Multidisciplinary Research on Oilseed Rape at Rothamsted

C.J. Rawlinson
Rothamsted Experimental Station, Harpenden, Herts., U.K.

Justification

A major aim in crop research is to tell the grower the relative importance of factors that might restrict the realisation of the full potential of the genetic material provided by plant breeders. For this to be done for oilseed rape more research is needed to provide greater understanding and better integrated information about crop response to natural complexes of environmental, agricultural and management factors. Much of the research done hitherto in field experiments with oilseed rape has concentrated on selected problems of interest to single scientific disciplines. Advisory, trade or technical organisations serving the grower have had to interpret results from numerous, often uncoordinated, trials designed to explore different aspects of crop response. The value of such independent research can be limited as crops respond to a range of factors outside the competence or practical ability of one discipline. This can restrict the useful application of results to commercial agricultural practice and this is especially true for a heterogeneous crop well known for its ability to compensate for some types of damage.

Recently there has been a change of emphasis from research into maximising crop yields to research into the best use of agricultural inputs for economic yields. For rape it is necessary to identify, define and rank the importance of inputs and constraints to yield so that they may be avoided, manipulated or controlled efficiently.

At Rothamsted this is being done by across-discipline collaboration in large multifactorial field trials serviced by a multidisciplinary team of research workers. This new approach, begun in autumn 1984, represents the first attempt to integrate information gained from a trial by a range of expertise. From a co-ordinated study of the effects of individual inputs and limiting factors the aim is to determine whether their effects are additive, synergistic or interactive. This should enable a thorough evaluation of those factors determining economic yield, and a better understanding of crop responses to combinations of inputs under a range of environmental conditions should also follow. This information will become increasingly necessary to underpin growers' decisions as they respond to future adjustments in price, political support and market forces, and the advent of new agrochemicals and low glucosinolate varieties, all of which may impose changes on presently accepted growing systems.

Experimental design and treatments

The first multidisciplinary multifactorial field experiment was with cv. Bienvenu sown after winter barley. The experimental design was a half replicate of 27 plus 30 extra plots for additional treatments or study and 2 for observation where no treatments were given (total of 96 plots each 3x17 m). The main effects and interactions of 7 treatments were tested and a large proportion of 256 possible combinations of treatments studied by a team of 16 specialists plus scientific and farm support.

The main treatments are :

1. Time of sowing (16 August v. 6 September).
2. Amount of spring nitrogen (175 v. 275 kg/ha).
3. Division of nitrogen (1/3 February + 2/3 March or all in February).
4. Nil v. full insecticide programme (deltamethrin in autumn + pre- and post- flowering sprays as necessary).
5. Nil v. autumn fungicide (fenpropimorph seed dressing + prochloraz in November).
6. Nil v. spring and summer fungicide (prochloraz in March + iprodione post-flowering).
7. Nil v. growth regulator (ethephon at late flowering).

Eight extra plots test a range of spring nitrogen rates from nil to 325 kg/ha on both sowing dates. Eight other plots test a seedbed application of nematicide (5 kg/ha oxamyl) on both sowing dates. Eight further plots increase the replication of treatments 1, 2, 3 and 7, receive a full programme of insecticides and fungicides and are used for detailed work on the development and physiology of the crop. Three plots are used for a study of uptake and loss of nitrogen applied at different times and rates to four micro-plots (2 x 2 m) per plot with each plot receiving ammonium nitrate at 5 atom % excess ^{15}N. All these extra plots are randomised into the main expriment. Two further plots, both sown early and given 275 kg N/ha as a single dressing and full pest and disease control but no growth regulator and sited together for convenience, are used for a study of root growth. Basal treatments were herbicides (paraquat after winter barley and 'Matri-kerb' later), shallow cultivation, seedbed nitrogen (50 kg/ha), seedrate (8 kg/ha) and row width (17 cm). The experiment covers 0.8 ha, set within 6.7 ha also sown to rape, and is netted from December to March to prevent pigeon damage. The choice of cultivar and treatments reflects a compromise between research and grower needs, short and long term objectives, practicality and resources.

In 1985-86 the same treatments will be tested again using the same design but in a blocked layout of larger plots (3x20 m), with the addition of extra plots to test late foliar application of nitrogen with and without micro-nutrients and sulphur.

Measurements

The disciplines involved in the experiment are agronomy, entomology, nematology, nutrition, pathology, physiology, physics and statistics. Measurements made include, emergence counts and establishment in relation to soil water and air volume and dry bulk density to help identify factors influencing establishment, dry matter, leaf area, plant structure and development, detailed growth analysis, light interception and quality, soil water using neutron probes, nitrogen analysis of dry matter samples and frequent stem or petiole nitrate tests on selected plants, nitrogen uptake and loss on root study and ^{15}N plots, root growth quantity and distribution in relation to nutrient uptake, development and identification of leaf surface microflora in relation to spray treatments, pests and diseases, nematode infestation, components of yield, total yield and oil content of seed. Weather and crop microclimate are constantly monitored and records stored on a computer data-base. After harvest, plots given ^{15}N will be marked and succeeding crops will be monitored to measure the residual value to these crops of nitrogen applied to rape.

Associated research

In addition to the multidisciplinary experiments other research on oilseed rape continues on (1) fertilizers, urease and nitrification inhibitors ; (2) cultivars and response to fungicide timings ; (3) effects of spray-additive and fungicide timing on disease control ; (4) effects of growth regulators and related sterol-inhibiting fungicides on disease ; (5) effects of novel slow release formulations of isothiocyanates on disease ; (6) effects of pollination by honeybees on pod position, maturation and yield ; (7) the biology of pod midge *(Dasineura brassicae)* on spring and winter rape, trapping methods and development of a pheromone monitoring system for this pest ; (8) biology and control of nematode problems ; (9) measurements of wind flow in the rape canopy and crop microclimate in relation to splash and wind-borne spore dispersal ; (10) precision sowing in relation to sowing date, seed rate and seed treatment ; (11) cereal straw treatments and incorporation into soil in relation to rape establishment and yield ; (12) effects of rape and other combinable break crops on post-harvest soil nitrogen and the effects on subsequent cereal crops. Where appropriate the results from the above work will be used to complement or modify future multidisciplinary work. Conversely, any important interaction revealed in multidisciplinary work will be the subject of a further detailed independent study.

Results

Few results are yet available. However, it appears that the potential advantages of better growth and increased leaf area from early sowing is counteracted by loss of plant population from much increased damage by larvae of *Psylliodes chrysocephala* and increases in *Phoma, Pyrenopeziza, Botrytis, Peronospora* and beet western yellows virus. As the research programme continues the balance between advantage and constraints will be assessed and justification for treatments validated or questioned. The multidisciplinary approach will need to be repeated on a range of soil types in other climatic conditions for the results to have widest application. The spectrum and severity of pest and disease attack, and other constraints to yield, may change with the widespread introduction of low glucosinolate varieties in Europe. If, through national and international co-operation, multidisciplinary trials could be extended to include these new varieties some consequences of the changeover may be anticipated.