

# Comparative Study of Seed Production in Hermaphrodite and Female *Silene vulgaris* Plants, a Gynodioecious Species

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## Abstract

Among the great number of autochthonous species from SE Spain that can be used as food, *Silene vulgaris* (Moench) Garcke, a perennial herb from *Caryophyllaceae* family and native to Eurasia is an outstanding example. However, the agronomic aspects of this species have not been studied yet, for which reason the seed production ability and seed obtention possibilities for planting, was studied in this work as a first phase towards plant selection.

Five hundred seedlings of *Silene vulgaris* were transplanted on the 22 February, 2001 in the Universidad Politécnica Cartagena Research Station (Murcia, SE Spain). From the whole plants used in the experiment, 35 were hermaphrodite and the rest female. In the anthesis period (10-21 May), 125 hermaphrodite and 125 female flowers were randomly labelled. After the flower maturation (7-14 June), each capsule was harvested individually. The number of seeds and weight per capsule were registered. Additionally, in order to know the mean seed production per plant, the number of flowers was noted in both type of plant.

There were no significant differences in the number of flowers per plant (c.a. 200) or in the number of ovules per flower (c.a. 135) and the results showed a higher seed production from hermaphrodite than female flowers ( $48.2 \pm 22.6$  and  $33.1 \pm 15.4$  seeds/capsule, respectively). According to the preliminary results, the selection of hermaphrodite plants for commercial seed production could be of interest due to the increased production (200 kg per ha more when hermaphrodite plants are used).

## INTRODUCTION

*Silene vulgaris* (Moench) Garcke is one of the 500 species of the genus belonging the family *Caryophyllaceae*. This species is native to Eurasia, and the subspecies *vulgaris* is present throughout Europe except for some northern islands. *Silene vulgaris* is widespread on grassy soils and cliffs in all of Europe. In temperate climates, this species grows as a troublesome weed in spring sown crops, but is also common in uncultivated lands along the sides of country roads and lanes. In Central Europe and the Mediterranean Region, people have used *S. vulgaris* as a vegetable for some time. In particular, when the shoots are tender, people gather the apical ones from wild plants for consuming raw or for stewing and flowering more or less like spinach. These shoots are in great demand by gourmets that use them for preparing vegetable soups, rice soups, minestrone or risotti and fried with olive oil and eggs for preparing a sort of omelette (Laghetti and Perrino, 1994).

Following Tutin et al., *Silene vulgaris* subsp. *vulgaris* is a perennial herb, glabrous or poorly pubescent, 30-70 cm high, generally with erect habit but sometimes prostrate; leaves always sessile and opposed, the largest ones (the median) 12-18 mm x 40-60 mm are linear-lanceolate acute but not pointed. The flowers, dioecious or polygamus, gathered in bunches, hanging from of flexuous peduncles 5-15 cm high. The calyx is ovoid, much wider than the ovary and the capsule itself, therefore apparently inflated around them, and the corolla is composed of five white or lightly rosy petals with the nail as long as the calyx. Fruits are capsules three times longer than the carpophore.

The possibility of cultivating this species as a leafy vegetable led as to conduct a series of experiments to assess its seed production. However, the species shows

gynodioecious phenomenon, a term used to describe the occurrence of females and hermaphrodites plants within the same population of a species (Darwin, 1877).

Numerous investigators have studied this phenomenon in wild species in an attempt to explain why female plants grow within hermaphrodite populations despite the loss of fitness caused by male-sterility (Assouad et al., 1978; Philipp, 1980; Kesseli and Jain, 1984; Van Damme and Van Delden, 1984; Schraeder, 1986; Gouyon and Couvet, 1987; Shykoff, 1988, 1992; Stevens, 1988; Kohn, 1988; Agren and Willson, 1991). According to these studies, the advantages of females over hermaphrodites include a greater numbers of flowers per plant ovule per flower, greater adult survivorship of seeds per plant, greater seed weight, lower seed predation and better germination or progeny success. Similar conclusions were reached by Pettersson (1992) studying an endemic *S. vulgaris* population in Sweden. However, Jolls et al. (1989) showed that hermaphrodite plants in this species produce more seeds and flowers than females.

The present study was carried out with the aim of ascertaining the ability of the fitness of plants to produce commercial seeds and to test the overcome hypothesis on seed production in both female and hermaphrodite *S. vulgaris* cultivated plants from Southern Spanish populations.

## **MATERIAL AND METHODS**

### **Plant Material and Study Site**

The experiment was carried out in a plot of the Universidad Politécnica Cartagena Research Station sited in the south-eastern part of Murcia province (SE Spain) on the Mediterranean coast (20 m a.s.l.; 37° 36'52'' N, 0° 58'07'' W), using the autochthonous *Silene vulgaris* subsp. *vulgaris*.

The climate of the area is typically Mediterranean with mild winters, low rainfall and dry summers. The temperature averages 18°C throughout the year. Rainfall is characterised by extreme interannual variations, its low overall value (300 mm year) and a tendency to fall as storms. During the period studied (January to June 2001) 90.3 mm of rain fell.

### **Sampling Design**

The seedlings of *Silene vulgaris* used were obtained from seeds collected in Sierra Morena (Córdoba province). They were sown in the nursery in polystyrene tray (61 × 40.8 × 5.5 cm) with 176 cells (31.4 cm<sup>3</sup>) filled with a commercial substrate of peat. The plants stayed in the nursery for 23 days.

Five hundred seedlings were transplanted to the field on 22 February 2001. Planting was in 35 cm wide ridges with 20 cm between plants. A trickle irrigation system was used. Of all the plants used in the experiment, 35 were hermaphrodite and the rest female. The design was totally random.

In order to know the mean seed production per plant, the number of flowers was noted in both types of plant and, in the anthesis period (10-21 May), 125 hermaphrodite and 125 female flowers were randomly labelled. After the flower had matured (7-14 June), each capsule was harvested individually. The number of seeds per capsule was counted and weighed (to the nearest 0.0001 g on SCALTEC SBA 33 automatic electrobalance).

Additionally, seeds from of both types of plant were sown on a wet filter paper in a petri dish, in a germinating chamber with the temperature controlled at 20°C and in the dark to compare the germination potential of both types of seed.

### **Statistical Analysis**

Statistical analysis was carried out using the SPSS package. Data were analysed with ANOVA using seed mass and other characters, including flowers per plant, ovules per plant, seeds per capsule and seed weight per capsule as dependent variables, and sex as treatment variable.

## RESULTS AND DISCUSSION

The results showed that the female plants had more flowers per plant than hermaphrodite plants with values of  $204 \pm 55.1$  and  $190 \pm 50.9$  respectively, even though there were no significant differences (Table 1).

The female plants presented a greater proportion of flowers with fruits (93 %) than their hermaphrodite counterparts (87 %).

The number of seeds per capsule was significantly higher in hermaphrodite flowers than in female flowers ( $48 \pm 22.6$  vs.  $33 \pm 15.4$ ). However, there was no significant difference in the number of ovules in the respective types of flower, suggesting that the higher number of seeds in hermaphrodite is due to better pollination. Indeed, in female plants from wild populations containing no hermaphrodite specimens we found a very high proportion of empty capsules (90 %). The weight of seeds per capsule was significantly greater in the hermaphrodite flowers due to no doubt to the higher number of seeds present. However, individual seed was greater in female flowers, also to statistically significant extent, leading as to think that the reason was their better nutrition since they were fewer in number.

As regards the germination (Fig. 1), seeds from of female plants showed better germination than hermaphrodite plants, perhaps due to greater food reserves of the seeds from female plants.

## CONCLUSIONS

In conclusion, a comparison of our findings with those of other author points to several differences as regards the greater production of flowers and seeds in female plants, although the greater weight of seeds was in accordance with others results. According to our results, even though the seeds from hermaphrodite plants have less germinative potential, hermaphrodite plants may be better for commercial seed production, since they produce 200 kg more per ha when these plants are used. However, new studies on the vigour of plants from both sexes are needed to complete this work.

## ACKNOWLEDGEMENTS

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## Literature Cited

- Chater, A.O. and Walters, S.M. 1964. *Silene*. In: *Flora europea* (eds., Tutin *et al.*), vol. 1. Cambridge. Pp. 158-181.
- Hammer, K. 1986. *Caryophyllaceae*. In: *Rudolf Mansfelds, Kulturpflanzen-verzeichnis*. Schultze-Motel (ed), Berlin I: p. 141.
- Jolls, C.L. and Thomas, C.C. 1989. Gynodioecy in *silene vulgaris* (caryophyllaceae): Progeny success, experimental design, and maternal effects. *Amer. Jour. of Botany*. 76 (9): 1360-1367.
- Jurgens, A., Witt, T. and Gottsberger, G. 1996. Reproduction and pollination in central European populations of *silene* and *saponaria* species. *Bot. Acta* 109 (1996): 316-324.
- Kohn, J.R. 1988. Why be a female? *Nature* 335: 431-433.
- Petterson, M.W. 1992. Advantages of being a specialist female in nodioecious *silene vulgaris* s. l. (caryophyllaceae). *Amer. Jour. of Botany*. 79 (12): 1389-1395.
- Pignatti, S. 1982. *Flora d'Italia*. Edagricole. Bologna, I:pp. 246-247.
- Shykoff, J.A. 1988. Maintenance of gynodioecy in *Silene acaulis* (caryophyllaceae): stage-specific fecundity and viability selection. *American Journal of Botany* 75: 844-850.
- Shykoff, J.A. 1992. Ex polymorphism in *Silene acaulis* (caryophyllaceae) and the possible role of sexual selection in maintaining females. *Amer. Jour. of Botany* 79: 138-143.
- Stevens, D.P. 1988. On the gynodioecious polymorphism in *saxifraga granulata* L. (saxifragaceae). *Biological Journal of the Linnean Society* 35: 15-28.
- Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. and Webb, D.A. 1964-1980. *Flora Europea*. Cambridge university Press, Cambridge.

Willson, M.F. and Agren, J. 1989. Differential floral rewards and pollination by deceit in unisexual flowers. *Oikos* 55: 23-29.

### Tables

Table 1. Comparative results of different parameters studied in *Silene vulgaris* (Mean  $\pm$  S.D.)

	N	Female	Hermaphrodite
Flowers / plant	15	204 $\pm$ 55	190 $\pm$ 50.1
Flowers with fruit (%)	125	93	87
Seeds / capsule	125	33 $\pm$ 15.4	48 $\pm$ 22.6 *
Seed weight / capsule (mg)	125	72 $\pm$ 6.3	90.6 $\pm$ 26.1 *
Seed weight (unit) (mg)	100	2.25 $\pm$ 0.4	1.90 $\pm$ 0.3 *
Ovules / capsule	15	133.9 $\pm$ 19.9	139.8 $\pm$ 22.8
Final germination (%)	200	99.5	87

### Figures

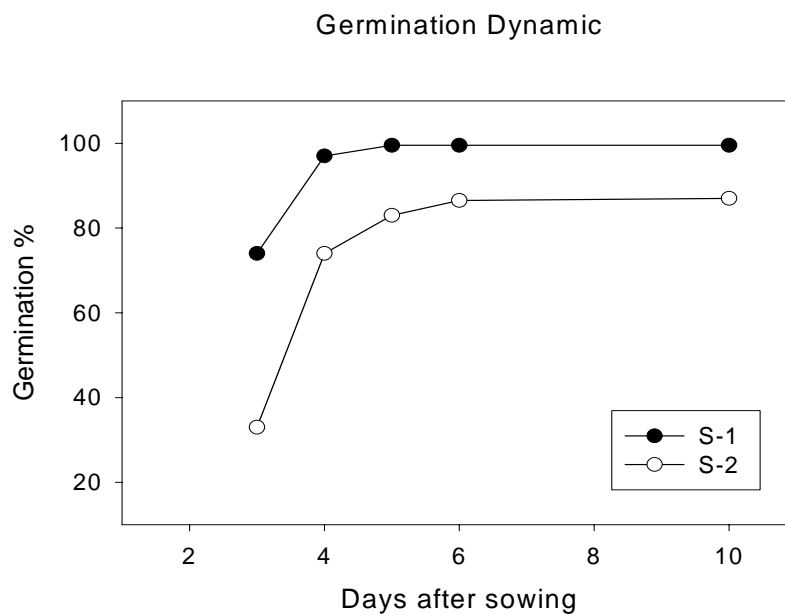


Fig. 1. Germination dynamics for seeds from both plant types. S-1 indicates germination dynamic of seeds from female plants. S-2 indicates germination dynamic of seeds from hermaphrodite plants.