A New Weed Killer

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Foreword

The idea of selective control of weeds has long been of interest to the American farmer. The Oregon Experiment Station has taken a leading part in the development of the selective weed killers. Even before the advent of 2,4-D, many Oregon farmers were successfully using certain selective herbicides.

The discovery of 2,4-D, with its subsequent application to the control of weeds in grains and grasses, has effected a major revolution of farming methods in many areas. Possibly no single development in the last twenty-five years has been of more far-reaching significance. As important as the grasses are, however, there are conditions when the grass plants themselves become weeds. Until recently, there has been little hope that the grasses could be removed from crops such as legumes, which are rather susceptible to the commonly used growth-regulator herbicide. The results of recent research indicate that now the growth of grass may be controlled satisfactorily, particularly in legume and similar crops.

I.P.C. is a new member of the growing family of weed chemicals. Enough has been learned of its behavior to permit of its recommendation for grass control under certain conditions. The Oregon Experiment Station has been especially active in the development of this material as a herbicide and was one of the first to put I.P.C. to use in agriculture. Studies on I.P.C. are being continued and intensified.

IPC mixed with Dinitro general makes an effective pre-emergence treatment for control of grassy weeds in bulb crops. In this experimental plot of lilies, rows on the left treated with IPC are free from weeds; the untreated rows on the right are overrun with the grasses.

Wm. A. Schoenfeld
Dean and Director
The problem of controlling grassy weeds was not solved with the development of 2,4-D. Effective as 2,4-D has been in controlling broadleaved plants, it has been of little value for the control of grasses. For that reason it has been necessary to look for other materials that will control weedy grasses. It now appears that IPC (Isopropyl N-phenyl Carbamate) offers promise for such control. Sufficient progress has been made to justify its recommendation for weedy-grass control under many conditions. This bulletin presents a summarization of what is known about its use to date.

IPC—the chemical

Technical IPC, or as it is sometimes known, INPC or IPPC, is a grayish-white crystalline substance, soluble in some organic solvents, but insoluble in others, and nearly insoluble in water. The chemical melts at about 84° Centigrade and volatilizes readily as the temperature goes higher.

While 2,4-D and 2,4,5-T are translocated materials—that is, materials which when applied at one point on the plant, move to another part of the plant—IPC does not translocate. The serious physiological disturbance brought about in the plant by 2,4-D is easily recognized, but the killing effect of IPC is more subtle.

It has been demonstrated that the Carbamates generally are growth inhibiting materials, or mitotic poisons. In the process of growth, the plant cells divide rapidly. IPC and related compounds prevent cell division and thus prevent growth. The prevention of growth, or stunting of the plant, usually results in its death.

IPC best used at early growth stage

Since IPC is primarily effective in preventing growth (and thereby killing the plant) it is evident that the chemical must be used at an early growth stage. In the younger stages, the plants are most active in their growth; their cells are rapidly dividing and, hence, the plants are most susceptible to IPC at this time.

IPC acts primarily through the soil to bring about control of weedy grasses. This material gains entry into the soil where it comes in contact with the germinating grass seed, or with the roots of the
seedling grass, causing the plant to die. It has only a limited effect by acting on the tops of the plants since it does not translocate.

Since the material acts through the soil, it becomes important to provide a means for it to get into the soil. IPC is not particularly soluble in water, but is best carried into the soil by this means. It requires approximately one-half inch of rainfall, or irrigation, to a normally moist soil to leach most effective concentrations of IPC into the soil.

In the control of the more tolerant species, such as water grass, wild oats, and green squirrel tail, moisture alone does not seem to be effective in bringing the material into contact with the seed in sufficient concentrations. Disking or tilling IPC in the soil has a decided advantage when trying to control these plants.

In controlling perennial grasses, such as quackgrass and bentgrass, a slightly different problem is encountered than in dealing with the annual grasses. Here it is not possible to treat the grass in the seedling stage. The grass already has a well-established root system, and it has been found necessary to treat it when the grass is eight to ten inches tall. It is essential to use oil as a carrier for IPC when attempting to control the perennial grasses. Apparently, the oil creeps into the crown and upper roots of the plant, carrying IPC with it, or in other words, serves as a means of moving IPC in the grass plant. Following treatment of perennial grasses with IPC and oil, cultivation is necessary for effective control.

After once making entry into the soil, IPC remains there for some time. This residual action of IPC is important in grassy weed control. It means, for example, IPC can be applied before there is sufficient moisture to germinate the seed and yet the chemical will remain in the soil to destroy the plant when moisture becomes available later. The length of time IPC will remain effective in the soil varies with the amount of IPC applied, the temperature, and the soil moisture. Generally, as moisture and temperature increase, the length of time IPC is effective decreases. During fall conditions in western Oregon, an application of four pounds of IPC per acre may be effective for as long as six weeks. The IPC is destroyed by the micro-organisms of the soil.

As pointed out earlier, the younger the plant the more effective the control by IPC. After a grass plant has tillered, it becomes much more tolerant to IPC applications. It is not unusual for well-established seedlings to survive an application of three to five pounds of IPC per acre. Grass plants show a varying degree of tolerance for IPC. Some plants, such as wild oats, are quite tolerant of IPC, except during the germinating stage. On the other hand, grasses such as cheat grass and common rye grass will be very easily controlled. A table in the back of the bulletin shows the relative tolerance of several weedy grass species.
IPC used in only two forms

Because the technical form of IPC is impossible to use for weed control, it is necessary to treat this weed killer to put it in usable form. Since IPC is a water-insoluble chemical, it has been possible to prepare only two forms of IPC: a wettable form and an emulsifiable form. The so-called wettable form of IPC is a powder in which the IPC has been mixed with a diluent and a wetting agent. This form suspends in water. When using the wettable form of IPC, it is necessary to have a good mechanical agitation to keep the material in suspension. In general, one can assume that 5 gallons of water is required for each pound of wettable IPC when applying it. In other words, 8 pounds of wettable IPC will require 40 gallons of water for application.

The emulsifiable form of IPC is a liquid in which the IPC has been dissolved in a suitable organic solvent. To this has been added an emulsifying agent so that the material will mix or emulsify with water. This form of IPC mixes readily with oil, or it may be applied with low volumes of water.

For pre-emergence control of grasses—that is, applying the material before the grass germinates—there seems to be a little difference between the two forms of IPC. After the grass has once become established, however, for controlling perennial grasses, the emulsifiable form seems to be the better of the two, particularly when a small amount of diesel oil is used along with it.

For the selective control of weedy grasses in legume seed crops, strawberries, alfalfa, and fall-planted bulb crops, fall applications seem to be the most successful under Oregon conditions. As a general rule, the grassy weeds germinate and start growth in the fall, and of course, our Oregon winters are characterized by the rainfall occurring in these months. Both of these facts make the fall the optimum time of application.

Control of annual grasses

Fall is the best time of application for the control of annual grasses in alfalfa, legume seed crops, strawberries, and bulb crops. When making an application of IPC to these crops, it is recommended it be applied in 40 gallons of water per acre, if the wettable form is used, and not less than 20 gallons per acre if the emulsifiable form is used. Four to six pounds of actual IPC per acre will be required in the fall application, and in some crops which have a tolerance for IPC a greater amount may be used if such grasses as velvet grass and perennial bunch grasses are present. It should be pointed out that, not infrequently where grassy weeds are controlled in the fall, broadleaf weeds may become a problem, particularly in the case of alfalfa. This may necessitate a late-winter application of Dinitro general or 2,4-D, depending on the tolerance of the crop.
Where it is possible to apply IPC in the late winter for grass control, the broadleaved weed problem is often negligible.

In the case of bulb crops, cane berries, or nursery stock, it is not uncommon to find both grassy weeds and broadleaf weeds present in the fall of the year. In this case, it is recommended that the normal amount of IPC be applied in a combination with the Dinitro general with diesel oil in water, Pentachlorophenol (PCP), or heavy applications of calcium cyanamide. These combinations are particularly effective if some of the grass has already germinated and if the broadleaf weeds have emerged. These materials have no residual effect on the soil and should be applied only when the broadleaf weeds have germinated and emerged. The Dinitro general-IPC mixture is quite effective for pre-emergence weed control in vegetable crops. In this instance, it is well to work the ground sufficiently ahead of planting to give weeds an opportunity to germinate and start growing. Then after the weeds begin to appear in the crop planted, shortly afterwards a mixture of Dinitro, IPC, diesel oil, and water is applied. For most annual crops, the following formulation is recommended: Dinitro, 1 to 1\(\frac{1}{2}\) pints; IPC, 2 to 3 pounds; diesel oil, 5 gallons; water to make 40 gallons. Forty gallons of this mixture is applied per acre.

Control of perennial grasses

Patches of perennial grasses such as quackgrass, bentgrass, Bermuda grass, and velvet grass are often serious problems on crop land. Cultivation is not always practicable because it is often desirable to put the land to use in the near future. For certain special problems, IPC offers promise in controlling these grasses. For example, since IPC is not leached deeply into the soil where it may injure tree roots, it is safe to use in orchards. Furthermore, it may be used for the control of perennial grasses such as bentgrass.

The most successful treatment for the control of quackgrass with IPC to date has been by dissolving the IPC in oil. The IPC is dissolved in 80 to 100 gallons of weed oil and used at a rate to give 80 gallons of oil and 10 pounds of IPC per acre sprayed. This application is made when the quackgrass is 8 to 12 inches high. After a period of a week or ten days the vegetative material is disked or thoroughly worked into the soil. The land is permitted to lie idle for several months, and during the course of this time the quackgrass dies.

Another method of application of IPC for the control of grasses was encountered in the case of mint. There, by applying one-half of the IPC and 50 gallons of oil per acre before plowing and one-half after plowing, control of the grass was achieved and the mint grew well. Such a split application may be advantageous under a number of conditions, such as control of bentgrass in a field prior to planting nursery crops or strawberries. In controlling the perennial
## Crop Tolerance—Dosage Tables for IPC

<table>
<thead>
<tr>
<th>Crop</th>
<th>Tolerance to IPC</th>
<th>Suggested time of application</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-emergence rate per acre</td>
<td>Post-emergence rate per acre</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pounds</td>
<td>Pounds</td>
<td></td>
</tr>
</tbody>
</table>

### Alfalfa
- **Rate per Acre:** 2-4 Pounds
- **Dosage:** Pre-emergence 2-4, Post-emergence 4-8
- **Time of Application:** Late fall to early spring
- **Remarks:** Emulsifiable form most convenient

### Clovers
- **Rate per Acre:**
  - Alside: 2-3 Pounds
  - White: 2-4 Pounds
  - Crimson: 2-3 Pounds
  - Ladino: 2-4 Pounds
  - Sub: 2-4 Pounds
  - Red: 2-3 Pounds
  - Lotus: 2-3 Pounds
- **Dosage:** Pre-emergence 2-4, Post-emergence 4-8
- **Time of Application:** Late fall or winter, Early spring
- **Remarks:** Emulsifiable form most convenient

### Vegetable Crops
- **Rate per Acre:**
  - Beans: 2-3 Pounds
  - Beets (table): 2 Pounds
  - Carrots: 3 Pounds
  - Chard: 3 Pounds
  - Lettuce: 2 Pounds
  - Onions: 2 Pounds
  - Radishes: 2 Pounds
  - Turnips: 2 Pounds
  - Cabbage: 3 Pounds
  - Cauliflower: 3 Pounds
  - Peas: 2-3 Pounds
- **Dosage:** Pre-emergence 2-4, Post-emergence 4-8
- **Time of Application:** Fall or winter
- **Remarks:** Wettable form safest for selective application

### Bulb Crops
- **Rate per Acre:**
  - Lilies: 6-8 Pounds
  - Gladioli: 3-5 Pounds
  - Narcissus: 6-8 Pounds
  - Daffodils: 6-8 Pounds
  - Tulips: 3-5 Pounds
  - Iris: 3-5 Pounds
  - Strawberries: 6-8 Pounds
- **Dosage:** Pre-emergence 6-8 Pounds
- **Time of Application:** Fall or winter
- **Remarks:** Suggest using with contact material such as Dinitro general or calcium cyanamide to control both grass and broadleaf weeds

### Cane Berries
- **Rate per Acre:** 6-8 Pounds

### Established Woody Nursery Stock
- **Rate per Acre:** 6-8 Pounds

### Flax
- **Rate per Acre:** 2 Pounds

### Mint
- **Rate per Acre:** 6-8 Pounds

### Remarks
- **General:**
  - Very little tolerance
  - Suggest using with contact material such as Dinitro general or calcium cyanamide to control both grass and broadleaf weeds
  - Use with 2,4-D 1 pound in fall
  - Apply after 2-4 inches high
  - Shortly after plowing
  - Tilt in soil pre-planting for control of oats and deep-seeded grass
grasses, oil is extremely important since it serves as a means of getting the IPC into the plant. Cultivation a week or ten days after application is also very important because it serves to incorporate the IPC with the soil and bring it into contact with the roots that have not been reached by the oil. In the split application, this is accomplished by the plowing and subsequent application to the roots of the grass. Eight to 15 pounds of IPC per acre will be required for perennial grasses. The time of application for perennial grasses does not seem to be as critical as for the annual grasses, but best control is usually obtained in the late summer or early fall applications. Any time that a good vigorous growth of grass occurs, IPC may be applied.

### Suggested Dosage for Weedy Plants

<table>
<thead>
<tr>
<th>Plant</th>
<th>Suggested dosage per acre</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickweed</td>
<td>4-6</td>
<td>Must be applied just at or prior to germination</td>
</tr>
<tr>
<td>Purslane</td>
<td>4-6</td>
<td></td>
</tr>
<tr>
<td>Knotweed</td>
<td>6-8</td>
<td></td>
</tr>
<tr>
<td>Susceptible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rye grass</td>
<td>4-6</td>
<td></td>
</tr>
<tr>
<td>Sweet vernalgrass</td>
<td>4-6</td>
<td>Apply at germination or early seedling stage</td>
</tr>
<tr>
<td>Cheatgrass</td>
<td>3-5</td>
<td></td>
</tr>
<tr>
<td>Chess</td>
<td>3-5</td>
<td></td>
</tr>
<tr>
<td>Annual bromegrasses</td>
<td>3-5</td>
<td></td>
</tr>
<tr>
<td>Rat tail fescue</td>
<td>4-6</td>
<td></td>
</tr>
<tr>
<td>Velvet grass</td>
<td>5-8</td>
<td></td>
</tr>
<tr>
<td>Intermediate to semi-resistant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wild oats</td>
<td>5-8</td>
<td>Till into soil prior to germination</td>
</tr>
<tr>
<td>Witch grass</td>
<td>6-8</td>
<td></td>
</tr>
<tr>
<td>Foxtail</td>
<td>6-8</td>
<td>Must be present at time of germination.</td>
</tr>
<tr>
<td>Water or pigeon grass</td>
<td>6-8</td>
<td></td>
</tr>
<tr>
<td>Crabgrass</td>
<td>4-6</td>
<td>Apply at or just before germination</td>
</tr>
<tr>
<td>Bentgrasses</td>
<td>8-10</td>
<td></td>
</tr>
<tr>
<td>Quackgrass</td>
<td>12-15</td>
<td>Apply in 100 gallons of oil per acre</td>
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<tr>
<td>Canary grass</td>
<td>12-15</td>
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</tr>
</tbody>
</table>

1 This is only a partial list of plants controllable by IPC. As additional information becomes available it will be included in other publications.

2 Also other annual species of Polygonum.