CROP DEFOLIATION*

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SUMMARY

VARIOUS aspects of crop defoliation are discussed in this paper. The requirements of potato defoliation and the suitability of arsenical and other preparations are dealt with. Practical considerations in respect of the application of defoliants to red clover and lucerne seed crops are mentioned and commonly used chemicals are compared. Preliminary investigations into the feasibility of defoliating white clover are described and results from a detailed yield trial are given and discussed. Certain practical considerations in white clover defoliation are outlined.

INTRODUCTION

The term crop defoliation as we use it in New Zealand is delightfully comprehensive. As I see it, the definition chemical defoliant applies equally to a material which totally eradicates all above-ground vegetation in a potato field as it does to a chemical which merely dehydrates the few top leaves of a clover crop. Such licence dictates that a paper entitled "Crop Defoliation" must be truly comprehensive in its scope of subjects and demands that these widely differing techniques be equally described. In the paper which follows I have tried to enumerate some of the practical considerations associated with both types of crop defoliation in the hope that their understanding will promote a more precise knowledge of this rather vague subject.

POTATOES

The use of chemical defoliants on the potato crop can be regarded as the absolute criterion of crop defoliation, in as much as the objective is to destroy completely and permanently all above-ground vegetation, including weeds and surviving haulms. The widespread use of digging and bagging machines has increased the popularity of this technique, as the presence of large quantities of trash and weeds reduces their efficiency. Mechanical methods of cleaning crops are available, but the description of their merits and demerits is better left to someone with greater mechanical understanding than myself. With blight infected crops and crops subject to widespread second growth, defoliation aims at the quick and complete destruction of all surviving top-growth, including stems. Chemical defoliants do not necessarily destroy the blight fungus, but they should be capable of destroying the infected haulm, thus preventing the migration of the fungus down the stem and into the tubers. Speed in achieving an adequate level of defoliation is therefore of the utmost importance.

Obviously, the need in potato defoliation is for a potent and comprehensive material capable of giving quick and complete results. Arsenical weedicides possess these particular attributes and for lack of a suitable alternative have been used very widely in recent years. Under high temperature conditions arsenic acts rapidly and effectively controls a wide range of plant species. Admittedly it becomes slower and slightly less potent in colder temperatures, but is still capable of giving excellent results if applied a few weeks before harvesting at 10 to 12 lb. of arsenic trioxide in 30 to 40 gallons of water per acre. Even at this comparatively

* This process is more usually referred to as crop desiccation.

high rate arsenic is a cheap and very efficient defoliant for potato crops.

A word of warning, however. Arsenic is a very dangerous poison capable of killing livestock and humans even at very low dosages. Carelessness and misapplication could have, and have had, disastrous results. Prolonged exposure without the necessary protective devices could prove fatal to operators and I can only plead that extreme care be taken when it is used. Thousands of acres have been safely and effectively sprayed without serious mishap, but the risk is always present, and extreme care is necessary if this record is to be maintained. In addition to the precautions necessary during application rejected grades of potatoes should be washed before feeding to livestock, and peeling or thorough rinsing should precede domestic usage.

Of the other materials suitable for potato defoliation, endothal, a mixture of dinoseb and dinosam (a proprietary mixture which contains 5 lb. phenol equivalent dinoseb and 1 lb. phenol equivalent of dinosam, and which I shall hereafter refer to as mixed-phenols) and PCP appear the best. Unfortunately, the susceptibility of potatoes to taint precludes the use of all but the smallest quantities of diesel or kerosene and this prohibition reduces the effectiveness of PCP and mixed-phenol preparations. This deficiency is further aggravated by the fact that potato defoliation is usually carried out late in the season when temperatures are low. In cold weather phenol preparations rely to a large extent on the boost provided by aromatic oils such as kerosene or diesel. Oil-water emulsions containing 2 to 3 gallons of diesel per acre can be used, but high volume applications of not less than 50 gallons per acre are necessary. Endothal and arsenic, which are water miscible, have distinct advantages in this respect.

SMALL SEEDS

The production of small seeds is fraught with many difficulties, not the least of which is the weather. Although seed production has tended to become concentrated in areas where growing and harvesting conditions are suitable, such are the vicissitudes of climate that very often even the most earnest efforts to secure the crop are defeated by the presence of moisture in some form or another. Recurrent rains, frosts, and even dews can prevent crops from reaching a proper state of fitness. Under conditions of high fertility the very vigour of the crop itself may present problems through the presence of excessive growth and the succulence of that growth. Where harvesting is delayed through one or another of these reasons wastage and deterioration of the seed are inevitable. Often these ingresses into the profit fraction are further aggravated by additional expenses incurred in under-cutting, lifting, or aerating in an attempt to save the crop from complete ruination. The prime function of defoliants is to minimise these losses and expenses.

(A) Red Clover and Lucerne

Already the defoliation of lucerne and red clover has become accepted as a common farming practice in many localities. At a previous Conference Hadfield gave a very comprehensive paper on this subject and it is not my wish to embark on a lengthy recapitulation of his findings. (1) However, because of the widespread interest in this aspect of defoliation I feel that some brief summary is warranted.

Essentially the defoliation of red clover and lucerne aims at facilitating the harvesting of the crop by accelerating ripening and reducing the moisture content of the plant. In practice this has been found to be both feasible and economic and the widespread adoption of this technique is adequate testimony to its effectiveness. The method most commonly adopted is to apply the defoliant by means of a ground unit at the time cutting would normally take place. Providing suitable weather follows

application harvesting can be commenced within 2 to 3 days. In any event ripening to a state suitable for heading is greatly accelerated no matter what type of weather follows application. Wherever possible, direct heading is advocated and this is one of the paramount benefits of chemical defoliation.

With the average upright crop, defoliation to ground level is not necessary and it is sufficient to dehydrate or remove leafage only part of the way down the plant. The objective in red clover and lucerne defoliation should be to expose the seed heads to wind and sun and to ensure that succulent green material is no longer in close proximity to the seed heads. This is sufficient, and more complete defoliation is unnecessary and uneconomic. With severely lodged crops adequate defoliation is not always practicable, for there is a sensible economic limit to the volume of material which can be applied. However, even partial defoliation is of immense benefit in accelerating maturation.

Of the material I have seen used PCP at 3 to 4 lb. per acre and mixed-phenols at 1 to 1½ lb. per acre, both diluted with 8 to 10 gallons of diesel, are equally effective on red clover. PCP appears to be slightly less potent on lucerne than the mixed-phenol preparation. Experimentation has convinced me beyond doubt that the use of aromatic oils is essential when phenol preparations are used for defoliation. Sodium chlorate I personally consider as suspect despite its widespread recommendation, but in fairness I must confess that this opinion is based only on limited experience, although results obtained by other investigators are inclined to support this contention. (2) Endothal, which is now commercially available, performed quite favourably in Hadfield's trials.

(B) White Clover

The defoliation of white clover presents a slightly different problem, concerned as it is with the removal and desiccation of a very dense leaf mass. In the early autumn of 1957 a small pilot trial was laid down to determine the feasibility of defoliating a very succulent white clover crop. Results of this work were sufficiently encouraging to warrant further investigation and paddock-scale trials were then attempted. At this stage phenol preparations with diesel as a diluent appeared to offer the most promise. However, even at this early juncture it appeared obvious that the economics of defoliation would have to be carefully watched and a limit placed on the amount of money which could be sensibly expended on the diesel. It was therefore decided to restrict the volume of diesel to a maximum of 10 gallons per acre. This immediately posed a problem in respect of coverage and penetration in really dense crops, and to overcome this deficiency emulsions of diesel and water were tried. These proved eminently satisfactory.

These preliminary trials were largely observational, but limited yield data was obtained and although it was not thoroughly reliable, there was evidence that defoliation did increase yields. In an attempt to determine the truth of this a replicated yield trial was laid down on 13 February 1958 on the property of Mr J. DeBeer, Rakaia. A randomised block trial containing four replicates of five treatments was used. The treatments are set out in Table 1.

TABLE 1

Treatment	Rate lb./acre	Diluent	Rate Gal./acre
1. Control	---	---	---
2. Dinoseb + Dinosam	2.0	Diesel	12.6
3. Dinoseb + Dinosam	1.7	Diesel	9.3
		Water	9.3
4. PCP	4.8	Diesel	10.4
5. Sodium chlorate	27.4	Water	20.4

The treatments were applied by means of an experimental machine which sprayed a 6 ft. swath from which only the centre 5 ft. were harvested. To ensure the fairest possible comparison the control plots were cut at the time the chemical treatments were applied. The trial was threshed by a 5 ft. self-propelled header 14 days after the treatments were applied. All plots were cut about 2 hours ahead of the header and because of the prolific second growth the control plots had to be undercut as well.

The conditions under which the trial was conducted could not have been more exacting. An unusually wet summer encouraged vigorous and succulent growth before treatment and frequent rains plus consistently high humidities between treatments and harvest aggravated this condition. Second growth was prolific and completely covered the defoliated plots within 7 days. Harvesting was begun within 30 hours of the actual cessation of rain. Yield data are set out in Table 2.

TABLE 2

Treatment	Yield (lb. pure seed/acre)	Difference from control
1. Control	340.0	—
2. Dinoseb + Dinosam (diesel)	316.5	—23.5 N.S.
3. Dinoseb + Dinosam (emulsion)	374.5	+34.5 *
4. PCP	368.0	+28.0 *
5. Sodium chlorate	376.2	+36.2 **

S.E. as % M.P.Y. 4.8%

Difference for significance 5% * 26.1
1% ** 36.0

The yield figures from this trial make an interesting study and in themselves give an explanation of the principle involved in white clover defoliation. The reduction in yield caused by the mixed-phenol/diesel treatment, although not statistically significant, does raise a rather crucial point. This treatment was too efficient. Defoliation from this high rate was extremely effective, with the result that the disintegration of the leafage was almost complete. In the succeeding wet weather the clover seed heads collapsed on to the wet ground, were smothered by second growth, and sprouting inevitably took place. Furthermore, because of their proximity to the ground many heads passed under the mower at cutting time and many more were left by the header pick-up.

Treatments 3 and 4, on the other hand, did not defoliate with such completeness, but left a percentage of the clover leaf intact. The mixed phenol/emulsion treatment gave almost perfect defoliation in the early stages. Penetration was superior to that of any other treatment, but defoliation at the lower levels appeared more as spotting than as complete desiccation. At the top levels defoliation was complete. After the first few days, sufficient leafage still survived at the bottom of the crop to support the white clover heads, thus preventing them from collapsing on to the wet ground. The PCP treatment was less effective at the lower levels, but gave excellent defoliation at the top, and here again the heads were supported by the lower foliage. This particular aspect of defoliation is only of significance where prolonged wet conditions follow treatment and is not a normal consideration.

The sodium chlorate treatment was successful mainly because of the peculiar circumstances under which the trial was conducted. Firstly, one of the inherent weaknesses of this material is its slowness of action, but because of the time which eventually elapsed between application and harvest this inadequacy could not be measured. Secondly, the persistent

nature of sodium chlorate, also in my opinion a weakness, served to reduce the extent and vigour of the second growth. All in all, conditions could not have been more favourable for the use of this chemical.

When making an assessment of the results obtained in this trial, it must be remembered that it was conducted under particularly difficult conditions. Despite this, however, effective defoliation did give significantly increased yields and this is the most important feature of the trial. Had threshing been completed at an earlier stage, I venture to suggest that yield difference would have been even greater.

One important factor has emerged from these investigations and that is that the presence of a limited amount of green leaf does not prevent the complete threshing of the crop, provided the seed is fit. In practice this green material stays up in the straw rack and does not appear in the sample to cause heating. Incomplete defoliation or the presence of second growth need not delay threshing and neither is it necessary that cutting precede threshing by more than an hour or so. This, of course, does not apply to undefoliated crops.

Of the materials so far used PCP and the mixed-phenol preparation appear the best. PCP at 4 lb. per acre has shown to be a little inferior to the mixed-phenols at 1½ lb. per acre. For light and medium crops 10 gallons per acre of diesel is suggested as a diluent, and for heavy crops an emulsion containing 10 gallons of diesel and 10 gallons of water per acre has given excellent results. Despite its rather excellent performance in the trial sodium chlorate has many limitations. To my mind it is too slow and too persistent, and its inherent phytotoxicity could have deleterious effects on the pasture if dry weather followed application. Altogether I feel that sodium chlorate is a rather risky proposition and one I would be loathe to recommend except under extraordinary circumstances.

CONCLUSION

Obviously it would be idle to suggest that chemical defoliant offer the complete answer to the problems of excess moisture at harvest time. Equally, it would be untrue to claim that they are of no value. Practical experience has shown beyond all shadow of doubt that the benefits associated with the thoughtful use of defoliant are many and varied. Their successful employment is consequent on the understanding of the manifold factors which affect their performance. I trust that the information contained in this paper will contribute something to that understanding.

Acknowledgments

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References

- (1) Hadfield, W. V., "Crop Desiccation Trials". Proc. 9th N.Z. Weed Control Conference 1956, p. 60.

DISCUSSION

Q.—Could the speaker explain the reason for the low standard error, 4.8 per cent?

A. The area was very uniform.

Q.—What was the plot size used? This may have bearing on the standard error.

A.—Two chains long by 6 ft. wide and 5 ft. strip up centre cut for yields.

Q.—Has the speaker found any particular type of nozzle more useful for specific crops?

A.—Hollow cone nozzles are better for upright crops, red clover, and lucerne. Solid cone nozzles give better penetration for white clover crops.

Comment: The speaker stressed danger of arsenical preparations. This cannot be over-emphasised both from point of public health and marketing of products.

Q.—Would chemicals used for desiccation affect recovery of plant following season?

A.—No, with the possible exception of NaClO_3 , as they are only contact materials.

Q.—Would the speaker comment on dangers in use of phenols?

A.—PCP is a poison and should be treated as such. Use respirators and protective clothing.

Stock should not be grazed for 4 days after rain, baling should not take place for fortnight after spraying.

Dinitrophenols are even more poisonous and should be considered in the same class as arsenicals. Farmers have suffered pains in the chest when threshing, in dry weather, as a result of dust, after using phenols as desiccants. Under these conditions respirators should be worn on threshing machines.