

PRODUCTION OF ANNUAL CARAWAY IN SERBIA

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Abstract

Caraway (*Carum carvi* L.) is an aromatic herb of the Apiaceae family. It has two forms: a biennial, which is grown in the colder and humid climates, and annual that is grown in temperate climate. In Serbia is mostly cultivated biennial caraway, which in the first year formed only a leaf rosette, and with the end of the growing season above-ground parts dies and the roots over winter and in the spring of the second year of plant development begins early. After four to five weeks from appearing of first leaves, it started growth of flowering stems. Lack of cultivation of these forms of caraway is that in the first year does not provide benefits but requires investment. Unlike the biennial forms, vegetation period of annual caraway lasts from 140-160 days, it forming a rosette with less leaves, and very quickly starts to develop flowering stems. For this reason, the aim of our study was to investigate the possibility of growing annual caraway in condition of Serbia.

Trials were conducted at three locations in Serbia, during 2011 and 2012. Sowing was carried out during April to row spacing of 35 cm, after germination of plants, thinning plants was carried to obtain 70 plants per meter. From our research, it can be concluded that the yield of annual caraway, weather conditions have a statistically significant impact. In a favorable year (2011) has been achieved the average yield of 850 kg ha⁻¹, while in the dry year yield was very reduced (193 kg ha⁻¹).

Keywords: annual caraway, yield, weather conditions

Introduction

Caraway (*Carum carvi* L.) has been grown as a spice plant for many centuries and is almost cosmopolitan. It is native to Europe, parts of Asia and northern Africa, but it is grown also in the northern US and Canada. Caraway has two forms: biennial which is grown mainly in the northern parts of the world (Europe and America), and annual which is grown commercially in temperate zones (Mediterranean, Africa, South America and Asia).

Caraway seed has been mainly used as a spice or rather like essential oil. The seed essential oil has been used as a fragrance and flavour in the food, drinks and alcoholic beverages, perfumery and pharmaceutical industries, and for medicinal purposes. Beside essential oil, caraway seed also contain lipid (13-21%), nitrogenous compounds (25-35%), fiber (13-19%) and water (13-19%) (Gwari et al., 2012).

In Serbia, mostly is grown biennial caraway type, which in first year forming only a leaf rosette with 7-18 leaves. With the first frosts, above-ground parts die, and early in the spring next year, with increasing temperature vegetation started. After four to five weeks from the appearing of first leaves it started growth of flowering stems. In the case of biennial caraway fruit yield depends on the size of leaves rosette and root thickness reached in the first year of its vegetation (Seidler-Lozykowska et al., 2010).

As the seed is the only part of the plant used, the quality of the biennial form is considered to be superior to the annual one, according to size, aroma, color etc. (Bouwmeester et al., 1993), but lack of cultivation of these form of caraway is that in the first year does not provide benefits but requires investment.

In the moderate climate of Central Europe beside pure crop cultivation methods, and mixed cultivation methods is used (Nemeth, 1998). Mixed cultivation with a cover crop is usually preferred by the owners of relatively smaller farms located under favorable soil and climatic conditions. Those growers are orientated towards intensive usage of arable land. Cover crops are cultivated together with caraway and yield in the first year, being mainly represented by garden poppy, pea, coriander, spring oilseed rape, spring barely, chamomile, flax and spinach.

Weed control is a very important factor mainly during the early developing stages before plants cover the field, at early spring. During this period the ground is bare and winter weeds can grow very easily. From early spring the caraway plants cover the ground and normally (when there are enough plants per unit area) no addition of annual weeds can be observed. The growing season of biennial caraway is much longer, therefore a wide range of weed control is needed for a longer time. Most of the weed controls found suitable for the establishment phase of biennial caraway.

At difference of biennial forms, annual caraway forms a less rosette of leaves (usually four to five leaves), and quickly began developing umbel. The vegetation period of annual caraway usually lasts 140-160 days. Shorter growing period significantly reduced investment in growing practices, especially the competition with the weeds. For this reason, the aim of our study was to investigate the possibility of growing annual caraway in Serbia.

Material and method

The field experiment was carried out during 2011 and 2012 years, on tree localities in Serbia, Vojvodina Province: (1) Mosorin (latitude 45°18'5" N; longitude 20°09'32" E; altitude 111 m), (2) Ostojicevo (latitude 45°53'16" N; longitude 20°09'31" E; altitude 88 m) and (3) Veliki Radinci (latitude 45°02'26" E; longitude 19°40'15" E; altitude 111 m).

Caraway seed (local ecotypes) obtained from medicinal plant farm from Kulpin were used in this study. Caraway is grown only from direct sowing, which is performed in rows at 35cm spacing during April. After germination it was performed thinned for obtaining 200 plants on meter square.

Seedlings emerge usually after 2 weeks and, like in other plants from *Apiaceae* family, their initial growth is slow. At that time the young plants are particularly sensitive to shading, and also to insufficient aeration and moisture of the soil. According this reasons it was need 2-3 hoeing. Harvest was performed in full ripening stage by hand. In the first experimental year, harvest was in September, and in second experimental year, one month earlier (i.e. during August).

Data of meteorological conditions were obtained from nearest meteorological station for each experimental field (<30 km), and average value of temperatures and precipitations for all tree localities, for both investigated years, as well as long time average of these parameters, is shown on Figure 1.

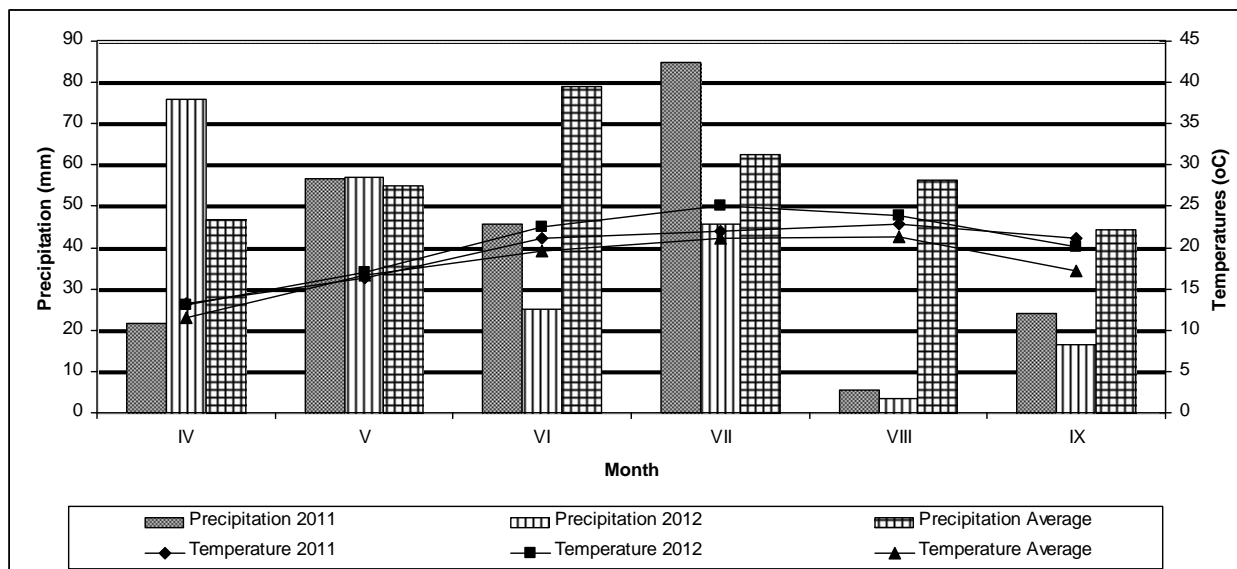


Figure 1. Average monthly values of precipitations and temperatures for vegetation period (IV-X) in both experimental years and long time average (Source Republic Hydrometeorological service of Serbia)

Soil samples were taken from 0-30 cm, and analyzed in Soil tested laboratory of Agricultural Extension Service, Sremska Mitrovica, and shown in Table 1. For determination pH soil was used potentiometric method, for CaCO_3 molar volume of carbon dioxide, humus content was determine by Turin method, total nitrogen by Kjeldahl method, available phosphorous and potassium with Al-method, Egner-Riehem.

Table 1. Agrochemical analysis of soil

	pH (KCl)	CaCO_3 (%)	Humus (%)	Total Nitrogen (%)	AlP_2O_5 (mg/100 g)	AlK_2O (mg/100 g)
Location 1	7.3	8.4	2.7	0.18	81.6	75.1
Location 2	7.3	8.8	2.2	0.14	17.6	30.3
Location 3	7.1	2.0	2.5	0.16	22.4	21.7

Data were subject to statistical analysis using the program package STATISTICA (Statsoft, 1998) and expressed as mean, variance (s^2) and coefficient of variation (CV). The mean values were compared by using the one-way analysis of variance (ANOVA) followed by Duncan's multiple range tests. The differences between individual means were deemed to be significant at $p < 0.05$.

Results and discussion

From table 2, it can be concluded that on the yield of annual caraway weather conditions during year have a statistically significant influence. In a favorable year (2011) has been achieved the average yield of 850 kg ha^{-1} , while in the dry year yield was reduced (193 kg ha^{-1}).

In a year that was favorable for the formation yields, it varied from $460,16$ to $1208,67 \text{ kg ha}^{-1}$. According to the literature, yield of annual caraway varies from 900 kg ha^{-1} (Chevalho and Fonseca, 2006) up to 1250 kg ha^{-1} (Bailer et al., 2001). During a drought in 2012, the yield of caraway was very low ($72,55$ to $310,95 \text{ kg ha}^{-1}$). In our country has already recorded a very

low yield of caraway grown in Stara Pazova (Drazic et al., 1998), which was 124 kg ha^{-1} , and it has varied a lot ($\text{CV}=53$).

Table 2: Yield of caraway fruits (kg ha^{-1}) during two investigated years

	Yield	Variance	CV
2011	849,5 ^a	41961,27	24,11
2012	192,8 ^b	9023,40	49,28
Average	521,2	-	-

Mean values in a column with different letters (a, b) are significantly different at $P < 0,05$ (Duncan's test).

It may be noted that the site significantly affects on formation yields, which is particularly evident in the year with unfavorable weather conditions as it was in 2012, with the coefficient of variation was 49,28%. The great variation of yields in the second year, most likely is the result of the uneven distribution of rainfall that had downpour character. That the yield of caraway a lot depends on the influence site, i.e. that the height and yield stability depend on the ability of the population to react to environmental factors indicated Drazic (1992).

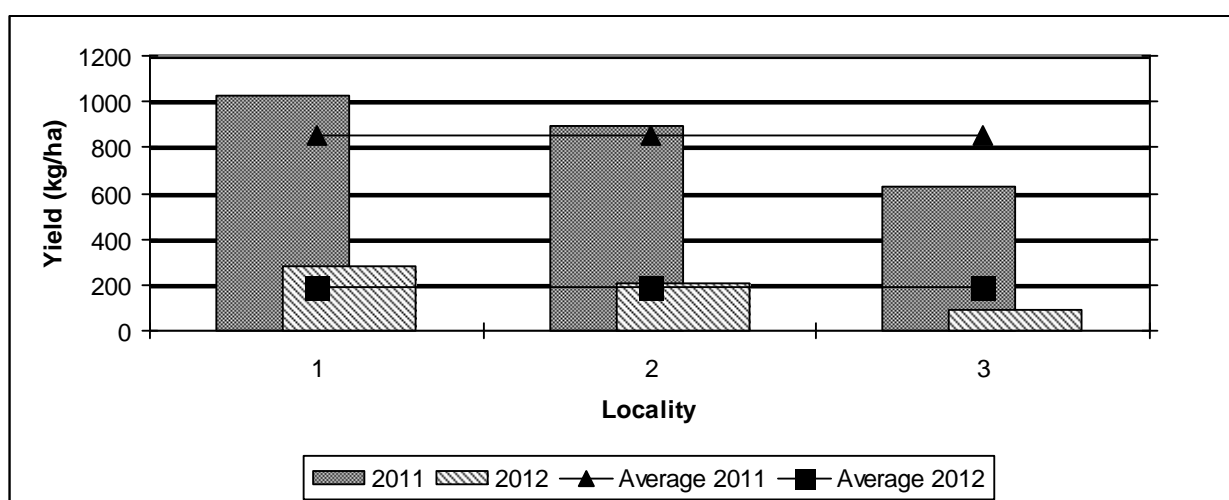


Figure 2. Yield of caraway fruits (kg ha^{-1}) during two investigated years depending on locality

As it can be seen from figure 2, the highest yield in both investigated year was achieved on locality 1 ($1027,7 \text{ kg ha}^{-1}$ in 2011, and $279,8 \text{ kg ha}^{-1}$ in 2012), where was the highest amount phosphorus in soil ($81,6 \text{ mg}/100 \text{ g soil}$). Phosphorus plays an important role in photosynthesis, respiration, energy storage, cell division/enlargement and several other processes like seed formation, hastening maturity and also contributes to disease resistance in coriander (Ibadullah et al., 2011).

Seed yields of caraway vary considerably between years at the same site and in the same year at different sites with the same variety. It means that environmental conditions affected the yield or determining processes of seed production (Nemeth, 1998).

Due to poor rainfall for the last few years in Poland the moisture in the soils has decreased and that has affected growth and yielding of many crops, including caraway. Water deficit causes changes in almost all the cell processes, which affected plant growth and development (Seidler-Lozykowska et al., 2010).

Water deficit is considered to be a major environmental factor affecting agriculture productivity worldwide and causing considerable crop yield reduction (Laribi et al., 2011).

According to Nemeth (1998), in semiarid regions where the annual caraway grows, there are two critical stages during its growth, where irrigation is necessary: from germination to establishment and at seed formation. The first stage appears at spring and the other at summer usually during July and August. At those periods the amount and date of rainfall change from year to year, so it is necessary artificial irrigation.

Seed yield seems to be determined mainly by the conditions during flowering Bouwmeester et al., (1995). Undoubtedly, weather conditions, i.e. rain, humidity and wind also affect pollination efficiency (Nemeth, 1998).

Conclusion

The yield of annual caraway mostly depended on weather condition during year. In semiarid regions where the annual caraway grows, amount and date of rainfall change from year to year, and from site to site. From that case, it is impossible growing annual caraway in dry years in field condition without artificial irrigation.

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