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# Does 2,4-D follow assimilate translocation in leafy spurge

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## Introduction

Literature on spurge control has suggested that control by herbicides is more complete during certain growth stages because photosynthates are being accumulated in the roots, and therefore phloem translocation is predominantly basipetal. This study was done in order to establish a basic pattern of 2,4-D and sucrose translocation in leafy spurge, to investigate what factors influence this pattern, and to determine the relationship between sucrose and 2,4-D translocation.

## Materials and methods

The model system devised by Jeffrey Suttle and Donald Schreiner was used in order to reduce variability in the physiological state of plant material.

Rooted cuttings of cloned plant material were obtained by the following method:

1. Tops are removed from older stems of cloned plants.
2. In one month new shoots are formed.
3. Shoots are removed and rooted in vermiculite.
4. In one month rooted cuttings are ready for experimentation.

Rooted cuttings were placed in mason jars in 1/4 strength Hoagland's solution two days before any treatment was made. Growth chamber conditions were: 25º/18º C (14-hour photoperiod) at 60% RH.

Non-radioactive herbicide solutions were applied in 5% ethanol + 0.05% Tween 20 using a Greenhouse Pot Sprayer with a T-Jet 8000067 nozzle.

Radioactive solutions were applied to three marked leaves on each plant. A fully expanded young leaf, a leaf in the middle of the plant, and an older but non-senescent leaf were chosen and gently abraded with carborundum in water. About 200,000 DPM of

each $^{14}$C-2,4-D (ring labeled) and $^{3}$H-sucrose (uniformly labeled) were applied to each abraded spot.

Upon sampling, plants were removed from the growth medium, divided into root, leaf, and stem tissue (labeled leaves were discarded), freeze-dried and oxidized. Collected radioactivity was determined by liquid scintillation spectroscopy (LSC). Duplicate aliquots of growth medium were also counted by LSC.

All data are expressed as the percent of $^{14}$C or $^{3}$H moved from the labeled leaves.

## Results and discussion

Each experiment will be represented by two figures. The first shows the influence of some factor on $^{14}$C distribution in the plant. The second shows the influence of that factor on $^{3}$H distribution in the same plants.

Increasing 2,4-D concentration (Figures 1 and 2) increased $^{14}$C in the stem and decreased $^{14}$C in the leaves. Increasing 2,4-D also had a tendency to increase $^{3}$H in the stem. However, increasing 2,4-D did not decrease $^{3}$H in the leaves. Since lower rates of 2,4-D were not consistently herbicidal, 2,4-D was applied at a rate of 1 kg/ha in all subsequent studies.

Stem tissue was the first tissue to show significant $^{14}$C after application (Figure 3). The proportion of $^{14}$C in the stem dropped off rapidly however as $^{14}$C was translocated to the leaves and then root zone. The distribution of $^{14}$C in the system reached an equilibrium about four days after application.

On the other hand, significant amounts of $^{3}$H appeared in the leaves only 2 hours after application (Figure 4). This indicates that $^{3}$H is translocated much faster than 2,4-D. It should also be noted that proportionally more of the $^{3}$H than $^{14}$C accumulated in the root zone.

Nutrient strength has been reported in the literature to have a large influence on assimilate translocation in plants. In this study, however, (Figures 5 and 6) except for the deionized water treatment, nutrient strength had very little influence on distribution of either $^{14}$C or $^{3}$H.

Decapitation of shoots has also been shown to increase sink strength of roots by removing the competing shoot apex. In this experiment the apex and immature leaves were removed at various intervals prior to 2,4-D treatment. This had the effect of decreasing both $^{14}$C and $^{3}$H in the leaf tissue (Figures 7 and 8). In intact plants the relative specific activity (DPM of isotope/gram dry weight of plant material) of both isotopes is extremely high in the shoot apex and young leaves (data not shown). Thus, both $^{14}$C and $^{3}$H tend to be translocated to strong sinks.

It has also been reported in the literature that ethylene can influence herbicide translocation in some species. The model system was used to test the effect of ethylene on $^{14}$C and $^{3}$H translocation in leafy spurge. Cerone, a commercial ethephon, was applied at 1 kg/ha at various intervals before 2,4-D application. Cerone decreased $^{14}$C in the stems (Figure 9) if applied at the same time or up to a day before 2,4-D treatment. However,

earlier Cerone pretreatment increased $^{14}C$ in the stems. These increases and decreases in stem $^{14}C$ was mirrored by decreases and increases in leaf $^{14}C$. $^{14}C$ in the root zone was hardly influenced. Cerone had little effect on $^{3}H$ distribution in the plants.

The distribution of $^{14}C$ and $^{3}H$ were very different in several experiments (Table 1).

1. Distribution of $^{14}C$ and $^{3}H$ in leaves showed different responses with time.
2. Increasing 2,4-D concentration increased $^{14}C$ in the stem and decreased $^{14}C$ in the leaves. The effect of 2,4-D concentration of $^{3}H$ distribution was ambiguous.
3. Decapitation yielded similar responses with both $^{14}C$ and $^{3}H$.
4. Nutrient strength decreased $^{14}C$ in the leaves, but decreased $^{3}H$ in the roots and stem.
5. Cerone caused several responses in $^{14}C$ distribution but had little effect on $^{3}H$ distribution.

# Conclusions

The results of these experiments are summarized as follows:

1. The pattern of 2,4-D translocation is not necessarily similar to the pattern of sucrose translocation.
2. A great deal of applied $^{14}C$-2,4-D remains in the leaves and especially the stem, suggesting that it moves out of the phloem and becomes less available for translocation.
3. A great deal of applied $^{3}H$-sucrose enters the roots very quickly, indicating that the direction of phloem translocation is not impeding movement of applied materials to the roots.

**Table 1. Effect of five factors on $^{14}C$-2,4-D and $^{3}H$-sucrose distribution in leafy spurge.**

| | M% | | R% | | L% | | S% | |
|---|---|---|---|---|---|---|---|---|
| Factor | $^{14}C$ | $^{3}H$ | $^{14}C$ | $^{3}H$ | $^{14}C$ | $^{3}H$ | $^{14}C$ | $^{3}H$ |
| Time | **▲ | **▲ | **▲▼ | *▲▼ | **▲ | **▼ | **▼ | **▼ |
| (2,4-D) | NS | *▲▼ | NS | NS | **▲ | NS | *▼ | **▲ |
| Decapitation | NS | NS | NS | NS | **▼ | *▼ | NS | NS |
| (Nutrient) | **▲ | **▲ | NS | **▼ | **▼ | NS | NS | **▼ |
| Ceron Pretreat. | *▼ | NS | NS | *▲ | **▲▼ | NS | **▼▲ | *▼ |

*, ** Indicate significance at 0.05 and 0.01 levels, respectively.

**Figure 1. Effect of 2,4-D concentration on $^{14}C$ distribution 7 days after application.**

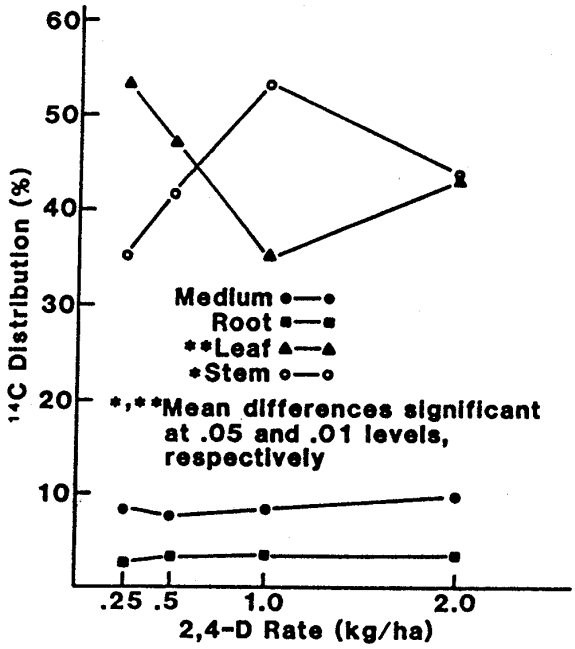


**Figure 2. Effect of 2,4-D concentration on $^{3}H$ distribution 7 days after application.**

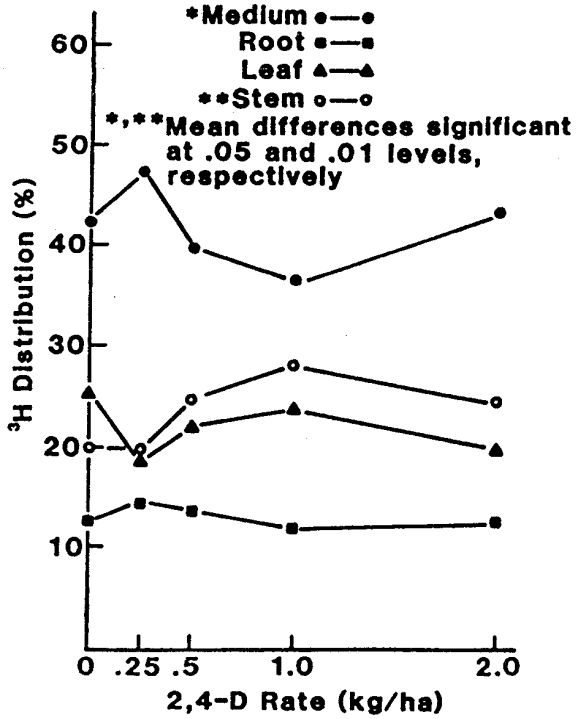

**Figure 3. distribution of $^{14}C$ as a function of time after application.**

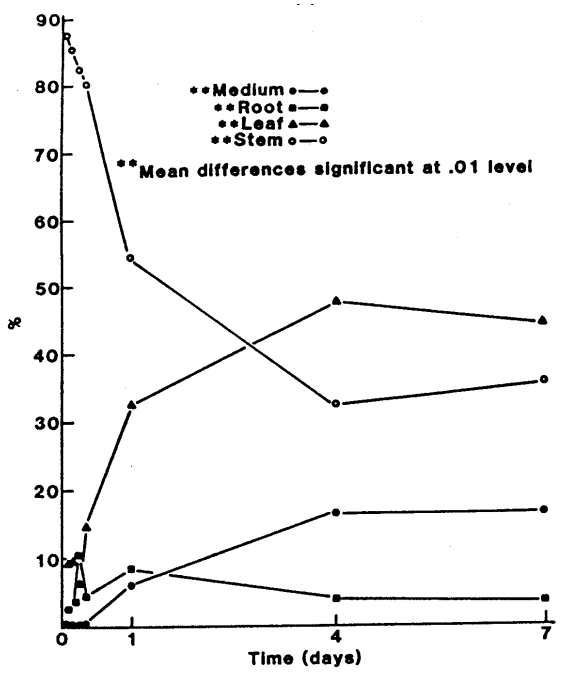


**Figure 4. Distribution of $^{3}H$ as a function of time after application.**

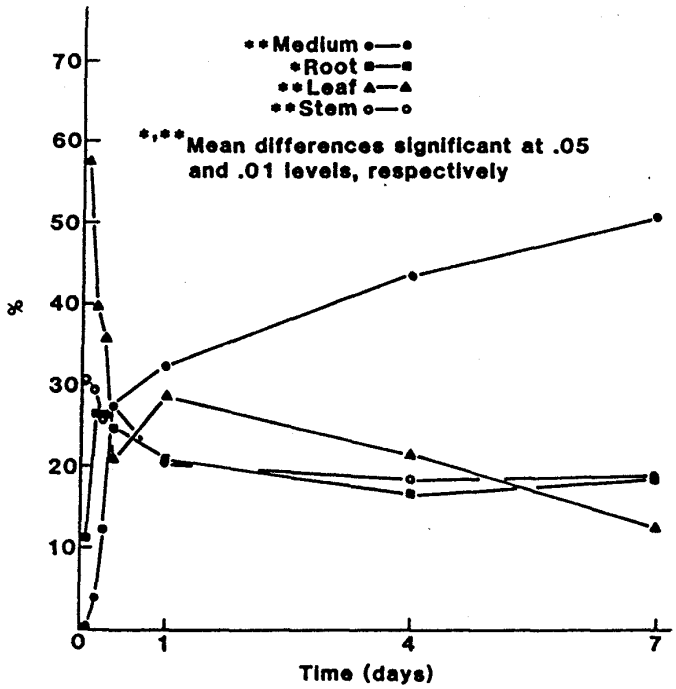

**Figure 5. Effect of nutrient strength on $^{14}C$ distribution 7 days after application.**

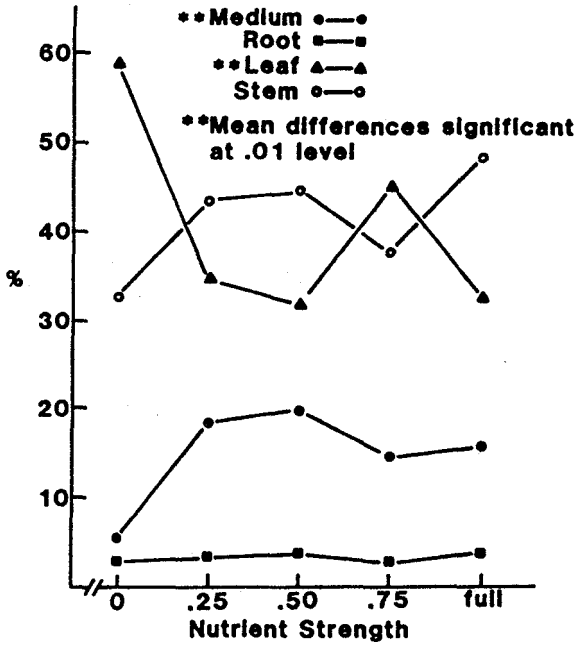


**Figure 6. Effect of nutrient strength on $^{3}H$ distribution 7 days after application.**

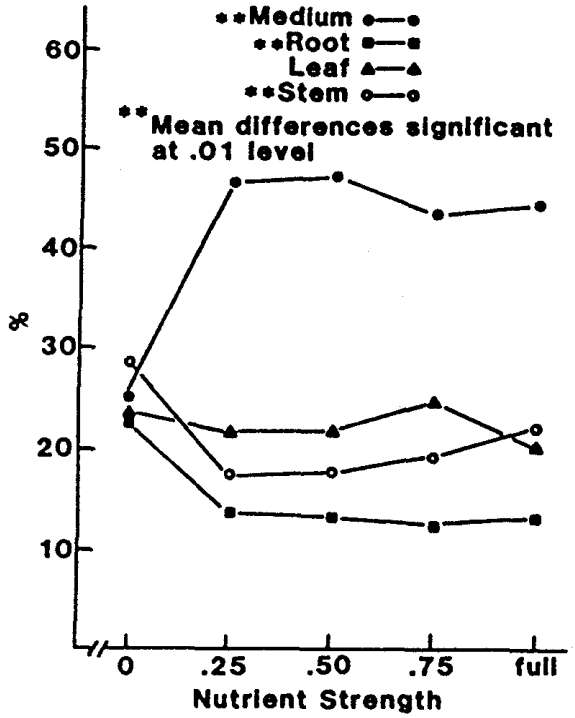

**Figure 7. Effect of decapitation on $^{14}C$ distribution 7 days after application.**

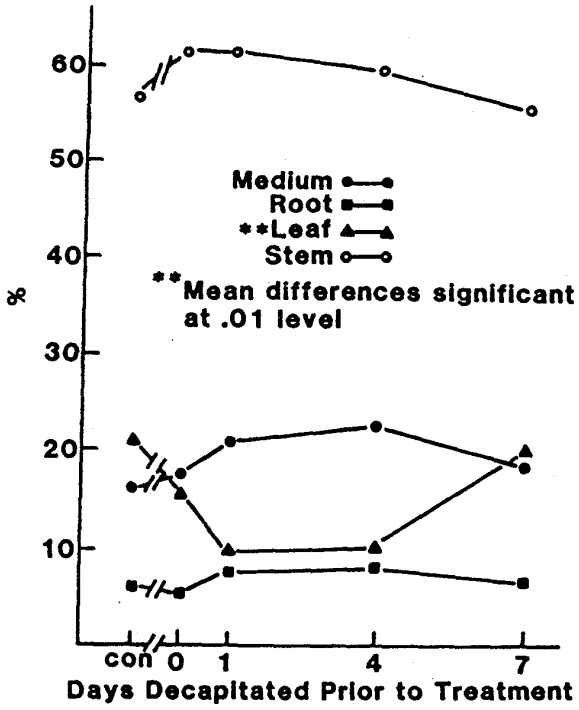


**Figure 8. Effect of decapitation on $^{3}H$ 7 days after application.**

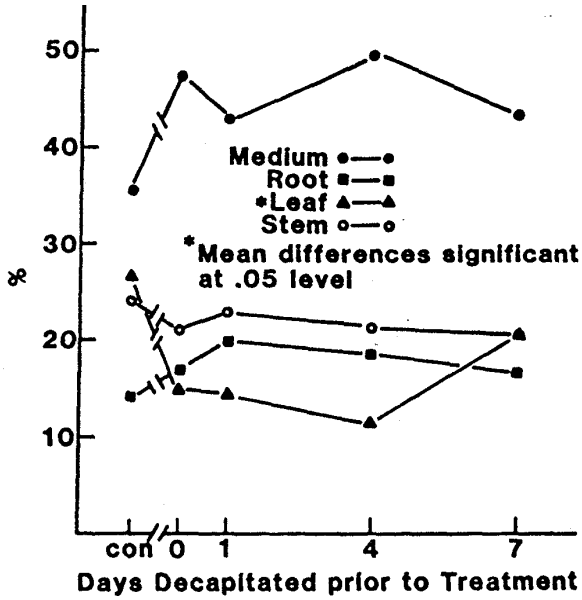

**Figure 9. Effect of cerone pretreatment on $^{14}C$ distribution 7 days after application.**

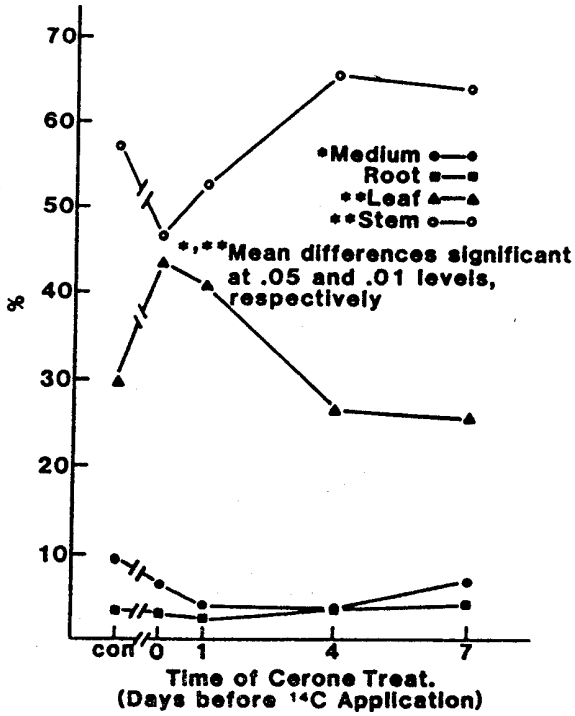


**Figure 10. Effect of cerone pretreatment on $^{3}H$ distribution 7 days after application.**