SIGNIFICANCE OF NECTAR SECRETION FOR HONEY BEE FORAGING (*Apis mellifica*), AND CONSEQUENCES OF POLLINATION ON OILSEED RAPE (*Brassica napus*) SEED PRODUCTION.

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INTRODUCTION.

Production of F1 hybrid seed in oilseed rape depends on exploitation of male sterility in a 'female' plant which must be pollinised by a male-fertile variety ('male' plants), because of predominance of autogamy. This is achieved in a crop system alternating rows of male and female plants, most pollination depending on bees, much less on wind (Mesquida & Renard 1982).

In the interests of efficiency and profitability, it is important to ensure a maximum presence of female plants, and a high level of fertilisation. However, this depends not only on bee populations, but also on distance of female from male parent plants, on synchronisation of male and female flowering, on attractiveness of nectar of different lines (i.e. on quality of nectar production), on bee foraging behaviour, and on environmental conditions (soil, weather, fertiliser, wind etc).

Given these considerations, trials were run with 'female' lines of a same origin (Ogura type male cytoplasmic sterility, Rousselle 1981) between 1978 and 1986 on the INRA estate farm at Rennes (Brittany, France).

Relationships between nectar production and quality, bee foraging behaviour, pollinisation of female strips as a function of distance to parent 'male' were studied on the basis of results from trials with line 3.22.3.7 on poorly nectiferous Ogura cytoplasm (Mesquida & Renard 1979 a) and b), Houedry 1980; and the FU-27 cytoplasm obtained by protoplast fusion (Pelletier et al 1983)

MATERIALS AND METHODS.

The male-sterile line 3.22.3.7 was used as 'female' (Primor line on Ogura cytoplasm), and Primor as 'male', for winter oilseed rape.

Brutor was the parent'male' and the alloplasmic Brutor line on FU-27 hybrid cytoplasm as the 'female' for spring oilseed rape.

Two strips of 'males' alternated with 20 strips of females (2/20) for the female line 3.22.3.7. The planting pattern was 4/28 (four lines of males between 28 of females) for the FU-27. Patterns were repeated three to five times in experimental plots.

All strips were 30 m long and 2.45 m wide (8 rows of plants, 0.35 m between rows, 0.70 m between strips) for 3.22.3.7. Strips were 1.00 m wide (5 rows of plants, 0.25 m between rows, 0.40 m between strips) for FU-27. Consequently, the first 'female' strip was at 0.70 m from the parent 'male' for 3.22.3.7, or at 0.40 m for FU-27. The furthest female strip was then at 29 m for the former, and at 18.60 m for the latter situation.

Observations bearing mainly on phenological parameters (nectar secretions and synchronisation of flowering), on insect biology (bee densities, foraging behaviour) and agricultural features (pod set and yield components) have been described elsewhere (Mesquida & Renard 1979).

Bee foraging behaviour recorded for the present paper is that during peak flowering of 'males' and females'. To permit comparison, bee numbers (log values in figures) are shown per unit visitable flower number (10^6), which takes account of both bee and flower densities.

RESULTS.

1) Nectar secretions: Female line nectar secretion was very low

(trace only) compared with parent males for 3.22.3.7, and at 70% for the FU-27 cybrid.

2) Foraging behaviour: two situations were found, according to line and nectar secretion (Figure 1).

i) line 3.22.3.7 with low nectar secretion, showed concentration of bees on the more attractive males, with reduced frequentation of female strips.(Figure 1A, 1B)

ii) cybrid line FU-27 with higher nectar secretion showed no concentration of bees on males, and a fairly uniform distribution over male and female strips.(Figure 1C). Only bees with pollen on hind legs showed a density gradient relative to 'male' plants.

3) Production of female strips:

i) Pod set - Figure 2 illustrates the difference between the two male sterilities which also differ in nectar secretion.

Line 3.22.3.7 with low nectar secretion had low pod set and showed a gradient in this respect (80% at less than 1m from the parent 'male' to 50% at 20 m, the latter subsequently maintained up to 30m (Figures 2A & 2B).

Line FU-27 with higher nectar production had higher levels of pod ser, identical over all 'male' and 'female' strips (above 90% up to 20m (Figure 2C).

ii) Yield - The preceding distinctions re-emerge when number of seeds per pod and yields are compared (Figure 4), but not when weights of 1000 seeds are considered. The latter is more open to compensatory effects.

Thus one group corresponded to line 3.22.3.7 with, however, a more pronounced gradient for seed number per pod (Figures 3A & 3B) than for yield (Figures 4A & 4B). Another corresponds with the FU-27 (Figure 3C & 4C) for which the pollination gradient is only reflected in seed number per pod (Figure 3C) whereas yields are constant over all strips.

The quantitative differences found between the groups may be explained by varietal or climatic factors. It may be noted that the most closely associated parameters were percentage pollen bearing bees, level of pod set, number of seeds per pod, and yield. Pod set and number of seeds per pod were negatively correlated with seed weight.

DISCUSSION.

It has been shown that improvement of oilseed rape nectar secretion in 'female' plants by protoplast fusion is accompanied by improvement in bee flower-frequentation, and levels of fertilisation. When 'female' nectar production is similar to that of the parent 'males' bee foragers alternate between plant types, flower exploitation is uniform, and pollination is good, measured in terms of pod set and seed number per pod. When, however, as for 3.22.3.7. female nectar secretion is low bee frequentation diminishes, and male flowers are preferred. This is reflected in measures of production, notably pod set and seed number per pod.

A major role of nectar secretions in relation to bee flower frequentation is thus confirmed (Masson 1983; Fonta et al 1983; Tepetino & Parker 1982).

However, nectar quantity may not be the only factor to be considered. In sunflower, for example, sugar composition and content of nectar also appears to be crucial for bee preferences. 'Female' sunflower lines, whose nectar is richer in saccharose are more attractive to bees than the parent 'males' (Fonta et al 1983).

However; a pilot study (Le Metayer 1985) suggests that for oil-seed rape, nectar quantity and sugar concentration may be more relevant to bee preferences. The hypothesis remains to be tested.

The present study has indicated that a gradient in bee frequentation in relation to nectar secretion could account for differences in production of female plants as a function of distance from males (pod set and seed number per pod). Triboi-Blondel (1986) has shown correspondance between variations in oilseed rape yield and other yield components. However, the fact that seed weight is negatively correlated with pod number and yield should be ascribed to compensatory phenomena which, themselves a function of environmental conditions, both add to the effects of bee pollination, but, at the same time, mask the latter.

Nevertheless, bee foraging is affected by flower densities and differences between male and female lines in nectar secretions. Number of bee foragers per unit surface area, was, indeed, significantly correlated with flowering level (Mesquida & Renard 1979 a)).

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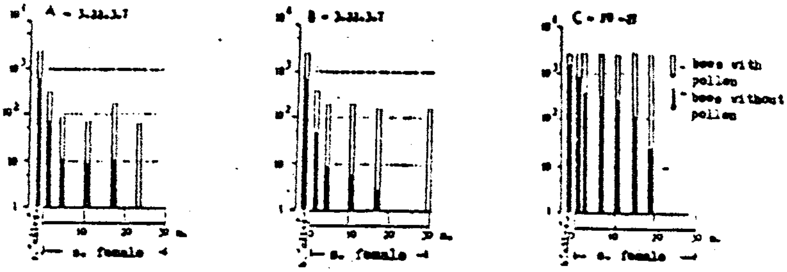
Figure 1. Number of bees with and without pollen on hind legs on 'male' and 'female' oilseed strips.



Abscissa: distances (m) of 'female' strips from 'male' strips.
Ordinate: Number of bees (log)/10^6 flowers.

Figure 2. Pod set (%) for male and female strips.

Abscissa: (same as Fig.1)
Ordinate: Seed set (%).

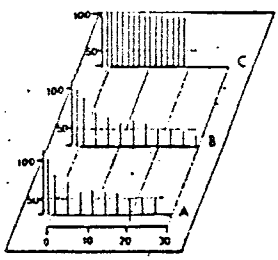


Figure 3. Number of seeds/pod, for 'male' and 'female' strips.

Abscissa: (same as Fig.1)
Ordinate: Number of seeds/pod.

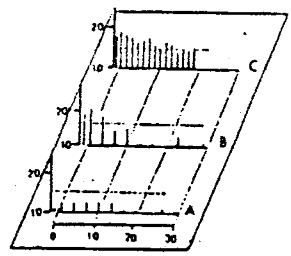


Figure 4. Male and female strip yield.

Abscissa : (same as Fig 1)
Ordinate: Yield (qux/ha).