FOLIAR ABSORPTION AND TRANSLOCATION OF PROMETRYNE IN SOME PLANT SPECIES

By

JAI NATH SINGH

Bachelor of Science
Government Agricultural College
Kanpur, U.P., India
1959

Master of Science
Government Agricultural College
Kanpur, U.P., India
1961

Master of Science
Auburn University
Auburn, Alabama
1967

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
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Thesis Approved:

Paul W. Santelmann
Thesis Adviser

James M. Davidson

Eddie Basler

J. F. Stritzke

D. D. Durham
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Prometryne (2,4-bis (isopropylamino)-6-methylmercapto-s-triazine) is a selective herbicide primarily used to control annual broadleaf and grass weeds in cotton and in grasses grown for seed. It has also been useful in certain vegetable crops such as potatoes, okra and parsley, small grains, ornamentals, and in combination with atrazine in corn. It can be applied pre-emergence, post-emergence directed or as a lay-by treatment. It is applied at the rate of 2 to 3 lb active ingredients (ai) per acre for selective pre-emergence or lay-by weed control. Rates of 0.25 to 1 lb are common for post-emergence directed treatments. The mode of action of prometryne is similar to other s-triazine herbicides in that it acts by interfering with the Hill reaction in photosynthesis. In interfering with the Hill reaction, it most likely is hydrogen bonded with the protein of an enzyme involved in the oxidation of water. It also inhibits oxidation of α-Ketoglutarate and succinate by mitochondria, and reduces transpiration.

Since prometryne is a fairly new addition to the s-triazine family, and is most widely used as a soil treatment, little information is available on the foliar absorption and translocation of this herbicide. For effective and efficient control of selected weed species without crop damage, a thorough knowledge of absorption, translocation, and mechanism of action of this herbicide is essential.

Therefore, the present investigation was undertaken in order to:

1. determine the effects of adjuvant concentrations on prometryne absorption through leaves.
2. determine the effect of growth stages and environmental factors (such as temperature, soil moisture level and fertility) on prometryne absorption.
3. determine the degree of translocation after foliar absorption and effects of environmental conditions on the translocation of prometryne.

CHAPTER II

REVIEW OF LITERATURE

The literature on prometryne absorption and translocation is scant, hence work conducted on other s-triazines is cited here as a point of reference.

Foliar Absorption and Translocation

Adjuvants are substances added to a herbicide to increase its phytotoxicity. Such substances may enhance toxicity by increasing spreading properties, promoting leaf retention and penetration or performing other functions. Certain adjuvants reduce interfacial tension and are known as surface-active-agents or surfactants (2). Mitchel and Linder (24) studied the absorption and translocation of radioactive 2,4-dichlorophenoxy acetic acid (2,4-D) iodine salt by bean (*Phaseolus vulgaris*) plants as affected by cosolvents and surface agents and concluded that all the tested adjuvants increased the rate of absorption and translocation of the salt even though solutions were applied and confined to uniform areas of the leaf surface. Similarly, Dybing et al. (15) studied foliar penetration by chemicals and found that cuticular penetration, with the exception of ^{32}P-phosphate, via this route was relatively slow. Stomatal penetration by aqueous solution occurred rapidly if an efficient surfactant was used at the proper concentration. However, surfactants varied in their ability to enter the stomata and the surfactant concentration necessary for stomatal penetration varied with the species being tested.

Dexter et al. (13) compared the effects of 12 surfactants and found few differences in their ability to increase atrazine (2-chloro-4-ethylamino-6-isopsoylamino-s-triazine) toxicity to large crabgrass (Digitaria sanguinalis (L.) scop.) and sorghum (Sorghum vulgare Pers.) or in their toxicity to large crabgrass and sorghum when used alone. Surfactants per se showed some toxicity to crabgrass and sorghum. As crabgrass increased in size it became less susceptible to injury from atrazine plus dodecyl ether of polyethylene glycol (surfactant WK). Early spraying with atrazine plus Surfactant WK reduced the top-growth yield of six grass species. McWhorter and Sheets (22) applied diuron (3-(3,4-dichlorophenyl)-1, 1-dimethylurea) to 9-day old crabgrass plants in sprays containing four different Surfactants at 0.0, 0.25 and 0.75% by volume and concluded that the addition of surfactants enhanced the post-emergence phytotoxic effect of diuron, but that spray volume did not greatly influence the results.

Biswas (7) studied absorption, diffusion and translocation of ^{14}C-labeled triazine herbicides in peanut (Arachis hypogaea L.) leaves and observed that a surfactant almost always increased herbicide absorption. The surfactant did not influence the diffusion of these herbicides. Bayer et al. (5) concluded that enhancement of diuron toxicity to oat (Avena sativa) plants was not dependent on surfactant type (anionic, cationic or nonanionic). However, the specific surfactant concentration was important. Surfactant concentrations alone 0.1% were required for consistent phytotoxic effects.

The apparent water solubility of 2-ethylamino-4-isopropylamino-6-methylmercapto-s-triazine (ametryne) and diuron was increased when a surfactant was added to the suspension. At a surfactant concentration of 0.5% considerable variation in solubility was found, both with regard to herbicide and surfactant concentration used as measured by ultraviolet absorption spectrophotometry. The triazine was more soluble in a cationic surfactant, followed by a nonionic one; diuron was more soluble in cationic followed by nonionic and anionic types. Minimum lethal levels of surfactants in water for 2 weeks old cucumber (Cicumis sativus Linn.) plants varied from about 0.1% for cationic to 0.2% for most nonionic and 0.1% or more for anionic surfactants of the alkylaryl sulfonate type (35).

The addition of a phytobland oil to atrazine-water solutions markedly increased the absorption of ^{14}C-atrazine at 7, 18 and 29°C. However, the greatest enhancement from oil occurred at the highest temperature. Foliar uptake of ^{14}C-atrazine with and without oil, was slightly greater at a higher humidity; however, the differences were not significant (27). Shrader (28) reported that in all instances studied, the addition of a phytobland oil greatly increased the foliar penetration of ^{14}C-atrazine into corn (Zea mays L.) and yellow foxtail (Setaria glauca). In most cases an increase from 5 to 10% phytobland oil did not change this effect. Bandeen (3) found that adding a light mineral oil to the spray tank at 1½ to 2 gallons per acre helped increase the penetration of atrazine into leaf tissues and caused rapid kill of emerged weeds.

The addition of an adjuvant (surfactant or oil) to an atrazine-water suspension increased retention of spray on giant foxtail (Setaria fabarii) by a factor of 3 to 5 but did not increase retention on red root pigweed (Amaranthus retroflexus). Application of ^{14}C-atrazine with and without an adjuvant to giant foxtail, red root pigweed and coleus (Coleus blumei) indicated that the stomata were not an important route of entry for foliar applied atrazine. All the surfactants and oils studied increased the effectiveness of foliar applied water suspensions of atrazine (34).

Negi et al. (25) studied metabolism of atrazine in susceptible and resistant plants and found that the amount of undegraded atrazine in the plants was roughly correlated with susceptibility, but that atrazine absorption was not directly correlated with plant susceptibility. Biswas and others (8) studied the differential absorption of ^{14}C-labeled atrazine and simazine by the upper and lower surfaces of raspberry (Rubus occidentalis) leaves and found that the amount of atrazine absorbed was always greater than simazine. In both cases the amount absorbed by the lower leaf surface was more than the upper surface.

Since it is generally thought that absorption of most foliar applied compounds are controlled by metabolic and nonmetabolic processes, it seems likely that the overall process would be accompanied by fairly high temperature coefficients. Bayer et al. (5) found that lowering the temperature from 72 to 60°F slowed the expression of toxicity and increased the chances of plant recovery. Pallas (26) reported that increasing temperature from 20 to 30°C increased foliar absorption and translocation of 2,4-D and benzoic acid. At temperature of 20, 25 and 30°C less 2,4-D or benzoic acid was absorbed and translocated at low humidities (34-48%) than at high humidities (70-74%).

It is generally believed that soil moisture stress inhibits absorption of foliar applied solutes. Although there appears to be no question that a favorable water balance is important for optimum translocation, the relation to foliar absorption is not clear (20). Moisture stress reduced foliar uptake of picloram (4 amino-3,5,6-trichloropicolinic acid) in mesquite (prosopis glandulosa) but not in winged elm (ulmus alata). It did not affect the absorption of 2,4,5-T (2,4,5-trichlorophenoxy acetic acid). Stress reduced the transport of herbicide differently for the two species, but reduced the transport phenomena generally paralleled the retarded plant growth. Moisture stress sufficient to slow growth markedly reduced transport of both herbicides into untreated tissue. (12).

According to Basler et al. (4) the relative turgidity of leaf tissue was a good indicator of the ability of bean plants to translocate 2,4-D. Plants with relative turgidities below 80% translocated only trace amounts of 2,4-D while plants above this value showed sharp increases in translocation. With a decrease in soil moisture level, there was a gradual decrease in translocation. Mild or severe water stress decreased the amount of 2,4-D absorbed very little, if any, as indicated by the amount of 2,4-D which could be washed from treated leaves with 80% ethyl alcohol. Plants which were subjected to temporary drought conditions required several hours to regain the inability to translocate significant amounts of 2,4-D even though they had regained their full turgidity within one or two hours.

Root Absorption and Translocation

Sheets (30) studied the uptake and distribution of simazine by oats and cotton seedlings and reported that simazine was absorbed by the roots and the ^{14}C was distributed throughout the oat seedling within 3 hours. Similarly, Davis et al. (11) found that the amount of atrazine absorbed by corn, cotton and soybean increased with increases in atrazine concentration, in transpiration and in period of absorption. Less atrazine was absorbed in the second than in the first 24 hour period after treatment with an occasional indication of atrazine loss back into the solution.

Various degrees of susceptibility to specific chemicals are often found among different plant species and varieties due to absorption, translocation and distribution differences. Cotton (Gossypium hirsutum) a tolerant species and soybean (Glycine max) a sensitive species absorbed essentially equal amounts of prometryne from solution culture. ^{14}C-prometryne was uniformly distributed throughout the soybean plant whereas it was concentrated in the lysigenous glands and in root primordia of cotton (32). The total amount of ^{14}C-simazine taken up after 40 days was similar for both red (Pinus resinosa) and white pine (Pinus strobus). In red pine the ^{14}C was fairly evenly distributed between roots, stem and needles, whereas in white pine it was retained in the non-photosynthetic organ of the plant (16). Thus, susceptibility variations were apparently not due to absorptive but due to distribution differences. Contrary to these results, soybean absorbed more atrazine per gram of fresh weight than corn or cotton when atrazine was applied to nutrient solution (11).

Hoie (18) studied, uptake, translocation and metabolism of simazine in Norway Spruce (Picea abies) and concluded that it was readily absorbed and distributed in spruce seedlings. Similarly, Dhillon et al. (14) found that ^{14}C-simazine readily entered red pine roots and moved rapidly into stem and needles. Shimabukuro et al. (31) found that a reduction in ^{14}C-atrazine absorption resulted in less translocation to the shoot apices but he states that this probably was not an important factor in early stages of injury. Absorption of ^{14}C-atrazine by oat plants was not reduced until 3 days of exposure to atrazine. Davis et al. (10) observed that the absorption and translocation of simazine from the soil followed the same pattern as from nutrient culture. More simazine was absorbed from soil that received simulated rainfall than from subirrigated soil. Simazine moved readily into the roots of corn, cotton and cucumber. Almost no absorption occurred through the intact leaves. However, simazine did enter when the leaf cuticle was broken.

Wax et al. (37) studied absorption and translocation of atrazine in quackgrass (Agropyron repens L. Beauv.) and concluded that uptake and translocation of root fed atrazine increased as temperature increased. Greater uptake and translocation of root fed atrazine occurred under low humidity. Slightly greater uptake and translocation of foliar applied atrazine occurred as temperature was increased from 60 to 80°F.

Kozlowski et al. (21) studied the effect of temperature on phytotoxicity of simazine, atrazine, propazine (2-chloro 4, 6-bis (isopropylamino)-s-triazine), prometryne, and prometone (2-methoxy-4, 6-bis (isopropylamino)-s-triazine) to young pine (Pinus resinosa) seedlings and found that high temperatures greatly accelerated herbicide toxicity but the effects of temperature varied greatly among herbicides. Atrazine and simazine were more toxic at all temperatures than other herbicides tested.

An application of potassium nitrate or urea to the soil of detopped potted tomato (Lycopersicon esculentum Mill.) plants increased the rate of exudation from the stumps of the plants from 100 to 300% and increased concentration of atrazine in this augmented exudate from 9 to 40%. The build up in the concentration of atrazine in the exudate occurred at faster rates in plants treated with potassium nitrate than in distilled watered plants. The concentration of the triazines in the exudate were proportional to their solubility in water. An application of urea increased the concentration of triazines in the exudates (23). Bingham et al. (6) studied the interaction between nutrient levels (N,P,K,Ca) and diuron in the growth of cotton and Italian ryegrass (Lolium multiflorum Lam.). He found that an interaction existed between phosphorus and diuron and that the effect of diuron on growth is partially regulated by the phosphorus level. Soil nitrogen, potassium and pH had little influence on the effect of diuron on the growth of plants in this study. However, nitrogen and potassium were not studied at concentrations sufficient to cause plant growth changes in the absence of the herbicide.

From the literature, it is evident that the effect of adjuvants, plant species, moisture stress and fertility status, etc., are very important from the point of view of absorption and translocation of other s-triazines. Therefore, it was decided to examine the effects of the above mentioned factors on the absorption and translocation of prometryne.

CHAPTER III

MATERIALS AND METHODS

The experiments conducted can be grouped into two broad categories, absorption and translocation experiments. All plants were grown in a growth chamber.

Foliar Absorption

Except where temperature was a variable, all the absorption experiments used a temperature regime of 90°F for a 14 hour day and 77°F for a 10 hour night. The humidity was 50%. The plan used was a completely randomized design with 5 or 6 replications. The data were statistically analyzed and treatment means evaluated using Duncan's multiple range test.

To determine the time required for maximum ^{14}C-prometryne absorption in Multi-Film X-77 (blended surfactant) or Sun 11E (Parafin base oil), soybean (Glycine Max variety Dare) seeds were germinated and then transplanted (about 4" tall) to brown bottles containing 400 ml full strength Hoagland's solution. Air was bubbled through the solution continuously and the solution was changed every fourth day. The plants were allowed to grow for at least ten days. When plants were about 9" tall, 10 ul of ^{14}C-prometryne (Specific activity 5.7 uc/mg) water solutions containing surfactant at ½% by volume (45.6 ppm prometryne) or oil at 2.5% by volume (15.8 ppm prometryne) were applied to the two opposite primary leaves. Absorption was allowed to occur for $\frac{1}{2}$, 1, 2, 4 or 20 hours. After the absorption, the treated leaves were excised and washed for 30 seconds by shaking them in scintillation counting vials containing 15 ml counting solution (p-dioxane, xylene, ethanol-5:5:3 solution containing 5 g PPO and 80g naphthaline per liter). The treated leaves were then removed from the counting vials and the radioactivity left in each vial was determined using a liquid scintillation counter. The amount of ^{14}C-prometryne absorbed by the leaf at a given period was determined by subtracting the unabsorbed radioactivity found in the washings from the total applied. The data were analyzed as a percent of standard applied to the leaves which were different with both the adjuvant.

Another experiment was conducted in a similar manner but four different volume concentrations of surfactant (0.25%, 0.5%, 1.0% and 1.5%) or oil (0.5%, 2.0%, 2.5% and 3.0%) with ^{14}C-prometryne were studied. A 10 ul ^{14}C-prometryne-water solution containing desired concentration of surfactant or oil was applied as above. The treated plants were allowed to absorb herbicide for 4 hours and then the treated leaves were excised from the plant, washed and unabsorbed radioactivity determined.

Plant age was varied by germinating the soybean seeds at different times. A 10 ul solution of ^{14}C-prometryne-water containing surfactant (0.5%) (52.6 ppm) or oil (2.5%) (15.8 ppm) was applied to the two opposite primary leaves of the plants which were 12, 16, 20 and 22 days old. The treated plants were then allowed to absorb herbicide for 4 hours. Thereafter all other steps were the same as in the previous study.

Prometryne absorption by soybean, cotton (Gossypium hirsutum L. Var. Kemp) and peanuts (Arachis hypogaea L. Var. Argentina) was compared. Seeds of the above mentioned species were germinated and transplanted in bottles containing full strength Hoagland's solution. When plants were about 9" tall, prometryne-water solution containing adjuvant was applied to the two opposite primary leaves of soybean and two mature leaves of the other plants. The treated plants were allowed to absorb herbicide for 4 hours.

In another experiment, prometryne absorption by jimsonweed (Datura stramonium L.) morningglory, annual (Ipomea spp. (L.) Jacg.) and sunflower (Helianthus annuus L.) was compared. The procedure was the same as in the crop species absorption experiment.

Prometryne absorption by soybean and cotton (Gossypium hirsutum L. Var. Verden) was compared at 4 temperature regimes with 14 hours day and 10 hours night and with day and night temperatures of 70°F and 60°F, 80°F and 70°F, 90°F and 77°F and 100°F and 90°F. Prometryne-water solution containing surfactant at 0.5% was applied and all other steps carried out as in the previous absorption experiments.

Soybean and cotton seeds were germinated in pots containing soil after which the plants were thinned to one plant per pot. The three moisture levels were imposed; daily watering, watered on alternate days, and watered every fourth day. 50 ml of water was applied to each pot at each watering. The plants were subjected to the imposed watering treatments for at least ten days prior to prometryne treatment. A prometryne-water solution (17.54 ppm) containing surfactant was applied to the two opposite primary leaves of soybean and two mature leaves of cotton. The treated plants were allowed to absorb herbicide for 4 hours. All other steps were the same as in the previous absorption period experiments.

Prometryne absorption by soybean and cotton at three fertility levels (1/16, 1/8 and 1/2 strengths of Hoagland's solution) was compared. The nutrient solutions were changed every fourth day. The plants were subjected to the desired fertility levels for at least ten days prior to prometryne treatment. All other experimental steps were the same as in the temperature experiment.

Foliar Translocation

All the translocation experiments were conducted under the same environmental conditions as the absorption experiments. The design used was a split plot completely randomized layout.

Translocation of prometryne in soybean and cotton at three fertility levels (1/16, 1/8 and 1/2 strengths Hoagland's solutions) was compared. As in the absorption experiments the seed of desired species were germinated and transplanted to bottles containing desired concentration of Hoagland solution. The plants were allowed to grow for at least ten days in these nutrient solutions prior to prometryne treatment. A 10 µl solution of ^{14}C-prometryne - 95% alcohol (6536 • 8 ppm) containing surfactant was applied on one leaf of each plant as 10 1-µl drops. Each treatment was replicated 8 times and the treated plants were allowed to absorb and translocate for 48 hours. At the end of 48 hours, two plants each of soybean and cotton were selected from each treatment and autoradiographed while fresh using the method described by Yamaguchi and Crafts (39). The method consisted of mounting the plant on poster cardboard pieces (9" x 7"), covering with Saran wrap and exposing these to Kodak, no screen x-ray film in dark room. The x-ray film packs were sealed with masking tape and aluminum foil to make it light proof and pressed in a plant press made up of wooden boards and soft rubber foam. These were then stored in deep freeze throughout one month exposure period. After this, each film was developed separately. Fresh plant samples were autoradiographed to prevent the loss of prometryne due to volatilization during the process of lyophilization which is required for dry plant samples, autogradiography. The remaining plants in each treatment were removed from the nutrient solution bottles, their roots washed with distilled water and sectioned into various segments: treated leaf, untreated leaves, upper stem, (above the treated leaf) lower stem (below treated leaf) and roots. These plant parts were weighed while fresh and frozen until ground. Each plant part was then homogenized in 20 ml of 95% alcohol, an aliquot from this homogenate was pipetted into vials containing 15 ml of counting solution as described previously and the ^{14}C-activity determined using the liquid scintillation counter, the DPM (disintegrations per minute) in the homogenate of each plant part was calculated and this data was statistically analyzed as (DPM/ fresh weight X standard DPM) X 100. Similarly, at the end of 48 hours of translocation, the volume of nutrient solution was brought up to 400 ml and a 5 ml aliquot was counted to determine the DPM in the nutrient solution using aquasol as counting medium.

Prometryne translocation in soybean and cotton at three moisture levels, watered daily, watered alternate days and watered every fourth day, was compared. The seeds were germinated in pots containing soil, thinned to one plant per pot, and watering treatments were begun. At least 10 days after thinning, 10 µl of ^{14}C-prometryne solution (27236 · 8ppm) containing surfactant were applied as 10 1-µl drops on one leaf of each plant. Each treatment was replicated 6 times. The treated plants were allowed to absorb and translocate for 48 hours. After this the remaining procedure was the same as in fertility and translocation experiments except that soil samples were not analyzed for radioactivity.

Soybean, sunflower, jimsonweed and cucumber (Cucumis stativus Linn.) seeds were germinated and the seedlings transplanted to bottles containing 1/2 strength Hoagland's solution. Air was bubbled through continuously and the solutions were changed every fourth day. When plants were about 9" tall, 1 µl of ^{14}C-prometryne (18,719 · 3 ppm)-95% ethyl alcohol solution was injected into the stem just below the cotyledonary node. The treated plants were allowed to translocate for 48 hours. Each treatment was replicated 10 times. After 48 hours, two plants of each species were selected and autoradiographed. All remaining plants were sectioned into various segments: treated stem, upper stem, above the treated stem, lower stem, below the treated stem, leaves and roots. These samples were weighed while fresh and frozen until ground. All other steps were similar to the foliar translocation studies. Similarly prometryne translocation was compared in jimsonweed and pigweed (Amaranthus hybridus L.). After stem injection, the plants were allowed to absorb and translocate for 24 hours. Nutrient solutions were analyzed at 8, 16, and 24 hours. Plants were sectioned into treated stem, upper stem, growing points, lower stem, roots, and individual leaves. All other steps were as described above.

Translocation of stem injected prometryne in soybean and jimsonweed was compared at two temperature regimes: 90°F for 14 hours day and 77°F for 10 hours night and 70°F for 14 hours day and 60°F for 10 hours night. The plants were grown at the desired temperature regimes for at least 10 days before prometryne injection. All other steps were the same as in the previous experiment except that autoradiograms were not made.

CHAPTER IV

RESULTS AND DISCUSSION

For convenience the results are discussed in three main sections: foliar absorption, foliar translocation, and translocation of stem injected prometryne.

Foliar Absorption

During all early hours of treatment soybean plants treated with prometryne solution containing oil absorbed prometryne more rapidly than plants treated with a prometryne solution containing a surfactant (Figure 1). The difference in absorption between absorption time were highly significant for the first three hours. Soybean plants treated with both adjuvant treatments absorbed increasing percentages of prometryne with increasing absorption periods, however, plants treated with oil showed a tendency to level off in absorption after 1 to 2 hours while plants treated with surfactant continued to absorb prometryne during the entire treatment period. This relationship was born out of the fact that the difference between adjuvants at each absorption period was statistically significant, indicating that each adjuvant responded differently for different absorption periods. The higher percentages of initial absorption with the oil might possibly be attributed to the fatty nature of oil that helps dissolve cuticle which is made of fat like substances and thereby leads to better penetration and absorption. The surfactant being non-fatty in nature is probably not as effective in dissolving cuticle and other fatty substances as oil and therefore may lead to a low absorption rate. The continuous absorption with time in samples treated with surfactant could eventually result in significantly more prometryne in the leaf tissue than in samples treated with oil.

Soybean plants treated with prometryne solutions containing oil absorbed slightly higher percentages of prometryne than the plants treated with prometryne solution plus surfactant when these were measured at 4 hours after treatment (Figure 2). The differences due to various concentrations of surfactant or oil were not significant. The plants treated with prometryne solutions containing surfactant or oil showed similar absorption trends.

Differences in absorption due to plant age were not significant (Figure 3). However, with the increase in plant age from 12 to 22 days, the plants treated with prometryne plus surfactant absorbed more prometryne; whereas plants treated with prometryne plus oil showed a slight decline in percent absorption. The interaction between adjuvant and plant ages was highly significant. The increase in percent absorption of plants treated with prometryne solution containing surfactant could be attributed to the cracks that might develop in the cuticle layer deposited on the leaf surface as the plant grows older thus aid the penetration of prometryne after application. The decreasing absorption by plants treated with prometryne plus oil could be due to a decreasing ability of the oil to dissolve successive cuticle layers deposited on leaf surface with increasing age. Also the prometryne solution containing oil remained as one drop with high

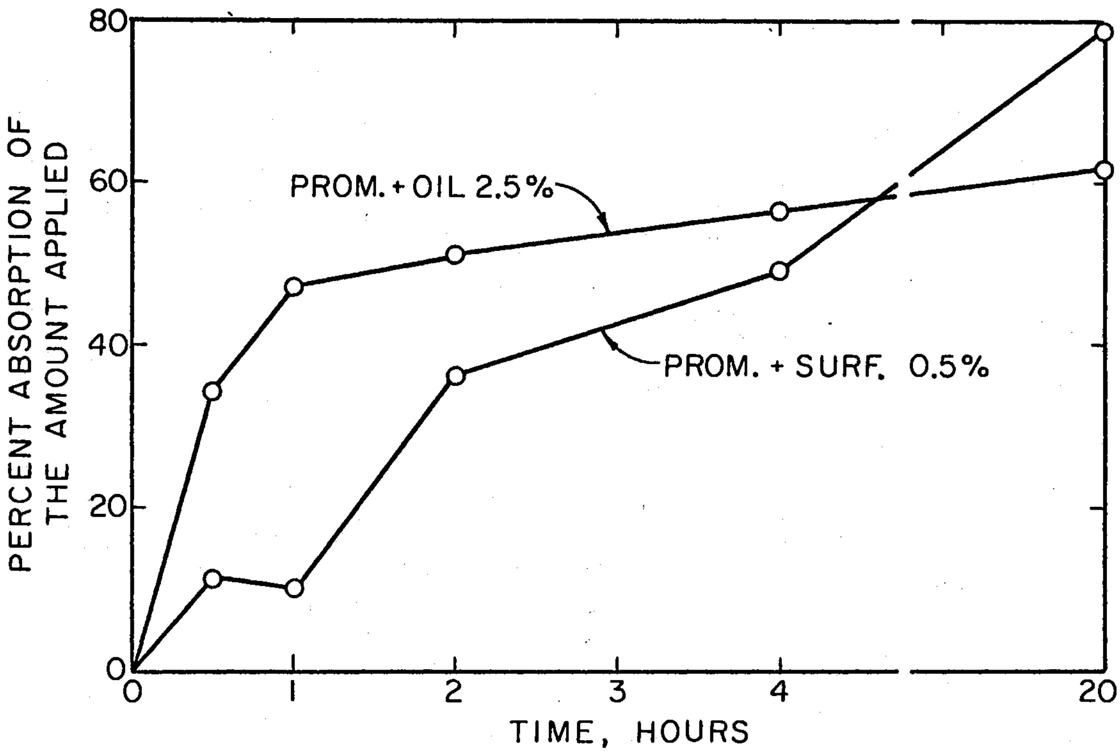

Figure 1. Prometryne absorption by soybean over various periods of time.

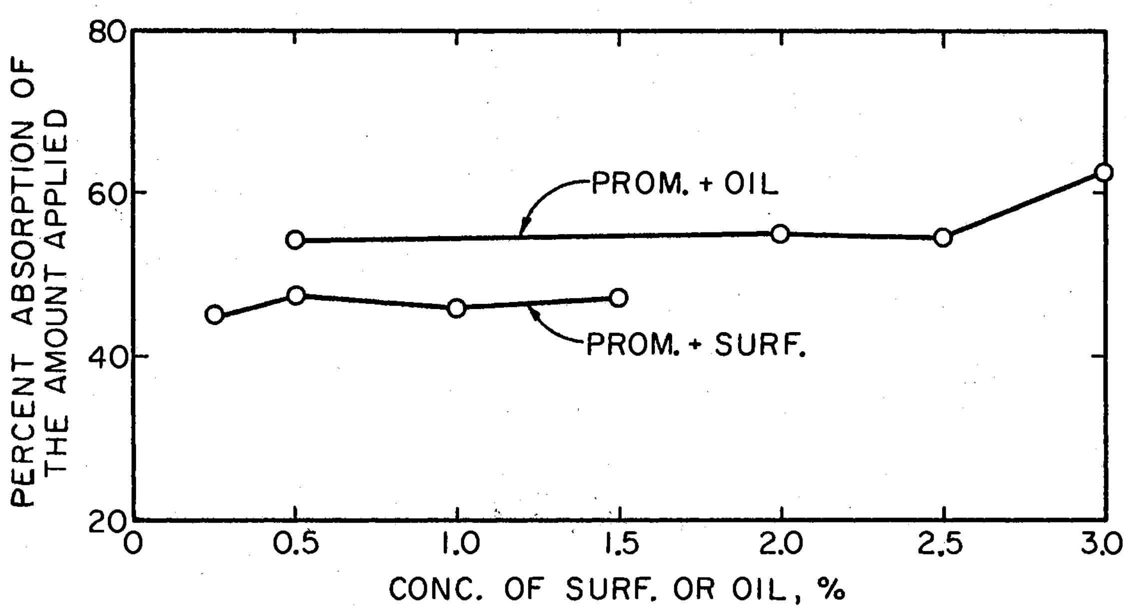

Figure 2. Prometryne absorption by soybean over various concentrations of surfactant and oil at 4 hours after treatment.

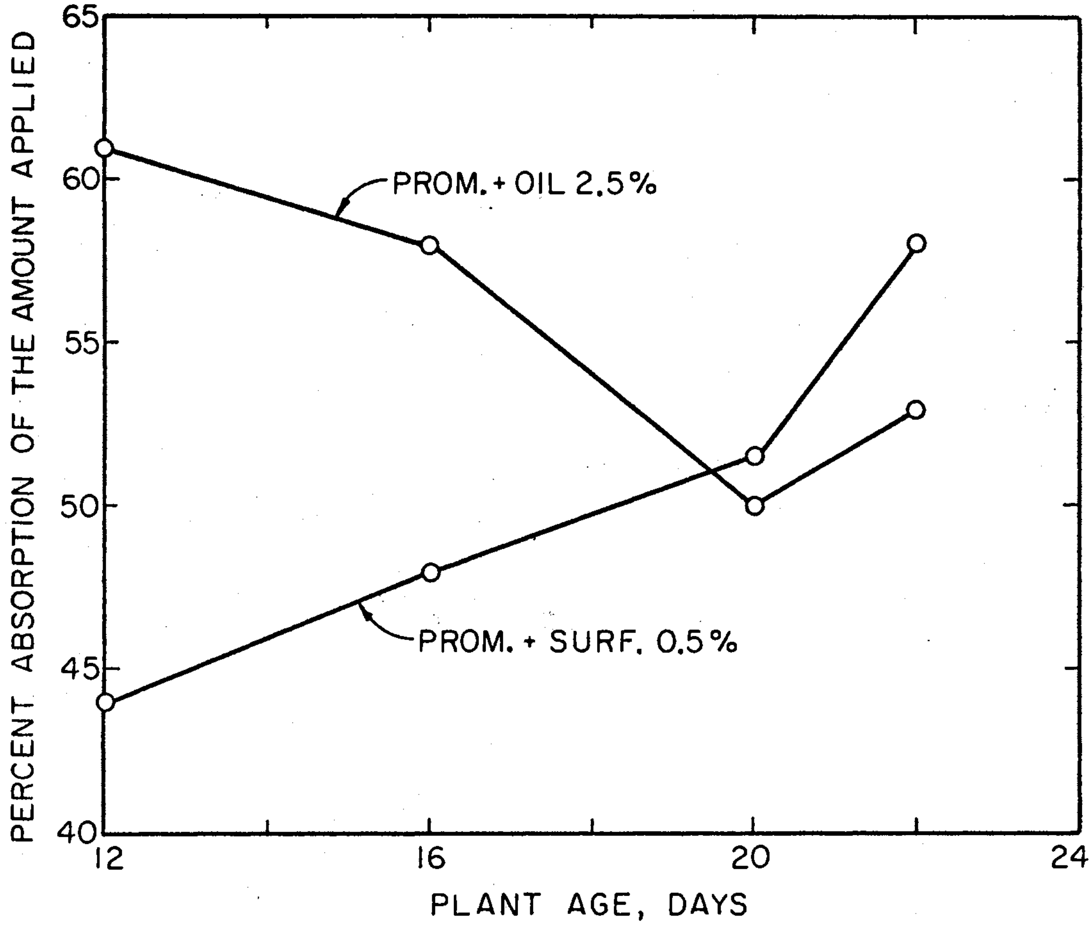

Figure 3. Prometryne absorption at 4 hours after treatment by soybean over various plant ages.

surface tension and therefore, did not spread on the leaf surface. This drop probably was too large to enter through tiny cracks on the leaf surface.

There were differences in absorption due to species variation (Table I). Soybeans absorbed the greatest amount of prometryne followed by peanuts and cotton, when plants were treated with prometryne plus surfactant; whereas in the case of plants treated with prometryne plus oil, the peanuts absorbed more prometryne than cotton or soybean. Here again the interaction between adjuvant treatments and crop species were highly significant. Cotton always absorbed the least prometryne and is also considered the least susceptible. These differences in absorption by various crop species is in accordance with what was expected because of species difference with respect to several characteristics like amount of cuticle, leaf orientation, number of stomata. Similar type of differential absorption by various species was reported by Davis et al. (11). Differences in absorption by various weed species were also highly significant (Table II). Jimsonweed absorbed the greater percentage of prometryne, followed by sunflower and morning-glory, regardless of adjuvant type used.

Soybean absorbed more prometryne than cotton under all four temperature regimes (Figure 4). The differences in absorption due to various temperatures were also highly significant. Both the species responded in a similar manner as the temperature was increased from a 70°F day temperature to 100°F day temperature. Both species absorbed the greatest amount of prometryne at the 70°F day temperature followed by the 100°F of the various temperature regimes studied. These temperature results are contrary to the report by Pallas (26) for the absorp-

TABLE I

PROMETRYNE ABSORPTION BY CROP SPECIES

Treatments	Crop Species	Averages Assumed DPM in Plant	Average % Absorption[1]
Prometryne + Surfactant (X-77, 1/2%)	Soybean	3281	49.0 b
	Cotton	1536	23.0 c
	Peanuts	3152	47.1 b
Prometryne + oil (Sun 11 E, 2.5%)	Soybean	883	49.1 b
	Cotton	979	54.0 b
	Peanuts	1298	72.2 a

Analysis of Variance			
Sources of Variation	df.	M.S.	Cal.F[2]
Totals	69	0.0280	--
Adjuvants	1	0.6343	71.3**
Crop Species	2	0.2689	30.2**
Adju. X Crop. Spp.	2	0.1619	18.2**
Plants (Adju. X Spp.)	29	0.0089	--
Leaves in Plants (Adju. X Spp.)	35	0.0063	--

[1]Means marked with the same letter are not significantly different at 5% level.

[2]F values with ** are significant at 1% level.

TABLE II

PROMETRYNE ABSORPTION BY WEED SPECIES

Treatments	Weed Species	Average Assumed DPM in Plant	Average % Absorption[1]
Prometryne + Surfactant (X-77, 1/2%)	Jimsonweed	2218	33.2 b
	Morningglory	1008	15.1 b
	Sunflower	1606	24.1 e
Prometryne + oil (Sun 11 E, 2.5%)	Jimsonweed	944	52.6 a
	Morningglory	407	29.4 bc
	Sunflower	433	46.4 a

Analysis of Variance			
Sources of Variation	df.	M.S.	Cal.F[2]
Totals	71	0.0252	--
Adjuvants	1	0.6255	65.2**
Weed Species	2	0.2610	27.2**
Adju. X weed spp.	2	0.0099	1.0
Plants (Adju. X weed spp.)	30	0.0096	--
Leaves in Plant (Adju. X Weed spp.)	36	0.0094	--

[1]Means marked with the same letter are not significantly different at 5% level.

[2]F values with ** are significant at 1% level.

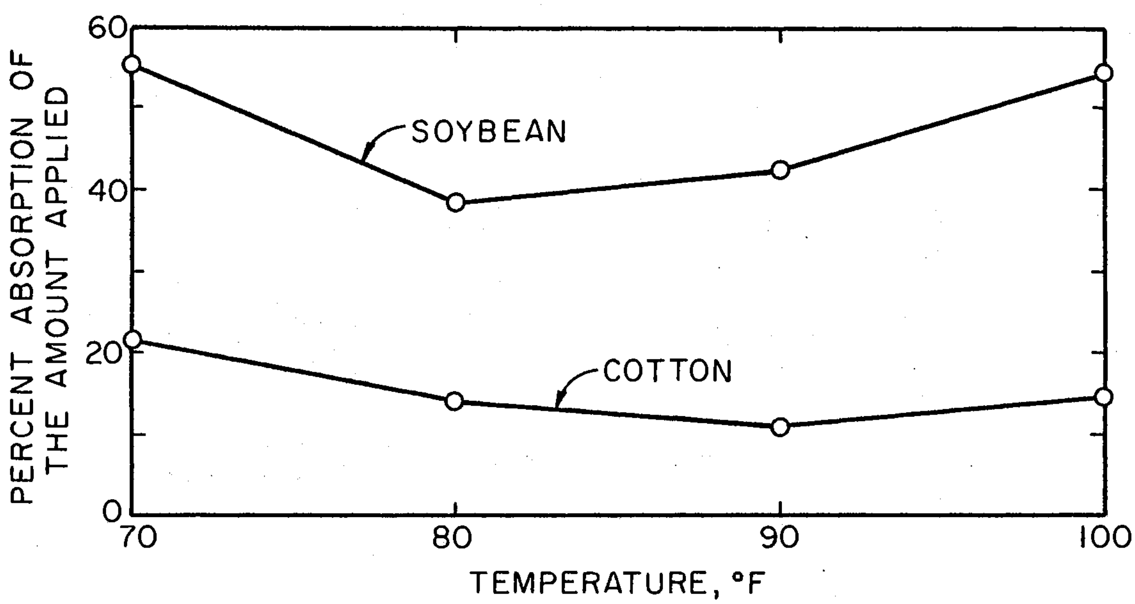

Figure 4. Prometryne absorption by soybean and cotton over various temperatures.

tion and translocation of 2,4-D and benzoic acid.

Differences in absorption of prometryne due to various moisture levels were highly significant with soybean, but not with cotton (Table III). Soybean absorbed the greatest amount of prometryne when watered on alternate days. Better absorption in plants watered on alternate days could be attributed to optimum aeration and moisture conditions for root development. Similar results were reported by Hull (20).

Differences in prometryne absorption within one species due to various fertility levels were not significant (Table IV), however, soybean plants absorbed the greatest amount of prometryne when grown in one-half strength Hoagland's solution. There was little difference with cotton.

Foliar Translocation

Soybean plants on the average showed a higher percentage of radioactivity applied in the treated leaves on a fresh weight basis than cotton. In soybeans the percentage radioactivity increased with fertility increases whereas in cotton the trend was different (Table V). The differences in radioactivity translocation to various plant parts were highly significant (Table VI). In both the species, most of the radioactivity applied was restricted to treated leaf (Figures 5 and 6). The other parts such as untreated leaves, upper and lower stem and roots, showed negligible amounts of radioactivity. The interaction between species and plant part was also significant. Very little amount of radioactivity was detected in the nutrient solution sampled at the end of 48 hours (Table XIV). Soybean plants showed

TABLE III

PROMETRYNE ABSORPTION BY SOYBEAN AND COTTON OVER VARIOUS MOISTURE LEVELS

Species	Moisture Levels	Average Assumed DPM in Plant	Average % Absorption[1]
Soybean	Watering daily	1801	69.5 b
	Watering alternate day	2031	78.5 a
	Watering fourth day	1838	70.7 b
Cotton	Watering daily	744	28.4 c
	Watering alternate day	832	32.2 c
	Watering fourth day	597	25.3 c

Analysis of Variance

Sources of Variation	df.	M.S.	Cal. F[2]
Totals	71	0.0552	---
Species	1	3.5244	518.2**
Moisture Levels	2	0.0377	5.5**
Spp. X Moisute Levels	2	0.0046	0.6
Plants (Spp. X Moisture Levels)	30	0.0068	---
Leaves in Plants (Spp. X Moisture Levels)	36	0.0030	---

[1]Means marked with the same letter are not significantly different at 5% level.

[2]F values with ** are significant at 1% level.

TABLE IV

PROMETRYNE ABSORPTION BY SOYBEAN AND COTTON OVER VARIOUS FERTILITY LEVELS

Species	Fertility Level	Average Assumed DPM in Plant	Average % Absorption
Soybean	1/16	3211	45.8
	1/8	3185	45.4
	1/2	3530	50.3
Cotton	1/16	2059	29.3
	1/8	1896	27.0
	1/2	1919	27.4

Analysis of Variance			
Sources of Variation	df.	M.S.	Cal.F[1]
Totals	71	0.0133	--
Species	1	0.6646	162.1**
Fertility level	2	0.0043	1.1
Spp. X Fert. Level	2	0.0066	1.6
Plants (Spp. X Fert.)	30	0.0041	--
Leaves in Plant (Spp. X Fert.)	36	0.0037	--

[1]F values with ** are significant at 1% level.

TABLE V

PROMETRYNE TRANSLOCATION IN SOYBEAN AND COTTON OVER VARIOUS FERTILITY LEVELS

Species	Fertility Level	Plant Part	% Average DPM	Average % DPM/gr. of Fresh Weight
Soybean	1/16	Treated leaf	59.87	1549.00
		Untreated leaves	0.55	0.21
		Upper stem	0.21	0.33
		Lower stem	0.06	0.15
		Roots	0.14	0.03
		% recovery	60.83	
	1/8	Treated leaf	60.53	4150.00
		Untreated leaves	1.19	0.30
		Upper stem	0.09	0.08
		Lower stem	0.38	0.74
		Roots	0.12	0.02
		% recovery	62.31	
	1/2	Treated leaf	63.68	6432.00
		Untreated leaves	0.83	0.36
		Upper stem	0.05	0.02
		Lower stem	0.10	0.11
		Roots	0.13	0.02
		% recovery	64.79	
Cotton	1/16	Treated leaf	57.02	134.00
		Untreated leaves	0.28	0.17
		Upper stem	0.07	10.65
		Lower stem	0.03	0.09
		Roots	0.09	0.08
		% recovery	57.49	
	1/8	Treated leaf	58.94	491.00
		Untreated leaves	0.73	0.25
		Upper stem	0.06	0.29
		Lower stem	0.04	0.08
		Roots	0.17	0.09
		% recovery	59.94	
	1/2	Treated leaf	49.92	41.00
		Untreated leaves	0.83	0.33
		Upper stem	0.04	0.09
		Lower stem	0.08	0.06
		Roots	0.09	0.03
		% recovery	50.96	

TABLE VI

ANALYSIS OF VARIANCE FOR PROMETRYNE TRANSLOCATION IN SOYBEAN AND COTTON OVER VARIOUS FERTILITY LEVELS

Sources of Variation	df.	M.S.	Cal F.[1]
Totals	164	3170.25	----
Species	1	2365.788	3.4
Fertility	2	414.260	0.6
Species X Fert.	2	308.760	0.5
Plants (Spp. X Fert.)	27	691.875	----
Plant Parts	4	3534.950	5.1**
Spp. X Plant Part	4	2368.600	3.4*
Fert. X Part	8	496.666	0.7
Spp. X Fert. X Parts	8	227.000	0.3
Parts in Plant (Spp. X Fert.)	108	695.593	----

[1]F values with * are significant only at the 5% level. F values with ** are significant at 1% level.

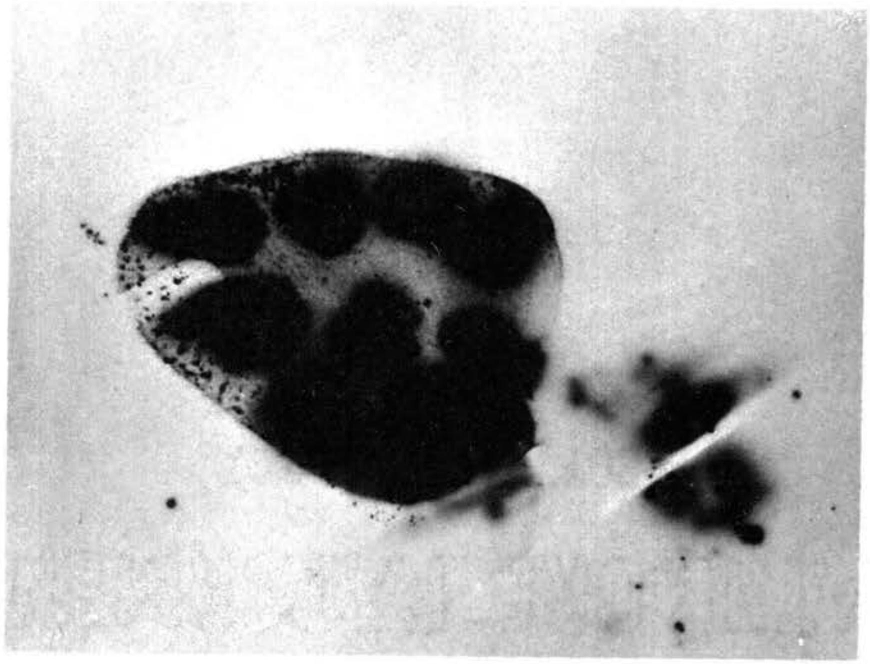

Figure 5. Autoradiogram of soybean leaf treated with ^{14}C-prometryne-water solution containing surfactant.

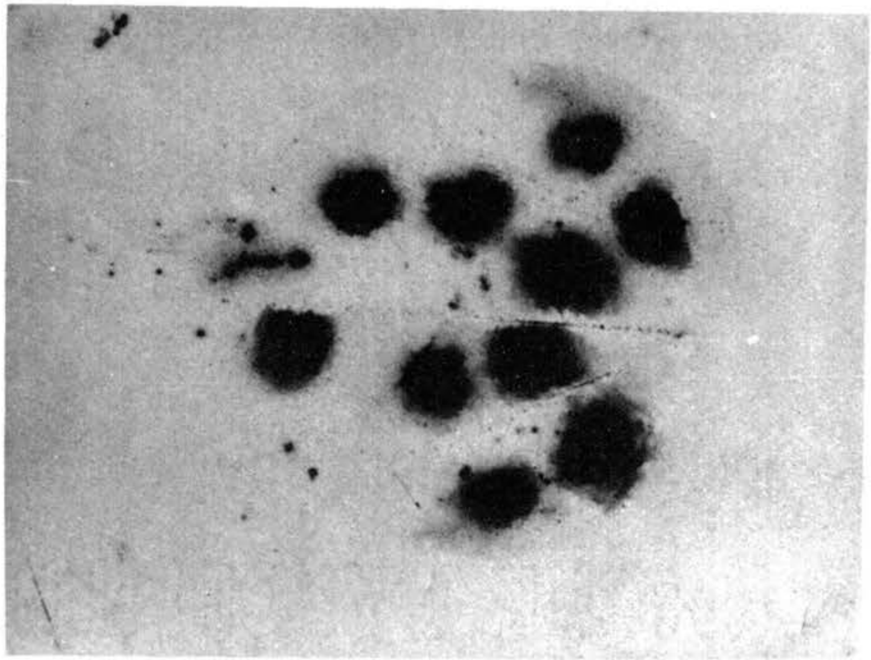

Figure 6. Autoradiogram of cotton leaf treated with ^{14}C-prometryne-water solution containing surfactant.

more radioactivity than cotton probably owing to the fact that it was susceptible to prometryne and did not tie up prometryne, whereas cotton was resistant and accumulates prometryne in lysigenous glands of the treated leaf. Secondly it may be due to less plant weight in soybeans than cotton. Increased percentages of radioactivity in treated leaves due to fertility levels in soybeans indicate that absorption processes or accumulation are snensitive to inorganic nutrient levels. There was a tendency for radioactivity to accumulate in upper stems of both cotton and soybean in plants at low fertility levels. This and the low level of uptake by low nutrient leaves, may indicate that living cells at low nutrient levels may have less affinity for radioactivity than cells with optimum nutrient levels. Most of the radioactivity applied was restricted to treated leaves in the area where the herbicide was applied (Fig. 5 and 6). There was very little apoplastic movement with the herbicide accumulating at the tip and margins of the leaves as is noted in some species. There appeared to be more spreading of the treated spots in soybean than cotton (Fig. 5 and 6).

Differences in translocation due to various moisture levels were significant (Tables VII and VIII). Plants receiving water on alternate day and watering every fourth day showed significantly higher amounts of radioactivity than those watered daily. The higher amounts of radioactivity in plants receiving watering alternate day and watering every fourth day could be attributed to better aeration and moisture necessary for plant growth and development because plants watered daily appeared sick and stunted. The differences in translocation due to plant parts were highly significant. Similar to the

TABLE VII

PROMETRYNE TRANSLOCATION IN SOYBEAN AND COTTON
OVER VARIOUS MOISTURE LEVELS

Species[1]	Moisture Levels	Plant Part	% Average DPM	Average % DPM/ gr.of Fresh Weight[2]
Soybeans	Watering daily	Treated leaf	89.22	809.47 a
		Untreated leaves	0.72	0.48 b
		Upper stem	0.16	0.17 b
		Lower stem	0.11	0.15 b
		Roots	0.04	0.01 c
		% recovery	90.25	
Cotton		Treated leaf	85.16	199.80 a
		Untreated leaves	0.51	0.39 b
		Upper stem	0.03	0.35 b
		Lower stem	0.06	0.09 c
		Roots	0.05	0.03 d
		% recovery	88.81	
	Average			0.63 b
Soybean	Watering alternate days	Treated leaf	80.52	709.25 a
		Untreated leaves	0.34	0.34 b
		Upper stem	0.12	0.22 bc
		Lower stem	0.05	0.12 c
		Roots	0.15	0.04 d
		% recovery	81.18	
Cotton		Treated leaf	73.99	254.04 a
		Untreated leaves	0.41	0.48 bc
		Upper stem	0.08	1.42 b
		Lower stem	0.19	0.40 c
		Roots	0.14	0.17 c
		% recovery	74.81	
	Average			1.12 a
Soybean	Watering fourth day	Treated leaf	80.06	1100.78 a
		Untreated leaves	0.31	0.56 b
		Upper stem	0.07	0.43 bc
		Lower stem	0.04	0.14 cd
		Roots	0.07	0.09 d
		% recovery	80.55	
Cotton		Treated leaf	80.68	337.83 a
		Untreated leaves	0.38	0.62 bc
		Upper stem	0.05	0.96 b
		Lower stem	0.12	0.21 c
		Roots	0.04	0.06 d
		% recovery	81.27	
	Average			1.24 a

TABLE VII (Continued)

[1]Comparisons were made among plant parts within a given species at a fixed moisture stress.

[2]Means marked with the same letter are not significantly different at the 5% level.

TABLE VIII

ANALYSIS OF VARIANCE FOR PROMETRYNE TRANSLOCATION IN SOYBEAN AND COTTON OVER VARIOUS MOISTURE LEVELS

Sources of Variation	df.	M.S.	Cal. F.[1]
Totals	119	2.1270	---
Species	1	0.2254	1.1
Moisture Levels	2	0.9855	4.9*
Spp. X Moisture Levels	2	0.4520	2.2
Plants (Spp. X Moisture Levels)	18	0.2017	---
Plant Part	4	58.1136	490.8**
Spp. X Plant Part	4	0.8663	7.3**
Moisture Levels & Plant Part	8	0.1639	1.4
Spp. X Moisture Levels X Plant Part	8	0.0780	0.7
Plant Part in Plant (Spp. X Moisture Levels)	72	0.1184	---

[1]F values with * are significant only at the 5% level. F values with ** are significant at 1% level.

fertility translocation study, the treated leaves showed significantly higher amounts of radioactivity than other plant parts. The other plant parts such as untreated leaves, upper and lower stem and root, showed very little radioactivity. The interaction between plant part and species was also highly significant.

Translocation of Stem-Injected Prometryne

The differences in translocation of stem-injected prometryne due to species were highly significant. Soybean as an average of plant parts showed the greatest amount of radioactivity after treatment followed by sunflower, jimsonweed and cucumber (Tables IX and X). In autoradiogrammed soybean plants, the radioactivity was uniformly distributed in the leaf but accumulated to a greater extent in old leaves. In sunflower it accumulated more extensively in leaf veins than the rest of the leaf area. In cucumber radioactivity tended to accumulate in older leaves with indications of movement towards leaf edges. In jimsonweed old leaves with indications of movement towards leaf edges. In jimsonweed old leaves showed more radioactivity than young large leaves and there was uniform distribution in each leaf. Difference in radioactivity as shown by scintillation counting translocation after stem injection due to plant part were highly significant. The treated stem sections showed the greatest amount of radioactivity regardless of species. The other plant parts such as upper and lower stem, leaves, and roots showed small amounts of radioactivity. The interaction between species and plant part was also highly significant. Soybean translocated more prometryne to lower stems than upper stems while the other species translocated similar amounts or more to upper stems. The

TABLE IX

PROMETRYNE TRANSLOCATION WHEN INJECTED IN STEM IN SOYBEAN, SUNFLOWER, CUCUMBER, AND JIMSONWEED

Species[1]	Plant Part	% Average SPM	Average % DPM/gr. of Fresh Weight[2]
Soybean	Treated stem	22.60	269.89 a
	Upper stem	1.05	2.06 d
	Lower stem	0.50	5.36 c
	Leaves	29.88	11.89 b
	Roots	0.24	0.12 e
	% recovery	54.27	
Average			5.28 a
Sunflower	Treated stem	24.35	82.57 a
	Upper stem	2.42	2.35 b
	Lower stem	0.70	1.81 b
	Leaves	7.17	0.94 c
	Roots	0.22	.04 d
	% recovery	34.86	
Average			1.66 b
Cucumber	Treated stem	2.51	5.67 a
	Upper stem	0.50	0.21 d
	Lower stem	0.64	0.89 b
	Leaves	7.50	0.45 c
	Roots	0.52	0.04 e
	% recovery	11.67	
Average			0.45 d
Jimsonweed	Treated stem	4.88	24.64 a
	Upper stem	0.57	0.56 b
	Lower stem	0.43	0.67 b
	Leaves	0.54	0.87 b
	Roots	0.45	0.09 c
	% recovery	6.87	
Average			0.94 c

[1]Comparison was made among plant parts of a given species.

[2]Means marked with the same letter are not significantly different at the 5% level.

TABLE X

ANALYSIS OF VARIANCE FOR PROMETRYNE TRANSLOCATION INJECTED IN STEM IN SOYBEAN, SUNFLOWER, CUCUMBER, AND JIMSONWEED

Sources of Variation	df.	M.S.	Cal.F[1]
Totals	139	1.0608	----
Species	3	7.1099	92.7**
Plants in Spp.	24	0.0767	----
Plant Part	4	28.2477	743.4**
Spp. X Plant Part	12	0.6370	16.8**
Parts in Plants (Spp.)	96	0.0380	----

[1]F values with ** are significant at 1% level.

amount of radioactivity found in nutrient solution was the greatest in cucumber followed by jimsonweed, soybean, and sunflower (Table XIV).

Soybeans showed a significantly higher total amount of radioactivity than jimsonweed at 2 days after treatment indicating a more rapid rate of loss from jimsonweed (Table XI). Plants grown under 70°F showed significantly higher amounts of radioactivity than those grown at 90°F regardless of species (Tables XI and XII). The interaction between species and temperature was also highly significant. The treated stem showed the greatest amount of radioactivity, however, the other plant parts such as upper and lower stem, leaves, and roots also showed some radioactivity. The interaction between species and plant part, temperature and plant part, and species and temperature and plant

TABLE XI

PROMETRYNE TRANSLOCATION WHEN INJECTED IN STEM IN SOYBEAN AND JIMSONWEED OVER VARIOUS TEMPERATURES

Species[1]	Temperature	Plant Part	% Average DPM	Average DPM/gr. of Fresh Weight[2]
Soybean	90°F and 77°F	Treated stem	24.98	177.34 a
		Upper stem	0.89	1.58 c
		Lower stem	0.24	1.77 c
		Leaves	30.75	9.66 b
		Roots	0.19	0.09 d
		% recovery	57.05	
	70°F and 60°F	Treated stem	7.30	2538.63 a
		Upper stem	0.44	12.84 c
		Lower stem	0.43	44.97 b
		Leaves	12.73	6.99 d
		Roots	0.30	0.05 e
		% recovery	21.20	
Jimsonweed	90°F and 77°F	Treated stem	39.54	66.37 a
		Upper stem	0.65	1.77 b
		Lower stem	0.47	2.19 b
		Leaves	18.95	1.33 b
		Roots	0.21	0.06 c
		% recovery	59.82	
	70°F and 60°F	Treated stem	28.11	167.57 a
		Upper stem	0.52	2.58 c
		Lower stem	4.16	1.94 c
		Leaves	21.69	5.32 b
		Roots	0.30	0.08 d
		% recovery	54.78	

[1]Comparisons were made among plant parts of a given species at a fixed temperature.

[2]Means marked with the same letter are not significantly different at the 5% level.

TABLE XII

ANALYSIS OF VARIANCE FOR PROMETRYNE TRANSLOCATION INJECTED IN STEM IN SOYBEAN AND JIMSONWEED OVER VARIOUS TEMPERATURES

Sources of Variation	df.	M.S.	Cal.F[1]
Totals	199	1.5609	---
Species	1	10.3314	65.1**
Temperature	1	9.3752	59.1**
Species X Temperature	1	1.6747	10.6**
Plant (Spp. X Temp.)	36	0.1586	---
Plant Part	4	64.6367	1144.0**
Spp. X Plant Part	4	0.9600	16.9**
Temp. X Plant Part	4	1.2355	21.9**
Spp. X Temp. X Plant Part	4	2.0133	35.6**
Plant Part in Plant (Spp. X Temp.)	144	0.0565	---

[1]F values with ** are significant at 1% level.

part were highly significant. Some radioactivity was detected in nutrient solutions after 48 hours.

An experiment was designed to determine the effects of leaf age on the accumulation of prometryne after stem injection. Jimsonweed and pigweed showed the greatest amount of radioactivity in treated stem sections at 24 hours after treatment followed by leaves, growing point, upper and lower stem and roots (Table XIII). Thus more radioactivity,

TABLE XIII

PROMETRYNE TRANSLOCATION WHEN INJECTED IN STEM IN JIMSONWEED AND PIGWEED

Species	Plant Part	% Average DPM	Average % DPM/gr. of Fresh Weight
Jimsonweed	Treated stem	8.63	75.91
	Upper stem	0.24	3.18
	Growing point	1.11	7.08
	Lower stem	0.27	1.73
	Root	0.21	0.39
	Leaf 1	3.09	22.28
	Leaf 2	8.44	18.97
	Leaf 3	10.55	17.19
	Leaf 4	6.62	19.16
	% recovery	39.16	
Pigweed	Treated stem	11.86	68.40
	Upper stem	0.94	2.32
	Growing point	2.28	9.43
	Lower stem	0.38	1.88
	Root	0.19	0.54
	Leaf 1	2.53	11.28
	Leaf 2	3.70	12.73
	Leaf 3	3.69	11.34
	Leaf 4	4.55	26.34
	Leaf 5	6.62	22.63
	Leaf 6	6.50	29.35
	Leaf 7	5.73	36.66
	% recovery	48.97	

moved in upward direction (acropetal) than in a downward direction (basipetal). In pigweed, young leaves showed more radioactivity than old leaves; whereas in jimsonweed, the trend was not the same. In jimsonweed the greatest amount of radioactivity was detected in nutrient solution when samples were taken after 16 hours; whereas in pigweed it was when sampled after 8 hours. High radioactivity in growing points, and young leaves indicate that it tends to move toward

TABLE XIV

AVERAGE DPM IN 400 ML OF NUTRIENT SOLUTION OF VARIOUS TRANSLOCATION EXPERIMENTS

Fertility Experiment		Stem Injection		Stem Injection			Stem Injection		
Fertility Level	Ave. DPM	Species	Ave. DPM	Species	Temp.	Ave. DPM	Species	Sampling After Hrs.	Ave. DPM
1/16	1851	Soybean	2424	Soybean	90°F & 70°F	2384	Jimson-weed	8	1856
1/8	1915	Sunflower	2392		70°F & 60°F	2032		16	2000
								24	1876
1/2	1815	Cucumber	3778	Jimson-weed	90°F & 77°F	2056	Pigweed (Smooth)	8	1949
		Jimsonweed	2889		70°F & 60°F	2656		16	1944
								24	1904

plant parts with high metabolic activity. This type of movement indicates symplastic movement. However, large amounts of radioactivity collected in leaves of all ages and this indicates that the movement may be strongly apoplastic in nature as has been shown for other triazine herbicides. The movement of prometryne label to young leaves of pigweed may indicate that prometryne is being metabolized to some compound which tends to show symplastic movement.

CHAPTER V

SUMMARY AND CONCLUSION

Various plant species were treated with radioactive prometryne under different conditions and the quantity of herbicide absorbed was measured. Soybean plants treated with prometryne solution containing oil absorbed more prometryne initially than plants treated with solutions containing surfactant where absorption was slow but continuous. The quantity of prometryne absorbed increased with increasing exposure periods at least up to 20 hours. The differences due to various concentrations of surfactant and oil were not significant. As plant age increased from 12 to 22 days, the plants treated with prometryne solutions containing surfactant absorbed increasing percentages of prometryne; whereas plants treated with prometryne solutions containing oil showed a slight decline in absorption.

Soybean plants absorbed more prometryne than did peanuts or cotton when treated with prometryne solutions containing surfactant; whereas if prometryne solutions containing oil were used, peanuts absorbed more prometryne than cotton or soybeans. Cotton always absorbed the least prometryne and was least susceptible to injury. Of the weed species used, jimsonweed absorbed the most prometryne, followed by sunflower and morningglory, regardless of adjuvant used.

Soybeans absorbed more prometryne than cotton under four different temperature regimes. Both species absorbed the greatest amount of prometryne for the 70°F day temperature followed by 100°F temperature regime. Differences in absorption of prometryne due to various moisture levels were significant with soybean, but not with cotton. Soybean absorbed the greatest amount of prometryne when watered on alternate days. Soybean absorbed the greatest amount of prometryne when grown in one-half strength Hoagland's solution in contrast to nutrient solutions which were suboptiomal in nutrient level. There was little difference for cotton.

In translocation experiments after foliar treatment, soybean plants showed higher percentages of radioactivity translocation than cotton. In soybeans the percentage of radioactivity increased with increased fertility levels; whereas in cotton the trend was different. In both these species most of the radioactivity applied stayed in the treated leaf. The other parts such as untreated leaves, upper and lower stem and roots contained only a little radioactivity. Only a small amount of radioactivity was detected in the nutrient solution sampled at the end of 48 hours. Cotton plants contained more radioactivity than soybeans when subjected to various moisture levels. Plants watered on alternate days or every fourth day showed significantly higher amounts of radioactivity than those watered daily.

In stem injection studies, soybean plants showed the greatest amount of radioactivity content followed by sunflower, jimsonweed, and cucumber. In autoradiogrammed soybean plants, the radioactivity was uniformly disturbed in the leaf but accumulated to a greater extent in old leaves. In sunflowers it accumulated more extensively in the leaf veins than the rest of the leaf area. In cucumber radioactivity tended to accumulate in older leaves with indications of movement towards leaf edges. In jimsonweed, the old leaves showed more radioactivity than young large leaves and there was uniform distribution in each leaf. The treated stem section showed the greatest amount of radioactivity regardless of species. The amount of radioactivity found in nutrient solution was greater where cucumbers were grown followed by jimsonweed, soybeans and sunflower.

Soybeans showed significantly higher amounts of radioactivity content than jimsonweed. Plants grown under 70°F showed significantly higher amounts of radioactivity than 90°F regardless of species. Some amount of radioactivity was also detected in nutrient solution taken after 48 hours of stem injection.

Jimsonweed and pigweed showed the greatest amount of radioactivity in treated stem section followed by leaves, growing point, upper and lower stem and roots. In jimsonweed the greatest amount of radioactivity was detected in nutrient solution when samples were taken after 16 hours; whereas in pigweed, it was when samples were taken after 8 hours.

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APPENDIXES

TABLE XV

PROMETRYNE ABSORPTION BY SOYBEANS OVER VARIOUS PERIODS OF TIME

Treatments	Absorption Periods In Hours	Average Assumed DPM in Plant	% Average Absorption[1]
Prometryne + Surfactant (X-77, 1/2%)	1/2	709	11.9 e
	1	621	10.2 e
	2	2176	36.6 d
	4	2965	49.9 c
	20	4663	78.5 a
Prometryne + Oil (Sun 11 E, 2.5%)	1/2	747	34.6 d
	1	1012	47.3 c
	2	1098	50.8 cb
	4	1221	56.5 cb
	20	1329	61.5 b

Analysis of Variance			
Sources of Variation	df.	M.S.	Cal.F[2]
Totals	93	0.0508	---
Adjuvant	1	0.4050	29.1**
Absorption Period	4	0.7107	51.1**
Adjuvant X Absorption Period	4	0.2019	14.5**
Plants (Adjuvant X Abs. Period)	38	0.0139	---
Leaves in Plant (Adjuv. X Abs. Period)	46	0.0084	---

[1]Means marked with same letter are not significantly different at 5% level.

[2]F values with ** are significant at 1% level.

TABLE XVI

PROMETRYNE ABSORPTION BY SOYBEAN OVER VARIOUS CONCENTRATIONS OF SURFACTANT AND OIL

Treatments	Cons. of Surfactant or Oil	Average Assumed DPM in Plant	Average % Absorption	Analysis of Variance			
				Sources of Variation	df.	M.S.	Cal.F[1]
Prometryne	0.25	1796	45.1	Totals	94	0.0087	---
+	0.50	2796	47.1	Adjuvant	1	0.2584	34.5**
Surfactant	1.00	2635	45.9	Levels	3	0.0133	1.8
(X-77)	1.50	2701	47.4	Adjuvant X Levels	3	0.0066	0.9
Prometryne	0.50	1247	54.7	Plants (Adjuvant X Level)	40	0.0075	---
+	2.00	804	55.0				
Oil (Sun 11	2.50	1150	54.7	Leaves in Plant (Adjuvants X Level)	47	0.0043	---
E)	3.00	1219	62.7				

[1]F values with ** are significant at 1% level.

TABLE XVII

PROMETRYNE ABSORPTION BY SOYBEAN OVER VARIOUS PLANT AGES

Treatments	Plant Age In Days	Average Assumed DPM in Plant	Average % Absorption	Analysis of Variance: Sources of Variation	df.	M.S.	Cal.F[1]
Prometryne	12	2948	43.8	Totals	92	0.0121	---
+	16	3178	48.2	Adjuvant	1	0.0568	4.9*
Surfactant	20	3545	52.5	Ages	3	0.0060	0.5
(X-77,1/2%)	22	3878	57.5	Adjuvants X Ages	3	0.0613	5.2**
Prometryne	12	1273	60.8	Plants (Adjuvant X Age)	40	0.0117	---
+	16	1225	57.5				
Oil (Sun 11E	20	1072	50.4	Leaves in Plant (Adjuvant X Ages)	45	0.0088	---
2.5%)	22	1125	52.8				

[1]F values with * are significant at 5% level only. F values with ** are significant at 1% level.

TABLE XVIII

PROMETRYNE ABSORPTION BY SOYBEAN AND COTTON GROWN AT VARIOUS TEMPERATURES

				Analysis of Variance			
Species	Temperature	Average Assumed DPM in Plant	Average % Absorption[1]	Sources of Variation	df.	M.S.	Cal. F[2]
Soybean	70°F and 60°F	1100	55.2 a	Totals	93	0.0359	---
	80°F and 70°F	769	38.7 b	Species	1	2.5002	297.6**
	90°F and 77°F	849	42.6 b	Temperatures	3	0.0857	10.2**
	100°F and 90°F	1090	54.7 a	Spp. X Temp.	3	0.0254	3.02**
				Plants (Spp. X Temp.)	40	0.0084	----
Cotton	70°F and 60°F	436	21.9 c	Leaves in Plants (Spp. X Temp.)	46	0.0051	----
	80°F and 70°F	288	14.1 cd				
	90°F and 77°F	218	10.9 d				
	100°F and 90°F	294	14.7 cd				

[1]Means marked with the same letter are not significantly different at 5% level.

[2]F values with ** are significant at 1% level.

2

VITA

Jai Nath Singh

Candidate for the Degree of

Doctor of Philosophy

Thesis: FOLIAR ABSORPTION AND TRANSLOCATION OF PROMETRYNE IN SOME PLANT SPECIES

Major Field: Crop Science

Biographical:

Personal Data: Born in Rajput family in Mahuar (Azamgarh), U.P., India, July 1, 1942, son of Sakal Deep and Maturna Singh.

Education: Graduated from Jiwan Ram Inter College, Mau, Azamgarh, U.P., India in June, 1955; received the Bachelor of Science degree from Government Agricultural College, Kanpur, U.P., with a major in Agriculture in June, 1959; received the Master of Science degree from Government Agricultural College, Kanpur, U.P., with a major in Agronomy in 1961; received the Master of Science degree from Auburn University, Auburn, Alabama with a major in Agronomy in June, 1967; graduate study toward doctoral degree at Oklahoma State University with a major in Crop Science, September, 1967 to May, 1971.

Experience: Lecturer in Agronomy at Government Agricultural College, Kanpur, U.P., India, July, 1961 to June, 1964. Part-time lab work from June, 1964 to June, 1967 at Auburn University; Graduate Research Assistant, Oklahoma State University, January, 1968, to May, 1971.

Member of: Weed Science Society of America. Member of the President's Honor Roll, 1969 at Oklahoma State University.