POLLINATION PATTERNS IN SAFFLOWER

(*Carthamus tinctorius* L.)

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ABSTRACT

The influence of environmental conditions on safflower *(Carthamus tinctorius* L.) floret characters and insects were studied in relation to pollination in this species.

Insect activity was studied in a field experiment using part of the world germplasm collection of safflower. Honey bees were the most likely cross-pollinators. Activity of honey bees did not vary between genotypes studied. Correlations between insect and weather data were mainly non-significant.

A sample of 12 genotypes from the world collection were intensively studied in controlled environment rooms. Single plants were used as plots in a randomised complete block design, in each of four environments (day/night temperature treatments of $28/22^{C}$c and $24/18^{O}$c in combination with vapour pressure deficit treatments of -1.0 and -0.4 kPa). Environments reflected New Zealand summer conditions.

Coefficients of variation were acceptable for most characters. Considerable genotypic, environmental and genotype-environment interaction variances were observed for most characters. Standardised partial regression coefficients (path coefficients) and principal factors were utilized to determine the characters most important in self-pollination of safflower. These characters were: the length of the style-stigma; the rate of style-stigma growth; the rate of corolla tube growth and amounts of viable

pollen present during floret expansion.

Pollen viabilities remained high for the longest time in higher humidity environments. Large amounts of pollen were produced at the lower humidity. Floral parts were largest in the cool dry environment, however rates of style-stigma and corolla expansion were greater at lower temperatures. It was concluded that synchronization of the rates of style-stigma and corolla tube growth were important in maintaining the stigma in close proximity to viable pollen, and thus promoting the possibility of self-pollination. Self-pollination was greatest at the lower temperature and lower humidity.

The basic self-pollination mechanism observed was in agreement with previous authors.

A number of improvements for future controlled environment experiments involving safflower were suggested.

The implications of pollination of safflower on germplasm collection and maintenance, artificial crossing and breeding plans were discussed.

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INTRODUCTION

Safflower *(Carthamus tinctorius* L.) is an errect annual thistle-like herb adapted to semi-arid areas. It has a deeply penetrating taproot (Henderson, 1962) and strong stem with many appressed or spreading branches (Leon and Knowles, 1964) each terminating in a capitulum. Lower leaves of most genotypes are entire and free of spines. Upper leaves vary from spineless to strongly spined (Rao, 1943; Claassen, 1952). A short rosette phase may exist (Zimmerman, 1973). Height at maturity ranges from 0.5m to 1.5m (Purseglove, 1968). Considerable genotypic variation in morphology exists (Ashri *et al.*, 1976). Environmental changes also have considerable impact on morphology (Beech and Norman, 1966).

Safflower is known only in the cultivated form (Wiess, 1971), and is thought to have evolved in the area bounded by the Eastern Mediterranean and the Persian Gulf (Ashri and Knowles, 1960; Hanelt, 1963). Widespread domestication and dispersion have resulted in the plant having had many varied uses, e.g. as a dye, vegetable, cosmetic and medicinal herb (Wiess, 1971; Knowles, 1960a).

Current interest centres on safflower's hydrophobic oil which is light coloured and easily clarified. Non-yellowing properties have led to its widespread use in paints and varnishes. Meal made from seed is also utilised as a protein supplement in animal diets (Knowles, 1958). Cultivars exist today with improved oil quality and quantity, disease and insect resistance (Wiess, 1971).

Interest in New Zealand centres on its use as a summer growing oilseed crop for North Island areas prone to drought. Such environments are also associated with high humidities, fogs and late summer rainfall, which lead to disease problems in the crop, and sprouting damage to the seed. Resistance of safflower to *Botrytis cinerea* (the most troublesome disease in N.Z.) and sprouting damage are thought to exist (Knowles, 1958; Kotecha and Zimmerman, 1978).

An effective breeding program is needed to produce cultivars suited to the New Zealand environment. A knowledge of population gene structure within the species is required if selection methods and breeding plans are to be utilized efficiently. To this end a study of pollination patterns in Safflower was initiated as past and present pollination patterns influence population structure. The present study consisted of two parts:

A. A field study was conducted to observe insect activity on the crop. The objective was to acquire knowledge of the role played by insect pollinators. The opportunity was taken to study floral characters such as floret morphology, pollen presence and stigmatic extrusion which might be of interest in subsequent studies.

B. The second part consisted of a controlled environment study of plant and floral characters. The objectives were to observe genotypic and environmental differences in characters potentially related to self-pollination; and to determine characters most important in self-pollination. Examples of such characters include amounts and viabilities of pollen, stigma receptivity, corolla characteristics and lengths of flowering.