# WEEDS

JOURNAL OF THE WEED SOCIETY OF AMERICA

630

LIBRARY

FEB 7 1967

TEXAS A&M UNIVERSITY

## CONTENTS

Page

A Technique for Studying Weed Competition in Forage Legume Establishment. Marvin M. Schreiber ..... 1
Water Lettuce—Nature, Problem, and Control. Lyle W. Weldon and Robert D. Blackburn ..... 5
Effect of Moisture Stress on Absorption and Movement of Picloram and 2,4,5-T in Beans. M. G. Merkle and F. S. Davis ..... 10
Arsenic Translocation in Nutsedge Tuber Systems and its Effects on Tuber Viability. Ethan C. Holt, J. L. Faubion, W. W. Allen, and C. G. McBee ..... 13
Control of Johnsongrass in Corn. Raymond D. Hicks and O. Hale Fletchall ..... 16
Calculating Synergistic and Antagonistic Responses of Herbicide Combinations. S. R. Colby ..... 20
Seasonal Variation in Sprouting and Available Carbohydrate in Yellow Nutsedge Tubers. R. B. Taylorson ..... 22
Height Differential of Corn and Giant Foxtail in Relation to Postemergence Weed Control. Ellery L. Knake and Fred W. Slife ..... 24
Silver Dollar Fish for Biological Control of Submersed Aquatic Weeds. R. R. Yeo ..... 27
Influence of Simazine on Chloroplast Ribonucleic Acid, and Protein Metabolism. R. P. Singh and S. H. West ..... 31
Extraction and Determination of Atrazine from Soil. Marshal D. McGlamery, Fred W. Slife, and Harold Butler ..... 35
Vegetation Control Along Fence Lines with Maleic Hydrazide. L. E. Foote and B. F. Himmelman ..... 38
Dissipation of Diquat and Paraquat, and Effects on Aquatic Weeds and Fish. R. R. Yeo ..... 42
Influence of Environment on Shoot Growth and Total Carbohydrate Reserves of Saltcedar. Eugene E. Hughes ..... 46
Wheatgrass Establishment with Paraquat and Tillage on Downy Brome Ranges. Raymond A. Evans, Richard E. Eckert, Jr., and Burgess L. Kay ..... 50
Histological Abnormalities Induced by Picloram on Canada Thistle Roots. Lester B. Kreps and Harold P. Alley ..... 56
Evaluation of Herbicide-Impregnated Cloth. L. L. Danielson ..... 60
Chemical Control of Three Chihuahuan Desert Shrubs. Ervin M. Schmutz ..... 62
Interactions of Several Paraquat-Surfactant Mixtures. L. W. Smith and C. L. Foy 67
Toxicity of DSMA Soil Residues to Cotton and Rotational Crops. E. E. Schweizer 72
Arsenic Residue Studies on Coastal Bermudagrass. G. G. McBee, P. R. Johnson, and E. C. Holt ..... 77

Brief Papers:

Toxicity of Root Residues of Weed Grass Species. Marvin M. Schreiber and J. L. Williams, Jr. ..... 80
Response of Bentgrass to Siduron. Walter E. Splittstoesser and Herbert J. Hopen 82
The Influence of DMPA on Peanut Yields. Ellis W. Hauser ..... 84
A Search for Atrazine Resistance in Flax (*Linum usitatissimum* L.). Robert N. Andersen and Richard Behrens ..... 85
Herbicidal Enhancement by Certain New Biodegradable Surfactants. L. W. Smith, C. L. Foy, and D. E. Bayer ..... 87
A Laboratory Sprayer for Potted Plants. L. F. Bouse and R. W. Bovey ..... 89
WSA Placement Service ..... 92
Sustaining Members ..... 93

VOLUME 15

JANUARY 1967

NUMBER 1

SYNGENTA EXHIBIT 1012
Syngenta v. UPL, PGR2023-00017

# WEEDS

*Issued Quarterly by the Weed Society of America*

EARL G. RODGERS, *Editor,* Department of Agronomy, University of Florida, Gainesville, Florida 32601

FRED W. SLIFE, *Treasurer-Business Manager,* Department of Agronomy, University of Illinois, Urbana, Illinois 61801

EDITORIAL COMMITTEE

W. R. BYRNES, Department of Forestry and Conservation, Purdue University, Lafayette, Indiana 47907

D. E. DAVIS, Department of Botany and Plant Pathology, Auburn University, Auburn, Alabama 36830

L. A. DERSCHEID, Department of Agronomy, South Dakota State University, Brookings, South Dakota 57007

C. L. FOY, Department of Plant Pathology and Physiology, Virginia Polytechnic Institute, Blacksburg, Virginia 24061

K. C. HAMILTON, Department of Agronomy, University of Arizona, Tucson, Arizona 85721

J. B. HANSON, Department of Agronomy, University of Illinois, Urbana, Illinois 61801

J. L. HILTON, Crops Research Division, ARS, USDA, Beltsville, Maryland 20705

R. D. ILNICKI, Department of Soils and Crops, Rutgers University, New Brunswick, New Jersey 08903

R. E. NYLUND, Department of Horticulture, University of Minnesota, St. Paul, Minnesota 55101

R. A. PETERS, Department of Plant Science, University of Connecticut, Storrs, Connecticut 06268

R. P. UPCHURCH, Monsanto Company V Building, 800 N. Lindbergh Blvd., St. Louis, Missouri 63166

A. D. WORSHAM, Department of Crop Science, North Carolina State University, Raleigh, North Carolina 27607

WEEDS is a quarterly journal published by the Weed Society of America. The subscription price is $12.00 yearly for four issues; single copies $3.00.

Address all communications regarding subscriptions and reprints to F. W. Slife, Department of Agronomy, University of Illinois, Urbana, Illinois. All checks, money orders, and other remittances should be made payable to the Weed Society of America.

The editorial office is located at Department of Agronomy, University of Florida, Gainesville, Florida 32603. Inquiries concerning manuscripts and other materials for publication should be addressed to the editorial office.

Printing is by the W. F. Humphrey Press, Inc., Geneva, New York.

To join the Weed Society of America, send remittance of $10.00, payable to the Weed Society of America, to Dr. F. W. Slife, Department of Agronomy, University of Illinois, Urbana, Illinois. Give name, official position (if any), and complete address. Dues are for the calendar year only.

The Conference Members of the Weed Society of America (WSA) and the abbreviations by which they may be designated in its publications, are the following:

| | |
|---|---|
| Western Weed Control Conference | WWCC |
| North Central Weed Control Conference | NCWCC |
| Northeastern Weed Control Conference | NEWCC |
| Southern Weed Conference | SWC |
| National Weed Committee of Canada | —— |

Entered as second-class matter at the post office at Urbana, Illinois, with additional entry at Geneva, New York.

This material may be protected by Copyright law (Title 17 U.S. Code)



2. Frans, R. E. 1961. Preplanting herbicides for controlling Johnsongrass in field crops. Proc. SWC 14:37–43.
3. Freeman, J. F. and T. W. Waldrep. 1963. Combination treatments of dalapon grass killer preplow and EPTC preemergence for control of Johnsongrass in corn. Down to Earth 18(4):20–23. 1963.
4. Hauser, Ellis W., J. T. Thompson, and S. V. Stacy. 1955. The effect of chemicals on the control of Johnsongrass and nutgrass with and without disking. Proc. SWC 8:399–404.
5. Pammel, J. H. and C. M. King. 1919. Johnsongrass as a weed in Southwestern Iowa. Iowa Agr. Expt. Sta. Cir. 25. 4 p.
6. Rea, H. E. 1955. The effectiveness of dalapon in controlling Johnsongrass. Proc. SWC 8:394–396.
7. Ryder, Gordon J. and C. J. Willard. 1956. You can control Johnsongrass. Ohio Agr. Ext. Serv. Bull. 342.
8. Watson, A. J. 1954. Field performance of dalapon, a new grass controlling herbicide. Proc. SWC 7:200–204.

# Calculating Synergistic and Antagonistic Responses of Herbicide Combinations[1]

S. R. Colby[2]

**Abstract.** The responses of herbicides applied singly are used in calculating the "expected" response when they are combined. The expected response for a combination is obtained by taking the product of the percent-of-control values for herbicides applied alone and dividing by $(100)^{n-1}$ where n is the number of herbicides in the combination.

In spite of the tremendous increase in testing of herbicide combinations, the words "synergistic" and "antagonistic" have been largely avoided in publication of results. Uncertainty in determining "expected" responses for herbicide combinations may be partially responsible for the failure of workers to report synergism and antagonism. Another difficulty frequently encountered is that the herbicides used in combination are not applied singly in the same study. When herbicides have not been applied singly, there is no basis for predicting the response when they are applied in combination.

Several mathematical methods are available for testing the additivity of herbicide combinations (3, 6). This paper presents a method which facilitates calculating "expected" responses of herbicide combinations. The "expected" response for a given combination of two herbicides can be calculated as follows (3, 5):

If X = the percent inhibition of growth by herbicide A at p lb/A
and Y = the percent inhibition of growth by herbicide B at q lb/A
and E = the expected percent inhibition of growth by herbicides A + B at p + q lb/A
then, according to Gowing (3):

$$E = X + \frac{Y\,(100-X)}{100} \qquad (I)$$

Algebraic manipulation of terms in equation I yields equation II, the form used by Limpel *et al.* (5):

$$E = X + Y - \frac{XY}{100} \qquad (II)$$

When the observed response is greater than expected, the combination is synergistic; when less than expected, it is antagonistic. If the observed and expected responses are equal, the combination is additive.

In the use of equation II, original units of data, such as weed counts or fresh or dry weights of plants, are converted to "percent inhibition" values. Once this is done, it is necessary to perform one addition, a subtraction, a multiplication, and one division to obtain each expected response (equation II).

If instead, we convert the original data to "percent-of-control" values, the number of arithmetic operations required to obtain "E" is reduced.

Let $X_1$ = growth as a percent-of-control with herbicide A at p lb/A
and $Y_1$ = growth as a percent-of-control with herbicide B at q lb/A
and $E_1$ = expected growth as a percent-of-control with herbicides A + B at p + q lb/A
then $E_1 = 100 - E$
$X_1 = 100 - X$
$Y_1 = 100 - Y$

hence $E_1 = 100 - (X + Y - \frac{XY}{100})$

and $E_1 = 100 - ((100-X_1) + (100 - Y_1) - \frac{(100 - X_1)\,(100 - Y_1))}{100}$

finally $E_1 = \frac{X_1\,V_1}{100}$ (III)

The use of formula III as compared with formula II eliminates the addition and subtraction, thus reducing the number of operations required to obtain an "expected" response.

Colby (2) extended formula I to apply to three-way combinations.

Thus, if Z = the percent inhibition of growth by herbicide C at r lb/A

then $E = X + Y + Z - \frac{(XY + XZ + YZ)}{100} + \frac{XYZ}{10{,}000}$ (IV)

[1]Received for publication April 11, 1966. Contribution No. 3796 and Scientific Article No. A 1271 of the Maryland Agricultural Experiment Station, Department of Agronomy, University of Maryland, College Park.

[2]Assistant Professor, Agronomy Department, University of Maryland, College Park.

Now if $Z_1$ = growth as a percent-of-control with herbicide C at r lb/A

$$\text{then } E_1 = \frac{X_1 Y_1 Z_1}{10{,}000} \qquad (V)$$

Obviously, the use of formula V instead of IV reduces the number of arithmetic operations required to obtain the expected response since the subtractions and additions are eliminated. In general, the expected response for any combination of herbicides may be obtained by taking the product of the percent-of-control values for herbicides applied alone and dividing by $(100)^{n-1}$ where n is the number of herbicides in the combination. Each herbicide must be applied singly at the same rate as used in combination.

Data published by Jagschitz and Skogley (4) are used to illustrate the calculation of expected responses for herbicide combinations. Four herbicides were applied singly and in certain combinations for the control of several weeds in turfgrass. The data as originally presented have been converted to percent-of-control values and are shown in Tables 1 and 2. Expected values for the combinations are shown in

*Table 1.* Dandelion control in fairway turf treated with various herbicides October 8, 1964.[a]

| Herbicide | lb/A | Dandelion response, %-of-control, 10-7-65[b] | | |
|---|---|---|---|---|
| dicamba | 0.125 | 55 | | |
| | 0.25 | 25 | | |
| | 0.5 | 43 | | |
| mecoprop | 0.5 | 97 | | |
| | 1.0 | 81 | | |
| | 1.5 | 79 | | |
| 2,4-D | 0.5 | 63 | | |
| | 1.0 | 54 | | |
| | 1.5 | 44 | | |
| picloram | 0.0625 | 40 | | |
| | 0.25 | 10 | | |
| dicamba + mecoprop | 0.125 + .5 | 51 | (53) | + 2 |
| | 0.125 + 1.0 | 33 | (45) | +12 |
| dicamba + 2,4-D | 0.125 + 0.5 | 51 | (35) | −16 |
| | 0.125 + 1.0 | 64 | (30) | −34 |
| | 0.25 + 1.0 | 58 | (14) | −44 |
| | 0.5 + 1.0 | 46 | (23) | −23 |
| mecoprop + 2,4-D | 0.5 + 0.5 | 56 | (61) | + 5 |
| | 0.5 + 1.0 | 47 | (52) | + 5 |
| | 1.0 + 0.5 | 43 | (51) | + 8 |
| | 1.0 + 1.0 | 57 | (44) | −13 |
| | 1.5 + 1.0 | 76 | (43) | −33 |
| dicamba + mecoprop + 2,4-D | 0.125 + 0.5 + 0.5 | 63 | (34) | −29 |
| | 0.125 + 1.0 + 0.5 | 31 | (28) | − 3 |
| | 0.125 + 0.5 + 1.0 | 52 | (29) | −23 |
| | 0.125 + 1.0 + 1.0 | 54 | (24) | −30 |
| dicamba + mecoprop + 2,4-D + picloram | 0.125 + 0.5 + 0.5 + 0.0625 | 77 | (13) | −64 |

[a]Adapted from the data of Jagschitz and Skogley (4).
[b]Expected responses for combinations are shown in parentheses following each observed response. The differences between observed and expected values also are shown by a plus sign to indicate synergism and a minus, antagonism.

parentheses following each observed value. To the right of each expected value, the difference between observed and expected values is shown. A positive value is indicative of a synergistic response while a negative value is indicative of an antagonistic response. If the observed and expected values had been computed individually for each replication, then a chi-square test could have been used to determine the statistical significance of the differences between observed and expected values. Even without the chi-square test, several conclusions seem probable from the data in Tables 1 and 2. First, the combinations appear antagonistic on dandelion. Furthermore, the antagonism seems to be greater with increasing combined rates, especially when the herbicides were applied in 1964. Possibly this antagonism is caused by greater contact injury or more plant tops being killed at higher rates resulting in less translocation of herbicide into the dandelion roots. It also appears from Table 2 that different weeds respond differently to the same

*Table 2.* Chickweed and dandelion control in fairway turf treated with various herbicides May 25, 1965.[a]

| Herbicide | lb/A | Chickweed response, %-of-control, 10-19-65[b] | | | Dandelion response, %-of-control, 10-19-65[b] | | |
|---|---|---|---|---|---|---|---|
| dicamba | 0.125 | 40 | | | 66 | | |
| | 0.25 | 1 | | | 53 | | |
| | 0.5 | 0 | | | 49 | | |
| Mecoprop | 0.5 | 16 | | | 87 | | |
| | 1.0 | 0 | | | 62 | | |
| | 1.5 | 0 | | | 72 | | |
| 2,4-D | 0.5 | 51 | | | 75 | | |
| | 1.0 | 32 | | | 64 | | |
| | 1.5 | 71 | | | 36 | | |
| dicamba + mecoprop | 0.125 + .5 | 1 | (6) | + 5 | 70 | (57) | −13 |
| | 0.125 + 1.0 | 0 | (0) | | 28 | (41) | +13 |
| dicamba + 2,4-D | 0.125 + .5 | 9 | (20) | +11 | 67 | (50) | −17 |
| | 0.125 + 1.0 | 3 | (13) | +10 | 21 | (42) | +21 |
| | 0.25 + 1.0 | 0 | (3) | + 3 | 41 | (34) | − 7 |
| | 0.5 + 1.0 | 0 | (0) | | 53 | (31) | −22 |
| mecoprop + 2,4-D | 0.5 + .5 | 1 | (8) | + 7 | 77 | (65) | −12 |
| | 0.5 + 1.0 | 1 | (5) | + 4 | 68 | (56) | −12 |
| | 1.0 + 0.5 | 1 | (0) | − 1 | 70 | (47) | −23 |
| | 1.0 + 1.0 | 1 | (0) | − 1 | 55 | (40) | −15 |
| | 1.5 + 1.0 | 1 | (0) | − 1 | 69 | (46) | −23 |
| dicamba + mecoprop + 2,4-D | 0.125 + 0.5 + 0.5 | 1 | (3) | + 2 | 57 | (43) | −14 |
| | 0.125 + 1.0 + 0.5 | 0 | (0) | | 64 | (31) | −33 |
| | 0.125 + 0.5 + 1.0 | 0 | (2) | + 2 | 54 | (37) | −17 |
| | 0.125 + 1.0 + 1.0 | 0 | (0) | | 29 | (26) | − 3 |

[a]Adapted from the data of Jagschitz and Skogley (4).
[b]Expected responses for combinations are shown in parentheses following each observed response. The differences between observed and expected values also are shown by a plus sign to indicate synergism and a minus, antagonism.

combination. Thus, combinations which were about additive or possibly synergistic on chickweed were antagonistic, in general, on dandelion.

The calculations involved in determining the expected response of one three-way combination from Table 1 illustrate the efficiency of formula V compared to formula IV. For example, using dicamba at 0.125 lb/A in combination with mecoprop at 0.5 lb/A and 2,4-D at 0.5 lb/A the expected response is calculated as follows using formula IV and the data in terms of percent weed control as originally reported by Jagschitz *et al.* (4).

$$E = 45 + 3 + 37 - \frac{(45(3) + 45(37) + 3(37))}{100} + \frac{(45)\,(3)\,(37)}{10{,}000}$$

$$= 85 - \frac{(135 + 1665 + 111)}{100} + \frac{4995}{10{,}000}$$

$$= 85 - 19.11 + 0.50$$

$$= 66.39\% \text{ weed control expected}$$

Using formula V and percent-of-control values, the computation is

$$E_1 = \frac{(55)\ (97)\ (63)}{10{,}000}$$

$$= 33.61 \text{ percent-of-control}$$

and 33.61%-of-control is equal to 66.39% weed control.

Obviously, there are practical limitations in using mathematical formulas in predicting the responses for herbicide combinations. The methods described here are approximations, but they represent an improvement over no attempt to predict responses. The computations described should most effectively be applied to populations of single species although this would not seem to be an absolute requirement. Furthermore, the formulas are most accurate when values of X, Y, and Z are near the 50% level since the dose-response curves deviate least from linearity at the 50% level.

### Literature Cited


1. Colby, S. R. and G. F. Warren. 1963. Herbicides: combination enhances selectivity. Science 141:3578.
2. Colby, S. R. 1965. Greenhouse evaluation of herbicide combinations. Proc. NEWCC 19:312–320.
3. Gowing, D. P. 1960. Comments on tests of herbicide mixtures. Weeds 8:379–391.
4. Jagschitz, J. A. and C. R. Skogley. 1966. Dicamba, mecoprop and 2,4-D combinations for the control of clover, chickweed and dandelion in turfgrass. Proc. NEWCC 20:496–501.
5. Limpel, L. E., P. H. Schuldt, and D. Lamont. 1962. Weed control by dimethyl tetrachloroterephthalate alone and in certain combinations. Proc. NEWCC 16:48–53.
6. Tammes, P. M. L. 1964. Isoboles, a graphic representation of synergism in pesticides. Neth. J. Plant. Path. 70:73–80.


# Seasonal Variation in Sprouting and Available Carbohydrate in Yellow Nutsedge Tubers[1]

R. B. Taylorson[2]

**Abstract.** Two morphological types of tubers of yellow nutsedge (*Cyperus esculentus* L.) were collected over a 2-year period and were sprouted in the laboratory. Tuber dormancy occurred during late summer and early fall. Sprouting was highest during the winter and spring. Mechanical disturbance of the nutsedge stand increased tuber sprouting. Available carbohydrates followed a pattern similar to sprouting; minimum levels were found during late summer. The two types of tubers appeared to be similar in respect to the characteristics studied.

### Introduction

Dormancy commonly occurs in various organs and at different seasons of the year among species of higher plants (7). Generally, little is known of dormancy in subterranean organs of weeds, including tubers of yellow nutsedge (*Cyperus esculentus* L.). Tumbleson and Kommedahl (6) indicated that tubers were dormant when dug in September but would germinate in June. Breaking of tuber dormancy was thought to be associated with low temperature and leachable inhibitors. Other research has dealt mainly with methods of breaking dormancy of tubers by chemical techniques (2). Control of yellow nutsedge with postemergence herbicides is partially dependent on tuber dormancy, since emergence of shoots must be optimum when the herbicides are applied for maximum effects.

Another factor often related to effectiveness of herbicides in the control of perennial weed species is the level of reserve carbohydrates. However, studies attempting to relate carbohydrate levels with herbicide susceptibility have not been clearly successful (4, 5).

In these studies, I have attempted to characterize tuber dormancy and carbohydrate content and their possible relation to herbicide utilization.

### Methods and Materials

A dense stand of yellow nutsedge growing in a field of Tifton loamy sand was the source of plant material. Samples were collected at monthly intervals from July, 1962, to June, 1964. During July, 1962 to June, 1963, samples were randomly collected over the infested area. The stand was not disturbed mechanically except for an early spring plowing and harrowing. During the months of July to November, 1963, the area was subdivided into 25 by 50 ft plots. Three twice-replicated treatments were imposed. One treatment was a continuation of the mechanically undisturbed stand mentioned above. Other treatments were (a) mowing approximately 2 weeks prior to the next sampling date and (b) disk-harrowing approximately 2 weeks prior to the next sampling date. At the conclusion of this sampling period, further collections were made only from the mechanically undisturbed plots.

At each sampling date, duplicate lots of approximately 500 tubers were recovered by working the soil through a coarse screen. On several occasions during 1963, unwashed tubers were recovered from mechanically undisturbed plot samples by searching the soil samples and brushing off most of the adhering soil from the tubers.

Except for the unwashed lots, the tubers were subjectively graded into four types according to external color and morphology, and then counted. Type A tubers were black-skinned, shriveled, and usually dead; type B were black but turgid; type C were brown and turgid;

[1]Received for publication February 24, 1966. Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Coastal Plain Experiment Station, Tifton, Georgia.

[2]Plant Physiologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Tifton, Georgia. Present address is Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.