GENOTYPE X ENVIRONMENT INTERACTION IN Calendula officinalis L.

J. Novak, K. Zitterl-Eglseer and Ch. Franz
Institute of Applied Botany
University of Veterinary Medicine
Veterinärplatz 1
A-1210 Wien, Austria

Keywords: Calendula officinalis, stability parameters

Abstract

Eight cultivars of Calendula officinalis L. were cultivated in 1993 and 1994 at 2 different locations in Austria. Morphological traits (number of inflorescences, dry weight of inflorescences, diameter of flower heads and number of rings of ray florets) as well as content of faradiol-3-monoesters and ψ-Taraxasterol, determined by TLC, were investigated. Regarding the morphological traits strongest environmental influence could be observed for the number of inflorescences, followed by the number of rings of ray florets. The ‘diameter of flower heads’, ‘dry weight of inflorescences’ and ‘content of faradiol-3-monoesters’ proved to be ‘stable’ parameters.

1. Introduction

Calendula officinalis L. is a plant widely used in formulations with known anti-inflammatory activity, both in dermatology and in cosmetics (Isaac, 1992, 1994). Recent investigations demonstrated that a number of lipophilic compounds of hydroalcoholic (70%) and CO₂-extracts account for the topic anti-inflammatory activity (Della Loggia et al., 1990, 1994). Especially faradiol-3-myristic acid ester, faradiol-3-palmitic acid ester, both with equal activity, and ψ-taraxasterol are of importance (Zitterl-Eglseer et al., 1997). The aim of this study was the evaluation of genotype-environment interactions expressed as some morphological traits and the content of faradiol-3-monoester for a basic estimation of selection criteria and stability in plant breeding.

2. Material and methods

Eight different cultivars and accessions of Calendula officinalis L. were grown in 1993 and 1994 at 2 different locations in Austria. Following parameters were measured: number of inflorescences per plant (flowering and buds), dry weight of inflorescences, diameter of flower disks, diameter of flower disks and number of rings of ray florets. Faradiol-3-mono-esters were determined using a semi-quantitative TLC-method.

Reagents: Dichloromethane p.a., n-hexane p.a., anisaldehyde, methanol, acetic acid (100%), sulfuric acid (100%) MERCK.

Extraction: 100mg of dried powdered flower heads of Calendula officinalis L. were extracted with dichloromethane 15min. in an ultrasonic bath at room temperature and filtered.

TLC: Stationary phase: HPTLC, silica gel 60F254, MERCK; mobile phase: n-hexane/ethyl acetate (8+2); detection: anisaldehyde reagent; application: Linomat, 5µl; evaluation: semiquantitative determination, dimensions and intensities of the TLC-spots were grouped in 6 categories.

Genotype to environment interaction: Genotype x environment interaction was calculated according Bos and Caligari (1995), based on the linear regression analysis

Proc. WOCMAP-2
Agr. Production, Post-Harvest Techniques, Biotechnology
Eds. G. Giberti et al.

67
proposed by Finlay and Wilkinson (cit. from Bos and Caligari, 1995). In addition, the stability parameters \( b_k \) (regression coefficient of genotype \( k \)) and \( s_{a(k)}^2 \) (residual variance of genotype \( k \)) were calculated. A genotype \( k \) is considered stable if the regression coefficient is close to 1 and if the residual variance is close to zero.

\[
g_k = a_k + b_k \overline{y}_j
\]

**Equation 1: Linear regression function of genotype \( k(k=1,\ldots,K) \) when cultivated in macro-environment \( j(j=1,\ldots,J) \)**

3. Results and discussion

**Number of inflorescences**

Some cv.’s showed regression coefficients near to 1 but sometimes with remarkable high residual variance (e.g. cv.’s ‘Gelber Riese’ or ‘Eiffler’ with coefficients of 1.06 and 0.98, respectively and residual variances of 67.3 and 29.5, respectively) (fig. 1). Best overall performance regarding this trait was observed with ‘Balls Orange’ with a coefficient of 1.16 and, as compared to the other cultivars with remarkable low residual variance of 5.5.

**Number of circles of ray florets**

Concerning the degree of ‘flower-filling’ (i.e. number of circles of ray florets) the stability of the single cultivars was in general lower than in number of inflorescences (fig. 2). ‘Eiffler’ showed an extremely low coefficient of 0.25 together with a high residual variance of 0.89. ‘Balls Orange’ and ‘Plamen’ can also be considered as not stable with coefficients of 0.39 and 0.53, respectively, and variances of 0.26 and 1.52, respectively.

**Diameter of flower heads**

The diameter of the flower heads was a quite stable parameter with regression coefficients between 0.88 (‘Pacific’) and 1.13 (‘Plamen’) only (fig. 3). The highest residual variance was found in cv. ‘Erfurter Orangefarbige Gefüllte’ \( (s_{a(k)}^2 = 8.10) \).

**Dry weight of inflorescences**

With the exception of ‘Eiffler’ \( (b_k = 0.57) \) and ‘Plamen’ \( (b_k = 1.27) \), the stability regarding this parameter was quite high (fig. 4). The residual variances approached zero.

**Content of faradiol-3-monoesters**

The regression coefficient was lowest in ‘Erfurter Orangefarbige Gefüllte’ with 0.78 and in ‘Plamen’, a cultivar showing also the highest residual variance (0.12) with almost three times higher variance than the next cv. (‘Pacific Persinnan Beauty’ with 0.04) (fig. 5).

In general, the stability of parameters number of inflorescences and number of rings of ray florets were the lowest, whereas in the parameters ‘diameter of flower heads’, ‘dry weight of flower heads’ and ‘content of faradiol-3-monoester’ the stability was quite high.

4. Acknowledgements

We gratefully acknowledge the financial support of our Calendula research by the company ‘Naturwaren GmbH - Dr. Peter Theiss’, Homburg, Germany.

5. References


---

Figure 1 - Linear regression of the number of inflorescences of *Calendula officinalis* on the environmental value.

Figure 2 - Linear regression of the number of circles of ray florets of *Calendula officinalis* on the environmental value.
Figure 3 - Linear regression of the diameter of flower heads of *Calendula officinalis* on the environmental value.

Figure 4 - Linear regression of dry weight of inflorescences of *Calendula officinalis* on the environmental value.

Figure 5 - Linear regression of the content of faradiol-3-monoesters of *Calendula officinalis* on the environmental value.