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Oil Pumpkins: Niche for Organic Producers

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Oil seed pumpkins (*Cucurbita pepo* L. group Pepo, Cucurbitaceae) are produced from two subspecies var. *styriaca* Greb. and var. *oleifera* Pietsch. Naked seeds of oil pumpkins are edible and easily crushed to extract edible oil, mainly used for salad dressing. Nutritional value of seeds and oil is also very high (Iduraine et al. 1996). Seeds and oil can be used in official and alternative medicine, pharmacology, and cosmetics, especially when organically produced. This represents a new challenge for small scale and part time farmers to develop a new market niche for farmers that have knowledge and skills in organic crop management (Bavec and Bavec 2006). The objective of this paper is to present an overview of oil seed pumpkin production systems for organic growers.

NUTRITIONAL AND HEALTH VALUE

The nutritional value of pumpkin seeds is based on high protein content and high energy potential due to high percentage of oil. Oil content in the seeds is 40%–60%; 98%–99% of the oil is from the fatty acids oleic (up to 46.9%), linolenic (up to 60.8%), palmitic (up to 14.5%), and stearic (up to 7.4%), with a ratio of monounsaturated to polyunsaturated acids from 0.60 to 0.75 (Murković et al. 1996, Nakić et al. 2006). Because of its high protein content (61.4%±2.6%), and certain functional and electrophoretic properties (Lazos 1992), pumpkin seed flour obtained after oil pressing might be a potential food (Mansour et al. 1993).

Pumpkin seed oil and seeds are rich in unsaturated fatty acids. Due to high omega-3 (6 and 9)-fatty acids (Murković et al. 1996), seeds and oil have been claimed to promote HIV/AIDS wellness (Zimmerman 1997). The lignans and phytosterols such as delta 7-sterols and delta 5-sterols, are of special interests (Nakić et al. 2006). Antioxidative compounds, such as vitamin E, especially gamma-tocopherol are also high. In fresh dried seeds concentration of alpha-tocopherol is 37.5 µg/g and gamma tocopherol is 383 µg/g, (Murković et al. 2004).

GROWTH CONDITIONS AND ORGANIC CULTIVATION PRACTICE

Basic Growth Characteristics

Cucurbits are very sensitive to low temperatures because growth ceases at 6 to 7°C. In oil pumpkins temperatures between 2 and 4°C lasting longer than 3 days can reduce seedling growth and potential yield by more than half. At a temperature lower than 8°C seed germination can be reduced, and temperatures of –1°C can be lethal. The plants require high levels of sunlight and a warm climate. Although pumpkins are quite resistant to drought, yield is significantly reduced after drought periods.

Organic production of oil pumpkins requires special attention to mineralizable organic matter in the soil, good soil structure, available nutrients, good agricultural practice to maintain soil moisture or irrigation, effective weed suppression, and good disease suppression.

Pollination is an important factor for successful production which can be influenced by climatic conditions and pollinating insects. At least 4–5 hives/ha of bumblebees (*Bombus terrestris*) are beneficial since bumblebees forage in diverse weather, even during rain (Fuchs and Muller 2004).

Soil, Fertilization, and Tillage Systems

Many soils are suitable for oil pumpkins, but the most successful production can be obtain in light sandy-loam soil. Appropriate soil pH must be higher than 6. In case of lower pH calcification needs to be applied at least one month before sowing or seedling planting. The soil needs to be airy, rich in humus and organic compounds with many available nutrients for the plants.

Plowing depth is adjusted to the depth of the common tillage layer but should go no deeper than 25 cm. Compact soils and soils that do not have enough drainage are unsuitable for pumpkin production. Dry soil is harrowed in spring, as soon as conditions allow to preserve as much moisture as possible. Shallow spring plowing and harrowing are recommended only if soil is too compact.

Fertilization occurs in autumn with 25,000 to 45,000 kg/ha of stable manure, or the highest amount prescribed by regional legislation. In Europe, the annual amount of nitrogen with organic fertilizers should not exceed 170 kg N/ha.

Genotypes and Cultivars

Vine genotypes are recommended in most cases, but, bush type plants have been grown at the University of Maribor (Ivančič) and in Austria. The only cultivars presently established in production are 'Gleisdorfer Ölkürbis', 'Wies 371', 'Slovenska Golica', and 'Olinka'. Oil pumpkins are mostly short-vine types; adventitious roots, tendrils, and branches grow from the stems.

Cultural Practice

Oil pumpkins share diseases with cucumbers, so the repeated production of pumpkins or cucumbers in the same field is not recommended for at least 4 to 5 years. Pumpkin production is most successful following legumes, green fodder, green manure, and clover. A high level of organic fertilizers or resistant humus and catch crops that do not over winter provide good growth conditions for pumpkins.

Pumpkins are susceptible to various diseases; but except for *Erysiphe polyphaga* and *Sphaerotheca fuliginea*, diseases appear only occasionally and to a limited extent. *Pseudomonas lachrymans* appear occasionally during rainy seasons in fields that are close to larger nurseries. Spraying with copper preparations is inefficient. The extent of infection at emergence can be reduced by presowing soil preparation for a light soil structure and abundant organic fertilizing; these precautions will also help reduce stem rot caused by *Fusarium* and *Sclerotinia*. Compost of remains of tomato, pepper, eggplant, cucumber, and bean stems are unsuitable for pumpkin fertilization.

Oil pumpkins are susceptible to zucchini yellow mosaic virus which reduces yield as a result of reduction of flowering and flower abortion. The leaves of infected plants show blister-like symptoms and fruits display bump-like bulges. Zucchini yellow virus is transmittable from aphids to the plant and through the seed. Weeds as natural virus reservoirs seems negligible in comparison to infected seed (Riedle-Bauer et al. 2002).

Target values for nitrogen fertilization, based on Slovenian growing conditions, in sandy and sandy-loam soil, have been established (Bavec and Bavec 1998). Sowing can be implemented with nongerminated seeds (Fig. 1), germinated seeds, and transplants. Seedling transplantation without developed roots is unsuccessful. Soil temperature should be at least 12 to 15°C at the early growth stage. Pumpkins are sown 3 to 5 cm deep, but the sowing depth should be deeper in sandy soil. Optimal yield may be achieved with 1.0 to 1.5 plants m^{-2}. In Slovenian conditions, the traditional recommendation with manual seeding was to plant in the shape of a 1 × 1 m square. Due to the possibility of seeding pumpkins with a pneumatic corn seeder, and based on the later interrow cultivating, we recommend the interrow spacing to be 1.4 m or 2.1 m, with the widest possible spacing between rows. With manual seeding, 3 to 4 kg of seeds/ha are needed, and between 6 to 7 kg of seeds/ha are required for mechanical seeding. It is important to use healthy seeding material to avoid virus. Empty spaces originating from manual square seeding are filled in with germinated pumpkin seeds a week after emergence. Two seeds can be placed together and thinned to one plant after emergence by cutting, in order to avoid damaging adjoining plants. The suggested final plant population for optimal yielding varies between 1 and 1.5 plants/m^2.

Efficient weed control should be provided through manual hoeing and with mechanical hoeing between rows.

Higher yield and more reliable production of cucurbits are obtained through the use of transplants. Plants developed from direct seeding grow and develop more slowly in comparison to plants developed from transplants. At the University of

Fig. 1. Oil seed pumpkin plantings after conventional tillage and sowing with seeding machine for corn.

Maribor transplants were produced in plug trays in a heated greenhouse and seedlings were hardened before transplanting. After 14 days at 20°C at the first true leaf stage (Fig. 2), plants were transferred outdoors and covered with plastic overnight. Seedlings were transplanted after a month to the field location when they had 2 to 3 true leaves, stood 15 cm tall, and displayed visible first flower buds. Plant development at the beginning of summer is shown in Fig. 3. In all years, the transplants had the greatest fruit yield, the highest number of harvested fruit, the largest fruit, and the highest seed yield. The average seed yields for three years were 1.03 t/ha for the direct seeding of dry seed, 1.27 t ha^{-1} for the direct seeding of germinated seed, and 1.68 t/ha for transplants (Bavec et al. 2002b). Multi criteria model for decision support on organic farms was developed at University of Maribor (Pažek et al. 2006).

HARVESTING, STORAGE, AND PROCESSING

Fruit should be completely mature to achieve the highest oil content (Fig. 4). Mature fruits are yellow with exception of the shady side, where they have yellow and green stripes. Leaves are yellow at this stage. With mature fruits the innermost fruit tissue can be easily removed from the seeds, either by hand or machine (Fig. 5). When mechanically cleaning and drying a larger quantity of seeds, it is necessary to wash them well with water under low pressure. Seed is dried at 40 to 60°C until it reaches the final moisture content of 8% to 10%.

For producing oil from pumpkin seeds, two pressing procedures are used, traditional "hot" and new "cold" pressing. The traditional pressing method includes milling of pumpkin seeds in a stone mill, homogenization of milled seeds with water and salt (about 50 kg seeds, 6 L water, 250 g salt), roasting the milled seeds (in a pan to a temperature of 100 to 130°C), which results in a dark gold green to red ochre colored oil with spicy aroma. The new "cold" method of pressing is based just on mechanical pressing of dry seeds without roasting or chemical treatments. The yield of oil is about 10% lower, but it is higher quality and rich in antioxidative compounds.

Fig. 2. Seedlings of oil seed pumpkins.

Changes in chemical composition of pumpkin seeds during roasting influences the aroma of the oil, due to pyrazines (Nikiforov et al. 1996; Buchbauer et al. 1998). Several volatile (Siegmund and Murković 2004) and non-volatile (Murković et al. 2004) compounds were followed to optimize temperature levels during seed roasting in order to achieve typical oil aroma. The physical quality of pumpkin seed oil was unaffected by heating temperature and duration of heating pretreatments (Joshi et al. 1993). To determine adulteration of pumpkin seed oil with other vegetable oils, the phytosterol fraction (specific delta 7-phytosterols) can be analyzed by capillary gas chromatography (Mandl et al. 1999).

Fig. 3. Oil seed pumpkins plants at the stage of the first brached primary stems (identification growth stage: BBCH 20–201).

Fig. 4. Mature fruits of oil seed pumpkins (identification growth stage: BBCH: 89–809)

Fig. 5. Harvesting oil seed pumpkins.

SUMMARY

The normal expected yield in a small area of central Europe (the Styria region in Austria and Slovenia, the western part of Hungary) ranges between 500 to 800 kg dry seeds/ha, often to 1200 kg/ha, depending on climatic circumstances, production systems, weed competition, and plant diseases. Oil pumpkin production will be adapted to pumpkin growing regions where full maturity of the seeds can be achieved.

Organic pumpkins should find a market niche because high nutritional and health value is desirable, especially in organic products such as edible oils or softgels, natural or roasted seeds, and supplements for edible seed bars, and snack foods. Profit to growers will be influenced by production systems (Bavec et al. 2002a). Special attention should be focused on branding and promoting pumpkin seed oil, using suitable packaging, maintaining strict control over the quality of oil produced, and making use of new marketing opportunities to expand the market for these products.

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