A COMPARISON OF HARVESTING TECHNIQUES TO MAXIMISE THE YIELD OF RAPESEED OIL - ALTERNATIVE FUEL

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SUMMARY

Replicated and randomised field experiments to compare cultivation methods, sowing and harvesting techniques of oilseed rape were carried out on two sites, one a fertile silt loam, the other a marginal cropping soil.

The comparison of cultivation methods is reported elsewhere.

1. Maximum seed yield resulted from the crop being windrowed at 38-41% seed moisture content (2029 kg/ha). Dessiccation using diquat slightly lowered the yield but could be a cheaper alternative to windrowing (1924 kg/ha). Direct heading of the crop at 12% m.c. gave lower yields due to losses from shedding and bird damage (759 kg/ha).

2. Yields on the poorer site were less than half the quantity of those on the fertile site but treatments were ranked in similar order.

3. Oil yields are more important than seed yields. Desiccated plots gave the highest oil contents but both windrowed and desiccated treatments gave similar oil yields, both being far in excess of direct headed plots.

Some comments on the potential of rapeseed oil as a diesel fuel substitute are given following a considerable number of engine tests and a major report to the New Zealand Government's Liquid Fuels Trust Board entitled "Yields, costs and availability of natural oils/fats as diesel fuel substitutes" for which the author was Project Manager.

1. INTRODUCTION

Oilseed rape has been grown extensively for many years, particularly in Europe and Canada. Apart from the accepted uses of the oil, it has recently been shown to be a feasible but expensive alternative to diesel fuel (Sims et al., 1982).

Tests have shown that a compression ignition engine can run satisfactorily on a variety of vegetable oils and animal fats without major modifications and without power loss. (See for example Sims and Johnson, 1982). Work is continuing to ascertain whether any detrimental effects to the engine arise in the long term.

Regardless of the ultimate use of the oil however, maximising the oil yield per hectare is important if the crop is to remain competitive and therefore attractive for farmers to produce.

Oilseed rape is not a simple crop to grow and success of establishment varies. Also problems often occur at harvest time due to

a. the shattering of pods, particularly when windy or very dry,
b. uneven maturity of the pods in the field,
c. bird damage,
d. drying of the seed to a satisfactory storage level (less than 8% moisture content (m.c.) for prolonged periods).

Field trials were laid down at Massey University, New Zealand in 1975 and 1976 to evaluate establishment and harvesting methods in order to maximise oil yields of spring sown crops (Sims, 1979a ; Sims, 1979b).

Maximum dry matter seed yields occurred when the seed was at 42-38% m.c. (wet basis). Maximum oil yields occurred at seed moisture contents of 35-38%, the seed oil content reaching a maximum of 54.4% soon after maximum dry matter yields were reached. Windrowing the crop at 40% m.c. gave highest seed and oil yields compared with 5 other harvesting methods but this was not significantly higher than direct heading at 14% m.c.

Due to renewed interest in this crop as a potential energy source, a further series of trials was laid down in 1979 in an attempt to verify the results above for different soils and in a different growing season. In addition a variety of cultivation and establishment techniques were evaluated including the fuel saving technique of direct drilling. A statistical analysis clearly showed there was no interaction between cultivation techniques and harvesting methods. The two were hence considered separately and only the harvesting factors are discussed here.

2. MATERIALS AND METHODS

Trials were laid down on 2 sites both following permanent pasture.

2.1 Site A :

This was a particularly fertile cropping soil (Kiwitea loam). Fertiliser in the form of 30% potassic superphosphate was broadcast at a rate of 300 kg/ha over all plots before cultivation. A split plot experiment was designed with main plot size 10.5 x 55 m and four replicates of each treatment.

Conventional cultivation techniques were carried out on 22 October, 1979 using a 3-furrow semi-digger mouldboard plough at a depth of 150 mm followed by a Cambridge roller. The bare ground was sprayed with trifluralin at the rate of 1 kg/ha active ingredient prior to sowing to control weeds and incorporated with a power rotary harrow at 80-100 mm depth (Mecklah and Mitchell, 1974).

Drilling was completed on 23 October, the roller drill being carefully calibrated to sow 7 kg/ha of seed (var. Tower) mixed with 31.5 kg/ha of compound fertiliser (13-6-11) and 20 kg/ha disyston as a precaution against springtail or aphid damage. This system had previously given good results with oilseed rape (Sims, 1976) but care was taken to avoid long term contact between seed and fertiliser. Depth of sowing was 15 mm.

Rain followed immediately after sowing and good establishment was obtained.

2.2 Site B :

This was a marginal cropping soil (Tokomaru silt loam) on the foothills of the Tararua ranges and exposed to the wind. A split plot experiment with 3 replicates of each treatment and main plot size 10 m x 30 m was laid down. The crop was established in a similar manner as for site A. the plots being sown on 26 October.

Potential bird damage was reduced on site A by spraying with mesurol at 1 kg/ha plus wetting agent. Control measures at site B proved less successful, particularly at the later maturing stages of the direct headed plants and some damage resulted.

2.3 Harvesting :

2.3.1 Fifty plant samples were taken regularly from selected treatments to monitor the growth of the crop and give comparative measurements of dry matter yields and moisture contents. Seed yields were obtained by threshing these samples using a small laboratory seed thresher to separate seed from the previously air-dried plants. This seed was then oven-dried and weighed. Moisture contents were calculated from additional seed samples oven-dried on the date of sampling.

2.3.2 Machine harvested samples

2.3.2.1 Windrowing. On reaching 45% seed moisture content a 4.0 m wide strip of each plot was windrowed using a New Holland self propelled windrower. This operation carried out on the 5 February would have been better left for a week as previous work had shown maximum oil yield to be obtained when cut at nearer 38% m.c. (Sims, 1979b). Unfortunately the contractor was only available on this date so the maximum potential yield was not realised. The stubble was left as long as practical to avoid the wind blowing the windrows causing seed loss. The particularly heavy crop on site A caused some problems with tangled plants catching on the crop dividers. A vertical reciprocating knife would have been advantageous (Howe, 1973) but they are not available in New Zealand.

2.3.2.2 Desiccating. Also on the 5 February a second strip of each plot was sprayed with 0.5 kg/ha a.i. of the desiccant diquat (Palmer, 1975), using a knapsack sprayer and boom. Drift of spray on to neighbouring plots was successfully avoided.

On reaching approximately 12% seed m.c., each of these two treatments was harvested with a 1.3 m plot harvester adjusted to minimise seed loss (Biggar et al., 1971).

2.3.2.3 Direct heading. A third of each plot was left untreated until direct headed on reaching 12% m.c. using the same plot harvester. In New Zealand this is the common harvest method for spring sown crops as also in Australia (Garside, 1972).

All seed yields were weighed and corrected to 12% m.c. Oil contents were obtained by analysing small samples of seed from each treatment using the Soxhlet extraction method and correcting for moisture content.

3. RESULTS AND DISCUSSION

3.1 Moisture Content v Seed Dry Matter Yield

The typical variations in seed moisture content with time and the corresponding dry matter yields are shown in figure 1 for selected cultivation treatments recorded on each of the two sites.

In spite of variations of yield, soil type, climate, cultivation treatment etc., the maximum "potential" seed yield occurred at 41-38% m.c. for all treatments which corresponded very favourably with results from experiments carried out previously (Sims, 1979a). This potential yield was almost 6000 kg/ha on site A but only slightly over 2000 kg/ha on site B.

The drop in seed yields as the crop matured and dried was due to seed loss (from birds and the shattering of mature pods) becoming greater than the increase in seed weight of the immature seed in the lower pods.

Oil yield is obviously dependent on the oil percentage at the time of harvest as well as the seed yield. Oil content appeared to reach a peak slightly before maximum seed yield though only a small number of samples were analysed giving limited confidence in the results.

3.2. Harvesting Methods v Seed Yields

The final seed yields and oil yields are shown in figure 2 for both the 50 plant samples and the machine-harvested samples.

The windrowing operation resulted in the seed moisture content dropping from 45% to 12% within 8 days. The desiccated plots also reached this moisture content after 8 days. However the untreated plots required natural drying for a further 14 days on site A and a further 7 days on site B (where the plants were smaller) before reaching the 12% moisture content deemed to be the level suitable for direct harvesting.

It was during this additional period that significant seed losses became evident from the untreated standing crop. These corresponded to the loss of yield recorded whilst the crop matured as shown in figure 1. Consequently the direct harvested treatment (U) resulted in a significantly lower yield on both sites.

Of the two preharvest treatments windrowing produced the greater yields in all cases, though for the main harvest on site A the difference between it and the desiccated treatment was not significant.

The large yield differences recorded between the 50 plant samples and those machine harvested were probably partly due to differences in experimental techniques and partly due to a physical seed loss during harvest even though all due care was taken. Due to the size of sample the yields recorded in the main harvest were considered to be the more accurate. The 50 plant sample yields shown in figure 2 however can be compared directly with those in figure 1. From this it appears that approximately 85% of the potential seed yield as at the 5 February and as measured and shown in figure 1, was recovered by windrowing, 60% by desiccating and only 35% when the standing crop was left to dry naturally. The even greater loss for this treatment recorded on site B can be attributed to the less successful bird control measures taken.

The additional treatment "E" taken from site B and shown in figure 2, depicts the equivalent yield of the untreated standing crop measured on 13 February at the time of the final harvests of the windrowed and desiccated crops. At this time the seed moisture content was still well above 30% whereas the treated crops had dried to 12% m.c. and were at a stage fit for harvest. Some seed loss from the untreated standing crop was already evident at this time as shown by the lower seed yields of this treatment.

3.3. Oil Contents

The oil contents for the harvesting treatments on the 2 sites are given in Table 1 :

Table 1 : Percentage oil contents (corrected to 12 % moisture content)

	Windrowed	Desiccated	Direct harvested	L.S.D. (0.01)
Site A	43.8 b	45.8 c	41.0 c	0.918
Site B	48.4 a	48.1 a	47.1 b	0.986

The lower yielding crop on site B produced higher seed oil contents but this had negligible effect on the total oil yields.

The desiccated and windrowed treatments had similar oil contents both exceeding those of the direct harvested samples. This corresponded with the reduction in oil content with time of harvest as implied in figure 1.

4. POTENTIAL DIESEL FUEL SUBSTITUTE

Oilseed rape is the most suitable oil producing crop for fuel use in New Zealand due to (a) its agronomic suitability for many regions, (b) its relatively high oil yield per hectare (c) its oil quality, having a relatively low degree of unsaturation.

Typical harvestable seed yields of say 1.6 - 1.8 tonnes/ha and oil contents of 40-45% produce oil yields after processing in the region of 600 l/ha (from 360 l/tonne of seed).

Engine performance tests worldwide have highlighted combustion problems when using the oil as a fuel. One exception is a Leyland 245 tractor which has currently been run on 99% rapeseed oil fuel for over 1000 hours on a farm in the South Island with reasonable success other than two damaged fuel pumps in the early stages (McLeod, 1981). Interesterification of the oil to reduce the viscosity may be a solution to this problem (Sims & Johnson, 1981) though addition of 1% lubricating oil has also been claimed to overcome the problem (McLeod loc. cit). The relative success of this engine trial has been largely attributed to the oil being alkali refined prior to use to remove the gums and free fatty acids. However the oil was extracted by a mechanical process (not solvent extraction) which may also have some relevance. Work is currently being undertaken to verify this.

Allowing for by-product credits for the meal and taking into account the opportunity cost of the land involved, a national economic analysis determined that even for a reasonably large scale plant (31.000 litres of oil per day), rapeseed oil was not an economically viable alternative as a diesel fuel substitute (Sims et al., 1982).

5. CONCLUSIONS

Windrowing the crop at 38-41% seed m.c. produced the highest seed and oil yields. Desiccating the crop at this time gave yields which were slightly lower but it could be that this may be a more practical alternative to windrowing, being dependent on cost differences and the availability of a windrower. Direct harvesting although avoiding an extra field operation, is not a viable alternative due to the heavy seed loss encountered during the additional natural drying period.

Rapeseed oil is not currently considered to be a viable alternative to diesel fuel. Regardless of use of the oil however, yields can be maximised by giving due consideration to the time and method of harvesting.

6. ACKNOWLEDGEMENTS

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Figure 1. Seed moisture contents, seed yields and oil contents with time on two sites.

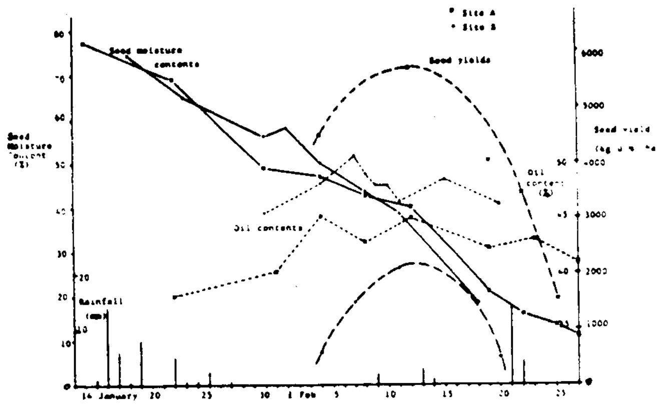

Figure 2. Seed and oil yields of large and small samples corrected to 12% moisture content.