Scientia Horticulturae 246 (2019) 1005–1008

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Short communication

Effect of flower sex ratio on fruit set in pumpkin (*Cucurbita maxima*)

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ARTICLE INFO

Keywords:
Cucurbita maxima
Flower sex function
Pollination
Pumpkin
Sex ratio

ABSTRACT

Flower sex expression and sex ratio are the two plant functional traits likely to explain pollination efficiency in monoecious animal-pollinated plants. Cucurbitaceae crop plants are staminate flower-biased, but, relatively little is known about the natural variation in flower sex expression and the effect of flower sex ratio on fruit set. To address these, 325 plants of *Cucurbita maxima* were monitored for the entire flowering cycle and studied fruit set in 1515 pistillate flowers under open conditions for two years. The flower sex ratio of the fields and the plants and the flowering age (=phase) of the plants were used as the predictors of fruit set. The blooming in *C. maxima* started with the staminate flowers; 67% of the plants produced a staminate flower first, which continued for about ten days. The number of staminate flowers produced in the plants strongly predicted the number of pistillate flowers bloomed later. The sex ratio of the fields, rather than that of an individual plant, predicted the fruit set. Although pollinators are vital for pollination in animal-pollinated monoecious plants, our results suggest that flower sex ratio is also a crucial predictor of pollination efficiency. Monitoring flower sex expression in fields may be required to predict realistic fruit set and to take necessary measures, including facilitated pollination to improve fruit set.

1. Introduction

Pollination crisis in animal-pollinated crop plants is a global concern (Klein et al., 2007). The monoecious plants suffer more from the ongoing pollination crisis (Klein et al., 2007; Garibaldi et al., 2013). Globally, pumpkin (*Cucurbita pepo* in North America and *C. maxima* in India) is considered pollination-deficient; the lack of effective pollinators and the poor functional group diversity of the pollinators are identified as the reasons (Hoehn et al., 2008; Petersen et al., 2013; Sinu et al., 2017 and references therein). In monoecious plants, however, flower sex ratio could be an important proximate predictive factor of crop pollination and fruit set (Aizen, 1997; Cuevas and Polito, 2004). However, it has been hardly incorporated as a predictor of pollination in monoecious crop plants.

Cucurbitaceae plants produce a disproportionately large number of staminate flowers (Ne Smith et al., 1994; Ashworth and Galetto, 2001; Anusree et al., 2015). Maintaining a staminate flower is inexpensive for monoecious plants than maintaining a pistillate flower (Bertin 1982). In *C. maxima*, the staminate flower is smaller than the pistillate flower and offers relatively less amount of poor quality nectar (Ashworth and Galetto, 2001). Therefore it may be economical for *C. maxima* to hold more staminate flowers than pistillate flowers. Biologists suggest that day length, temperature, soil type, and cultivar type influence flower sex ratio in cucurbits (Tiedjens, 1928; Whitaker, 1931; Ne Smith et al., 1994). Long days favour staminate flower production and short days favour pistillate flower production (Tiedjens, 1928). Woodson and Fargo (1991) postulated that the temperature-linked flower sex ratio change in cucurbits may be due to the fluctuation in the number of staminate flowers. On the other hand Stapleton et al. (2000) suggests that climatic conditions are secondary to plants' physiology in affecting flowering pattern in *C. pepo*. Most of these studies happened in temperate climates, where temperature and day length are highly variable. No studies, to our knowledge, however, examined the pattern of flower sex expression and sex ratio in *C. maxima* during its entire flowering phase in tropical natural conditions or studied the effect of flower sex ratio on fruit set.

In this study, we address the following questions: a) what percent of plants in field populations are monoecious, androecios and gynoecious? b) what is the pattern of flower sex ratio and flower sex expression in plants across fields and years? c) can the staminate-pistillate flower sex ratio of the plant or field predict fruit set?

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https://doi.org/10.1016/j.scienta.2018.11.081
Received 2 July 2017; Received in revised form 31 October 2018; Accepted 28 November 2018