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Genetic Variability Studies in *Calendula officinalis* Plant

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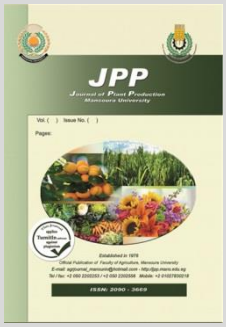

ABSTRACT

The experiment was conducted at the empirical field of the Aromatic and Medicinal Plants, Faculty of Agriculture, Mansoura University. Twelve genotypes of *Calendula officinalis* were assessed for flowering, vegetative, and chemical attributes to study some of their genetic parameters; *i.e.*, heritability, variability, genotypic coefficient of variance (GCV) and phenotypic coefficient of variance (PCV). The maximum values of GCV and PCV were recorded for plant height, number of inflorescences/ plant, number of branches/ plant, chlorophyll A, chlorophyll B, and carotenoids. The highest values of heritability were recorded for chlorophyll A, chlorophyll B, and carotenoids. While, moderate values were recorded in plant height and numbers of inflorescences and branches number per plant. The highest genetic advance percent of mean was restricted for plant height, number of inflorescences and number of branches, as well as chlorophyll A, chlorophyll B, and carotenoids. As a result of the additive gene action, the data are high in genetic advance as percent mean and heritability.

Keywords: Calendula officinalis - Variability - Heritability - Genetic advance

INTRODUCTION

Calendula officinalis L. (pot marigold) belongs to family *Asteraceae*, the Mediterranean region is habitat to *Calendula*, it is an annual herb with bright or yellow to orange flowers (Mohammad *et al.*, 2011). *Calendula officinalis* L. is essential ornamental plant utilized for landscaping as a source of color within gardens (Azzaz and El-Emarey, 2007). It is a herb of old therapeutic utilized in conventional and homeopathic pharmaceuticals (Bernatoniene *et al.*, 2011). Its flowers are widely appreciated for their therapeutic properties throughout the world (Paim *et al.*, 2010). They are utilized for therapeutic or culinary purposes (Ahmed and Zaghloul, 2006). Dray composite flowers and herb of *Calendula officinalis* are collected amid the blossoming period for utilized in therapeutic items (Bernatoniene *et al.*, 2011). It is cultivated for its flowers with or without receptacles (Mohammad *et al.*, 2011). It can be used as a natural colorant because its inflorescences contain two classes of carotenoids, flavonoids, and pigments. Natural colors have been getting great attention, studies concerning the safety of synthetic colorants showed risks in the use of some of these substances giving rise to carcinogenic allergic and toxic effects (Ahmed and Zaghloul, 2006). Dyes made from these flowers are safer than synthetic dyes, which showed risks for use in medicinal or culinary purposes (Elhindi, 2012). Colors of blossoms are utilized in nourishment coloring (Azzaz and El-Emarey, 2007).

Plant breeding is the science of changing the characteristics of plants to deliver wanted characteristics. It has been utilized to progress the quality of sustenance for people and creatures. Plant breeding can be performed through numerous diverse methods; selection is one of the major techniques of plant breeding. Selective breeding (artificial selection) is the process by which humans use plant breeding to selectively develop particular phenotypic traits (characteristics) by choosing which typically plant (Poehlman and Sleper, 1995). However, the objective of this study was to investigate the variability in some marigold genotypes to start a breeding program for improve this plant. At the same time, an attempt will be made to develop new inbred lines that have a staple and homogenous flower.

MATERIALS AND METHOD

The experiment was conducted at the empirical field of Aromatic and Medicinal Plants, Faculty of Agriculture, Mansoura University during the two consecutive winter seasons of 2016/ 2017 and 2017/ 2018. This study aimed to investigate the variability in twelve marigold genotypes to start a breeding program for improve this plant. At the same time, an attempt will be made to develop new inbred lines that have a staple and homogenous flower.

I- Plant Material:

Calendula officinalis seeds were received from the Aromatic and Medicinal Plants Field, Fac. Agric., Mansoura Univ. For the two experimental seasons, seeds were sown in the nursery on 15th September. Then 45 days after seed sowing, when the seedlings were averaged 10 cm in height and developed six leaves, plants were transplanted on rows in the experimental field.

II- The Procedures

On 2016/ 2017 winter season, plants were transplanted in experimental area contained 30 rows. The distance between plants on row was 30 cm and rows were 50 cm apart. At flowering time, 12 genotypes were selected and their inflorescences were covered for

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encourage self-pollination to produce S_0 seeds. Seeds of each selected plant (genotype) were separately collected.

In the next winter season (2017/ 2018), seeds of all selected plants (12 genotypes) were planted separately at the same distances as in the first season (Seeds of each plant planted in 3 separate lines), then 4 plants per line were selected and their inflorescences were covered to self-pollination for production S_1 seeds.

All the recommended agronomical and plant protection practices of marigold plant commercial production were made during the two seasons.

III- Studied Traits and genetic parameters

The 12 genotypes were evaluated and the perceptions were recorded for different vegetative, flowering, and chemical characteristics viz. number of branches/ plant, plant height (cm) and number of inflorescences/ plant as well as contents of chlorophyll A, chlorophyll B and carotenoids in petals tissues. Where, Plant height was measured for all selected plants at the end of growth. The measurement started from soil to the most elevated fluorescence, number of branches/ plant and number of inflorescences/ plant were measured at the end of growth. As for chlorophyll A, B and carotenoids (mg/g fresh weight) in petals tissues were estimated according to the procedure described by Mazumdar and Majumder (2003).

The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) as percentages were calculated according to the method of Burton and De Vane (1953). Heritability in the broad sense (h^2b.s) characterized as the extent of the genotypic variation to the aggregate variance (phenotypic variation) was assessed by utilizing the equation given by Hanson *et al.*, (1956). the predictable genetic advance as a percent of the mean for every studied trait was anticipated using the equation given by Johnson *et al.*, (1955).

Statistical analysis:

Collected data were subjected to statistical analysis of variance utilizing the costat software program. Means were compared using least significant difference test at 0.05 probability level according to the method described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Data in (Table 1) shows the mean performance of twelve *Calendula officinalis* genotypes. Where, genotype (T9) recorded the highest values in most of the traits such as number of branches/ plant, plant height (cm), number of inflorescences/ plant and carotenoids, while genotype (T 10) recorded the highest values in chlorophyll A, chlorophyll B.

In each breeding program, the variability is the essential factor for selection because variability probably utilized for the selection strategy. To get it the degree to which the watched varieties are due to hereditary variables, the extend, mean, phenotypic coefficient of variety (PCV), genotypic coefficient of variety (GCV), heritability (h^2), and genetic advance as percent mean (GAM) was worked out and are submitted in (Table 2) and (Fig 1, 2). Within submit consider, the rating of **(**PCV) was high than their comparing **(**GCV) for each trait. The greatest esteem of (GCV) and phenotypic coefficient of variety **(**PCV) were recorded for Chlorophyll A (27.52% and 29.9% respectively), Chlorophyll B (27.52% and 29.9% respectively), Carotenoids (80.31% and 81.97% respectively), number of inflorescences/plant (18.50% and 25.11% respectively), number of branches/plant (13.15% and 22.77% respectively) and plant height (8.51% and 11.98% respectively). For all the parameters, the estimating of (PCV) was greater than (GCV) refer to the function of environmental agents for the expression of these characteristics. However, apart from Chlorophyll A, Chlorophyll B, and Carotenoids the difference between phenotypic coefficient variance and genotypic coefficient variance was very less for the rest of the characters, an indication of the evidence that traits are not considerable influencing by the ecological impact. This moreover proposes the presence of adequate genetic variability, which can be exploitable by practicing pure line selection. The results are following the findings of also reported similar finding Gobade *et al.*, (2017), Giri *et al.*, (2019) and Patil *et al.*, (2019).

Table 1. Mean performance of twelve *Calendula officinalis* genotypes

Traits Genotypes (T)	Plant height (cm)	Branches No/ plant	Inflorescences No/ plant	Chlorophyll A mg/g fw	Chlorophyll B mg/g fw	Carotenoids mg/g fw
T1	55.25	5.92	37.67	0.88	.86	0.78
T2	55.33	4.50	36.67	0.58	.60	0.19
T3	55.83	5.58	56.42	0.56	.50	0.09
T4	59.17	5.17	56.42	0.58	.60	0.05
T5	68.17	6.58	54.92	0.45	.49	0.32
T6	67.92	7.25	50.83	0.47	.45	1.29
T7	64.17	5.83	48.83	0.89	.90	0.12
T8	62.75	6.00	50.08	0.51	.51	0.75
T9	70.58	7.83	58.75	0.47	.48	1.39
T10	63.25	7.00	46.33	0.98	.99	0.30
T11	52.17	5.42	33.33	0.80	.80	1.31
T12	57.67	4.75	46.42	0.74	.73	0.68
General Mean	61.02	5.99	40.06	0.66	.66	0.61
LSD at 5 % level	8.72	1.89	11.51	0.05	.05	0.17

Table 2. Heritability, variability, and genetic advance for some studied traits of *Calendula officinalis* genotypes

	Plant height (cm)	Branches No/ plant	Inflorescences No/ plant	Chlorophyll A mg/g fw	Chlorophyll B mg/g fw	Carotenoids mg/g fw
$\sigma^2 G$	26.94	0.62	54.93	0.033	0.033	0.24
$\sigma^2 E$	26.50	1.24	46.22	0.001	0.001	0.01
$\sigma^2 P$	53.44	1.86	101.15	0.034	0.034	0.25
$h^2_{(b.s)}$ (%)	50.41	33.33	54.31	97.06	97.06	96.0
GCV (%)	8.51	13.15	18.50	27.52	27.52	80.31
PCV (%)	11.98	22.77	25.11	27.9	27.9	81.97
GA	7.59	0.94	11.25	0.37	.37	0.99
GA as a percent of the mean (%)	12.44	15.69	28.08	56.06	56.06	162.30

The genotypes appeared high heritability for most of the characteristics, and it was extended from 33.33 and 79.06 percent. The highly broad-sense heritability was registered for Chlorophyll A and Chlorophyll B the same result (97.06%). Carotenoids come after them with a slight difference (96%). The moderate value of heritability is recorded for the number of inflorescences/plants (54.31%), plant height (50.41%), and also the number of branches/plant (33%).

Highest genetic advance percent of mean was registered for Carotenoids (162.30%), Chlorophyll A, Chlorophyll B (56.06%), and the number of inflorescences/plant (28.08%) but the moderate value was recorded in plant height (12.44%), and the number of branches (15.69%).

Generally, it indicates that the characters are highly heritable and the phenotypic values could give a fairly good idea about their genetic potential but it does not mean a great genetic advance. But, high genetic advance correlated with high heritability establishes more valuable for effective amelioration of traits through a natural selection. When the high genetic advance is accompanied with high heritability, it refers to an additive gene effect, and selection may be viable. The results were similar also observed by Giri *et al.* (2019), Divya *et al.*, (2019), and Patel *et al.*, (2019).

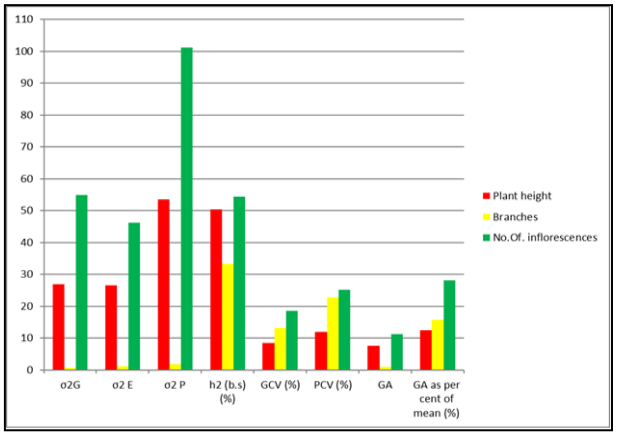

Fig. 1. Heritability, variability, and genetic advance for traits of plant height, branches No/ plant and inflorescences No/ plant of *Calendula officinalis* genotypes.

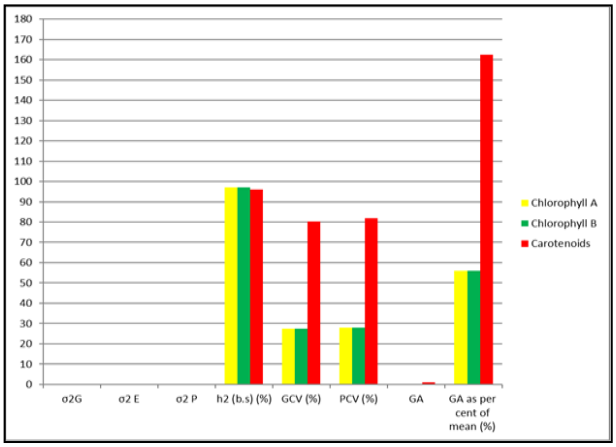

Fig. 2. Heritability, variability, and genetic advance for traits of petal contents of chlorophyll a, chlorophyll b and carotenoids of *Calendula officinalis* genotypes.

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دراسات علي التباين الوراثي في نبات الأقحوان

حكمت يحيى مسعود ، أميمة محمد عبدالكافي ، أحمد عبدالمنعم هلالي و محمد عيد غانم

قسم الخضر والزينة – كلية الزراعة – جامعة المنصورة

أجريت هذه الدراسة خلال موسمين زراعيين متتاليين 2016-2017 ، 2017-2018 في حقل التجارب الخاص بالنباتات الطبية والعطرية بكلية الزراعة جامعة المنصورة وذلك لدراسة التباين الوراثي في نبات الاقحوان وتم أخذ قياسات خاصة بالصفات الخضرية والزهرية وكذلك الكيمائية مثل طول النبات، التفريع، عدد النورات علي النبات الواحد، محتوي البتلات من كلوروفيل أ كلوروفيل ب وكذلك الكاروتين. وأوضحت الدراسة تفوق واضح للتباين البيئي مقارنة بالتباين الوراثي في كل من صفات - عدد النورات علي النبات الواحد(PCV= 25.11%- GCV= 18.5%)-التفريع (PCV= 22.77%- GCV= 13.15%) طول النبات (PCV= 11.98%- GCV= 5.51%) بينما الصفات الكيميائية (كلوروفيل أ ، كلوروفيل ب والكاروتين) فلم يكن هناك فروق ملحوظة بين التباين البيئي والتباين الوراثي. حيث - كلورفيل أ ، كلوروفيل ب يأتوا متساويين في التباين الوراثي والتباين البيئي (PCV= 27.9%- GCV= 27.52%) بينما يأتي الكاروتين بأعلي تباين بيئي ووراثي *(PCV= 81.97%- GCV= 80.31%) أما من ناحية درجة التوريث والتقدم الجيني فقد حصلت الصفات الكيميائية علي أعلي درجة توريث وأعلي تقدم جيني - كلوروفيل أ ، كلوروفيل ب (56.06% - GA= 97.06% = $h^2_{(b.s)}$)- الكاروتين (96% - GA= 162.30% = $h^2_{(b.s)}$) أما من ناحية صفات طول النبات والتفريع النبات الواحد فكانت متوسطة في درجة التوريث وكذلك التقدم الجيني كالاتي- طول النبات (12.44% - GA= 50.41% = $h^2_{(b.s)}$)- التفريع (15.69% - GA= 33.33% = $h^2_{(b.s)}$)أما صفة عدد النورات علي النبات الواحد فكانت متوسطة في درجة التوريث ومرتفعة في التقدم الجيني (28.08% - GA= 54.31% = $h^2_{(b.s)}$)