Modern Phytomorphology **4**: 87–90, 2013

THE EFFECT OF GIBBERELLIC ACID GA_3 ON MORPHOLOGICAL FEATURES OF ARTICHOKE (*CYNARA SCOLUMUS* L.)

Andrzej Sałata *, Robert Gruszecki, Jan Dyduch

Abstract. An artichoke is a commonly cultivated vegetable in the Mediterranean region. It is cultivated for an undeveloped flower head. Because of high thermal requirements in Poland the artichoke is cultivated as an annual plant. In the years 2009-2011 the research on the influence of gibberelic acid (GA_3) on yielding and morphology of artichoke plants was conducted. In order to establish the optimal date of spraying and development stage of plants GA_3 was used in 2 different variants: spraying done once at the stage of 8 leaves, spraying done twice at the stages of 8+12 leaves, in comparison to the control (without use of GA_3). Plants which were sprayed with gibberellic acid once or twice formed inflorescences up to 45 days earlier in comparison to control plants. Plants treated with GA_3 were shorter, formed less leaves in rosettes, leaves had blades of smaller length and width and shoots at the base were thicker in comparison to control plants. Plants sprayed with GA_3 formed less floral heads on inflorescence shoots but they characterized with higher mean weight in comparison to plants not treated with the gibberellic acid. Plants sprayed once gave higher yield of heads by 0.4 kg · plant^{-1} in comparison to control plants and plants sprayed twice.

Key words: *Cynara scolymus*, artichoke, gibberellic acid, yielding, morphology, features of flower head

*Department of Vegetable Crops and Medicinal Plants, University of Life Sciences in Lublin, 58 Leszczyńskiego, 20-068 Lublin, Poland; * andrzej.salata@up.lublin.pl*

Introduction

An artichoke (*Cynara scolymus* L.) belongs to the Asteraceae family and is a perennial. In Poland, due to the risk of freezing out during winter, it is cultivated only in an amateur way (Sałata & Gruszecki 2010). This vegetable is cultivated for fresh, undeveloped flower head (Sałata *et al.* 2012).

The artichoke needs lower temperature and specific photoperiod to form generative stem and bloom (Mauromicale & Ierna 1995). The most suitable temperature for vernalization ranged from 2°C to 7°C (Harwood & Markarian 1968). Basnizki & Goldschmidt (1994) observed that artichoke plants in the unfavourable photoperiod conditions initiate generative stems under the influence of gibberellic acid. Many authors indicate that this compound shortens period from planting to harvest and increases yield (Calabrese & Bianco 2000).

The aim of this work was to estimate the effect of gibberellic acid (GA_3) on yielding and morphology of artichoke plants. In order to determine the best date of spraying and stage of plant development, GA_3 was used in two different variants.

Material and methods

The research was conducted in the years 2009-2011 at the Felin Research Station of the Department of Vegetable Crops and Medicinal Plants of the University of Life Sciences in Lublin. The research material was artichoke (*C. scolymus*) of *'Green Globe'* variety. A single-factor experiment was established in a completely randomized blocks in four replications with 20 plants per each combination. Plants were planted in spacing of 1.0×1.0 m, the area of each plot was 20 m^2. Plants were sprayed with gibberellic acid solution in concentration of 60 ppm (1 ppm=1 mg/1 l H_2O). Two levels of the factor were used in the experiment: GA_3 used once at the stage of 8 leaves and GA_3 used twice at the stages of 8+12 leaves. Control plants were not treated with GA_3. 100 ml of solution

per plant was used at the stage of 8 leaves and 300 ml of solution per plant was used at the stages of 8+12 leaves.

Plants were cultivated from transplants produced in a greenhouse. In the years of research transplants were planted to the ground in the first decade of May. During artichoke vegetation dates of arising of new generative stems were noted. The assumed moment of inflorescence shoots development beginning was when at least three plants per object formed them in leaf rosettes.

Measurements of such features as: main shoot height together with bud, number of leaves per plant, length and width of all leaves and stem base diameter were done before harvest of buds. Harvesting of artichoke floral heads was done successively as they developed. The evaluation of yield of heads was done as well. Directly after harvesting the diameter and height of head and its unit weight were established.

The obtained results were analyzed statistically with the analysis of variance using SAS 9.1 software and applying Tuckey's confidence half-intervals at the 0.05 level of significance.

Results and discussion

In the years 2009-2011 differences in the date of inflorescence shoots formed on artichoke plants were observed (Tab. 1). Plants formed inflorescence shoots the earliest (in June) if they had been treated with GA_3. Plants sprayed with gibberellic acid once or twice formed inflorescences up to 45 days earlier in comparison to control plants. Earlier initiation of generative shoots after using of GA_3 was also observed by other authors (RANGARAJAN *et al.* 2000; GARCIA *et al.* 2004).

Studies on morphological structure changes of artichoke shoots were conducted during full generative development stage. Significant differences were observed in case of main shoot height (Tab. 2). When gibberellic acid was used twice plants were on average shorter by 56% in comparison to control once. Plants sprayed with GA_3 formed less leaves in rosettes, had shorter and narrower leaf blades and thicker shoots at the base in comparison to control plants. There were less floral heads, but of bigger mean weight on inflorescence shoots of plants sprayed with GA_3 in comparison to plants not sprayed (Tab. 3). Larger yield of heads by 0.4 kg · plant^{-1} was obtained from plants sprayed once in comparison to plants sprayed twice or not treated with gibberellic acid.

Use of gibberellic acid (GA_3) in cultivation of artichoke sown directly into the ground in warm climate conditions allowed to get yield in the same year (LÓPEZ *et al.* 2007), and to obtain earlier harvest of buds by 20 days (MIGUEL *et al.* 2004). FIRPO *et al.* (2005) noted that use of gibberellin in cultivation of *'Violet de Provence'* plants increased early yield of artichoke buds by 115%. The advantageous influence of gibberellin (GA_3) on equality of artichoke buds and their even maturing on plants was observed (HALTER *et al.* 2005).

Character and effectiveness of gibberellins changes depend on artichoke variety, phenophase, concentration used as well as climate conditions during and after use (MAUROMICALE & IERNA 2000; GARCIA *et al.* 2004). Stimulative influence of gibberellins in concentration of 20-30 ppm on plants was observed in research of PARADISO *et al.* (2007). High concentration of gibberellic acid stimulated flowering of late flowering varieties, and low concentration stimulated flowering of early flowering varieties (BAIXAULI *et al.* 2007). In the research conducted in Turkey the influence of gibberellic acid used in concentration of 25 ppm on earlier yielding of *'Sakiz'* variety was not observed (ERCAN *et al.* 2007). In the conducted experiment gibberellic acid (GA_3) used in a form of spray on plants in a stage of 8 leaves and in stages of 8+12 leaves influenced yielding and growth habit of artichoke plants.

Conclusions

1. A course of growth and development of artichoke plants in climate conditions of Poland did not differ significantly from the ones typical for the species cultivated in traditional regions of cultivation.
2. Used doses of gibberellic acid (GA_3)

Table 1. Period of inflorescence shoots formation on artichoke plants depending on GA_3 use.

Level of factor	2009	2010	2011
GA_3×1	11.06-27.06 (34-50)*	17.06-30.06 (40-54)	27.06-11.07 (50-66)
GA_3×2	14.06-28.06 (37-51)	20.06-29.06 (45-53)	22.06-30.06 (45-53)
Control	7.07-15.07 (74-82)	5.07-18.07 (72-85)	15.07-29.07 (84-102)

* number of days from planting.

Table 2. The mean number of leaves and some morphological features of the artichoke plants depending on GA_3 use.

Level of factor	Main shoots height, cm	Number of leaves per plant	Leaf length, cm	Leaf width, cm	Shoot diameter at the bottom, cm
GA_3×1	56.1b	18.5b	62.3b	40.0b	3.7b
GA_3×2	36.0c	15.0c	59.0c	33.0c	4.2a
Control	64.6a	19.5a	80.3a	57.0a	3.5b
p=0.05	3.04	0.33	1.44	2.06	0.30

* mean in the columns followed by the same letters do not differ significantly at α = 0.05.

Table 3. The influence of GA_3 on yielding and morphological features of the artichoke head.

Level of factor	Yield of head per plant, kg	Number of head per plant	Mean weight of head, g	Height of head, cm	Diameter of head, cm
GA_3×1	2.12a	7.9b	268.5a	5.7ab	5.4a
GA_3×2	1.68b	6.6b	255.2a	6.0a	5.6a
Control	1.74b	11.6a	145.5b	5.5b	5.6a
p=0.05	0.26	2.1	15.51	0.46	0.26

* mean in the columns followed by the same letters do not differ significantly at α = 0.05.

influenced a shape of artichoke plants: height of plants, number and size of leaves.

3. A significant effect of gibberellic acid (GA_3) on number of floral heads formed per plant was observed.

4. Gibberellic acid (GA_3) used in a form of spray once, in stage of 8 leaves, significantly increased yield of floral heads.

References

Baixauli C., Giner A., Miquel A., López S., San Bautista A., Maroto J.V. 2007. Interaction between cultivar and gibberellic acid concentration in seed propagated artichoke. *Acta Hort.* **630**: 165–170.

Basnizki Y., Goldschmidt E.E. 1994. Further examination of gibberellin GA_3 effects on flowering of globe artichokes (*Cynara scolymus* L.) under controlled environment and field condition. *Isr. J. Plant Sci.* **42**: 159–166.

Calabrese N., Bianco V.V. 2000. Effect of gibberellic acid on yield and quality of seed grown artichoke (*Cynara cardunculus* L. var. *scolymus* (L.) Fiori). *Acta Hort.* **514**: 25–32.

Ercan N., Temirkaynak M., Ayar Sensoy F. 2007. Comparative efficiency of some treatments on earliness and yield of globe artichoke. *Acta Hort.* **630**: 177–179.

Firpo I.T., García S.M., Cointry E.L., López Anido F.S., Cravero V.P. 2005. Evaluation of the performance of different cultivars in offseason production. *Acta Hort.* **681**: 89–93.

García S.M., Cointry E.L., Firpo I.T., López Anido F. S., Cravero V.P., Asprelli P. 2004. Vernalization of seed-grown artichoke. *Acta Hort.* **660**: 443–445.

Halter L., Habegger R., Schnitzler W.H. 2005. Gibberellic acid on artichoke (*Cynara scolymus* L.) cultivated in Germany to promote earliness and to increase productivity. *Acta Hort.* **681**: 75–81.

Harwood R.R., Markarian D. 1968. Annual culture of globe artichoke (*Cynara scolymus* L.). I. Preliminary report. *Proc. Amer. Soc. Hort. Sci.* **92**: 400–409.

López J., González A., Vicente F.E., Condés L.F., Fernández J.A. 2007. Artichoke production in the province of Murcia (SE Spain). *Acta Hort.* **630**: 223–227.

Mauromicale G., Ierna A. 1995. Effects of gibberellic acid and sowing dates on harvest time and yields of seed-grown globe artichoke (*Cynara scolymus* L.). *Agronomie* **15**: 527–538.

Mauromicale G., Ierna A. 2000. Characteristics of heads of seed-grown globe artichoke (*Cynara cardunculus* L. var. *scolymus* (L.) Fiori) as affected by harvest period, sowing date and gibberellic acid. *Agronomie* **20**: 197–204.

Miguel A., Baixauli C., Aguilar J.M., Giner A., Maroto J.V., López S., San Bautisa A., Pascual B. 2004. Gibberellic acid concentration in seed propagated artichoke. *Acta Hort.* **660**: 167–172.

Paradiso R., Cuocolo B., De Pascale S. 2007. Gibberellic acid and nitrogen rate affect yield and quality of artichoke. *Acta Hort.* **630**: 211–216.

Rangarajan A., Ingall B.A., Zeppelin V.C. 2000. Vernalization strategies to enhance production of annual globe artichoke. *Hort. Technol.* **10 (3)**: 585–588.

Sałata A., Gruszecki R. 2010. The quantitative analysis of poliphenolic compounds in different parts of the artichoke (*Cynara scolymus* L.) depending of growth stage of plants. *Acta Sci. Pol., Hort. Cultus* **9 (3)**: 175–181.

Sałata A., Gruszecki R., Dyduch J. 2012. Morphological and qualitative characterization of globe artichoke (*Cynara scolymus* L.) cultivars *'Symphony'* and *'Madrigal'* on depending of the heads growth. *Acta Sci. Pol., Hort. Cultus* **11 (5)**: 67–80.