EFFECT OF ROW SPACING ON CALENDULA (*Calendula officinalis* L.) FLOWERS PRODUCTION

UTICAJ MEĐUREDNOG RAZMAKA NA PRINOS CVASTI NEVENA (*Calendula officinalis* L.)

Jelena MRĐA, B. MARINKOVIĆ, G. JAĆIMOVIĆ

Faculty of Agriculture, University of Novi Sad, Serbia.
Corresponding author: Branko MARINKOVIĆ, e-mail: branko@polj.ns.ac.yu

Abstract: *In experiment which was established in four repetition, we researched the influence of various row spacing (40, 50, 60 and 70 cm - factor A) and two varieties (factor B) on the flowers production and petals yield of pot marigold, and also we determined percentage of petals in totally mass of flowers. Investigation was managed on experimental field in Research institute of field and vegetable crops, on Rimski Šančevi, Novi Sad, Serbia. In average, variety Bački Petrovac was realized higher flowers yield in relation to variety Plamen Plus, for 1061 kgha^{-1}. In average for both varieties, maximum mass of flowers (5379 kgha^{-1}) was realized at 40 cm row spacing. Mass of petals at tested variety, in average for all four row spacing was not significantly different. Petals allotment in totally mass of flowers in average for all row spacing at variety Bački Petrovac was 33,58 %, and it was lower in relation to variety Plamen Plus, in average for 7,53 %.*

Izvod: *U ogledu postavljenom u četiri ponavljanja ispitivan je uticaj različitih međurednih razmaka (40, 50, 60 i 70 cm - faktor A) i dve sorte (faktor B) na prinos cvasti i jezičastih cvetova nevena, a utvrđen je i procentualni udeo mase jezičastih cvetova (latica) u ukupnoj masi cvasti. Istraživanje je izvedeno na oglednom polju Naučnog instituta za ratarstvo i povrtarstvo, na Rimskim Šančevima. Sorta Bački Petrovac u proseku je ostvarila za 1061 kgha^{-1} veći prinos cvasti u odnosu na sortu Plamen Plus. U proseku za obe sorte, najveća masa cvasti (5379 kgha^{-1}) ostvarena je pri međurednom razmaku od 40 cm. Masa latica kod ispitivanih sorti, u proseku za sva četiri međuredna razmaka, nije se statistički značajno razlikovala. Udeo latica u ukupnoj masi cvasti prosečno za sva četiri međuredna razmaka, kod sorte Bački Petrovac iznosio je 33,58%, a bio je niži u odnosu na sortu Plamen Plus, u proseku za 7,53%.*

Key words: *pot marigold, row spacing, variety, flowers production, yield of petals.*
Ključne reči: *neven, međuredni razmak, sorta, prinos cvasti, prinos latica.*

INTRODUCTION

Marigold (*Calendula officinalis* L.) is the species that belongs to the family of *Asteraceae*. Large numbers of the species from this family are applying in horticulture, industry, and some of them have important role in everyday life (spices, salad…). At the same time, some of them, including the marigold, are utilizing as medical plants.

Marigold flowers (*Calendulae flos*) are used as the medical row material. In the shape of tea, flowers are used for treatment of the stomach and intestines diseases, for mouth and throat rinsing. In the shape of cream, flowers are used for injury, swelling, burn and bee stab treatment. Flower essential are using for high blood-fat. Internal, it was used for treatment of inflammation intestine organs. It strengthens the organism immunity. People are using it for making all kinds of laxative tea. In combination with nicotinic acid it is used for tumour therapy. Active subject matter of marigold flowers are: flavonoids, karotenoids, ethereal oils, triterpenic saponosins, kalenduloside, phytoncids, tannins, resins, slime, glycosides, C vitamin and organic acids.

Cultivation of medical plants has advantages in relation to assembling the medical plants from the nature-in the first place there is the production of the pure, flat rate and quality medical raw material. It can be accomplished by choosing the right plant species, right cultivars, soil, with the appropriate practical measures, with the optimal sowing date, the right plant nutrition, harvest, drying… There are more advantages, like the high yield, possibility of the professionally supervision, obtaining the quality row material without additive and impurity. *Calendula officinalis* L. was originated from the Mediterranean region, but it can be cultivated broad wise Europe, often as the decorative plant (Cromack *et al. 1998)*. The same authors indicated various possibilities of marigold utilization: as medical plant, in cosmetic, colour production (for painting). Froment *et al.* (2002) indicated that the marigold is popular also as the oil culture, considering of the high percentage of oil in the seed (17 – 20%).

Marigold cultivation goes forward together with the development of the agricultural science and technology, particularly with the requirement of the quality medical plant raw material. Accomplished results in the production of the medical row material point out to the great possibilities for successful and profitable cultivation in all areas where the appropriate conditions exists.

For those reasons, in our explorations we decided to investigate effects of two important practical measures, which are size and shape of vegetative area and the exact cultivars selection.

The cause of these explorations was to anchor the effects of the row spacing and cultivars at flower and petal yield, as two important medical row material. These explorations will be contributed for the optimal technology (cultivars and optimal density discovering). Also one of the causes was to anchor the cultivars reaction at the size of the vegetative area.

MATERIAL AND METHODS

Investigation was managed on experimental field in Research institute of field and vegetable crops, on Rimski Šančevi, at carbonate chernozem soil type.

Two marigold cultivars were investigated: one native -„Bački Petrovac" (cultivar made by Research Institute of Field and Vegetable Crops from Novi Sad) and one foreign cultivar -"Plamen Plus" (Czech Republic). In the trial conducted in four rehearsals, effects of different row spacing at flower and petal yield was investigated. Percentage of petal mass share in the entire flower mass was established as well.

The trial was conducted as a split-plot system, in four rehearsal, on the parcel size 1000 m^2. Trial fertilization was conducted in autumn (during the primary tillage), with 100 $kgha^{-1}$ of NPK nutrient. Because marigold tolerates low temperatures, sowing was executed during the March. Used row spacing was 40, 50, 60 and 70 cm (A factor) for both cultivars (B factor). Sowing was conducted manual, plant spacing in the each row was 5 cm, and two seeds were put in the soil. In the 3 - 5 leaves phase plants were thin out to final row distance (10 cm). During the vegetation, used practical measures were standard (3 earth up and pest protection). Petal harvest was done manual, 18 times, twice a week. In this paper work results of all harvests are shown. All the results were preceded by appropriate statistical method – analysis of variance of two-factorial trial and all of them are shown in the tables.

RESULTS AND DISCUSSION

Between investigated cultivars, at an average for all four rehearsals and all cultivars, there was statistically significant difference between flower yields (Table 1): cultivar Bački Petrovac accomplished better yields then cultivar Plamen Plus. Flower yield was higher for 1061 $kgha^{-1}$ in 60 and 70 cm row spacing.

Table1

Marigold flower mass (kgha^{-1}) at different row spacing

Row spacing (cm) (A)	CULTIVAR (B)		Average (A)	LSD	0.01	0.05
	Bački Petrovac	Plamen Plus				
40	5792	4965	**5379**	**A**	2147	1494
50	5330	4523	**4926**	**B**	768	548
60	5573	4448	**5011**	**BxA**	1882	1317
70	4626	3142	**3884**	**AxB**	1535	1095
Average (B)	**5330**	**4269**	-			

At an average, the highest flower mass (5379 kgha^{-1}) was accomplished at 40 cm row spacing. However, there wasn't statistically significant difference between this variant and the rest of the row spacing variants (50 and 60 cm). Statistically significant difference between flower yields appeared only between the smallest (40 cm) and the highest (70 cm) row spacing. The yield between these two row spacing was 1495 kgha^{-1} for the benefit of 40 cm.

Cultivar Bački Petrovac accomplished the highest flower yield at the variant with 40 cm row spacing. Referring to the other two row spacing, this difference was not statistically significant.

Cultivar Plamen Plus accomplished the highest flower yield at the variant with 40 cm row spacing. As for the flower yield at 70 cm row spacing, that difference was statistically significant. The other differences were not statistically significant.

Petal mass of all investigated cultivars, at an average for all four row spacing was not statistically significant. The difference between the cultivars was not statistically significant even between the individually row spacing. (Table 2)

Table 2

Petal mass (kgha^{-1}) at different row spacing

Row spacing (cm) (A)	CULTIVAR (B)		Average (A)	LSD	0.01	0.05
	Bački Petrovac	Plamen Plus				
40	1963	2053	**2008**	**A**	732	510
50	1773	1883	**1828**	**B**	290	207
60	1886	1800	**1843**	**BxA**	667	467
70	1541	1288	**1414**	**AxB**	580	414
Average (B)	**1791**	**1756**	-			

At an average for both cultivars, the highest petal mass (2008 kgha^{-1}) was accomplished at 40 cm row spacing. Statistically significant difference between petal masses

appeared only between the smallest (40 cm) and the highest (70 cm) row spacing. The yield between these two row spacing was 594 kgha^{-1} for the benefit of 40 cm. Between the 40, 50 and 60 cm row spacing, individually, there wasn't significant differences.

Important difference in petal mass (765 kgha^{-1}) at cultivar Plamen Plus was accomplished between 40cm and 70 cm, for the benefit of smaller row spacing.

At cultivar Bački Petrovac there wasn't statistically significant differences between yields of individually row spacing.

The smallest petal yield (considering even the fresh flower yield) was accomplished at 70 cm row spacing.

Petal share in the entire flower mass (Table 3), at an average for all four row spacing, at cultivar Bački Petrovac was 33.58%. This petal share was smaller then the share of cultivar Plamen Plus (41.11%), at an average for 7.53%. Similar differences between the cultivars appear within all row spacing. Differences between petal share in the entire flower mass between the individually row spacing were irrelevant.

Table 3

Petal share in the entire flower mass (%)

Row spacing (cm) (A)	**CULTIVAR (B)**		**Average (A)**
	Bački Petrovac	**Plamen Plus**	
40	33.89	41.35	**37.62**
50	33.26	41.63	**37.45**
60	33.84	40.47	**37.15**
70	33.31	40.99	**37.15**
Average (B)	**33.58**	**41.11**	

Marigold production technology in our conditions was not study enough. Large numbers of authors deal only with individual aspects of marigold production technology. For example, Dražić *et al*. (2001) were dealing with temperature and precipitation influence. Belić (2001) and Vujošević (1999) were investigated nitrogen, selenium and zinc fertilization, while Nikolić and Milenović (1996) were dealing with marigold chemical properties. Our row spacing results are in accordance with the results of Kišgeci (2002) and Dražić (2004). These authors quote that the optimal row spacing for marigold sowing are 40-50 cm, while Stepanović (1998) and Šilješ *et al*. (1992) as optimal row spacing quote 50-60 cm.

Adamović (1995), investigated three variants of harvest sowing date at 50 cm row spacing and gained high yield of dry flower mass (1560 kgha^{-1}). Between investigated harvest sowing date variants, there weren't significant yield differences. The same author recommended harvest that will last for five days, as the best for high yield.

Šilješ *et al. (1992)* recommended manual harvest twice a week, wile Stepanović *et al. (2001)* proposed marigold harvest 4 - 5 times in the period of 10 - 15 days. With the harvest like that yield from 0.8-1 t of dry flowers or 0.4-0.5 t of dry petals can be accomplished. Martin and Deo (2000) were investigating the crop density effects and they concluded that the higher yield was accomplished with 332 plants/m^2 (848 g/m^2). There weren't statistically significant differences with 46 plants/m^2. In accordance with this results are results of Cromack *et all* (1998), which induced that density over 40 plants/m^2 had no effect on yield.

CONCLUSIONS

Based on the gained results, the next conclusions can be made:

- The cultivar Bački Petrovac accomplished higher yield then the cultivar Plamen Plus. The yield was higher for 1061 $kgha^{-1}$.
- At an average for both cultivars, the highest flower mass (5379 $kgha^{-1}$) was accomplished at 40 cm row spacing. The only difference in flower yield that was statistically important was the one between the smallest (40 cm) and the highest (70 cm) row spacing.
- Difference between petal masses of all used cultivars, for all 4 row spacing was not statistically significant.
- At an average for both cultivars, the biggest mass of fresh petals (2008 $kgha^{-1}$) was accomplished at the variant with the smallest row spacing (40 cm). This petal yield was statistically significant just referring to 70 cm row spacing.
- The smallest petal yield (including the fresh petal mass yield) was accomplished at 70 cm row spacing.
- In the entire flower mass, average petal share for all four row spacing, for the cultivar Bački Petrovac was 33.58%, and for the cultivar Plamen Plus was 41.11%. It can be concluded that the petal share of the cultivar Bački Petrovac was (at an average) smaller for 7.53%.

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