POLLINATION OF SELF FERTILE WINTER OILSEED RAPE (*Brassica napus*, L.) BY HONEY BEES (*Apis mellifica*).

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INTRODUCTION.

Oilseed-rape flowers are highly attractive to, and visited principally by honey bees which collect pollen and nectar abundantly for food and offspring. The intensity and consistency of this behaviour, together with the action of other insects and wind, contributes to flower pollination. However, rape is partly autogamous (70% self-fertilisation reported by Olsson 1952; Rives 1957). Furthermore, cross-pollination is not essential, and when absent or at low level, is unlikely to adversely affect yield in France, since most lines currently grown are 'pure'. Nevertheless, some studies have indicated an effect of bee pollination on yield, though results vary and some are contradictory. Thus Ewert (1928); Nicolaisen (1943); Free & Nuttall(1968) found no significant effect, while Fujita (1939); Kubisova et al(1980); and Kamler (1983) did do so. The present study of rape pollination in field crop conditions and in enclosed plots was undertaken to determine whether oilseed rape production can indeed benefit from bee foraging activity (Mesquida et al in press).

MATERIALS AND METHODS.

Trials covered three years (1982-1984), using winter oilseed rape strain 'jet-neuf', on the INRA estate farm (Rennes, Brittany, France).

Test plots measured 3 x 3 x 2 m (9m^2), with plants planted in eight 3m lines, spaced at 0.3 m, at a density of 50-60 m^2. Each trial consisted of five treatments and four blocks. In all years treatments were used: 'cages with bees', two controls, 'cages without insects' and 'field crop', with'cages with fans' and'cages with fans and bees' in 1982, 'cages with bumble bees (<u>Bombus</u> <u>terrestris</u>)' and 'cages with fans' in 1983, and 'cages with flies (*Calliphora*)' and 'cages with bumble bees' in 1984. Pollination in cages without insects was dependent on wind alone. In field crops it was the result of wind and local insect activity together. Consequences of pollination were assessed using phenological parameters (branching, flowering, pods), some yield components (number of seeds per pod, weight of 1000 seeds) and yield

RESULTS.

The following points were recorded in cages, notably in those with bees, and in comparison with cages without insects.

Lower production of secondary and tertiary stems between onset and end of flowering (approx -24%); shorter flower life (approx - 2.5 days); lower flower production (approx - 23%); and lower pod set (approx -4% to - 12% on average) for whole plants. However, the latter was significantly greater on the first sections of the main branch (a compensatory effect).

Fewer seeds per pod (Table 1); equal or larger seed size; slightly higher (but non-significant) yield (+ 3%).

No bee effect on yield was therefore detected in cages.

In field crops pods contained smaller grains (Table 1) but yield was distinctly higher. These differences, sometimes highly significant, compared with cages, indicate presence of an important 'cage effect'.

DISCUSSION.

Some features which seem to be linked to bee foraging (lowered stem production, duration of flowering, and flower life) accord with results reported in other studies (Ewert 1928; Zander 1952; Versely 1962; Mesquida & Renard 1981; Lerin 1982; Williams 1984). Bee effects on oilseed rape therefore appear as more homogenous flowering and pod maturation.

However, bee effects on oilseed yield are differently expressed according to whether the whole plant, or only part (e.g. main flower head) is considered.

A positive effect of insect pollination on the main flower head has already been demonstrated by Lerin (1982) and Barbier (1978). This, however, alone, overestimates the effect of insects on yield. In general the bee effect is masked by compensatory phenomena dependent in particular on environmental conditions. Lerin (1982) also showed that overall plant yield was more closely related to that of secondary stem flower heads than to that of the main stem. The larger number of secondary stems produced by plants not pollinised by insects had consequences for overall yield. This accounts for significant differences when main stems only are considered, and none when whole plants are.

The present results also suggest that disparate results obtained by other workers (Kaeser et al 1978; Woznica 1979; Kubisova et al 1980; Kamler et al 1983), attributed by them to a bee effect, could be due to experimental conditions. They compared yield of field crop plants with plants in cages without insects, without taking account of a cage effect on vegetative growth and seed production. Such cage effects, which are difficult to master (e.g. shelter effects reducing shaking, pollen tranfer and thus likelihood of wind dependent self pollination) make comparisons questionable. Field crop yields invariably diverge from those of cages.

Although some appreciable effects of bee pollination have been detected (shorter flowering period,higher seed number per pod, better pod set on the first sections of main stems), this was not so for yield, due to compensation in our experimental conditions: Production of new secondary and tertiary stems, and of more pods (albeit with fewer seeds per pod) hide a real and beneficial effect of insect pollination on self fertile oilseed rape yield.

However, the method used revealed some unsuspected complications due to competition, and selectioners would be well advised to consider cytoplasmic effects on yield and other features, prior to any practical action. These competitive effects might, indeed be even more pronounced in any 'mixed' varieties that could ultimately be established, because of a double intervention of hybrid nuclear and cytoplasmic structures. It remains to find a mixture with a maximum of F1 hybrid 'females', while still maintaining good inter-varietal equilibrium, in order to attenuate competitive effects. We consider variation either in polliniser type (e.g. use of more vigorous synthetic 'males') or in percentage composition of the latter.

Some other points require clarification:

- wind as a pollen vector and its role in pollination, in order to better understand that of bees. Its importance for plants in close proximity has been demonstrated in other situations (Mesquida & Renard 1982; Olsson 1955).
- the role of other insect pollinators.
- relevance of results obtained for spring oilseed rape (used because of availability of CMS) to winter oilseed rape under as varied environmental conditions as possible during flowering.

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TABLE 1 : INFLUENCE OF BEES AND DIFFERENT POLLINATION CONDITIONS ON OILSEED RAPE YIELD COMPONENTS.

	Yield component mean		
	NSP	W	Y
1982			
+ B			27,50 (±1,71)
- B			26.90 (±1,17)
+ F			24,82 (±1,01)
+ F + B			24.36 (±1,11)
FC			-
Signif.			NS
1983			
+ B	16,30 (±0,69)(B)	5,38 (±0,11)	23,11 (±2,44)
- B	16,08 (±0,56)(B)	5,15 (±0,09)	22,62 (±1,97)
+ BB	14,56 (±0,58)(A)	5,34 (±0,11)	24,11 (±1,02)
+ F	14,77 (±0,64)(A)	5,46 (±0,28)	23,03 (±2,87)
FC	18,21 (±0,59)(C)	5,21 (±0,27)	29,10 (±1,69)
Signif.	S**	NS	NS
1984			
+ B	14,95 (±1,73)	5,55 (±0,14)	28,86 (±1,13)(A)
- B	12,03 (±1,69)	5,55 (±0,18)	30,72 (±1,12)(A)
+ BB	16,31 (±1,05)	5,54 (±0,21)	28,56 (±0,71)(A)
+ FL	13.51 (±1,36)	5,46 (±0,11)	29,44 (±0,80)(A)
FC	15,59 (±0,69)	5,29 (±0,25)	38,11 (±1,82)(B)
Signif.	NS	NS	S***

- (±) standard error.
- NSP: number of seeds/pod.
- W: weight of 1000 seeds.
- Y: yield (qux/ha)
- Means signalled by a same letter do not differ significantly
- N.S: not significant.
- S^{***} : significant at p 0.001
- + B: cages with bees.
-- B cages without bees. (control 1)
- + F: cages with fans.
- F + B : cages with bees and fans.
- FC : field cross. (control 2).
- +BB : cages with bumble bees.
- +FL : cages with flies.