THE RELATIONSHIP BETWEEN CANOPY STRUCTURE AND YIELD IN OILSEED RAPE

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ABSTRACT

Both anecdotal evidence from growers and yield data from past experiments have indicated that thick, advanced crops of oilseed rape do not always yield as much as their thinner counterparts. This paper uses results from detailed measurements of growth and radiation interception made in two experiments to identify the likely mechanisms responsible for these observations.

INTRODUCTION

Yields of oilseed rape are notoriously variable; interestingly, farmers have reported similar or even better yields from sparse crops. Experiments examining the influence of plant establishment, sowing date and defoliation have also shown yield advantages following poor initial growth and the production of sparse and more open canopies (Mendham, Shipway & Scott, 1981; Spink, 1992). Table 1, reproduced from Jenkins and Leitch (1986) shows how the smaller biomass, fewer pods m^{-2} and lighter seeds of late sowings, were totally offset by a twofold increase in the number of seeds per pod.

TABLE 1. Yield components showing compensatory effect on seed number per pod.

Sowing Date	Yield (t/ha) 91% dm	Pods per m^2	Seeds per pod	1000 seed wt (g)	Harvest Index (%)	Total Biomass (t/ha)
10/9/82	4.82	7224	11	6.1	31	14.6
2/12/82	4.77	4703	20	4.9	35	13.1
7/9/83	4.35	11068	9	4.53	24	16.5
20/10/83	5.03	7208	19	3.68	30	15.4

The inference is that unlike crops such as sugar beet and cereals for which yield is strongly correlated with the amount of radiation intercepted and hence biomass produced, the yield of oilseed rape is more subtly linked with canopy architecture and the distribution of radiation within the canopy, particularly features which favour a high seed number per pod. This paper investigates the mechanisms that prevent thick crops from doing well while sometimes allowing sparse crops to do better.

EXPERIMENTAL

Plant population studies

A field experiment sown on 8 September 1992 examined the response of oilseed rape (cv. Libravo) when thinned in March to 7, 15, 30, 70 and 120 plants m^{-2}. Characteristically, lower populations compensated for fewer pods by retaining more seeds per pod (Table 2).

Between thinning in March and flowering in late April, biomass production was linked with green area index (GAI); higher populations had larger GAIs (Fig 1), intercepted more radiation and produced more biomass (Table 2). However, between flowering and harvest, the thicker canopies produced less biomass, despite maintaining larger GAIs (Fig 1) and intercepting more radiation (1370 MJ in 120 plants m^{-2}, but only 1220 MJ in 7 plants m^{-2}). Therefore, yield production seemed not to be linked with radiation interception by the whole crop. Examination of the pod layer in the 7, 15 and 120 plant m^{-2} canopies showed that the low densities (Fig 1) intercepted less radiation between flowering and maturity; 730MJ (120), 580MJ (15) and 540MJ (7). Thus, despite intercepting more radiation both in the pod layer and in the crop as a whole, the thicker crops used this radiation less efficiently, produced less growth after flowering resulting in greater loss of seeds and slightly smaller yields at harvest. The explanation for this must lie in the fate of intercepted radiation within the canopy.

TABLE 2. Yields and components from the plant population experiment

Plant Pop. m^{-2}	Yield(t/ha) 91% dm (SED=0.21 12df)	Pods per m^2	Seeds per pod	1000 seed wt (g)	HI (%)	Biomass (t/ha) Flowering	Harvest
7	3.6	4600	16	4.78	35	3.5	10.0
15	3.4	5300	15	4.49	33	5.0	10.0
30	3.7	6700	13	4.40	33	6.5	11.5
70	2.9	6200	10	4.84	27	8.4	11.0
120	3.0	6500	10	4.56	26	8.5	11.5

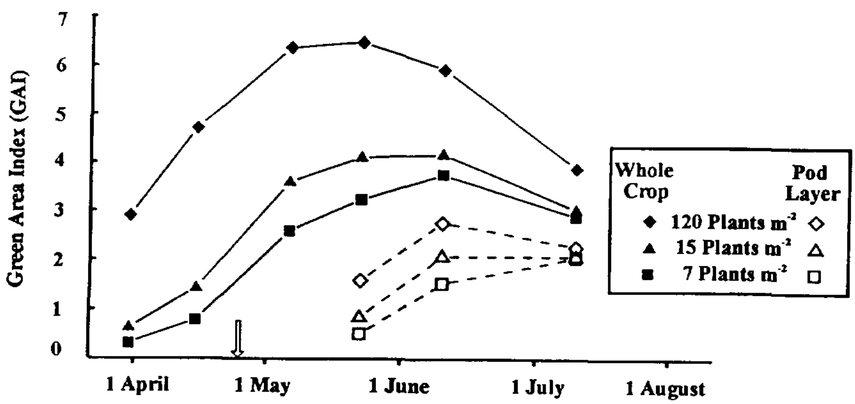

FIGURE 1. Green area index from 15 April to 8 July for whole crop and pod bearing layer from the 7, 15 and 120 plants m^{-2} populations; arrow indicates flowering.

<u>Contrasting canopies in successive years</u>

Following similar husbandry of autumn-sown Capricorn in 1992 & 1993, exceptionally bright weather in May 1992 resulted in the growth of a much thicker pod canopy (GAI 6.8, 9500 pods m^{-2}) in late May compared with more normal conditions in 1993 (GAI 5.2, 6000 pods m^{-2}). Fig 2 shows a 'snap-shot' in mid June (early pod development) of the canopy profiles, with radiation penetration calculated for a typical day in June (incident radiation = 20 MJ m^{-2}). Pods set and seeds per pod at the end of May and those which were retained through to final harvest are represented diagrammatically for the different layers of the profile.

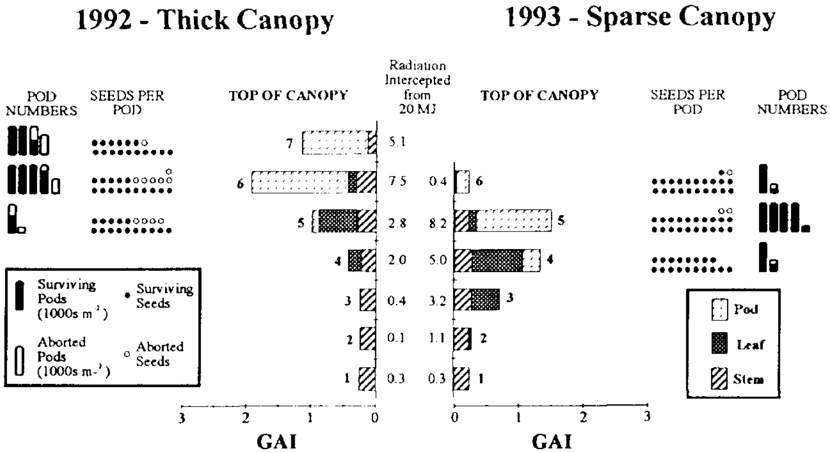

FIGURE 2. Diagrammatic representation of the canopies in 20cm layers showing the distribution and nature of the intercepting surface, radiation interception and fate of pods and seeds.

The thick crop resulted from 50% more pods setting. The top layer was well illuminated and few seeds per pod were lost. The pods lost in this layer were initiated late and almost certainly doomed not to survive, irrespective of radiation environment. In layer 6 of the thick crop, which was also dense, the shading from the top layer resulted in losses of pods and seeds per pod. Importantly, only one quarter of the radiation penetrated through to the lower layers (5 and 4) where the majority of leaves were situated. In contrast, the sparse crop allowed almost half the radiation to penetrate to the base of the pod layer and it seems that this better illumination and hence greater contribution to photosynthesis from lower leaves and pods is the likely causal mechanism leading to the maintenance of a high seed number per pod and the route through which sparse crops yield better than expected.

ACKNOWLEDGEMENTS

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