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## THE EFFECT OF CULTIVAR AND STAND DENSITY ON YIELD COMPONENTS AND YIELD OF POT MARIGOLD

### VPLYV ODRODY A HUSTOTY PORASTU NA ÚRODOTVORNÉ PRVKY A ÚRODU NECHTÍKA LEKÁRSKEHO

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Field trial with Pot Marigold (*Calendula officinalis* L.) was conducted in 2008 at experimental field of Institute of Field and Vegetable Crops at Rimski Šančevi (φ 45° 20 N, ë 19° 51 λ), Novi Sad, Serbia. The experimental design was a split-plot arrangement, where the main plots were cultivars and the sub-plot stand densities. There were 4 cultivars: “Bački Petrovac-BP”, “Orange King-OK”, “Plamen-P” and “Plamen Plus-PP” and 4 densities: 20, 30, 40 and 50 plants per square meter. Dry matter content of receptacle, petiole and whole flower was significantly the highest in BP and the lowest in PP. Fresh/dry ratio was in opposite position for receptacle 5.4 and 6.0, for petiole 6.4 and 7.2 and for flower 5.7 and 6.6 respectively. Plant density does not influence dry matter and fresh/dry ratio. Fresh and dry flower yield was the highest in all cultivars at density of 40 plants per square meter. There is no difference between cultivars in fresh; while in dry flower yield of BP cultivar was the highest (1 299 kg.ha<sup>-1</sup>) and P cultivar the lowest (1 082 kg.ha<sup>-1</sup>). Fresh and dry ratio of petal/flower was the highest in PP (50 and 45%) and the lowest in P (37 and 33 %). Those ratios regularly increase with increasing of stand density.

**Key words:** pot marigold, stand density, cultivar, yield, dry matter

*Calendula officinalis* L. – Pot Marigold is a native of the Mediterranean area but is grown widely across Europe as ornamental or for medicinal and even culinary purposes. It produces large numbers of yellow-orange flowers over a long period. In Serbia and Vojvodina province pot marigold is used as a traditional medicinal plant – floral drug.

Use of „natural“ products has dramatically increased interest in medicinal and aromatic plants as food preservatives, pharmaceutical compounds, seasonings, and flavorings (Craker, 1999), among them is calendula, whose production is also increasing. Like other medical plants, crop management of marigold is not studied enough so further agronomic research is needed to ensure that validated crop management guidelines are available to growers if and when large-scale calendula production occurs (Martin and Deo, 2000). It was feasible according to Wilen et al. (2004) and Habán et al. (2010) cultivation of *Calendula* as a dual purpose for seed and flower yield. Accomplished results from commercial production of calendula in Vojvodina, point out to the great possibilities for successful and profitable cultivation of this crop. For those reasons, we chose to research two main cultural practices: plant density and cultivars. The effects of plant density at two widely spread cultivars in Vojvodina and two new cultivars from Czech Republic were investigated. According to the results of Kišgeci (2002) optimal row spacing for marigold is 40 – 50 cm, while Šilješ et al. (1992) as optimal row spacing quote 0.50 – 60 m. According to Martin and Deo (2000) recommended row spacing with commercial seed drills is 0.12 – 25 m, although wider, 0.50 m rows are used for mechanical weeding systems and optimal populations for flower yield was around 46 plants/m<sup>2</sup>. Flower and seed yield were the highest at the maximum investigated 25 plants/m<sup>2</sup> (Seghatoleslami and Mousavi, 2009). Gomes et al. (2007) quote that yields of fresh and dried mass of capitula were not

influenced by densities from 6 – 12 plants per m<sup>2</sup>. Like optimal for oilseed production Smith et al. (1997) suggested a population of 50 – 60 plants per m<sup>2</sup> and Cromack and Smith (1998) and Froment et al. (2002) about 40 plants per m<sup>2</sup>. The aim of this research was to find the best adapted variety and optimal row spacing, concerning petal yield, as the most important medical row material of marigold. These researches will contribute the optimal cultural practices for marigold in Vojvodina province and will also be the beginning of variety specific cultural practice of marigold.

## Material and methods

Field trial with calendula or pot marigold (*Calendula officinalis* L.) was conducted in 2008 at experimental field of Institute of Field and Vegetable Crops at Rimski Šančevi (φ 45° 20 N, λ 19° 51 E), Novi Sad, Serbia. The experiment was on calcareous Chernozem soil type, with good soil properties and followed a crop of sunflower. On autumn (under plough), was applied 100 kg.ha<sup>-1</sup> NPK nutrients (15 : 15 : 15) and in spring (before sowing) 100 kg.ha<sup>-1</sup> of Urea (46% N). The experimental design was a randomized complete block with split-plot arrangement, where the main plots were cultivars and the sub-plot stand densities. There were 4 cultivars: “Bački Petrovac-BP”, “Orange King-OK”, “Plamen-P” and “Plamen Plus-PP” and 4 densities: 20, 30, 40 and 50 plants per square meter. Row distances were 50 cm for all densities. There were three replicates, and plots sizes were 10 m<sup>2</sup>.

Sowing was manually at depth of 2 – 3 cm, with 2 – 3 seeds per hill and in the stage of 3 – 5 leaves were thinned to the single plant. Weed control was by hand weeding. Fully opened flowers in the sampling length (two rows x 3 m) were plucked by

hand, 7 times during vegetation, once a week. In this paper totals of all harvests are shown. Dry matter content, fresh and air dry yield and fresh/dry ratio of receptacle, petiole and whole flower were measured. Analysis of variance of two factor randomized complete block design with split plot done by Mstat C statistical package.

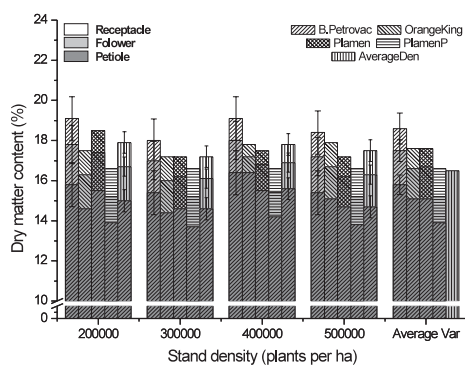
## Results and discussion

Dry matter content (DM) was the highest in receptacle (17.6%) and lowest in petiole (15.0%). At each density and in average for variety in receptacle, petiole and whole flower, DM were significantly the highest in BP and the lowest in PP, while between OK and P there are not differences (Figure 1). Stand densities do not influence DM.

There are no significant differences between varieties in fresh yield of flower and receptacle, but in petiole variety PP had significantly the highest yield. That is because only PP have higher yield of petiole than receptacle, at each density. On an average and at each variety, significantly the highest yield of fresh flower, petiole and receptacle were at density of 40 plants per square meter, while between other densities there were not significant differences (Figure 2).

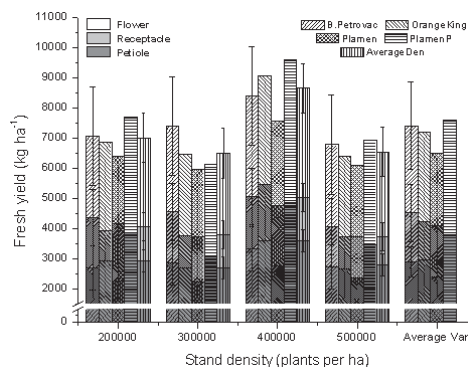
There are no significant differences between varieties in air dry yield of flower and petiole, but the highest flower yield had variety BP (1 299 kg.ha<sup>-1</sup>) and the highest petiole yield variety PP (526.4 kg.ha<sup>-1</sup>). The only significantly lower yield of

receptacle had variety PP. On average for variety, significantly the highest yield of air dry flower, petiole and receptacle were at density of 40 plants per square meter, while between other densities there were not significant differences (Figure 3). It corresponds with results of Kišgeci (2002) for row distance and with results of Martin and Deo (2000), Gomes et al. (2007) and Seghatoleslami and Mousavi (2009) concerning plant number per square meter. Flowers yield of varieties OK and PP were significantly the highest at density of 40 plants while between other densities there aren't significant differences. Variety BP



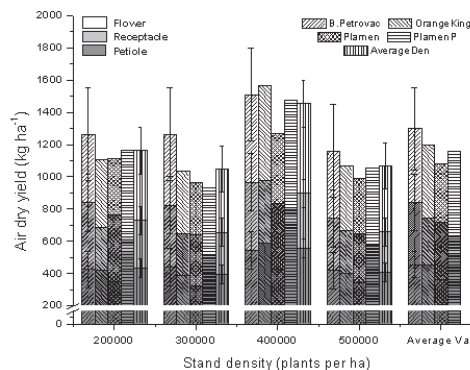
**Figure 1** The effect of variety and stand density on dry matter content of calendula

**Obrazok 1** Vplyv odrody a hustoty porastu na obsah suchej hmoty nechtika



**Figure 2** The effect of variety and stand density on fresh yield of calendula

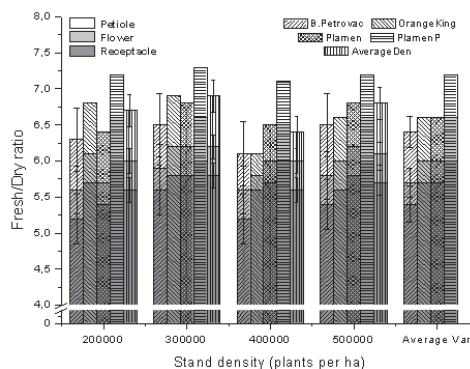
**Obrazok 2** Vplyv odrody a hustoty porastu na úrodu čerstvej hmoty nechtika



**Figure 3** The effect of variety and stand density on air dry yield of calendula

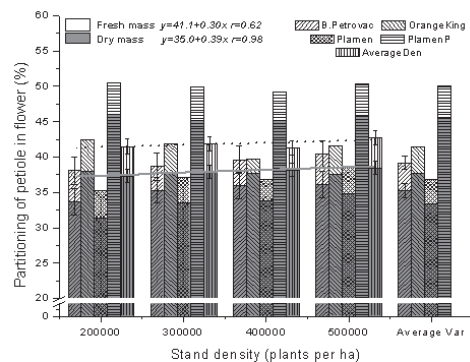
**Obrazok 3**

Vplyv odrody a hustoty porastu na úrodu vzduchom sušeného nechtika



**Figure 4** The effect of variety and stand density on fresh/dry ratio of calendula

**Obrazok 4** Vplyv odrody a hustoty porastu na pomer čerstvej/suhej hmoty nechtika



**Figure 5** The effect of variety and stand density on petiole flower ratio of calendula

**Obrazok 5** Vplyv odrody a hustoty porastu na podiel jazykovitých kvetov na úbore

had only significant lower flower yield at density of 50 plants, while in variety P there were no significant differences. Similarly to flower yield, stand densities and varieties influenced air dry yield of receptacle and petiole.

Fresh/dry ratio present quantity of fresh mass to one weight unit of air dry mass and it mainly depends on dry matter content. Significantly the lowest fresh dry ratio of receptacle, flower and petiole had variety BP, 5.4, 5.7 and 6.4 respectively. Variety PP had significantly the highest ratio of 6.0, 6.6 and 7.2 respectively. Ratio of other two varieties was ranged in this value. On density average only ratio of flower was significantly lower at density of 40 plants. In interaction variety\*density significant difference was in flower fresh dry ratio only, where variety BP had significantly lower ratio at density of 40 plants (Figure 4).

Fresh and dry ratio of petal/flower was significantly the highest in variety PP (50 and 45%) and significantly the lowest in P (37 and 33 %) between them were varieties BP and OK with significant differences too. In average for densities in fresh and dry ratio there were significant differences only between 20 and 50 plants, but those ratios regularly increased with increasing stand density,  $r = 0.62$  and  $0.98$  respectively. Only significant differences of interaction variety\*density was between the lowest and highest densities of fresh and dry petiole/flower ratio of varieties BP and P (Figure 5).

### Conclusions

According to results next conclusions could be made:

- Dry matter content was the highest in receptacle (17.6%) and lowest in petiole (15.0%).
- Dry matter content in receptacle, petiole and whole flower highly influenced by variety (the highest in BP and the lowest in PP) and not by stand density.
- There is no significant difference in fresh and dry flower yield between cultivars, although BP had the highest ( $1\ 299\ \text{kg}\cdot\text{ha}^{-1}$ ) and P the lowest ( $1082\ \text{kg}\ \text{ha}^{-1}$ ) dry yield.
- Fresh and dry flower yield was the highest in all cultivars at 40 plants per square meter.
- Fresh dry ratio of receptacle, flower and petiole was the lowest in variety BP; 5.4, 5.7 and 6.4 respectively and the highest in variety PP; 6.0, 6.6 and 7.2 respectively. Plant density doesn't influence this trait.
- Fresh and dry ratio of petal/flower was the highest in PP (50 and 45%) and the lowest in P (37 and 33 %). Those ratios regularly increase with increasing stand density.

### Súhrn

Poľný pokus s nechtíkom lekárskym bol uskutočnený v roku 2008 na experimentálnej ploche Inštitútu poľných a záhradných plodín v lokalite Rimski Šančevi ( $\varphi\ 45^\circ\ 20\ \text{N}$ ,  $\lambda\ 19^\circ\ 51\ \text{E}$ ), v Novom Sade v Srbsku. Pokus bol založený metódou delených dielcov, pričom odroda bola považovaná za hlavnú parcelku a faktor hustota porastu bol hodnotený v podparcelkách. Hodnotili sa štyri odrody: „Bački Petrovac“, „Orange King“, „Plamen“ a „Plamen Plus“ a štyri hustoty porastu pri 20, 30, 40 a 50 rastlinách na meter štvorcový. Suchá hmota kvetného lôžka, okvetných lístkov a celého kvetu bola preukazne vyššia pri odrode Bački Petrovac a najnižšia pri odrode Plamen Plus. Protichodne bol pomer čerstvá/suchá hmota pre kvetné lôžko v pomere 5,4 a 6,0, pri okvetných lístkoch 6,4 a 7,2, pri kvetoch 5,7 a 6,6. Hustota porastu neovplyvnila produkciu suchej hmoty a pomer čerstvá hmota/suchá hmota. Najvyššia produkcia čerstvej a suchej hmoty kvetov

bola pri hustote porastu 40 rastlín na  $\text{m}^2$ . Nebol zistený rozdiel v produkcii čerstvej hmoty kvetov medzi odrodami, ale úroda suchej hmoty kvetov pri odrode Bački Petrovac bola preukazne najvyššia  $1\ 299\ \text{kg}\cdot\text{ha}^{-1}$  a pri odrode Plamen najnižšia ( $1\ 082\ \text{kg}\cdot\text{ha}^{-1}$ ). Pomer čerstvej a suchej hmoty jazykovitých kvetov úborov bol najvyšší pri odrode Plamen Plus (50 a 45%) a najnižší pri odrode Plamen (37 a 33 %). Tieto pomery pravidelne narastali s narastajúcou hustotou porastu.

**Kľúčové slová:** nechtík lekársky, hustota porastu, odroda, úroda, suchá hmota

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