Time of cutting effects on seed yield of autumn sown winter oilseed rape

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Abstract

Oilseed rape (*Brassica napus*) is an important crop for arable farmers providing a 'break' in the largely cereal and grass rotations. Generally harvesting is carried out through desiccation and directly combining the crop three to ten days later. However a shift to food grade oil production has seen renewed interest in windrowing as no products are registered for crop desiccation. Seed yield of oilseed rape windrowed at 12 different dates 43-76 days after mid-flowering was determined. The highest seed yields of 4.0 to 4.5 t/ha were achieved when the crop was cut between 60 and 67 days after mid-flowering with a thermal time requirement of 775-870 growing degree units (GDU). Optimum seed yield occurred when seed had a seed moisture content between 44-48% at windrowing. Yield increases of 76 kg/ha/day with delayed cutting were associated with increasing thousand seed weight (TSW). Seed yield declined at 127 kg/ha/day or 2.8%/day after 870 GDU, which was associated with seed shattering and bird predation. These results demonstrate the importance of correct harvest timing in achieving optimum seed yield in brassica crops.

Additional keywords: *Brassica napus*, growing degree units (GDU), swathing, thousand seed weight (TSW), windrowing

Introduction

In the past decade, oilseed rape (*Brassica napus* L.) has become an important crop in the rotation of arable farmers, particularly autumn sowing of winter type cultivars which require vernalisation in the South Canterbury region. In the 2014/-15 growing season approximately 15,000 tonnes (t) of seed was produced (FAR, unpublished data). The east coast of New Zealand is prone to strong winds at any time throughout the year, particularly the inland areas close to the foothills. Strong winds at or near harvest can lead to high harvest losses through seed shattering. Oilseed rape is an indeterminate species where flowering can span 30 plus days. As seed pods mature they become fragile and as the seed ripens the pods dehisce easily (split open) losing seed to the ground where losses during the harvesting process of 20-50% are common (MacLeod, 1981; Price *et al.*, 1996). Therefore harvesting should be completed as seed matures but prior to significant losses. Price *et al.* (1996) reported on harvest losses of winter and spring sown oilseed rape (WOSR and SOSR respectively) with comparisons made at various stages throughout different harvesting processes. They demonstrated a 177 kg/ha advantage to direct harvesting compared with swathing and using a draper pickup in WOSR. However, no difference was shown in SOSR and no adverse weather events occurred during the harvesting process. Over the past decade growers have moved away from windrowing oilseed rape in favour of chemical desiccation and direct harvesting. However, with the majority of oilseed rape being used for human consumption and no products registered for chemical desiccation in New Zealand, swathing (or windrowing) may once again provide a viable alternative to aid crop dry down and potentially reduce the impact of adverse weather events.

This paper reports on a single year experiment investigating time of cutting to maximise seed yield for autumn sown WOSR.

Materials and Methods

WOSR hybrid cultivar cv. 'Exstorm' was sown at 70 seeds/m^2 (5.1 kg/ha) on the 27 March 2015 at the FAR Chertsey Arable Research site (43º 47' 32" S; 171º 51' 49" E). Weed control was achieved with a pre-plant glyphosate (1,080 g/ha), followed by dicamba (140 g/ha) post emergence on 30 June. The molluscicide, metaldehyde (Slug Out®) was applied on 14 April. Total spring applied nitrogen was 154 kg N/ha applied as ammonium sulphate (42 kg N/ha on 28 August) and Sustain N (split application (56 kg N/ha) on 22 September and 19 October). Fungal disease control consisted of a single application of 150 g/ha tebuconazole (Folicur® SC) applied with the insecticide 36 g/ha tau-fluvalinate (Mavrik®). A total of 355 mm of irrigation was applied over 12 applications between 14 October and 23 December 2015 to maintain a potential soil moisture deficit of less than 50 mm. Growth stages (GS) and flowering was assessed using the BBCH oilseed rape growth stages (Stauss, 1994). A 12 treatment randomised complete block design experiment with four replicates was established on 27 November 2015. Plot size was 1.35 m x 10 m and the treatments consisted of 12 cutting dates with sequential cutting times at three to five day intervals until 30 December 2015 (Table 1). Plots were cut at 15 cm above ground level using a Stihl hedge trimmer as a surrogate for windrowing/swathing. Seed samples were taken at each swathing to assess seed moisture content (SMC). Seed moisture data was achieved by randomly selecting pods from the plot and hand shelling 10 g of seed and oven drying at 103°C degrees for 17 hours. All plots were harvested on 7 January 2016 using a 'Sampo Rosenlew 2010' plot combine. Seed yield was based field dressed seed of >98% purity, adjusted to 9% SMC. Thousand seed weight (TSW) was determined by weighing 200 seeds per plot and weighing to four decimal places.

Thermal time (GDU) was calculated as the sum of mean daily temperature, with a base temperature of 0°C. For data analysis, mid-flowering (BBCH growth stage 65) occurred 15 October 2015.

Statistical analysis was completed using Genstat version 17 (VSN International Ltd, UK) where individual plot data was subjected to ANOVA and treatment means separated using the least significant difference test (LSD). Split-line regressions were calculated using Genstat version 17.

Results

Mid-flowering (BBCH GS65) occurred on 15 October 2015. Seed yield was significantly influenced ($P<0.001$) by time of cutting (Table 1). A maximum seed yield of approximately 4.5 t/ha was achieved between 64 and 67 days, or 825 and 870 GDU after mid-flowering. These yields were not significantly higher than those achieved at cutting 60-62 days or 775-805 GDU after mid flowering.

Seed yield was well described (R^2 = 0.93) by two straight lines when expressed over either days after mid-flowering or thermal time after mid-flowering (Figure 1). In thermal time, maximum seed yield was achieved approximately 825 GDU days post mid-flowering and declined after 900 GDU. In days, the seed yield increased by 76 kg/ha/day up to the maximum and then decreased by 127 kg/ha/day or 2.8% per day from 870 GDU (based on spilt line linear regression, data not shown).

Seed dry weight, expressed as TSW, was associated with a corresponding increase in seed yield until shattering/bird predation commenced (Figure 2). The 62% increase in TSW explains the majority of the 70% increase in seed yield. TSW increased (P<0.05) as cutting was delayed until physiological maturity occurred at 43% SMC (Figure 3) or approximately 870 GDU days post mid-flowering.

Table 1: Effect of time of cutting/swathing on seed yield at 9.0 % seed moisture content (SMC) of autumn sown winter oilseed rape cv. Exstorm, sown at the FAR Arable Research Site, Chertsey, New Zealand during 201516. GDU: thermal time after mid flowering. TSW: thousand seed weight.

Treatment	Date	Days after mid flowering	GDU	SMC (%)	Seed yield (t/ha)	TSW (g)
1	27-Nov	43	520	73.2	2.64	2.09
2	30-Nov	46	560	73.3	3.24	2.02
3	3-Dec	49	620	64.6	3.66	2.58
4	8-Dec	54	685	57.5	3.86	2.95
5	10-Dec	56	715	55.3	3.96	3.06
6	14-Dec	60	775	50.2	4.16	3.52
7	16-Dec	62	805	52.2	4.29	3.33
8	18-Dec	64	825	48.9	4.50	3.69
9	21-Dec	67	870	44.2	4.47	3.96
10	24-Dec	69	910	44.5	4.11	3.83
11	27-Dec	73	950	34.4	3.60	4.05
12	30-Dec	76	990	37.4	3.33	3.97
			Mean	52.9	3.82	3.25
			Pvalue	P<0.001	<0.001	<0.001
			$LSD_{0.05}$	3.82	0.35	0.35
			S.E.M	1.33	0.12	0.12

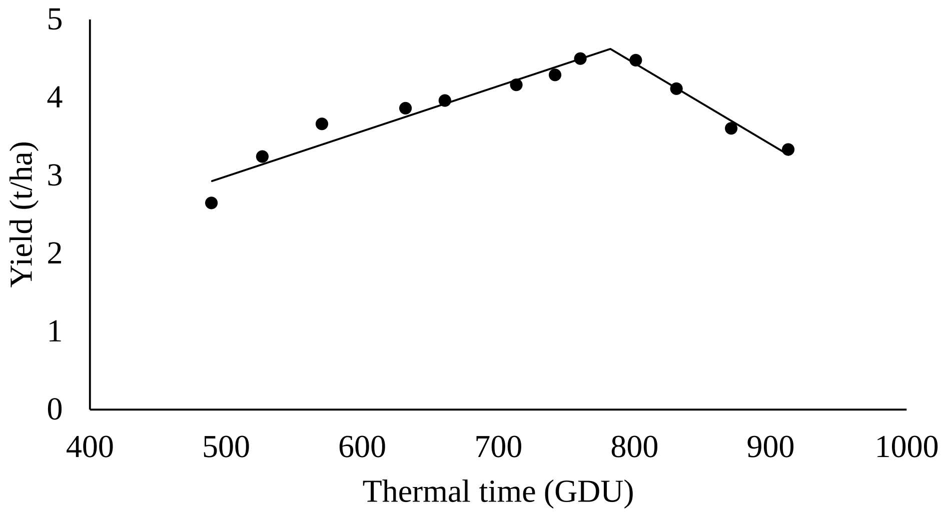

Figure 1: Seed yield at 9% seed moisture content of winter sown oilseed rape cv, 'Exstorm', following swathing at 12 different times when grown at the FAR Arable Research Site, Chertsey, New Zealand during 2015-16.

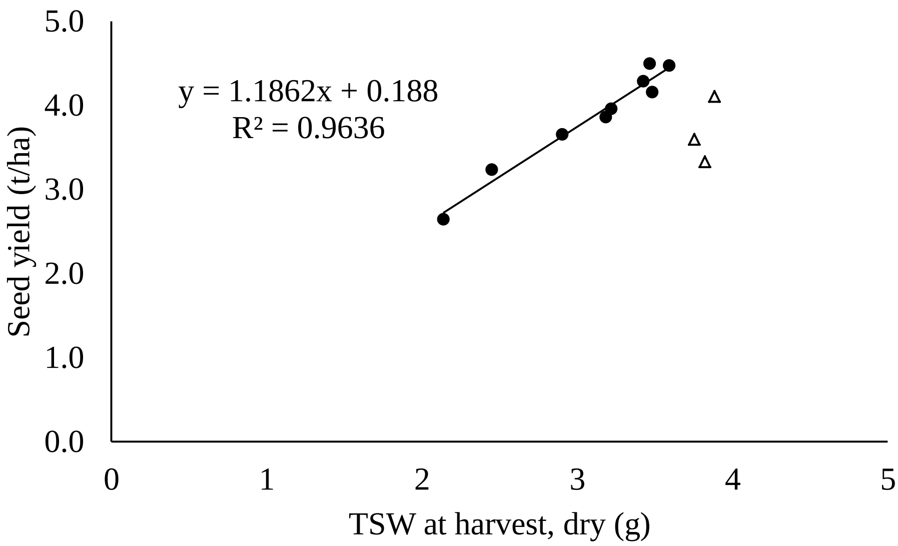

Figure 2: Relationship between thousand seed weight and seed yield adjusted to 9.0% seed moisture content of oilseed rape for 12 different swathing times when grown at the FAR Arable Research Site, Chertsey, New Zealand during 2015-16. Outliers (open symbols) refer to times when seed yield was limited by seed shattering.

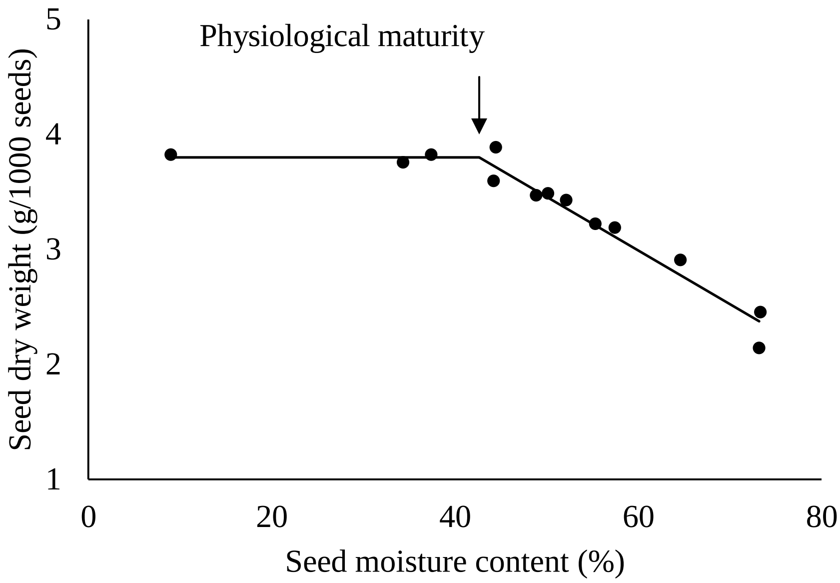

Figure 3: Relationship between seed moisture content and thousand seed dry weight for 12 different swathing times when grown at the FAR Arable Research Site, Chertsey, New Zealand during 2015-16.

Discussion

Seed yield was increased as cutting was delayed until approximately 60-67 days or 775-870 GDU days after mid flowering (Table 1; Figure 1) followed by a decrease. In days these results are significantly longer than the 43 days reported by Berry and Spink (2006) for the cultivar 'Victor' in the United Kingdom. Berry and Spink (2006) calculated the thermal time requirements for seed filling for 'Victor' at 715°C days based on data from Mendham *et al.* (1981) but used a base temperature of 4.2°C, thus leading to differences in the seed filling times to maximum yield. Jullien *et al.* (2011) presented results showing thermal time requirements for seed development range from 640°C days with a base temperature of 4.2°C up to 940°C days with a base temperature of 0°C. It is possible that a wind event on 22 December, where gusts of up to 60 km/hr were recorded, or bird feeding induced some shattering and thus reduced measured seed yield in treatments cut from 910-900 GDU. Physiological maturity occurred at approximately the same date (Figure 3). It is possible there is either genetic variation in the time to maturity or in the definition of flowering between the data from the 1970s (Mendham *et al.*, 1981), modelling data (Jullien *et al.*, 2011) and that presented here for the cultivar 'Exstorm'.

As expected, change in seed weight was closely correlated to the change is seed yield (Figure 2). In this experiment cutting commenced approximately mid-seed fill during the linear period of seed growth (Brocklehurst, 1977), thus halting the filling process and reducing seed weight. The change in seed dry weight from cutting to machine harvest showed no correlation thus no estimate of filling post cutting was made (data not presented). Although the first cutting times had a longer than normal time gap to combine harvest, the relationship between seed yield and TSW suggests that seed loss from this delay was not a factor (Figure 2). When expressed as seed moisture content (SMC), the optimum time of cutting in this trial was between 44-48%. This is similar to those reported by Sims (1979) where seed yield was optimised by cutting spring sown oilseed rape at between 38-43% SMC and for autumn sown oilseed rape between 40-50% SMC (Ghassemi-Golezani *et al.*, 2011). As described by Sims (1979) the decrease in seed yield following the optimum can be explained through seed shattering and perhaps some bird damage. In this trial physiological maturity occurred at 43% seed moisture (Figure 3) at which point all seed reserve accumulation has ceased and maximum seed weight had been obtained. Once seed reaches physiological maturity it is generally accepted that desiccation can occur with limited possibility of seed quality issues. In New Zealand it is common currently for oilseed rape crops to be desiccated with diquat and direct harvested seven to ten days later. However, since 2013, there has been a change in end-use from bio-diesel to food-grade oil for human consumption. While diquat is registered in Canada for canola as a harvest desiccant there is no current New Zealand label registration for the use of diquat (or any other product) as a desiccant in oilseed rape and growers may need to change back to windrowing or direct combining without desiccation as the preferred commercial practice. This trial produced high seed yields, with five treatments between 4.0 and 4.5 t/ha, compared with typical grower seed yields of 3.5 to 4.5 t/ha (M. Bates, ProductionWise®, pers. comm., 2016). Further work is required to compare swathing and desiccation to give growers confidence that swathing risk is manageable. As part of any further work, oil content or quality should be considered, but these were not measured in this study.

Conclusion

The optimum time to cut autumn sown oilseed rape for maximum seed yield is between 775 and 870 GDU; which in the 2015-16 season was 60 to 67 days after mid flowering. Cutting early reduced thousand seed weight and hence seed yield. Cutting later increases the risk of seed losses through shattering and bird predation.

Acknowledgements

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References

Berry, P.M. and Spink, J.H. 2006. A physiological analysis of oilseed rape yields: Past and future. *Journal of Agriculture Science, Cambridge* 144: 381-392.

Brocklehurst, P.A. 1977. Factors controlling grain weight in wheat. *Nature* 266: 348-349.

Ghassemi-Golezani, K., Sheikhzadeh-Mosaddegh, P., Reza Shakiba, M. and Nasrollahzadeh, S. 2011. Development of seed physiological quality in winter oilseed rape (*Brassica napus* L.) cultivars. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* 39: 208-212.

Jullien, A., Mathieu, A., Allirand, J-M., Pinet, A., de Reffye, P., Cournède, P-H. and Ney, B. 2011. Characterization of the interactions between architecture and source–sink relationships in winter oilseed rape (*Brassica napus*) using the GreenLab model. *Annals of Botany* 107: 765-779.

MacLeod, J. 1981. Harvesting winter oilseed rape. pp. 107-119. *In*: Oilseed rape book: A manual for growers, farmers and advisors. Cambridge Agricultural Publishing. Cambridge, UK.

Mendham, N.J., Shipway, P.A. and Scott, R.K. 1981. The effects of delayed sowing and weather on growth, development and yield of winter oil-seed rape (*Brassica napus*). *Journal of Agricultural Science, Cambridge* 96: 389-416.

Price, J.S., Hobson, R.N., Neale, M.A. and Bruce, D.M. 1996. Seed losses in commercial harvesting of oilseed rape. *Journal of Agricultural Engineering Research* 65: 183-191.

Sims, R.E.H. 1979. Drying cycles and optimum harvest stage of oilseed rape. *New Zealand Journal of Experimental Agriculture* 7: 85-89.

Stauss, R. 1994. Compendium of growth stage identification keys for mono- and dicotyledonous plants: Extended BBCH scale. Ciba- Geigy AG., Berlin/Braunschweig. 94 pp.