CO1978BRE03

# A STRATEGY FOR IMPROVING SPRING RAPE (BRASSICA NAPUS) YIELDS IN WESTERN AUSTRALIA THROUGH MODIFICATION OF THE DEVELOPMENTAL PATTERN

By Noel Thurling
The University of Western Australia
Nedlands, Western Australia

## INTRODUCTION

The commercial production of rapeseed in Western Australia commenced in 1969 and since then has been based entirely on spring varieties of B.napus and B.campestris introduced from Canada, Europe and Japan. Growing areas occur in a typically Mediterranean climate where the growing season extends from late autumn to late spring. Between 300 and 600 mm of rain is normally received during the growing season and mean daily temperatures range between 10 and 15°C. Temperatures and particularly levels of solar radiation are thus sub-optimal when compared with conditions prevailing in areas for which the introduced varieties were bred. A major aim of research at the University of Western Australia is improvement in yield through selection for better adaptation to the local environment. This will involve identification of an optimal developmental pattern which should allow for completion of seed development before the onset of drought stresses in late spring and also ensure maximum possible vegetative development.

## VARIATION IN DEVELOPMENTAL PATTERN

Substantial variation has been observed in the field between spring rape varieties in respect of the lengths of the two major pre-anthesis developmental phases - vegetative (sowing to initiation) and stem elongation (initiation to anthesis). Under controlled environments the duration of the vegetative phase is strongly influenced by vernalization, photoperiod and growing temperature whilst the duration of the stem elongation phase is affected only by photoperiod and growing temperature. Varieties differed significantly in their responses to these environmental factors (Table 1).

## GENETIC CONTROL OF DEVELOPMENTAL PATTERN

(a) Vegetative phase. Diallel analyses showed that variation in the field under continuous light was highly heritable over a range of sowings although dominance effects were more marked when plants were exposed to higher temperatures. Subsequent studies in controlled environments with early generation segregating populations and inbred-backcross links also provided evidence of major gene control of vernalization response. Bronowski possessed two recessive duplicate genes and Isuzu two independent recessive genes controlling their respective vernalization requirement under higher temperature and long days. Target possessed the dominant alleles of all four genes. Bronowski and Isuzu also carried genes for early initiation which were only expressed in $F_2$'s of crosses with Target.

(b) Stem elongation phase. A diallel analysis conducted in a controlled environment (15°C and 12hr. photoperiod) showed variation in the duration of stem elongation between six spring varieties to be highly heritable, although there was some evidence of over dominance.

## RELATIONSHIP BETWEEN DEVELOPMENTAL PATTERN AND SEED YIELD

Field studies in different parts of Western Australia have consistently shown a significant relationship between early flowering and higher yields.

TABLE 1

VARIATION IN THE DURATION OF VEGETATIVE AND STEM ELONGATION OF SPRING RAPE CULTIVARS IN DIFFERENT CONTROLLED ENVIRONMENTS

| Treatments | | | Cultivars | | | | | |
|---|---|---|---|---|---|---|---|---|
| Temp. (°C) | P'period (hrs) | Vern. (weeks) | Target | | Bronowski | | Isuzu | |
| | | | V+ | SE++ | V | SE | V | SE |
| 15 | 12 | 0 | 68 | 56 | 116 | 52 | 92 | 42 |
| | | 4 | 56 | 54 | 68 | 51 | 40 | 41 |
| | | 8 | 33 | 54 | 42 | 51 | 31 | 40 |
| | 24 | 0 | 34 | 20 | 48 | 26 | 79 | 26 |
| | | 4 | 32 | 19 | 38 | 24 | 29 | 23 |
| | | 8 | 31 | 19 | 30 | 23 | 28 | 22 |
| 25 | 12 | 0 | 50 | 26 | * | * | * | * |
| | | 4 | 33 | 25 | 123 | 42 | 130 | 33 |
| | | 8 | 32 | 24 | 76 | 41 | 32 | 32 |
| | 24 | 0 | 32 | 9 | 122 | 10 | * | * |
| | | 4 | 32 | 9 | 75 | 9 | 31 | 13 |
| | | 8 | 31 | 8 | 43 | 9 | 31 | 12 |

* No intitiation after 200 days from sowing
\+ Number of days between sowing and apparent initiation
++ Number of days between apparent initiation and anthesis

This relationship primarily reflects the adverse effects of both drought stresses and higher temperatures on harvest index.

Controlled environment studies, in which the relative lengths of the vegetative and stem elongation phases could be modified through manipulation of photoperiod, indicated that flower (and pod) numbers of Target were related to the length of the stem elongation phase but were essentially unaffected by variation in the duration of the vegetative phase (Table 2). A significant correlation between numbers of flowers per plant and seed yield per plant was also observed among 6 varieties and all possible $F_1$ hybrids when grown in controlled environments comparable to conditions prevailing in the field. Under Western Australien conditions, seed yields are most strongly influenced by numbers of pods per plant.

## BREEDING STRATEGY

From the above observations we might expect significant yield improvements in Western Australia through lengthening the stem elongation phase relative to the vegetative phase. Such modifications of developmental pattern would be particularly effective in a growing season characterized by cool temperatures and short days. The main selection objective would be to obtain lines initiating some 2-3 weeks earlier than Target, but flowering about a week later than the latter. Rapid screening of large numbers of plants could be conveniently conducted in standard growth chambers. Plants are being raised first under continuous light at 25°C to detect the early initiation types which are then transferred to a chamber set at 15°C and 12 hours photoperiod where plants flowering later than Target are selected.

TABLE 2

EFFECTS OF VARIATION IN PHOTOPERIOD ON DEVELOPMENTAL PATTERN, FLOWER PRODUCTION AND SEED YIELD IN TARGET

| Photoperiodic treatment (hr.) | | Duration of phase (days) | | No. of pods per plant | Thousand seed wt. (g) | Seed yield per plant (g) |
|---|---|---|---|---|---|---|
| V | SE | V | SE | | | |
| 8 | 8 | 100 | 50 | 88 | 4.7 | 3.8 |
| | 16 | 100 | 17 | 73 | 4.3 | 2.4 |
| | 24 | 100 | 9 | 62 | 4.1 | 1.7 |
| 16 | 8 | 53 | 50 | 87 | 4.6 | 3.6 |
| | 16 | 53 | 17 | 56 | 4.7 | 2.1 |
| | 24 | 53 | 9 | 56 | 4.5 | 1.4 |
| 24 | 8 | 36 | 50 | 86 | 4.5 | 3.5 |
| | 16 | 36 | 17 | 70 | 4.4 | 1.9 |
| | 24 | 36 | 9 | 52 | 4.0 | 0.9 |

Three generations of this form of selection may be completed in about 12 months prior to increase of seed of selected plants for appropriate field testing and further selection. Segregating populations of the cross (Midas x Isuzu) x Bronowski are now being screened in this manner.