May 2012
Cost £16.17

Project Report No. 494

Optimum N rate and timing for semi-dwarf oilseed rape

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This is the final report of a 23 month project (RD-2008-3578) which started in February 2009. The work was funded by a contract of £53,200 from HGCA and contributions from GrowHow UK Ltd (£47,600) and Bayer Ltd (£13,100), making a total of £113,900.

CONTENTS

1. ABSTRACT

This project compared a semi-dwarf variety (PR45D03) with a standard height variety (Excalibur) to investigate whether:

i) a semi-dwarf variety has a different economically optimum nitrogen (N) rate and different optimum N timings,

ii) 'Canopy Management' principles apply for a semi-dwarf variety,

iii) there are any differences in the N residues following harvest, and

iv) a semi-dwarf responds differently to a PGR.

Three winter oilseed rape experiments were established in each of the 2008-09 and 2009-10 growing seasons near ADAS sites High Mowthorpe (N. Yorkshire), Rosemaund (Herefordshire) and Terrington (Norfolk). The hybrid varieties PR45D03 and Excalibur were tested at six or seven N rates applied at Conventional or Canopy Management timings, with or without Folicur.

Results showed that, despite being, on average, 33 cm shorter the semi-dwarf variety required the same amount of fertiliser N to achieve optimum yield. Several of the Canopy Management principles were shown to be the same for the semi-dwarf and standard height varieties including; a crop N uptake of 50 kg N/ha to build each unit of green area index (GAI), a similar target optimum GAI at flowering and the same N uptake efficiencies. Shorter stems did not affect the amount of N required to build each unit of GAI because lower stem biomass at flowering was compensated by a greater concentration of N in the stem.

The semi-dwarf variety produced similar sized yields to Excalibur, and by harvest there were no significant differences in the amount of N taken up by the crop and the amount of N taken off in the seed between the variety types. The semi-dwarf variety had an average stem biomass of 3.75 t/ha compared with 4.52 t/ha for Excalibur, and a greater N concentration in the stem and pod wall tissue at two sites. As a result of these counteracting effects both the semi-dwarf and standard height variety left a similar amount of N in crop residues following harvest.

In the one experiment where the canopy following winter exceeded the minimum threshold GAI for using a PGR it was shown that Folicur applied at 1.0 l/ha at the green bud stage significantly increased the yield of the semi-dwarf variety. This indicates that semi-dwarfs will respond positively to PGRs when canopies are large. Folicur was shown to increase seeds/m^2 by increasing the amount of light that penetrated through the flowering layer.

2. SUMMARY

2.1. Introduction

Good yields, along with less lodging, easy management and swifter harvesting, make semi-dwarf oilseed rape varieties an attractive option for many growers. The semi-dwarfs developed so far have been around 20 cm shorter than Castille which, in turn, is about 25 cm shorter than the tallest hybrid (Excel). It is not known whether semi-dwarfs have a different requirement for fertiliser N compared with taller varieties, nor is it known whether the optimum N timings are different. However, two alternative hypotheses may be proposed: 1) the lower lodging risk of semi-dwarfs means that yields continue to respond to greater amounts of N, resulting in a greater economic optimum N rate; or 2) potentially lower stem biomass means that less N is required for supporting tissue, thereby reducing the N optima.

It is also unknown as to whether semi-dwarf varieties will benefit from the application of 'Canopy Management' principles of N timings and rates that aim to achieve optimum sized canopies. These principles have been shown to increase yield over conventional practices in standard height varieties in situations where they would have produced an over-large canopy (Berry and Spink, 2009). Over-large canopies have been shown to both set fewer seeds/m^2 and to be more lodging prone. In a recent study (Sustainable Arable LINK project LK0979), a semi-dwarf variety had a similar green area index in early spring to standard height varieties, indicating that this variety type may have a similar potential for producing over-large canopies by flowering.

This project aims to understand the physiological basis that determines whether semi-dwarf varieties have a different optimum rate and timing of N fertiliser. This will be used to understand whether the Canopy Management principals can be used with semi-dwarfs. The N use efficiency of a semi-dwarf is also compared with a standard height variety and also whether a different amount of N is returned to the soil (due to fewer crop residues). The latter will be important for determining whether the N requirement of following crops is different after a semi-dwarf oilseed rape crop.

2.1.1. Aim and objectives

Project Aim

Investigate whether semi-dwarf oilseed rape has a different optimum N rate and N timing from standard height varieties.

Specific Objectives

1. Investigate whether semi-dwarf oilseed rape has a different optimum N rate and N timing.
2. Understand whether the Canopy Management principals can be applied to Semi-dwarf varieties.
3. Quantify the N use efficiency of semi-dwarfs and whether they leave different amounts of N in crop residues for following crops.
4. Assess the response of the semi-dwarf variety to the growth regulatory effects of Folicur and any interactions with N management.

2.2. Materials and methods

2.2.1. Canopy management approach

Previous HGCA-funded work has demonstrated that oilseed rape must achieve an optimum green area index (GAI) of 3.5 units at flowering and the crop must take up 50 kg N/ha to build each unit of GAI. This means that the crop must take up 175 kg N/ha to achieve the optimum GAI of 3.5. Canopy Management principles assume that any N that the crop has taken up by the end of winter remains in the crop until flowering and therefore contributes to the production of the optimum GAI. The principles also assume that oilseed rape takes up 100% of the soil mineral N measured in the soil in February and 60% of any fertiliser N applied (55% on shallow soils over chalk or limestone). These uptake efficiencies are similar to average figures that have been measured in wheat. The rate of crop N uptake is assumed to be 3 kg N per ha per day from the start of active spring growth until flowering. It was expected that crops with a higher than average yield potential will require additional N which should be applied between yellow bud and mid-flowering to avoid this additional N causing the optimum canopy size to be exceeded.

In early February, the amounts of N in the soil and crop were measured and this was used to calculate how much fertiliser N was required for the crop to achieve a GAI of 3.5 using the assumptions described above.

Example: In February the amount of N in the soil was 50 kg N/ha and the amount of N in the crop was 50 kg N/ha. It is assumed that by flowering the crop will contain all of this soil and crop N (100 kg N/ha). This means it will be 75 kg N/ha short of the amount required for the optimum GAI. At 60% efficiency, 125 kg of fertiliser N must be applied to make up this shortfall.

In general the fertiliser N required to achieve the optimum sized canopy was applied at the 2nd conventional split timing at the green bud stage (GS3,3 to 3,5) when the stems were just starting to extend. This usually occurred in late March or early April. A small proportion of the N was applied at the 1st conventional split timing (late February/early March) when it was calculated that there would be insufficient time (assuming an uptake of 3 kg/ha/day) for the crop to take up all of the N required to achieve an optimum sized canopy by mid flowering if the first application was delayed. Additional N for high yield potential was applied at yellow bud to mid flowering, equivalent to 60 kg N/ha for each tonne above 3.5 t/ha.

2.2.2. Field experiments

Sites

Experiments were carried out in 2008/9 and 2009/10. Experiments were drilled near ADAS Terrington in Norfolk (silty clay loam), near ADAS High Mowthorpe in 2008/09 (Shallow silty clay loam over chalk) or Thorneholme in 2009/10 (silty clay loam) both in E. Yorkshire and near ADAS Rosemaund in Herefordshire (sandy clay loam).

Experimental factors and design

Four factors were investigated: variety, N rate, N timing and a growth regulatory fungicide Folicur. At each site, within each of four replicates, variety formed main plots in which the N rate and N timing were randomised. At each site Folicur was then applied across one half of each block. The position of the Folicur strip was randomised for each block. This type of design is a special case of a split plot design where the sub-plot treatments are not randomised separately for each whole plot, but are randomly allocated to strips of subplots across each block. This is usually called a strip design or a criss-cross design. Each plot measured 18 m by 3.5 m.

The two varieties used were the standard height variety Excalibur and the semi-dwarf variety PR45D03, each drilled at 70 seeds/m^2. In 2008/9 seven N rates were used (0, 60, 120, 180, 240, 300, 360 kg/ha) and in 2009/10 six N rates were used which differed with site: 0, 60, 120, 180, 240 and 300 kg/ha at Thornholme and Rosemaund, and 0, 70, 140, 210, 280 and 350 at Terrington. All N was applied by hand as ammonium nitrate (34.5% N). All N rates, apart from the nil, were applied at either Conventional or Canopy Managed timings. Conventional timings were for 50% of the N applied in late February/March and 50% applied at green bud (GS3,3 to 3,5) (late March/early April). Canopy Management timings were for all, or the majority, of the N required to achieve the optimum sized canopy to be applied at the 2nd Conventional split timing (GS3,3 to 3,5) and the remaining N was applied between yellow bud and mid-flowering. The Folicur treatment was applied at late green bud (GS3,6). The rate of Folicur was dependent on the size of the crop canopy measured in February. Crops with a GAI of less than 1 received 0.5 l/ha and crops with a GAI of 1 or more received a rate of 1.0 l/ha.

2.2.3. Measurements

Assessments included the amount of mineral N in the soil, together with the GAI and N content of the crop, in February. At flowering, the crop height, light interception/reflection, GAI, biomass and crop N content were measured. At crop maturity the biomass and N content of the stem, pod walls and seeds were measured. Lodging was assessed at regular intervals. Yield was determined for all treatments using a small plot combine from an area of at least $30m^2$ and the moisture content measured. Oil content was measured in 2008/9.

2.2.4. Calculations and statistics

Analysis of variance procedures within Genstat 11 (www.genstat.com) were used to calculate whether treatments were significantly different. Linear plus exponential N response curves were fitted to the seed yield data. The economically optimum N rate was calculated using a breakeven ratio of 2.5. The gross margin over N costs was calculated by assuming a seed yield price of £235/t (9% moisture), ammonium nitrate containing 34.5% N costing £200/t (which were typical average prices during the project and these give a breakeven ratio of 2.5). The oil premium was calculated as 1.5% of the basic oilseed rape price for each percentage point that the oil content was above 40%.

2.3. Results

As expected PR45D03 was significantly shorter than Excalibur, with height reductions ranging from 13 to 46 cm, and averaging 33 cm, across the six experimental sites. At 240 kg N/ha, the average height of Excalibur was 134 cm compared with 101 cm for PR45D03.

2.3.1. Economic optimum N rate

There were no differences detected in the economically optimum N rate between Excalibur and PR45D03, due to Canopy Management or due to Folicur in any of the experiments. This was despite differences in the components of yield (seed size and seeds/m^2) between the variety types. At Terrington and Rosemaund in 2008/9, PR45D03 produced significantly ($P<0.001$) more seeds than Excalibur (12% and 11% more seeds/m^2, respectively), and at all sites in 2008/9 and Thornholme in 2009/10 it had a significantly lower thousand seed weight, with reductions of 2.5% to 7.6% relative to Excalibur. The small seeds of PR45D03 indicate that higher yields could be achieved by providing better seed filling conditions. Seed yield (Summary Tables 1 and 2), total biomass and total N uptake for the two variety types were similar and it is likely that these characteristics are more important for determining optimum N rate than differences in crop height.

2.3.2. Canopy management

In 2008/9, soil and crop N measured in February was low at all three sites (Summary Table 1). In 2009/10, although the canopies at all three sites were moderate to large before winter, they were reduced by the unusually cold winter weather. Consequently, the canopies measured in February were very small at Terrington and moderate at Thornholme and Rosemaund (Summary Table 2). Therefore, in all experiments the differences in N management between Conventional and Canopy Managed treatments were not as great as they have been in some previous experiments. When SNS is low, it is necessary to apply some early N for the Canopy Managed treatments to allow sufficient time for the crop to take up all the N required to build an optimum sized canopy. This means that the differences in N timing between the Canopy Managed treatments and the Conventionally managed treatments is smaller particularly at the lower N rate treatments.

In 2008/9 Canopy Management did not affect yield at any of the three sites (Summary Table 1). In February the canopies were small, and Canopy Management did not affect growth up to flowering. There was no evidence that over-large canopies were achieved at flowering with the Conventional N timings, with the largest canopy being at Rosemaund, with GAI 3.2. There were also no significant differences in light interception or reflection at flowering, between Canopy Managed and Conventional treatments in 2008/9. The observation that Canopy Management did not significantly reduce the yield of the semi-dwarf variety (Summary Table 1), even in crops with very small canopies, indicates that Canopy Management is appropriate for semi-dwarf varieties and may increase the yield of semi-dwarfs when canopies following winter are large.

In 2009/10, Canopy Management did not affect yield of either Excalibur or PR45D03 at any of the three sites (Summary Table 2). This season provided a robust test for the Canopy Management approach because the uptake of later Canopy Management N applications were delayed by the dry spring and the third N application was applied later than planned at Thornholme. N uptake by OSR crops has been shown to slow after flowering therefore there is a risk associated with applying N too late. At Thornholme the 3rd N split was applied when PR45D03 was beginning to flower and Excalibur was in full flower. At Rosemaund the crop was less advanced when the 3rd split was applied, but the application was preceded by several days of dry weather and followed by a further two weeks without rain, so much of the applied N may not have been available to the crop until well into flowering. However, at both sites the differences in final crop N content between the N timing treatments were not significant, and there was evidence of continued N uptake after flowering of up to 58 kg/ha in the the higher N rates applied at Canopy Managed timings.

Summary Table 1. 2008/9 experiment summary.

	Terrington		Mowthorpe		Rosemaund	
Jan/Feb soil mineral N (kg/ha)	34		34		26	
Jan/Feb additionally available N (kg/ha)	17		75		26	
Jan/Feb crop N content (kg/ha)	12		3		22	
Jan/Feb GAI	0.25		0.09		0.57	
N timing strategy	Conv	CM	Conv	CM	Conv	CM
Optimum N rate (kg/ha)	253	253	244	244	209	209
N rate at 1st split (end Feb/early March)	126	60	122	60	104	60
N rate at 2nd split (early stem ext.)	125	155	122	184	105	149
N rate at 3rd split (yellow bud to mid flower)	0	38	0	0	0	0
Yield at opt N Excalibur (t/ha)	4.19	4.04	4.58	4.45	5.21	5.22
Yield at opt N Excalibur + Folicur (t/ha)	4.34	4.26	4.59	4.59	5.02	5.08
Yield at opt N PR45D03 (t/ha)	4.25	4.20	4.30	4.26	5.59	5.53
Yield at opt N PR45D03 + Folicur (t/ha)	4.34	4.34	4.28	4.27	5.04	5.05

Conv – conventional N timing strategy; CM – Canopy Managed N timing strategy.

Additionally available N (AAN) is an estimate of the amount of N that will become available for crop uptake through mineralisation between February and crop maturity.

Summary Table 2. 2009/10 experiment summary.

	Terrington		Thornholme		Rosemaund	
Jan/Feb soil mineral N (kg/ha)	18		38		14	
Jan/Feb additionally available N (kg/ha)	31		59		25	
Jan/Feb crop N content (kg/ha)	13		49		54	
Jan/Feb GAI	0.24		0.9		1.12	
N timing strategy	Conv	CM	Conv	CM	Conv	CM
Optimum N rate (kg/ha)	228	228	215	215	176	176
N rate at 1st split (end Feb/early March)	114	60	107	40	88	40
N rate at 2nd split (early stem ext.)	114	168	108	107	88	136
N rate at 3rd split (yellow bud to mid flower)	0	0	0	68	0	0
Yield at opt N Excalibur (t/ha)	3.47	3.47	4.98	4.85	4.78	4.98
Yield at opt N Excalibur + Folicur (t/ha)	3.73	3.70	5.20	5.17	5.54	5.61
Yield at opt N PR45D03 (t/ha)	3.50	3.64	5.00	5.07	4.89	4.78
Yield at opt N PR45D03 + Folicur (t/ha)	3.72	3.83	4.98	5.08	5.52	5.51

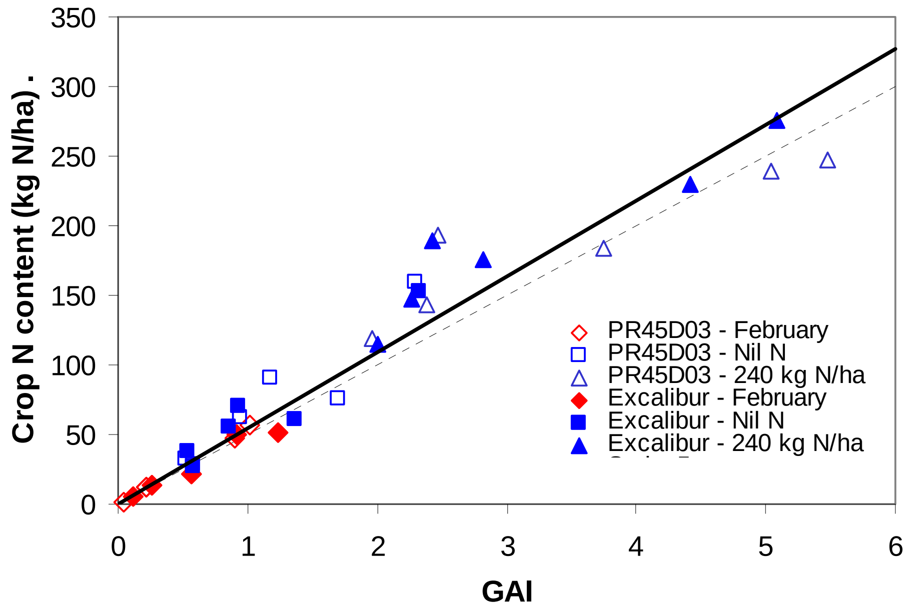
Conv – conventional N timing strategy; CM – Canopy Managed N timing strategy.

Additionally available N (AAN) is an estimate of the amount of N that will become available for crop uptake through mineralisation between February and crop maturity.

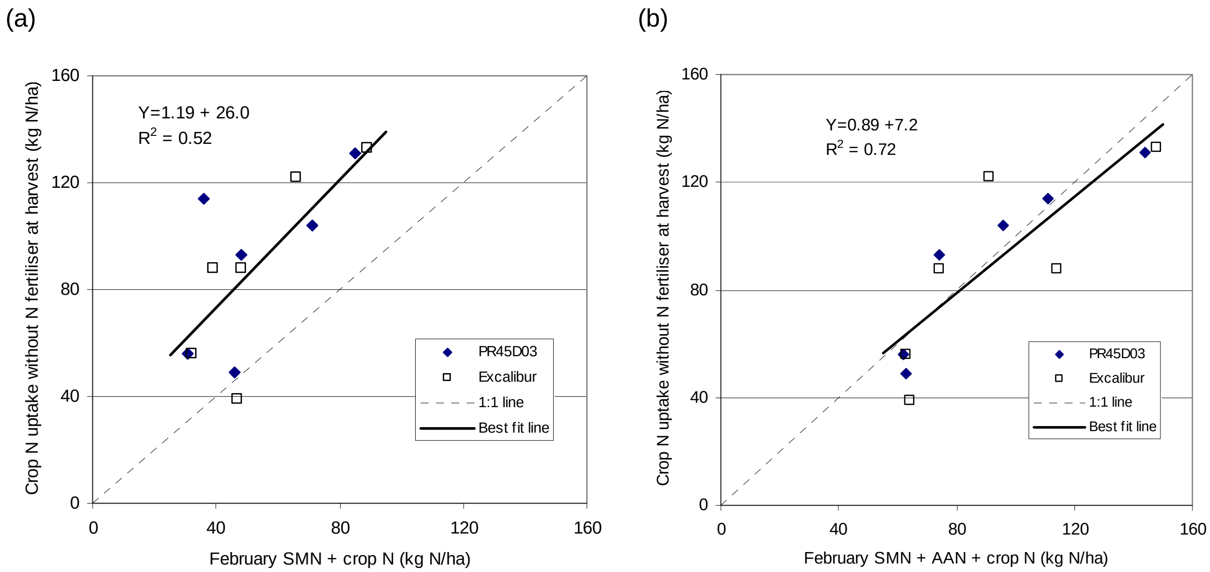
The only site at which over-large canopies were achieved at flowering in 2009/10 was Rosemaund, which averaged GAI 5.45 for the Conventional N timings (N rate 240 kg N/ha) compared to 4.70 for the Canopy Managed timings. Although the difference in GAI was not significant, Canopy Management did significantly reduce the amount of light intercepted by the flowers. This led to a small, but non-significant yield increase of 0.2 t/ha for Excalibur (Summary Table 2). At Thornholme there was a significant reduction in GAI and the amount of light intercepted and reflected by the canopy due to the Canopy Management strategy. These effects did not increase yield because the GAI for the Conventional N timings were less than the optimum. Importantly Canopy Management did not reduce yield. The small canopy at Terrington meant that the crop did not respond to Canopy Management.

Several components of the Canopy Management principles developed by Berry and Spink (2009) and Lunn *et al.* (2001) and used in the GrowHow 'N-Calc' fertiliser recommendation system were shown to be applicable for semi-dwarf varieties as described below. The requirement for the crop to take up 50 kg N/ha to build each unit of GAI was shown to hold true for both standard height and semi-dwarf hybrids (Summary Figure 1). At flowering PR45D03 produced a larger GAI than Excalibur at two sites with no differences at the other four sites. PR45D03 intercepted more light than Excalibur at one site, with no difference at the other sites. The relatively small differences in GAI and light interception between the varieties indicates that the optimum GAI for intercepting the majority of incoming light will be the same for both varieties. Across the six sites there were no significant differences for the efficiency with which the two varieties took up the soil mineral N (SMN) that was measured in February or the applied fertiliser N. There was a strong positive relationship between the amount of N taken up by the crop in the absence of fertiliser and the amount of SMN and crop N measured in February (Summary Figure 2a). It was apparent that the unfertilised crops generally took up more N than the combined SMN plus crop N measured in February. On average the crops took up an additional 36 kg N/ha. Previous research has shown that the amount of N taken up by unfertilised crops was similar to the amount of SMN plus crop N (Berry and Spink, 2009). The difference between these two studies is likely to have been caused by the experimental sites in this current study having soils with a greater potential for mineralisation between February and crop maturity. When an estimate of the amount of mineralisation (referred to as additionally available N – AAN) was added to the February SMN and crop N, then the prediction of the amount of N taken up by the unfertilised crops was improved (Summary Figure 2b). The fertiliser uptake efficiency was calculated for the 240 kg N/ha fertiliser rate by dividing the difference in crop N uptake at crop maturity between the unfertilised crop and the crop fertilised at 240 kg N/ha by the fertiliser rate. This showed that across the six sites there was no significant difference in fertiliser uptake efficiency between the variety types and the average uptake efficiency was 47%. The fertiliser uptake efficiency was lower than found by Berry and Spink (2009) who estimated an average uptake efficiency of 57% at the N rates closest to the economic optimum N rate (average of 169 kg N/ha). There are two possible reasons for this difference; 1) in this study the N uptake efficiency was calculated for 240 kg N/ha which was, on average, 19 kg N/ha greater than the economic optimum N rate, and it is known that N uptake efficiency decreases at higher N rates, 2) the very dry spring in 2010 reduced N uptake efficiency. The average uptake efficiency in 2010 was 41% compared with 53% in 2009.

This report indicates that both the standard height and semi-dwarf variety types take up N with similar rates of efficiency, require the same amount of N to build each unit of GAI and have a similar optimum GAI target. This indicates that both variety types will require the same amount of fertiliser to achieve optimum GAI and supports the observation that there was no difference in the economic N rates between the variety types (Summary Tables 1 and 2).



Summary Figure 1. The relationship between Crop N content (kg N/ha) and Green Area Index (GAI) of varieties PR45D03 and Excalibur when measured in February and at mid flowering (Nil N and 240 kg N/ha) in the growing seasons 2008/9 and 2009/10. The bold line is the fitted relationship and the dotted line is the expected relationship (1 unit GAI = 50 kg N/ha).

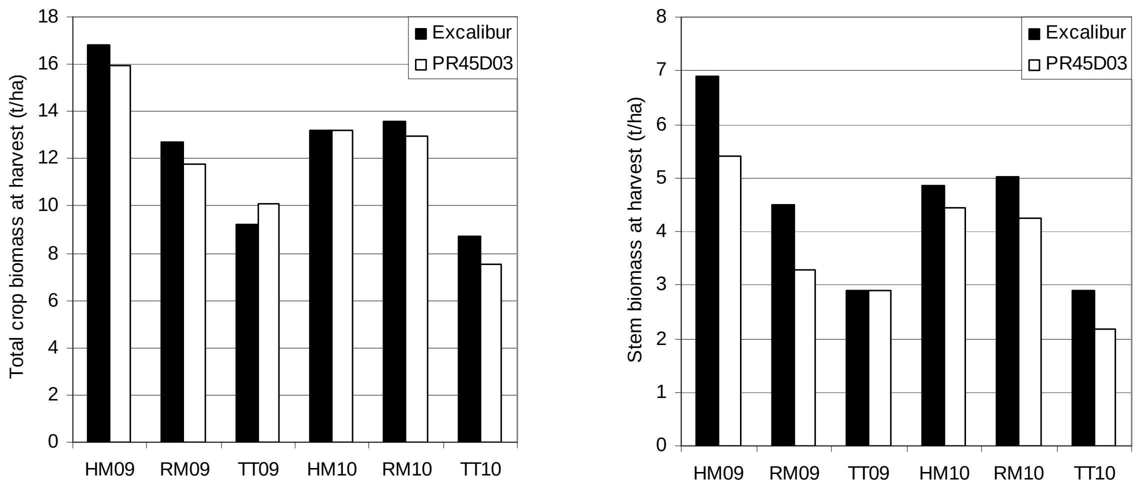


Summary Figure 2. Relationship between a) February SMN + crop N and the amount of N taken up by unfertilised crops by harvest and b) February SMN + additionally available N (due to mineralisation) + crop N and the amount of N taken up by unfertilised crops by harvest. Data from each of the 6 experiments carried out within the study.

2.3.3. Crop biomass, N uptake and N residues following harvest

At harvest there was no significant difference in total crop biomass measured at 240 kg N/ha between Excalibur and PR45D03 at any of the sites (Summary Figure 3). Across all sites the average crop biomass for Excalibur was 12.4 t/ha compared with 11.9 t/ha for PR45D03. PR45D03 had an average stem biomass of 3.75 t/ha which was significantly less than Excalibur at 4.52 t/ha (Summary Figure 3b). The reduction in stem biomass was less than may have been expected given that the height of PR45D03 was on average 33 cm (25%) shorter. Longer branches from the bottom of the semi-dwarf main stems may have partially compensated for the shorter main stems. There was no significant difference in the biomass of the pod walls with both varieties averaging 4.01 t/ha across the six sites.

(a) (b)



Summary Figure 3. a) Total biomass at harvest; b) stem biomass at harvest. All measurements for the 240 kg N/ha treatment without Folicur. HM – High Mowthorpe, RM – Rosemaund, TT – Terrington.

There was no difference between Excalibur and PR45D03 in the total amount of N taken up by the crop at harvest, with both varieties taking up on average 202 kg N/ha at a fertiliser rate of 240 kg N/ha across the six sites. PR45D03 took off 10 kg/ha less N in the seed at High Mowthorpe in 2008/9, but there were no variety differences in N offtake in the seed at any of the other five experiments. On average, both varieties took off 123 kg N/ha in the seed and both left a similar amount of N in the crop residues of approximately 75 kg N/ha. At two sites the stem and pod residues of PR45D03 had a significantly greater tissue N concentration than Exalibur which compensated for the lower stem biomass in terms of the N residues following harvest. These results indicate that the N residues following semi-dwarf oilseed rape are not different from those of standard height varieties.

2.3.4. Folicur

Effects of Folicur differed between the two seasons. In 2008/9 Folicur at 0.5 l/ha increased yield of both Excalibur and PR45D03, on average, by 0.15 t/ha at Terrington but did not affect yield at High Mowthorpe, and reduced the yield of PR45D03 by 0.51 t/ha and the yield of Excalibur by 0.16 t/ha at Rosemaund. In contrast, in 2009/10, Folicur application significantly increased yield at all three sites, by an average of 0.22 t/ha at Terrington, 0.67 t/ha at Rosemaund, and at Thornholme it increased the yield of Excalibur by 0.27 t/ha and had no effect on PR45D03. It should be recognised that all experimental sites, apart from Rosemaund in 2009/10, had a GAI in January/February of less than one (the threshold above which spring PGRs are normally recommended). In 2008/9 the average GAI in January/February across the three sites was 0.30 and in 2009/10 the average GAI was 0.75. The greater GAI in 2009/10 helps to explain the greater yield increases in this season. The yield responses to Folicur were not affected by the use of Canopy Managed N timings compared with Conventional N timings.

The greatest yield response to Folicur was at Rosemaund in 2009/10. This effect was likely to be because this site had the largest GAI in January/February (1.12) and at flowering (4.7 to 5.5) which was significanty above the optimum GAI required at flowering of 3.5. The significant yield increase for PR45D03 at this site indicates that semi-dwarfs will respond positively to PGRs when canopies are large. The most likely mechanism for the yield increases was the significant reduction in light reflection from the flowers that was caused by Folicur. This would have allowed more light to reach the photosynthetic tissues, thereby allowing more photosythesis during the critical period when the number of seeds were set. Folicur also reduced the amount of leaning at Rosemaund, particularly in Excalibur, although the relatively low levels of leaning which occurred were not likely to have influenced yield significantly. It is worth noting that this reduction in leaning occurred in the absence of any height response to Folicur, at Rosemaund or at the other sites in 2009/10, which indicates that Folicur may have reduced leaning by affecting the architecture of the canopy.

Disease was minimised in all experiments by using fungicides without PGR activity. However, it is impossible to rule out the possibility that part of the yield increases from Folicur were through improved disease control.

The yield reduction following Folicur application at Rosemaund in 2008/9, was likely to have occurred because even without the PGR the GAI at flowering was below the optimum for yield, and Folicur reduced this yet further causing a reduction in light interception by the green tissues during the seed setting period and consequently reduced yield. This hypothesis is supported by the observation that the reduction in yield was due to a reduction in seed number, rather than seed size. It should be noted that the GAI at the start of stem extension was 0.57 and PGRs would not normally be recommended for crops with a GAI of less than 1.

In five of the six experiments, Folicur treatment reduced the fraction of light intercepted by the flowers and/or reduced the amount of light reflected by the flowers of the standard height and semi-dwarf varieties. This shows that Folicur reduced the size of the flower layer, which for over-large canopies will help the crop set more seeds/m^2. This study has shown semi-dwarfs have the potential to produce over-large canopies which indicates that they will respond positively to PGRs in particular conditions.

2.4. Conclusions

- Across the six experiments the semi-dwarf variety PR45D03 had an avarge height of 101 cm compared with 134 cm for Excalibur.
- It was shown that Excalibur and PR45D03 had the same economic optimum N rates and produced similar yields.
- Canopy Management N timings gave the same yield as earlier Conventional N timings for the semi-dwarf and standard height varieties.
- Similar to standard height varieties, semi-dwarfs were shown to also have the potential to produce over-large canopies at flowering which would reduce the number of seeds set and yield potential. This indicates that Canopy Management N timings could increase the yield of semi-dwarfs when they have canopies following winter that are at risk to becoming over-large.
- It was shown that the Canopy Management principles used for standard height varieties also apply for semi-dwarf varieties. These include a similar soil and fertiliser uptake efficiency, the crop must take up 50 kg N/ha to build each unit of GAI and a similar optimum GAI at flowering.
- The experiments provided further evidence that the Canopy Management approach has been successfully adapted for crops with small canopies following winter, such that there is no yield penalty from delaying some of the N until yellow bud / early flowering.
- The semi-dwarf variety took up a similar amount of N and contained a similar amount of N in the seed to the standard height variety. There is therefore no evidence that the N residues remaining after harvest differ for semi-dwarfs.
- There was no difference in N use efficiency (kg of seed per kg of available soil and fertiliser N) between the semi-dwarf and standard height variety as both varieties yielded similarly at a range of N rates including the economic optimum rate.
- The prediction of the soil N supply (SNS) from the February soil mineral N plus crop N was improved by adding an estimate of the amount of N mineralised after February that would be available for crop uptake. This mineralisable fraction of soil N is known as the additionall available N (AAN).
- At harvest, the overall biomass of PR45D03 averaged 11.9 t/ha compared to 12.4 t/ha for Excalibur. This difference was not statistically significant.
- In the one experiment where an over-large canopy was produced it was shown that Folicur significantly increased the yield of the semi-dwarf variety, which indicates that semi-dwarfs will respond positively to PGRs when canopies are large.
- Folicur was shown to increase seeds/m^2 by increasing the amount of light that penetrated through the flowering layer.
- There may be an opportunity to maximise yields of PR45D03 by focusing on seed filling conditions. PR45D03 generally produced higher seed numbers than Excalibur, but lower seed weight.