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# THE TOXICITY TO PLANTS OF WOOD PRESERVATIVES AND THEIR SOLVENTS

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In the course of investigations in the treatment of wood with chemicals to protect it from decay and insect attack,[1] studies were made to determine the toxicity to plants of certain of the materials used. The work was confined to the response of tobacco plants growing near treated wooden posts under a shade tent where air circulation is somewhat retarded and to the response of certain other plants to exposure to wood-treating chemicals under greenhouse conditions where the circulation of air is frequently severely retarded.

The search for a safe preservative has thus far been fruitless. It seems worthwhile, however, to present the negative results for the benefit of nurserymen and others who may get into trouble by the indiscriminate use of wood preservatives. Further work to find a safe preservative is contemplated.

## INJURY TO TOBACCO PLANTS UNDER SHADE TENTS

Creosote used on the above-ground portions of shade tent posts can cause severe injury to tobacco plants in the immediate vicinity of the post without actual contact. This injury is recurrent, indicating that appreciable quantities of creosote are still being volatilized from the post surface after several years. There is apparently no injury to the plants if creosote is applied only to the part of the post below ground level.

Pentachlorophenol has been used only to a limited extent in treating tent posts and reports as to its effect on tobacco plants are conflicting. In one field plants growing in close proximity to posts freshly treated with pentachlorophenol, which were dripping oil when set, showed no apparent injury during one growing season. In another field injury was observed similar to that from creosote. This is not surprising because of the variation in atmosphere conditions in different fields. Since there is evidence that pentachlorophenol does injure tobacco plants under tents, it would seem advisable to delay its extensive use as a post preservative until more is known about its toxicity or the toxicity of its solvents.

Observations over a period of years of tobacco plants in close proximity to shade tent posts treated full-length with zinc meta-arsenite, Wolman salts, copper chromate and zinc chloride showed no injury from these materials.

1/ Reported in Bulletin 581 of The Connecticut Agricultural Experimental Station, entitled "Wood Preservation by Simple Methods", by Henry W. Hicoak and A. Richard Olson, 1954.

## INJURY TO PLANTS IN GREENHOUSES

Experiments to test the toxicity of wood preservatives to plants were confined solely to pentachlorophenol and copper naphthenate. Creosote was ruled out because it is extremely injurious to all living plant tissues. It was felt that the usual water-soluble wood preservatives, zinc chloride or chromated zinc chloride, copper sulfate, sodium fluoride, mercuric chloride or Wolman salts, would not be suitable because wood used in greenhouses is at a high moisture content most of the time. Any salt which is carried into the wood in water could conceivably be again brought to the surface in quantities sufficient to be harmful to plants if the wood were continuously wet. Moreover, copper sulfate and mercuric chloride are highly corrosive to ferrous metals, and materials containing mercury or fluorine must be handled with caution. Pentachlorophenol and copper napthenate are both insoluble in water and both are effective inhibitors of decay. They are carried into the wood in oil which theoretically should all volatilize into the atmosphere with time leaving the preservative in the wood. It was recognized that the solvent oils could also cause injury to plants and the experiments were designed, as far as possible, to test the effect of both the preservatives and their solvents on plants.

Copper naphthenate in its most concentrated form is an extremely viscous liquid containing about 11 per cent copper. Before it is distributed to the user, its copper content is reduced to 8 per cent by the addition of mineral spirits. At this concentration it will pour readily. Ordinarily the user will still further reduce the copper content to from ½ to 3 per cent by the addition of more mineral spirits, kerosene or fuel oil.

Pentachlorophenol in crystalline form is rather difficult to get into solution without special equipment and, moreover, is irritating to the nasal membranes. Before it is distributed it is usually brought into solution in diacetone alcohol and diluted with mineral spirits in which form it is non-irritating and can be readily handled by the consumer. Pine oil is often added to prevent the pentachlorophenol from crystallizing out on the surface of the treated wood. If the solution is concentrated it is reduced to about 5 per cent strength before use by the addition of mineral spirits, kerosene or fuel oil.

Both of the above preservatives are sold as solutions under proprietary labels with certain unspecified ingredients added. No materials were used in the experiments except the two preservatives and their usual solvents as noted in the two preceding paragraphs, and certain other solvents which will be mentioned later. The conclusions drawn are based solely on the preservatives and solvents named and do not apply to these preservatives in other solvents or in combination with other materials.

The experiments were conducted by exposing seedlings of lettuce and tomato and rooted cuttings of carnations and chrysanthemums to the preservatives and/or their solvents. There were differences in susceptibility among the several kinds of plants but, since all were injured to some extent, no attempt will be made to distinguish among them. After the initial tests, tomato seedlings were used exclusively because of the ease of handling.

Pentachlorophenol and copper napthenate, and their usual solvents were first tested.

The tests were made by:

(a) Placing potted plants, two to three inches tall, in a closed container of approximately ¼ cubic foot capacity. The preservative or solvent was placed in a petri dish near but not touching the plant. These were called "cage" tests.

(b) Growing plants in miniature flats of red pine which had been treated by cold soaking in preservative solutions or in the solvent being tested. The flats were allowed to dry out for varying lengths of time before use. The work was done in a greenhouse and the tops of the plants were not enclosed. These were called "flat" tests.

Suitable checks were maintained in both types of test and the plants received adequate light, moisture and nutrients. Injury in the early stages was exhibited by a browning and curling at the leaf edges. In later stages the leaves became entirely shrivelled and frequently the stems collapsed. The work extended over a period of two years. The more important results may be summarized as follows:

### Cage Tests

#### Preservatives Only

Pentachlorophenol introduced into the cages as dry crystals caused severe injury to the tops of the plants, the extent of injury being in proportion to the duration of exposure. Copper napthenate without solvent caused no apparent injury. This is not surprising considering the extreme viscosity of this grade of material.

#### Solvents Only

The solvents listed above, placed in petri dishes with the plant, caused essentially the same type of injury as the pentachlorophenol alone, the extent of injury depending upon the duration of the test. Pine oil caused injury sooner than the others, but all caused damage to the plant if exposure were sufficiently prolonged. The following solvents were also tested:

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| Astral oil | Methyl alcohol (95 per cent) |
| Deodorized kerosene | Mineral oil |

Some of these acted more slowly than others but none was found which did not in the end cause injury or death.

An auxiliary experiment was performed by mixing small amounts of pentachlorophenol crystals with sand, wetting the mixture and inserting the roots of growing plants in it. Even though pentachlorophenol is highly insoluble in water, death of the plant by collapse of the stem at the surface of the sand took place within a short time, the speed of collapse depending to some extent on the amount of crystals mixed with the sand.

## Flat Tests

Initially flats were soaked in solutions made up by (a) dissolving pentachlorophenol crystals in diacetone alcohol, adding pine oil and subsequently diluting the concentrate to 5 per cent strength with Stoddard solvent, kerosene or fuel oil (b) diluting copper napthenate with 8 per cent copper to 1 per cent copper by the addition of Stoddard solvent, kerosene or fuel oil. Later, the other solvents, listed under "cage tests", were used in making the preservative solutions. Flats were also cold soaked in the several solvents. Plants grown in flats, which had been treated with preservative solutions or with solvents alone but which had not been allowed to dry, showed injury symptoms quickly. As the drying time was increased, the appearance of injury was delayed and was less pronounced. But even after the flats had been dried at room temperature and low humidity for eight months, the effect of the preservative or solvent in the wood was still apparent. With the longer drying periods, the injury was more frequently exhibited by stunting or yellowing of the leaves, but without marked injury symptoms such as have been elsewhere described.

There was an appreciable difference in the reaction of plants to the various solvents but none was found which sooner or later did not cause some type of injury or stunting. In general, the more volatile the solvent, the sooner a high percentage of it was evaporated from the wood and the more delayed was the effect on the plant of the residual portion still in the wood. The injurious effect of pine oil was very evident but whether this was due to properties inherent in it, or to the slow rate at which it volatilizes from the wood, is not known.

No plants were grown in wooden cold frames treated with preservative solutions or their solvents but the severity of injury under the conditions described leaves little doubt that injury could also be severe to plants grown in cold frames of wood treated with the same materials.

## Conclusions

Based on these experiments, the authors are of the opinion first, that pentachlorophenol should never be used in close proximity to growing plants in greenhouses or cold frames; second, that of the numerous materials tested as solvents for pentachlorophenol or copper naphthenate, none can be used near plants with entire safety, and third, that while copper naphthenate itself is apparently not injurious to plants, there is no ready means known at present for introducing it into wood except in solvents which are toxic.