It appears that these species probably had a common ancestor and chromosomes differ in regard to gene arrangement and mutations. Pairing of chromosomes unequal in length in these species crosses has been observed (10). Such pairings, if between non-homologs, can give rise to chromosomes with different morphology. Emsweller and Jones (4) also reported the presence of morphologically different chromosomes in the mitosis of microspores of the species cross *A. cepa* × *A. fistulosum*. These chromosomes presumably arose from crossing over between the 2 parental genomes. Differences in chromosomes of a genome could arise by inversion, translocation, or crossing over in unequal chromosomes. It appears that inversions and pairings of unequal chromosomes have played an important role in the evolution of the species studied, and that speciation has proceeded on the background of an established chromosome number and slight changes in morphology. Differences in the karyotype of *A. cepa* have been pointed out by Battaglia (1), Bozzini (2), and Emsweller and Jones (3), in studies of various varieties. This further supports the observation that even in single species there are slight differences in the chromosomes, and that their morphology may change while the chromosome number remains the same.

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Differential Tolerance of Several Inbreds of Onion *Allium cepa* L. to Certain Herbicides[1]

L. K. Hiller[2] and J. L. Weigle, *Iowa State University, Ames*

Abstract. Considerable differences exist in the tolerances of onion inbreds to CIPC. Inbreds derived from 'Iowa Yellow Globe' were the most tolerant among the inbreds evaluated. Seedlings grown in the laboratory on agar containing the herbicide responded similarly to treated plants in field plots. The laboratory technique provides a fast, efficient method of screening large numbers of inbreds under controlled conditions.

Chemical weed control is often unreliable in onion production. Preemergence herbicides, such as isopropyl N (3-chlorophenyl) carbamate (CIPC), have shown toxicity to the onion crop and occasionally have caused extensive damage (5, 7, 9). Other investigations have shown no injury from use of CIPC (8, 11, 12).

The objective of most onion-herbicide research is to develop new chemicals that control weeds and show minimum crop toxicity. Another approach would be to select onion lines that have higher tolerance to present herbicides. Genetic differences in response to certain herbicides have been reported in several other crops (3, 10, 14, 16). Differential response by onion varieties to herbicides has been reported. A post-emergence treatment of CIPC did not appear to damage plants of 'Brigham Yellow Globe,' but did reduce yields in 'Sweet Spanish' (1). Differences in varietal resistance may be important with nonselective herbicides (13). In transplanted onions, the variety 'Sweet Spanish' was considerably more tolerant to several herbicides than was 'Early Harvest' (4).

Numerous laboratory techniques have been reported for studying the growth-regulating properties of chemicals, but not for the selection of plant material tolerant to chemicals. The criterion generally used is root elongation (15, 2). The present investigation was designed to determine if tolerance to herbicides exists among onion inbreds and to develop a laboratory technique for evaluating onion inbreds for inherent tolerance.

Materials and Methods

The plastic-box technique developed by Fults and Ross (6) for screening grass herbicides was modified for use with onion seedlings in the laboratory investigations (Fig. 1). Onion seedlings were grown on a nonnutrient agar in the presence of the herbicide being tested. Fifteen unselected seedlings, pre-germinated in petri dishes, were transferred to plastic boxes when the radicle was 2 to 3 mm long. Strips of filter paper impregnated with specific concentrations of the chemical solutions were placed on the surface of the agar, 44 mm from the young radicles. The chemical diffused through the agar toward the seedlings as they grew toward the treated area.

The boxes were tilted to 70° from the horizontal so that the roots would remain on the surface of the agar and grow toward the impregnated strip. The seedlings would not remain in place at a greater angle. Onion-skin

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[2]Present address: Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

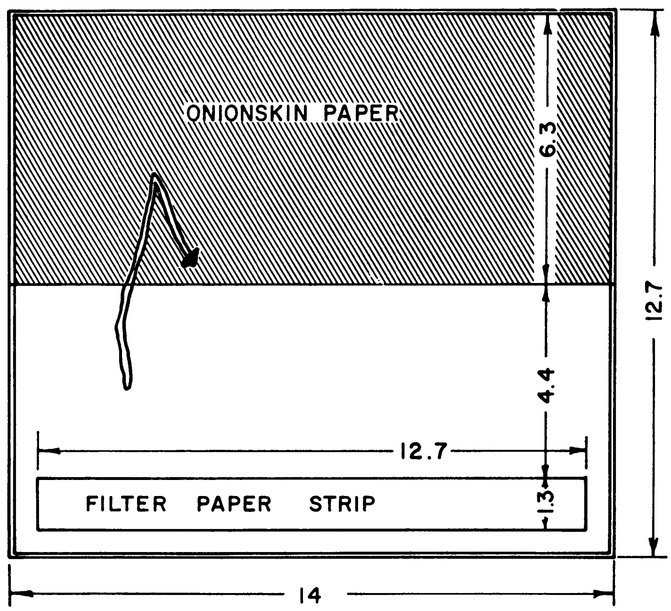

Fig. 1. Diagram of plastic box arrangement used in laboratory evaluation (dimensions in centimeters).

paper was placed on the surface of the agar under the expanding cotyledon. Otherwise, the seedcoats would stick to the agar, causing the seedlings to move out of position as they grew.

After 5 days, the primary root growth of the 10 most vigorous seedlings was measured (2). A tolerance index was calculated by dividing the average measurement of the treated material of each inbred by the average measurement of the untreated (control) material for that inbred and multiplying the quotient by 100.

Preliminary trials with CIPC indicated that the paper strips impregnated with 1250 ppm provided the most effective concentration of this chemical in the agar to differentiate among the levels of tolerance of the various onion inbreds. The concentration in the agar at the point of contact with the onion roots was not determined. In later trials potassium hexafluoroarsenate (TD-480[3]), was added to determine if there would be similarities in response to 2 chemicals.

The cultivar 'Downing Yellow Globe' and 27 inbreds selected from the Iowa State breeding program were screened for reaction to CIPC. The following 6 inbreds, which showed a differential response in tolerance that could be easily identified, were used in the main trials:

Inbred no.	*Pedigree*	*Source*
7B	Ia 5828	Iowa Yellow Globe
21C	IYG 51	Iowa Yellow Globe
36B	Ia 2020	Brigham Yellow Globe, Crookham
46B	Ia 4324	Yellow Sweet Spanish, Peckham
48B	Ia 4434	Downing Yellow Globe, Trapp's
53B	Ia 5834	Iowa Yellow Globe

A laboratory evaluation, arranged in a split-plot design and consisting of 3 replications, was made on the 6 selected inbreds. Whole plots consisted of chemicals, and split plots of inbreds. A field trial with 4 replications was arranged in a split-plot design. The 8 main-plot treatments consisted of a hand-weeded control, an unweeded control, and 3 levels of each of 2 herbicides, CIPC and TD-480. The levels, pounds of active ingredients per acre, for CIPC were 4, 6, and 8, and for TD-480 were 8, 12, and 16. The lower level of each was the recommended rate of application. The higher levels were incorporated to assure a toxic reaction for the measurement of variation in tolerance. Seeds of the 6 inbred lines were sown in individual rows in each main plot. The herbicide treatments were applied at emergence with an experimental plot sprayer. Oven-dry weight of 20 plants randomly selected from each plot was determined.

[3]Pennsalt Chemicals Corporation.

Table 1. Onion root lengths and herbicide tolerance indexes from laboratory trial.

Inbred	Root length, mm[a]			Tolerance indexes[b]	
	Control	CIPC	TD-480	CIPC	TD-480
7B	422	264	297	63	71
53B	376	170	305	45	81
36B	270	93	189	34	70
21C	476	152	308	32	65
48B	432	95	246	22	57
46B	466	79	255	17	55
LSD 5%	19	19	19		
LSD 1%	25	25	25		

[a]Sum of root lengths of 10 plants.
[b](Treated growth/control growth) × 100.

Results and Discussion

The data for the root length of the control plants in the laboratory trial indicate an inherent difference in growth among the inbreds (Table 1). A problem exists, therefore, in making comparisons for herbicide tolerance between 2 inbreds that differ widely in control root length. Comparisons between 7B and 48B or between 21C and 46B would be valid because the control measurements of the inbreds in these pairs are not significantly different (1%). Comparisons between other pairs of inbreds would not be valid.

The conversion of the root length data to tolerance indexes (Table 1) should compensate for the differences in control growth among inbreds, allowing comparisons for herbicide tolerance to be made between each pair of inbreds. This type of evaluation is especially important in making comparisons with inbreds 53B or 36B because of their low level of control growth. The tolerance indexes also should be more useful than growth measurements of treated plants in estimating the genetic potential of an inbred for herbicide tolerance.

A significant interaction (1%) between inbreds and chemicals in the laboratory trial indicates that not all of the inbreds responded similarly to both chemicals. This interaction appears to result mostly from a variation in degree of response, however, since the 3 inbreds which exhibited the most tolerance were the same for both chemicals (Table 1). The inbred 7B in particular, could be considered highly tolerant to both herbicides.

The tolerance indexes of the inbreds from the field trial (Table 2) fell into the same relative order as the indexes from the laboratory trial except for 53B and 36B. This discrepancy between the results of the 2 trials could have been caused by the comparison being made between root growth in one trial and top growth in the other, or

Table 2. Dry weights of onion plants without roots and herbicide tolerance indexes from field trial.

Inbred	Plant weight, g[a]			Tolerance indexes[b]	
	Control	CIPC	TD-480	CIPC	TD-480
7B	172	191	171	112	100
53B	291	253	192	87	66
36B	141	166	157	117	111
21C	276	279	230	101	83
48B	226	163	143	72	64
46B	324	222	154	69	48

[a]Weight of 80 plants.
[b](Treated growth/control growth) × 100.

it could have been related to a probable difference between the 2 trials in concentration of the chemicals in the root zone. Although this discrepancy does exist, the inbred 7B still was among the best in regard to tolerance indexes in both trials while 48B and 46B were the lowest in each case.

The combined data from the 2 trials indicate a detectable difference in herbicide tolerance exists among the onion inbreds tested. This is in agreement with previous reports (4, 13) and, in particular, with Alban (1) when it is noted that 36B is derived from 'Brigham Yellow Globe' and 46B is derived from 'Yellow Sweet Spanish'. It appears that this difference in tolerance should be large enough to permit breeders to develop onion inbreds that are highly tolerant to CIPC.

Since the data from the 2 trials do not correspond directly, the laboratory technique would be of most value as a preliminary screening method to eliminate the least tolerant inbreds. Subsequent field tests would be necessary to determine which inbreds have the highest tolerance under field conditions.

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Tolerance of Cranberry Plants to Manganese, Iron and Aluminum[1]

K. C. Medappa and M. N. Dana[2]
University of Wisconsin, Madison

Abstract. Cranberry cuttings grown in external solutions with several concentrations of Mn (0 to 1000 ppm), Fe (0 to 100 ppm) supplied as FeEDTA, and Al (0 to 150 ppm), showed tolerance to accumulations of high concentrations (8000 ppm from 1000 ppm in external solution) of Mn in the tissue and the ability to selectively exclude high level accumulation of Fe and Al from shoots. Root initiation by softwood cuttings was inhibited at high levels of Mn (275 ppm and above), Al (2.5 ppm and above) and Fe (2.5 ppm FeEDTA and above) in external solution.

The cranberry plant, *Vaccinium macrocarpon,* L., grows successfully on bog soils too acid (pH near 4.0) for production of most other crop plants. This implies nutritional tolerances different from those shown by many other crop plants. An understanding of the soil-plant relationship under an acidic root environment would be helpful in establishing new approaches to a weed control program in cranberry bogs and also in providing information for a better characterization of the ecology of the cranberry bog environment.

Arnon and Johnson (1) reported direct phytotoxicity from H+ activity only at extremes of the physiological range. Gerloff (4) concluded that poor plant growth at pH levels as low as 4.5 was due to either the toxic effects of high concentrations of metals made soluble under highly acidic conditions or to the insolubility and thereby deficiency of nutrient elements. Hewitt (6) reported that the deleterious effects of high acidity were the result of a complex of factors of which Al and Mn toxicity were among the most important.

Rorison (13) showed that excess Al^{+3} was responsible for the lack of growth of *Scabiosa* sp. from certain acidic sand cultures. Excessive Fe absorption was responsible for the failure of hemp and mustard on acidic soils according to Olsen (12). Manganese toxicity to crops on acidic soils has been shown by several workers (2, 6, 9, 14). Morris and Pierre (11) reported differences in sensitivity of legume species to Mn toxicity. Lohnis (9) showed that oats and mustard tolerated high Mn levels by selective exclusion of the metal from the tissue, while tobacco and strawberry showed a tolerance to high concentrations in

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[2]Former Research Assistant and Professor, respectively. Present address of senior author: Molecular Biology and Biophysics Laboratory, University of Wisconsin, Madison.