CHEMICAL DESICCANTS FOR POTATO HARVESTING

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HARVESTING of main crop potatoes in Canterbury is often hampered by a carpet of winter growing weeds. The effect of this weed growth is to prevent the soil drying out and to bind it into clods which ride over the digger chains with the weeds and potatoes and partially rebury the potatoes. Digging is slowed up due to the blocking of the digger elevator and the quantity of soil and weeds that has to be dealt with. Picking up is made more difficult through the need to hunt for potatoes. No matter how conscientious the worker may be potatoes will be missed and those going into the bag are likely to be in a damp and dirty condition. In very weedy fields contract pickers may be expected to increase their charge or ask for an hourly rate of pay. It can thus be seen that weeds at digging time mean increased harvesting costs plus loss of potential yield.

Weeds commonly found include: Fumitory (*Fumaria muralis*), shepherd's purse (*Capsella bursa-pastoris*), hedge mustard (*Sisymbrium officinale*), field pansy (*Viola arvensis*), *spurrey or yarr (*Spergula arvensis*), *mouse-eared chickweed (*Cerastium glomeratum*), perennial mouse-eared chickweed (*C. caespitosum*), *chickweed (*Stellaria media*), *catchfly (*Silene gallica*), *storks bill (*Erodium cicutarium*), musky storks bill (*E. moschatum*), tares (*Vicia* spp.), suckling clover (*Trifolium dubium*), nettle (*Urtica urens*), catsear (*Hypochaeris radicata*), *speedwell (*Veronica agrestis*), henbit (*Lamium amplexicaule*), winter grass (*Poa annua*), and hair grass (*Vulpia* spp.).

The asterisks mark weeds most likely to be troublesome. Sorrel, yarrow, thistles, flatweeds, and seedlings of other pasture weeds and grasses may also be present in varying numbers.

The incidence of the trouble varies from season to season and depends very largely on the interaction of the following factors:—

- (a) The size and density of the potato haulms during February and March.
- (b) The distribution of rainfall from February through to May.
- (c) District and soil type.
- (d) Date of harvest.
- (e) Cultural history of the field.
- (f) The number and severity of late autumn frosts.

These factors determine the type of weed and affect the date of germination, the subsequent rate of growth, and the length of growing period. The earlier the weeds strike and the later the harvest the greater the danger is likely to be. (Moist conditions in an open crop during January, however, are more likely to induce a strike of fat-hen or other summer weeds.) On the other hand weeds germinating in the latter half of April will make little growth during the winter and are unlikely to be a problem before the spring.

A comparison of the 1953 and 1954 seasons serves to illustrate these variations. The late summer and autumn of 1953 were wet and blight opened up the crop early in the year—trouble from weeds at digging time

was widespread. The late summer and autumn of 1954 were, on the other hand, very dry and although the crop opened up because of the drought, any weeds which struck made very little growth before the winter. There was very little trouble from weeds at digging except on moisture retentive soils.

From the above it follows that a means of preventing or removing this growth before digging could be of considerable value to potato growers. Accordingly in 1951, 1953, and 1954 trials were laid down to test the effectiveness for this purpose of various non-selective herbicides used for haulm destruction in the British Isles and the United States of America.

Haulm destruction was introduced in these countries to reduce the incidence of potato blight in storage. Murphy reported in 1921 that most of the blight that develops in potatoes during storage results from infection from diseased haulms at lifting time and later Murphy and McKay showed that this infection could be avoided if the potatoes were not dug until after the tops were completely dead. Trials in the early 1930s showed that tops could be killed effectively with from 10 to 20 gallons per acre of 1.7 specific gravity sulphuric acid, thus avoiding the need to wait for killing frosts before digging and in 1934 some 3500 acres in the British Isles were sprayed with acid. This treatment also made digging easier by drying off much of the weed growth present.

Because of the many difficulties in handling and spraying acid and shortage of supply during the war years trials have continued to find suitable alternatives. The most promising of these are:—

- (1) Tar acid compounds, by-products from the manufacture of coal gas.
- (2) Sodium chlorate.
- (3) Sodium arsenite.
- (4) Fortified fuel oils.
- (5) Fortified aromatic oils.

In (4) and (5) pentachlorophenol and the homologues of dinitrophenol (DNOC, DNBP, and DNAP) are used as fortifying agents. Emulsifying agents are included and the materials are applied as fortified oil emulsions.

TRIAL DATA

Suitable tar acid compounds are not readily available in this country and sulphuric acid was considered to be too hard on equipment. Trials have therefore been restricted to the other four groups. All these materials will sterilise the soil if used in sufficient quantity. For this reason as well as cost, the objective has been to determine the lowest effective concentration under field conditions. At these low concentrations the materials act as contact herbicides only and complete coverage is necessary for good results. Overseas workers recommend volumes of 80 to 100 gallons total mixture per acre to achieve this. Application of such large quantities of spray with the low volume spraying machinery generally available in this country is a costly process, so the possibility of using less water as carrier was also investigated.

During 1953 and 1954 the following treatments have been tried. They have been applied with a tractor-mounted sprayer to plots 4 rows wide and 2 to 3 chains long, every treatment being applied in duplicate. Chlorate and arsenite treatments have been applied in the three volume ranges 25 to 30 gallons per acre, 60 gallons per acre, and 85 to 95 gallons per acre, the actual rates used in any one trial depending on the calibration of the machine used. The fortified oils have so far only been used at the 85 to 95 range.

Materials used were:—

- Sodium arsenite, 5lb. and 10lb. As_2O_3 equivalent per acre (5 trials).
Sodium chlorate, 8½lb. and 17lb. per acre (5 trials).
10 per cent. pentachlorophenol (PCP) in dieselene at 6½ gallons per acre (2 trials).
6 per cent. sodium chlorate in dieselene at 6½ gallons per acre (1 trial).
5 per cent. sodium arsenite in dieselene at 6½ gallons per acre (2 trials).
10 per cent. pentachlorophenol in creosote at 5 gallons and 10 gallons per acre (2 trials).
20 per cent. dinitro ortho cresol (DNOC) in aromatic oil at 2½ gallons and 5 gallons per acre (2 trials).

RESULTS

Rate of kill: PCP formulations were the most rapid acting and produced their maximum effect in 3 to 5 days. Plants showing green growth at the end of that period usually recovered. DNOC and sodium chlorate took slightly longer (5 to 7 days) and sodium arsenite was the slowest (7 to 10 days).

Range of weeds killed: The PCP and creosote and the DNOC formulation killed the top growth of all broad-leaved weeds and killed or severely damaged young grass plants.

Sodium chlorate damaged or killed the top growth of broad-leaved weeds, but grasses other than seedlings rapidly recovered from the initial foliage scorch.

Sodium arsenite killed the top growth of all broad-leaved weeds except field pansy. (Later field scale spraying has also shown that hedge mustard and fumitory are also resistant.) Grasses except seedlings soon recovered from the initial foliage check.

The combination of dieselene with the chlorate and arsenite did not appreciably improve the grass control at the rates used and these treatments will not be referred to again.

Weeds, such as docks, storks bill, red and subterranean clover, which develop a strong taproot, can only be killed when they are small seedlings. Larger plants are easily defoliated but soon regrow from the crown. However, large plants of catsear and hawkweed can be killed with sodium arsenite.

Effect of alteration in volume: Good kills of seedling broad-leaved weeds were obtained at 25 to 30 gallons per acre, but larger weeds were often only singed and soon recovered. No difference in effectiveness was noted between the two higher volumes, though in an isolated case sodium arsenite failed to give the expected control of some dense tufts of slender chickweed when applied at 60 gallons per acre.

Effect of quantity of active material: In all cases the higher rates of application were more effective. With the PCP and DNOC emulsions an intermediate rate of application would probably be satisfactory except when grassy weeds are present. On the other hand a higher rate of application of sodium chlorate would be necessary to obtain a kill of broad-leaved weeds comparable to that given by the emulsions and sodium arsenite. In the case of the sodium arsenite a comparison of a 7½lb. and 15lb. rate with the 10lb. rate indicated that 10lb. per acre of As_2O_3 is near the optimum for this type of weed control.

It should be noted that these comparisons are based on an over-all weed control score and thus refer mainly to the control of large sized weeds.

Effect of treatments on ease of digging: Plots were checked at intervals to determine what effect weed control had had on soil conditions for digging. It was found that the root systems of plants, the tops of which had been killed, lost their grip on the soil particles to a large extent, even although the roots still appeared to be alive. This observation also applied to plants which had only been defoliated and later recovered. As a result of this the soil shook out from the potatoes more readily in the sprayed than the unsprayed plots, but it should be noted, not as readily as in the portions of the area that had been weed-free at the time of treatment.

The dead tops became very brittle after about 3 weeks and were easily removed by raking or chain harrowing. The latter method left a clean row which was very easy to dig.

EVALUATION OF CHEMICALS

From these trials it is evident that fortified oils, sodium arsenite, and probably sodium chlorate will give satisfactory kills of this class of weed growth. A brief comparison of their characteristics under some pertinent headings may help in making the decision as to which materials to use.

Cost: Sodium arsenite and sodium chlorate are comparable in cost at the rates used and less than a third the cost of the emulsions.

Operational hazards: Sodium chlorate is non-poisonous, but is a fire risk unless fire-proofed materials are used.

Arsenic is very poisonous and DNOC and PCP are also poisonous and operators have to wear suitable protective equipment.

DNOC is a permanent dye of animal skin and fibre.

Residual effect in the soil: All these materials will poison the soil at higher rates of application, but except in the case of sodium chlorate the rates are less than a quarter of those likely to cause harm to subsequent crops.

Sodium chlorate and DNOC and to a less extent PCP eventually break down in the soil into harmless products. Arsenic, however, is an elemental poison and there is a risk of build up of toxicity in the soil if the same field is sprayed in several successive seasons.

Convenience: Sodium chlorate is most frequently sold as a solid and must be weighed out and dissolved in water before it can be sprayed, a somewhat tedious operation if much spraying is to be done. Mechanical agitation is necessary to make a satisfactory emulsion in the case of the fortified oils.

Efficiency: As already noted the PCP and DNOC emulsions and sodium arsenite appear comparable for broad-leaved weeds and the former are to be preferred if grassy weeds are troublesome. Sodium chlorate was not as efficient at the rates of application used.

For this class of work we have chosen sodium arsenite, the deciding factors being its efficiency, convenience of handling, low cost, and the fact that potatoes are seldom grown in the same field more frequently than once in 3 or 4 years. Residues are thus not important. We have sprayed quite a large area in the last 2 years with excellent results. Of course operators must wear gumboots, overalls, hat and respirator, and be careful not to allow spray to drift on to crops for human or animal consumption. Special care has to be taken to wash down equipment and dispose of used containers. We are also careful to warn the farmer of the hazard to stock and birds and to ensure that the paddock is stockproof when we leave it.

We find that spraying should be carried out at least 14 days before digging to obtain satisfactory results.

There is no doubt that this type of weed control can be of great benefit to main crop potato growers. It is worth listing some of the advantages.

- (1) Reduced harvesting costs.
- (2) Fewer potatoes left in the field—in effect, higher yields.
- (3) Less digger damage, since the digger may be run at a slower speed.
- (4) It opens the way to the more general use of the digger-bagger type of harvester.
- (5) On well-drained land the potatoes can be left in the ground longer, thus reducing storage and handling charges while gaining the benefit of price increments.

As indicated earlier, the need for spraying will depend on seasonal factors and the anticipated time of digging. It should, however, be possible to predict the chances of a serious infestation early in the autumn (end of March, early April in Canterbury) and ensure against the possible consequences by spraying in the mid-autumn period while the weeds are still small. If this were done, it should be possible to reduce the cost of application, since less chemical and less water will be needed and weather conditions would be more suitable for spraying than later in the year when the "weed carpet" stage is reached.

OTHER USES FOR CHEMICAL DESICCANTS IN POTATO PRODUCTION

Trials were conducted last season to test these materials on haulm killers under New Zealand conditions and results have been most promising. Losses from Irish or late blight due to potatoes rotting in the bag have been serious at times in the Manawatu and Pukekohe districts where digging usually takes place before the tops are completely dead, thus allowing infection of tubers from blight still active on the tops. Efficient haulm killing should almost eliminate these losses. However, their use in early crops does not seem feasible since the delay necessary between spraying and digging could mean a loss of several tons of yield as well as incurring the risk of a price drop.

Killing the tops will hasten the setting of the potato skins and can be used to reduce damage to the tubers when the crop is to be dug before it is completely mature.

Premature top killing has also been used to increase the proportion of seed when the crop is being grown principally for seed.

In all cases, haulm destruction and the incidental killing of any weeds present will make digging easier.

In conclusion, I should like to emphasise the great potential value of chemical desiccants to the New Zealand potato industry.

References

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DISCUSSION

Q.—With the use of arsenical spray was there any possibility of arsenic being absorbed through the skins of the tubers?

A.—Tubers harvested from the trials were chemically analysed for arsenic. No trace was found, except in green tubers which had been exposed at the time of treatment, and in these trace amounts were found in the peel. It was stressed that these were results from one season only. Arsenicals were used extensively for the purpose in U.S.A. and Britain, and no unfavourable reports had been received.

Comment: In Britain sulphuric acid was widely used for haulm destruction. British growers disliked other materials, such as those employed in the trial described, because they tended to make the dead haulm tougher, which created difficulties with the harvesting machinery.

Q.—The speaker stated that 60 to 80 gallons of spray per acre were necessary for best results. Could this be reduced under conditions where heavy dew was a factor?

A.—This had been considered, but no results from trials were available. Sixty to 80 gallons per acre was considered necessary where the weed growth was fairly large. Less would be needed where weed growth was less prolific.

Q.—What pressures were used?

A.—50lb. per square inch.