 kg/da) was obtained from 40x10 cm plant density and researchers indicated based on cultivars that the greatest yields were obtained from 6-7-8th harvests (Crnobarac *et al.*, 2009) [10]. In another study carried out in Serbia, a total of 18 harvests (twice a week) were performed (Mrda *et al.*, 2007) [11]. The greatest fresh flower yield was obtained from the 8th harvest (Figure 1). Flower formation slowed down through the end of vegetation. Such a slowdown was also observed in plant height. Progress in plant height stopped after the 18th harvest (Figure 2). Flower harvest was performed in 7-10 day intervals from the 19th until the 24th harvest and the last

harvest was performed on 27th of October (Table 1). As compared to literature data, Samsun province had longer flowering durations.

Flower formation of pot marigold is greatly influenced by climate conditions. Significant differences were reported in number of flowers and flower yields per plant. For instance in previous studies, number of flowers per plant was reported as 20 in New Zealand (Martin and Deo, 2000) [12], as between 70-140 in India (Khalid and Zaghoul, 2006) [13] and as 60 in Lublin, Poland (Krol, 2011) [14]. In another study carried out in Iran about plant density and sowing date, the greatest number of flowers was reported as 28.3 (Berimavandi *et al.*, 2011) [15].

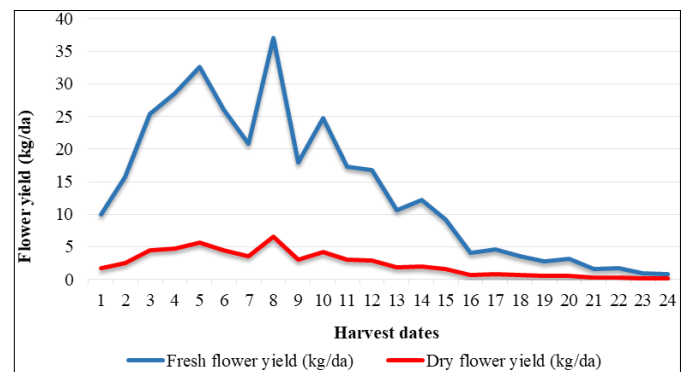


Fig 1: Fresh and dry flower yields of harvests

In present study, total number of flowers per plant was calculated as 49.11. Increasing number of harvests also increased number of flowers. The total of all harvests was taken as the fresh flower yield. The value was calculated as 328.6 kg/da. Flowers were dried under shade and dry flower yield was calculated as 56.68 kg/da (Table 1).

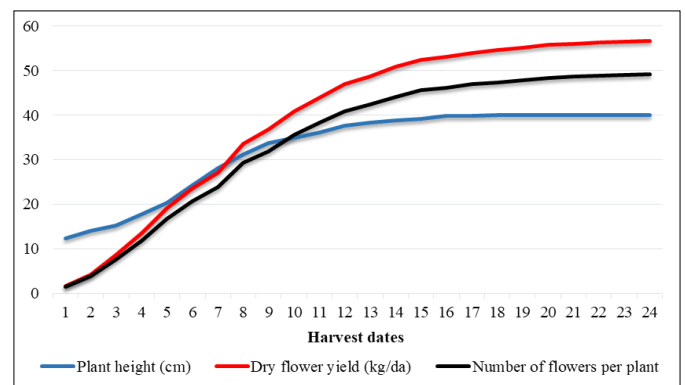


Fig 2: Plant height, dry flower yield and number of flowers of pot marigold plants

Table 1: Plant heights, fresh and dry flower yields and number of flowers per plant of pot marigold plants

Harvest	Harvest Date	Plant Height (cm)	Fresh Flower Yield (kg/da)	Dry Flower Yield (kg/da)	Number of Flowers per Plant
1	10 July	12.4	9.98	1.71	1.51
2	13 July	14.1	15.75	2.5	2.33
3	16 July	15.3	25.45	4.45	3.82
4	20 July	17.7	28.55	4.81	4.24
5	23 July	20.4	32.63	5.63	4.89
6	27 July	24.3	26.02	4.45	3.86
7	30 July	28.2	20.85	3.54	3.19
8	03 August	31.2	37.07	6.56	5.50
9	06 August	33.8	18.01	3.06	2.60
10	10 August	34.9	24.79	4.21	3.70
11	13 August	36.1	17.33	3.03	2.65
12	17 August	37.7	16.80	2.96	2.55

13	20 August	38.3	10.58	1.83	1.53
14	24 August	38.8	12.14	2.06	1.80
15	27 August	39.2	9.24	1.63	1.38
16	31 August	39.9	4.05	0.71	0.60
17	03 September	39.8	4.68	0.79	0.75
18	07 September	40.1	3.56	0.66	0.50
19	11 September	40.1	2.78	0.51	0.50
20	18 September	40.1	3.19	0.62	0.45
21	29 September	40.1	1.65	0.33	0.25
22	05 October	40.1	1.77	0.33	0.26
23	15 October	40.1	0.96	0.16	0.15
24	27 October	40.1	0.77	0.14	0.10
Total			328.60	56.68	49.11

Conclusion

The present study was conducted under ecological conditions of Samsun province. A total of 24 harvests were performed and such a high number of harvests indicated quite available conditions of the province for pot marigold production. High number of harvests also reflected on flower yields. Quite high values were observed both in number flowers per plant and total fresh and dry flower yields.

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