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VARIABILITY OF MAJOR TRAITS OF MARIGOLD SEED IN RESPECT OF GENOTYPE AND CLIMATIC CONDITIONS

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Abstract: The results of the two-year comparative research of qualitative and quantitative traits of marigold seed of different genotypes in regard to the standard cultivar were analyzed.

The highest yield of seed in both study years was registered in genotype "King orange", and the lowest in genotype "R". Concerning the quality of seed, that is, germination energy and total germination, the best results were established for genotype "King orange", and the poorest for genotype "R" in both study years. The highest absolute mass was registered in domestic cultivar "Domestic orange".

Climatic conditions had great influence on yield and quality of marigold seed. In the first study year, with 2.5 times higher water sediment during the vegetation period, seed yield in all genotypes was higher compared to the second study year. Also, absolute mass of seed of all genotypes was higher in the first study year. However, germination energy and total germination for all genotypes was better in the second year, when the sum of temperatures during the vegetation period was 3758^0C compared to the first year when the sum of temperatures recorded was 3523^0C.

Key words: marigold, genotype, climatic conditions, seed yield, seed quality.

I n t r o d u c t i o n

Marigold (*Calendula officinalis L.*) is decorative and medicinal plant. It belongs to the family of Astercea, sub-family Asteroidea (*Tubuliflorae*) (1). It is

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used more in folk medicine than scientific medicine (2). It contains sufficient amount of active substances, such as: saponosoides, ether oils, flavonides, sterols, polysaccharides, sesquiterpene lactones, etc (3). Some researches point out the fact that marigold extracts (especially extract from leaves) have protective effect from lipoid peroxidation of liposome (4).

In the field of agronomy research there have been studies on the effect of temperature and precipitation on marigold seed yield and quality (5, 10). Also, investigations on the effect of fractions and temperature on germination of marigold seed (6) as well as the effect of fertilization (7, 13) were carried out.

The objective of this study was to demonstrate if and to what extent the variation of marigold seed traits depends on the genotype and climatic conditions.

Material and Methods

In this investigation, seed of the plant species marigold (*Calendula officinalis L.*) was used, and the mentioned seed was grown and multiplied at the Institute of Medicinal Plant Research ¨Dr Josif Pančić¨ from Belgrade. The object of the investigation was genotype "King orange" as well as two new genotypes marked as "C" and "R", and domestic cultivar "Domestic orange" used in this case as control. Trials were set up on the territory of South Banat, on marsh dark soil type, 70 m above sea level. Investigations were carried out in the years 2001 and 2002. In both study years trials were carried out in four repetitions for each genotype and cultivar, surface of main trial plots was 50 m^2. Climatic conditions during vegetation period differed considerably in two study years.

T a b. 1. - Disposition of temperatures in decades, mean daily temperatures and sum of temperatures for vegetation seasons 2001 and 2002 (^{0}C)

Month	Decade I		Decade II		Decade III		2001		2002	
	2001	2002	2001	2002	2001	2002	Average daily	Sum	Average daily	Sum
IV	11.4	8.7	10.3	12.9	15.0	15.8	12.2	365.99	12.5	375.00
V	19.2	19.8	17.8	21.4	20.3	22.7	19.2	593.70	20.7	641.70
VI	17.8	20.2	22.0	24.5	21.4	25.7	20.4	612.18	23.5	705.00
VII	22.7	26.0	26.4	26.5	22.2	23.1	23.7	735.23	25.1	778.10
VIII	27.3	24.3	23.6	21.0	25.4	22.5	24.6	762.53	22.6	700.60
IX	14.4	22.1	14.8	16.9	17.9	16.7	15.2	454.35	18.6	558.00

For all genotypes and cultivars in both years, a direct seeding of marigold seed was carried out in the third decade of April, distance between rows was 70 cm and distance within the row 5 cm. Seeding depth was 4 cm.

During vegetation period, standard methods were carried out, weeds were removed mechanically, without using herbicides. No incidences of diseases were

registered on plants, the presence of harmful pests was not observed. Collecting of seed in both years was carried out in the first decade of September. Seed was dryed naturally until 9% of moisture was reached and additional ingredients were cleaned off. Yield was then measured and samples taken from all repetitions for investigating seed quality. On a precise scales the seed mass was determined and using the usual method (6), on filter paper in Petri dishes and at the temperautre of 20^0C, germination energy (after 7 days) and total germination (after 14 days) were determined in accordance with ISTA standards (9).

T a b. 2. - Disposition of precipitation in decades and total precipitation for vegetation seasons 2001 and 2002 (mm)

Month	Decade						Total precipitation	
	I		II		III			
	2001	2002	2001	2002	2001	2002	2001	2002
IV	44.6	4.1	14.5	26.0	78.3	6.6	137.4	36.7
V	29.0	2.4	23.7	2.8	12.6	10.3	65.3	15.5
VI	55.8	8.1	90.4	6.9	34.1	5.5	180.3	20.5
VII	3.6	5.9	6.2	22.7	14.8	12.1	24.6	40.7
VIII	10.2	49.1	32.5	36.4	9.5	2.6	52.2	88.1
IX	72.9	0.0	98.8	7.2	16.7	64.2	188.5	71.4

The obtained trial results were processed using mathematical-statistical methods (8). Evalution of significance was carried out based on F-test and LSD test for threshold of significance od 5% and 1%.

Results and Discussion

The achieved yield and germination of marigold seed in the investigated genotypes and cultivars, obtained from four repetitions, in both years, at the experimental station in Pančevo, are presented in Table 3.

The highest yield of marigold seed was obtained from genotype “King orange” in both years (571 kg/ha in 2001 and 485 kg/ha in 2002). Somewhat lower yield was established for “Domestic orange” and genotype ”C”, whereas the lowest yield registered was in genotype “R” (186 kg/ha in 2001 and 161 kg/ha in 2001). Seed yield produced by the best genotype concerning this trait – “King orange” was the most compact, with least variations (C_V = 5.36%), whereas the greatest dispersion of yield was established in genotype “R” (C_V = 16.29%). Favorable climatic conditions in 2001, i.e. higher amount of precipitation had positive effect on yield of all genotypes and standard cultivars (Graph 1). In the first study year, seed yields were higher by 9-16% compared to the year 2002. Therefore, the differences in demonstrated trait between years and genotypes indicate statistical significance ($P<0.01$), table 3. Only for achieved yield of

marigold seed of genotype "C" and standard cultivar "Domestic orange" no statistical differences were determined (P>0.05).

T a b. 3. - Parameters of marigold seed yield and quality

Property	Year	Genotype				F-quotient		
		″C″	″King orange″	″R″	″Domestic orange″	Year	Genotype	Year x Genotype
Yield kg/ha	2001	421	571	186	451			
	2002	383	485	161	400	16.911**	252.837**	0.386^{NZ}
	$\overline{X}$	402	501	173.5	425.5			
	Cv (%)	7.55	5.36	16.29	8.62			
Mass of 100 seeds,g	2001	0.634	0.729	0.753	0.770			
	2002	0.616	0.720	0.736	0.757	1.098^{NZ}	20.827**	0.020^{NZ}
	$\overline{X}$	0.625	0.724	0.745	0.764			
	Cv (%)	4.80	498	6.50	3.51			
Germination energy (%)	2001	75.00	82.25	71.50	78.25			
	2002	78.25	85.50	75.75	79.25	4.710*	10.174**	0.258^{NZ}
	$\overline{X}$	76.62	83.88	73.62	7875			
	Cv (%)	3.48	6.60	4.47	4.59			
Total germinat. (%)	2001	76.50	84.75	72.75	79.75			
	2002	79.25	86.75	76.25	80.50	2.726^{NZ}	12.042**	0.185^{NZ}
	$\overline{X}$	77.88	85.75	74.50	80.12			
	Cv (%)	3.32	5.90	4.48	4.74			

Source of variation	LSD	Year	Genotype	Year x Genotype
Yield	0.05	18.3198	25.9081	36.6396
	0.01	24.8258	35.1090	49.6517
Mass of 100 seeds	0.05	0.0280	0.0395	0.0559
	0.01	0.0379	0.0536	0.0758
Germination energ.	0.05	2.7937	3.9509	5.5874
	0.01	3.7858	5.3539	7.5716
Total germination	0.05	2.8125	3.9774	5.6250
	0.01	3.8113	5.3900	7.6226

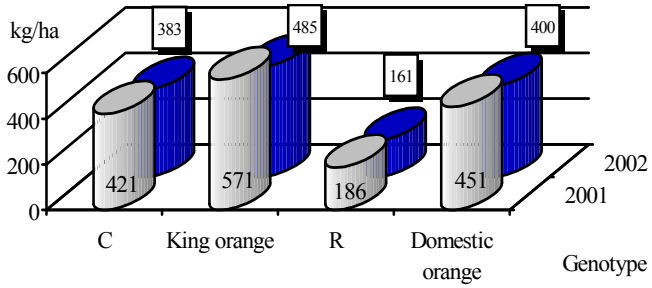
^{NZ} Stat. non significant
* Significant at the level of 5%
** Significant at the level of 1%

The obtained results are in accordance with numerous similar researches worldwide and in our country (5, 10, 11, 12).

The obtained results regarding the achieved average absolute mass of marigold seed of different genotypes in both years demonstrate equal variability and high level of homogeneity ($3.50\% < C_V < 6.50\%$).

Based on the obtained data, average mass of 100 seeds varied from 0.625 to 0.764 g. Genotype "C" produced seed of the lowest mass (0.625 g), whereas the other genotypes had approximately the same mass of seed; for instance, in

genotype “King orange” mass of 100 seeds was 0.724 g, in genotype “R” 0.745 g, and in standard cultivar “Domestic orange” 0.764 g. Therefore, the cultivar with the lowest yield – “Domestic orange” - had the highest absolute seed mass. The results of investigation also demonstrate that average value of this analyzed trait of seed quality for the seed of genotype “C” was significantly different compared to other genotypes ($P<0.01$). Differences between other genotypes demonstrated no statistical significance ($P>0.05$).



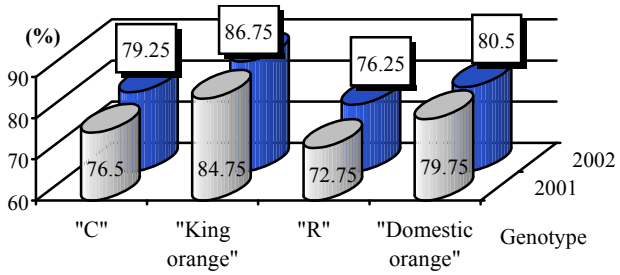
Graph 1. - Average yield of marigold seed of investigated genotypes in 2001 and 2002 (kg/ha)

Climatic conditions (precipitation and sum of temperatures) had no significant influence on seed mass; therefore, average masses in study years were approximately the same. Differences established in regard to this trait between years were of no statistical significance ($P>0.05$).

The obtained results regarding average values for germination energy of marigold seed show slight dispersion of seed material samples of different genotypes ($3.50\%<C_V<6.60\%$). However, the same indicator of seed germination ability demonstrated great differences between years and investigated genotypes and standards. In the second study year (2002), considerably greater germination energy was registered for all genotypes, on average 1-5%, therefore statistical significance on the level of reliability of 95% was determined (table 3). Seed of “King orange” genotype demonstrated the greatest germination energy, on average in both study years 83.8%, whereas seed of genotype “R” had the lowest germination energy (on average 73.62%). Recorded data indicate statistically highly significant differences in values of germination energy between genotype “King orange” and other genotypes as well as genotype “R” and standard cultivar “Domestic orange” ($P<0.01$), table 3.

Total germination of marigold seed indicates similar absolute and relative variability of previous indicator of germination ability, germination energy, (table 3) and varies in the interval between $3.32\%<C_V<5.90\%$. Value of this indicator in the first study year (2001) was somewhat lower in all genotypes (from 72.75% to 84.75%) compared to the value obtained for the second study year (from 76.25%

to 86.75%). Therefore, the obtained results indicate the absence of significant differences in average values for total germination of marigold seed between years (P>0.05), table 3.



Graph 2. - Total germination of marigold seed of investigated genotypes in 2001 and 2002(%)

Seed of genotype “King orange”, in both study years, demonstrated the greatest total germination (84.75% in 2001 and 86.75% in 2002). Seed of genotype “C” and standard cultivar “Domestic orange” have approximately similar value of total germination (77.88% - genotype “C”, and 80.12% - “Domestic orange”). The lowest value of total germination was established for the seed of genotype “R” (72.75% in 2001 and 76.25% in 2002). The obtained differences in average values for the indicator of total germination are statistically very significant ($F_{uz}>F_{0.01}$). Very significant differences in total germination of seed were also established between the seeds of genotype “King orange” and other genotypes, as well as genotype “R” and standard cultivar “Domestic orange” (P<0.01).

Interaction of analyzed factors (year and genotype) in all investigated traits of seed yield and quality (seed yield, absolute mass of 100 seeds, germination energy and total germination) demonstrated no statistical significance (P>0.05), table 3.

The results of the investigation of marigold seed quality show no significant deviation from the results of previous investigations (6).

C o n c l u s i o n

Based on the carried out research and analysis of obtained results the following can be concluded:

- Genotype “King orange” had considerably higher seed yield compared to other genotypes and standard cultivar.
- Genotype “R” had considerably lower yield compared to standard cultivar.
- Climatic conditions (higher precipitation) in the first study year influenced higher seed yield in all genotypes.

- "King orange" had the best seed quality (germination energy and total germination), and genotype "R" the poorest seed quality.
- Seed quality (germination energy and total germination) of all genotypes was better in the second study year.
- The greatest absolute mass of seed was established for standard cultivar "Domestic orange".
- Absolute seed mass of genotype "C" was lower than absolute masses determined for all other investigated genotypes.
- Absolute seed mass of all genotypes was higher in the first study year.

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VARIJABILNOST VAŽNIJIH OSOBINA SEMENA NEVENA U ODNOSU NA GENOTIP I KLIMATSKE USLOVE

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R e z i m e

Analizirani su rezultati dvogodišnjeg uporedog istraživanja kvalitativnih i kvantitativnih osobina semena više genotipova nevena u odnosu na standardnu sortu.

Najveći prinos semena u obe eksperimentalne godine zabeležen je kod genotipa ″King orange″ a najmanji kod genotipa ″R″. U pogledu kvaliteta semena, odnosno energije klijanja i ukupnog klijanja, najbolje rezultate dao je genotip ″King orange″ a najslabije genotip ″R″ u obe godine istraživanja. Najveću apsolutnu masu imalo je seme standardne sorte ″Domaći oranž″.

Klimatski uslovi imali su velikog uticaja na prinos i kvalitet semena nevena. Tako je u prvoj godini istraživanja, kada je u vegetacionom periodu bilo 2,5 puta više vodenog taloga, prinos semena svih genotipova bio veći u odnosu na drugu godinu. Takođe, i apsolutna masa semena svih genotipova bila je veća u prvoj godini istraživanja. Međutim, energija klijanja i ukupno klijanje bili su kod svih genotipova bolji u drugoj godini istraživanja, kada je suma temperatura u vegetacionom periodu bila 3758^0C, u odnosu na prvu godinu istraživanja kada je ista suma iznosila 3523^0C.

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