HELIA, **26**, Nr. 38, p.p. 121-126, (2003) UDC 633.854.78:631.527

INFLUENCE OF DIVERSE FACTORS ON THE VARIABILITY IN AUXIN AND GIBBERELLIN CONTENTS IN *Helianthus annuus* L.

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Received: June 17, 2002
Accepted: June 21, 2003

SUMMARY

A mono- and bifactorial dispersional analysis has been applied to determine the rate of influence of different factors on variability in the contents of auxins (AIA) and gibberellins (GA_3) in sunflower leaves and inflorescences.

It was found that environmental conditions influenced very little the contents of the studied phytohormones, the greatest influence being manifested in line MB 514 which was treated with gibberellins. Diverse affinity of organs to GA_3 was established in this line, as well as different functional roles of auxins and gibberellins, correlated with spatial isolation mechanisms.

The ontogenetic phase had an important role in the variability of auxin content in leaves. The genotypes´ rate is mainly significant in the gibberellins contents` variability on the inflorescence level.

Key words: **free IAA and GA_3 concentration, genotype, mono- and bifactorial dispersional analyses, sunflower leaves and inflorescences**

INTRODUCTION

Phytohormones have a significant function in the regulation of physiological processes in plants (Thimann, 1963; Chailakhyan, 1982; Romanov, 1989). These phytohormones serve as integrators and inducers of differentiation of multicellular organisms and they play a major role in the establishment of hereditary information, determine diverse types of correlations in the organism (Polevoy, 1982; Kuznetsov *et al.*, 1994; Macheev and Kuznetsov, 1996).

The phases of plant ontogenesis are the result of a dynamic balance between stimulating and inhibiting substances. The rates of growth and development of different organs correlate with the contents of natural hormones in vegetal organisms (Derfling, 1985).

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Auxins and gibberellins are important substances - components of the plant's self-regulating phytohormonal system. Their quantities in the different plant organs are presented as homeostatic self regulatory indexes. But the degree of their quantitative modifications depends on a number of factors: physiological condition of the organism, existence of different correlations between characters, the ontogenetic phase of growth and development, the epistatic and pleiotropic influences of genes, environmental conditions, etc.

In this study we analyzed the contents of auxins and gibberellins in sunflower leaves and inflorescences within the ontogenetic dynamic. Using the mathematical methods, which elucidate the quantitative rules of synthesis and accumulation, as well the way of variability is affected by diverse factors.

MATERIALS AND METHODS

Experiments were conducted during 1996-2000 in the laboratories of the Biology Section of the State University of Moldova. Sunflower was cultivated according to the conventional technologies (Vrânceanu, 1975; Berengena, 1978; Vronskih, 1980).

The experimental material were the following lines - MB 514, MB514 CMS (cytoplasmic male sterility), RW 637 Rf (the line with a gene of male fertility restoration), kindly provided by scientific association of production "SELECTIA" and the F_1 hybrid (MB514 ASC × RW637 Rf) developed in our laboratory. Gibberellins (GA_3) was applied in the phase of blossom formation (Anashchenko, 1971) to induce modificational androsterility (IMS).

The biological material for analysis was collected at five different phases of vegetation (cotyledons, first leaves, bud formation, active growth, flowering) in correlation with the growth and development of generative organs and with the process of microsporogenesis (Neagu, 1960 and 1961; Kuperman, 1984). The analyses were made on growing apices with or without the receptacle and on receptacles without leaves.

To determine the content of phytohormones in sunflower, we used the method of liquid-gas chromatography which has sensitivity of 0.1 μg (Cavell *et al.*, 1967; Duca *et al.*, 1997).

The experimental data were statistically processed using the standard mono- and bifactorial dispersional analyses (Dospehov, 1985).

RESULTS AND DISCUSSIONS

The modifications of the auxin and gibberellin contents taking place in the leaves of the growing apex and in the inflorescence during the growth and development of the five sunflower genotypes shows the complexity of the explored charac-

ters. The fluctuations in the rates of accumulation of these phytohormones were large and subject to certain rules.

We determined the influence of environmental conditions on the contents of phytohormones during ontogenetic development of the investigated lines and hybrids (Table 1). The results were processed by the monofactorial dispersional analysis.

Table 1: Influence of environmental factors on the variability of the contents of phytohormones in different sunflower genotypes (%)

Biological material	Leaves		Inflorescences	
	Auxins	Gibberellins	Auxins	Gibberellins
MB 514	11.50	15.48	8.15	21.17
MB 514 CMS	15.35	10.71	6.53	20.15
MB 514 IMS	33.20	12.60	6.7	47.99
RW 637 Rf	13.3	10.19	7.49	10.31
F_1	16.3	15.82	8.43	19.26

It was noted that the contents of auxins and gibberellins varied with the year of study, at the rate of up to 20%.

The highest influence of environment factors was found for the line MB514 treated with gibberellins that expresses a gap of balance in the internal ambience and degradation of the cells' homeostasis within the exogenous application of the phytohormone and as a result an increased affinity towards the environmental conditions.

This line had the largest variability of the investigated hormones, according to the environmental conditions. At the same time it was proved that the exogenous treatment of leaves influenced in a substantial way their auxin content. These auxins have a rate of 33% conformably of the year of study. Regarding inflorescences, the contents of gibberellins underwent significant modifications, the influence of the year reaching approximately 48%. These results demonstrate indirectly the diverse affinities of plant organs, the homeostatic sensitivity and different functional roles of auxins and gibberellins with special isolated mechanisms.

The dependence of the variability of phytohormone accumulation on the genotype, ontogenetic phases, repetition, non-estimable factors and interaction among variants was determined by the bifactorial dispersional analysis (Table 2).

Table 2: Ratios of different factors in the variability of phytohormone content in 3 isonuclear sunflower lines

Phytohormone	Biological material	Ratio, %				
		Genotype	Ontogenetic phases	Repetitions	Non-estimable factors	Interaction of variants
Auxin	Leaf apex	2.64	85.65	1.56	1.63	8.53
	Inflorescence	11.86	42.25	1.28	1.18	23.23
Gibberellin	Leaf apex	25.92	55.03	0.67	2.28	16.1
	Inflorescence	77.4	3.0	1.8	0.4	17.3

The above table underlines the cardinal role of genotype and ontogenetic phases as compared with non-estimable factors.

In the case of the 3 isonuclear lines (MB 514; MB 514 CMS, MB 514 IMS), the ontogenetic phase was the main factor which determined the auxin accumulation in leaves. The genotype and the interaction of the examined factors had a less important role, which means that the homeostatic stability is determined by the species.

The situation was different with the inflorescences of these lines. The interaction between genotype and ontogenetic phase was significantly increased to approximately 23%. In the case of the gibberellin content in leaves, the influence of the vegetal phase rose to 55%, of genotype to 25%, and the interaction of these factors covered 16% of the variability. The interaction of the investigated factors in inflorescences had a similar value (17.3%). If after treatment with gibberellins those three isonuclear lines, MB514, MB514 ASC and MB 514 IMS, did not differentiate from the initial line except for the character of hereditary cytoplasmatic male sterility determined by the mitochondrial gene orf H522, then we can consider the obtained results significant because they show the maximum influence of the genotype (77.4%) in the variability of gibberellins accumulation at the inflorescence level.

These results prove convincingly that the impact of gibberellins in the process of flowering is the main component of the florigen. The genotypes selected for examination have in their basis different components from the genetically system ASC-RF, which determine microsporogenesis and male fertility/male sterility of sunflower. The obtained results emphasize the important role of this hormone in the floral induction as well as in the plant sexualization process.

CONCLUSIONS

The obtained results were processed using the mono- and bifactorial dispersional analysis. Also, we determined the influence of environmental conditions on the contents of phytohormones during ontogenetic development of the investigated lines and hybrids.

The exogenous application of gibberellins deregulated the homeostasis and increased the plant's affinity to the environmental conditions.

Due to the fact that the influence of environmental factors on the variability of auxins content was maximal in leaves, but of gibberellins content in inflorescences, we can conclude that the functionality of these phytohormones is spatially diverse, giving to gibberellins the main role in the floral organs. This conclusion was also confirmed by the significant portion of the genotype (77.4%) in their variability in inflorescences.

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INFLUENCIA DE DIFERENTES FACTORES EN LA VARIABILIDAD DEL CONTENIDO DE AUXINA Y GIBERELINA EN LA ESPECIE *Helianthus annuus* L.

RESUMEN

Mediante los análisis monofactorial y bifactorial de dispersión, se ha determinado en qué medida influyen diferentes factores en variabilidad del contenido de auxina (AIA) y giberelina (GA_3) en la hoja e inflorescencia de girasol.

Los resultados del trabajo han mostrado que las condiciones del medio exterior tienen muy poca influencia en las fitohormonas examinadas, donde la mayor influencia se ha notado en la línea MB 514, que fue tratada con giberelinas. En esta línea se ha determinado diferente afinidad de órganos hacia GA_3, tanto como diferentes papeles funcionales de auxina y giberelina en correlación con los mecanismos del aislamiento en el espacio.

La fase de ontogénesis tiene un papel importante en variabilidad del contenido de auxina en la hoja. El genotipo es en mayor parte importante para la variabilidad del contenido de giberelina en el nivel de florescencia.

EFFET DE DIFFÉRENTS FACTEURS SUR LA VARIABILITÉ DU CONTENU D'AUXINES ET DE GIBBÉRELLINES DANS L'ESPÈCE *Helianthus annuus* L.

RÉSUMÉ

À l'aide de l'analyse de dispersion mono- ou bifactorielle, l'effet de différents facteurs sur la variabilité du contenu d'auxines (AIA) et de gibbérellines (GA_3) dans la feuille et l'inflorescence du tournesol a été établi.

Les résultats ont montré que les conditions du milieu extérieur avaient très peu d'influence sur les phytohormones examinées; toutefois, la plus grande influence a été notée dans la ligne MB 514 qui avait été traitée avec des gibbérellines. Cette ligne a montré une affinité différente des organes envers GA_3 ainsi que des rôles fonctionnels différents des auxines et des gibbérellines en corrélation avec les mécanismes isolés.

La phase de l'ontogenèse joue un rôle important dans la variabilité du contenu d'auxines dans la feuille. Le génotype est en général important pour la variabilité du contenu en gibbérellines au niveau de l'inflorescence.