Table 2. Effect of herbicides on NO\textsubscript{3}-N and total N concn of table beet leaf blade, petiole and root tissue.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Blades</th>
<th>Petioles</th>
<th>Roots</th>
<th>Blades</th>
<th>Petioles</th>
<th>Roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeded check</td>
<td>.23a</td>
<td>1.35cd</td>
<td>.73cd</td>
<td>4.30a</td>
<td>2.22a</td>
<td>2.23a</td>
</tr>
<tr>
<td>Pebulate</td>
<td>.32abc</td>
<td>1.54de</td>
<td>.73cd</td>
<td>4.39b</td>
<td>2.38ab</td>
<td>2.38ab</td>
</tr>
<tr>
<td>Cycloate</td>
<td>.34abc</td>
<td>1.71de</td>
<td>.72cd</td>
<td>4.40a</td>
<td>2.46ab</td>
<td>2.44abc</td>
</tr>
<tr>
<td>EPTC</td>
<td>.36abc</td>
<td>1.79f</td>
<td>.78efg</td>
<td>4.32a</td>
<td>2.51abc</td>
<td>2.57abc</td>
</tr>
<tr>
<td>TCA</td>
<td>.35abc</td>
<td>1.33cd</td>
<td>.65cd</td>
<td>4.14a</td>
<td>2.72bc</td>
<td>3.24df</td>
</tr>
<tr>
<td>CDIC</td>
<td>.33abc</td>
<td>1.09ab</td>
<td>.47a</td>
<td>4.08a</td>
<td>2.42ab</td>
<td>2.62abc</td>
</tr>
<tr>
<td>Chlorpropahm</td>
<td>.27ab</td>
<td>1.00a</td>
<td>.49a</td>
<td>4.15a</td>
<td>2.48abc</td>
<td>2.59abc</td>
</tr>
<tr>
<td>Propachlor</td>
<td>.24a</td>
<td>1.28bc</td>
<td>.62bc</td>
<td>4.33a</td>
<td>2.22a</td>
<td>2.60abc</td>
</tr>
<tr>
<td>Solubor</td>
<td>.35ab</td>
<td>1.10ab</td>
<td>.54ab</td>
<td>4.53a</td>
<td>3.06d</td>
<td>3.43f</td>
</tr>
<tr>
<td>Lenacil</td>
<td>.44c</td>
<td>1.22bc</td>
<td>.73cd</td>
<td>4.20a</td>
<td>2.51abc</td>
<td>2.62abc</td>
</tr>
<tr>
<td>IMC 3950</td>
<td>.26ab</td>
<td>1.34cd</td>
<td>.62bc</td>
<td>4.26a</td>
<td>2.60abcd</td>
<td>2.55abc</td>
</tr>
<tr>
<td>Pyrazon (pre)</td>
<td>.44c</td>
<td>1.17abc</td>
<td>.74def</td>
<td>4.44a</td>
<td>2.62abcd</td>
<td>2.66abc</td>
</tr>
<tr>
<td>Pyrazon (post)</td>
<td>.32abc</td>
<td>1.14abc</td>
<td>.49a</td>
<td>4.44a</td>
<td>2.90cd</td>
<td>2.88df</td>
</tr>
<tr>
<td>CNF</td>
<td>.40bc</td>
<td>1.56e</td>
<td>.82fg</td>
<td>4.44a</td>
<td>2.90cd</td>
<td>2.88df</td>
</tr>
<tr>
<td>Pebulate-Pyrazon</td>
<td>.27ab</td>
<td>1.64ef</td>
<td>.71cd</td>
<td>4.19a</td>
<td>2.33ab</td>
<td>2.33a</td>
</tr>
<tr>
<td>TCA + Pyrazon</td>
<td>.31abc</td>
<td>1.67ef</td>
<td>.87g</td>
<td>4.30a</td>
<td>2.32ab</td>
<td>2.39ab</td>
</tr>
</tbody>
</table>

\(^2\text{Mean separation within columns by Duncan's multiple range test, 5\% level.}\)

chlorophosph, lenacil and CNP.

There were 8 herbicides or herbicide combinations that provided acceptable weed control in table beets. Of these, CNP and lenacil led to reduced yields and to increased NO\textsubscript{3} and total N concn. An increase in root total N may seriously affect the quality of the processed product since bitter taste of cooked beets has been shown to be due to the formation of pyrrolidinecarboxylic acid from glutamine (4). Glutamine is known to accumulate in beet tissue.

With the exception of pebulate, all led to an increase in NO\textsubscript{3}-N in one or more plant parts. Cycloate has been shown to lead to increased NO\textsubscript{3} concn over weeded and non-weeded checks of spinach leaf blades and petioles (2). Although some of the registered herbicides in the present experiment caused NO\textsubscript{3} concn to accumulate over weeded checks, there is little concern that NO\textsubscript{3} poisoning would occur since the levels reached were far below the minimum necessary for toxicity in humans (7, 8).

One new compound, IMC 3950, gave good weed control and good yields compared to a hand-weeded check. It did not cause an increase in tissue concn of either NO\textsubscript{3} or total N. This herbicide appears to be very promising for usage on table beets.

Other researchers have reported that sub-herbicidal levels of chlorophenoxy or triazine herbicides have increased N and protein levels of various crop plants.

**Insect Pollinators of Onion in New York State**

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**Cornell University, Ithaca, New York**

Abstract. Honey bees and drone flies are the most common insects found on flowering onions in New York State; 1216 other insects, representing many species, were collected from 3 areas in the state. **Dialictus sp.** and **Halictus sp.** (Apoidea) and 3 Diptera species are common pollinators. The observed species are compared with those on onions in the western states.

The production of hybrid onions has been possible since about 1940 when it was found that male-sterile lines, which produce no pollen, could be crossed with a second pollen producing line (3). Insects are needed to transport the heavy, sticky pollen grains (7). Some hybrid seed is produced in cages using honey bees or flies (11, 7) but large scale production is undertaken in open field with rented colonies of bees placed in adjacent areas (10).

During the last 15 years, commercial onion seed production has become difficult due to inconsistent seed set (5, 14, 17). A high positive correlation between pollinator activity and seed set has been reported (2). Most previous investigations of onion pollination have emphasized the behavior of the principal pollinator, the honey bee (1, 6, 9, 10, 14, 17). The attractiveness of onion nectar in Arizona is reduced by high sugar concentrations (15) and by high potassium ion concentrations (15, 16). This may account for successful competition by wild flowers and other crops for honey bees provided for onion pollination. Where other species of insects have not been severely reduced by pesticide application (2, 5), they may become more important in the

**Literature Cited**


pollination of onion.

Knuth (8) listed 15 genera of Diptera and Hymenoptera found on onion. Shaw et al. (13) also identified some of the insects found on flowering onion heads; they found the honey bee, *Apis mellifera*, comprised 31.8%, Halictidae 14.9%, and a fly, *Eristalis arbustorum* (Syrididae) 14%. In all, 12 species of Diptera, 7 of Hymenoptera, 1 Lepidoptera and 1 Hemiptera were identified. Shaw and Bourne (12) subsequently revised honey bees downward to 27.8% and also indicated that Diptera comprised 27.8% of the 106 specimens identified. Bohart et al. (2) listed 263 species visiting onion plots in Utah.

In New York State we collected insects from flowering onions directly into killing jars (9, 10). Insect nets were not used as all collecting was conducted on commercial seed plots and only insects on the flowering heads were wanted. Specimens were pinned and identified. Honey bees, and drone flies, *Eristalis tenax*, were most numerous and were not collected.

We spent 16 hr collecting in Orange County in southeast New York; all the onion plots in this area were those of commercial growers of mother bulbs (about 100 acres of seed onion are grown in small seed plots scattered among production plots on muck soil). About 40 hr were spent collecting in Tompkins County; all plots were those of the College of Agriculture and Life Sciences and were small and widely separated. The third area comprised both large and small plots of a commercial seed producer in Monroe and Genessee Counties south and west of Rochester, N.Y. Honey bee colonies for use in larger plots were rented by growers. About 30 hr were spent collecting in this area, the time divided evenly between large and small plots. We collected 1216 insects from flowering onion. From this collection, 125 species were determined and an additional 15 groups of 1 or more specimens were identified to genus. Of those identified to species, 14% were collected in all 3 locations (and types of seed plots) while 56% were collected in 1 location only; 36% of the species collected were represented by a single specimen. Several multiple catches listings resulted from the collection of a single specimen of a species in each county. Additional collecting would affect the values for uncommon and rare species much more than for the most frequently collected species. Additional species probably would be collected, especially on the small plots in areas where insect diversity is usually greater.

To determine relative usefulness in onion pollination, pollinator efficiencies were estimated for the various species based on body size, hairiness, and activity patterns of the species (2). The abundance of each species was determined by its frequency in each of the 3 samples. The abundance of *Apis mellifera* and *Eristalis tenax* were determined through visual estimates. Combining abundance with efficiency, we ranked (highest to lowest) the species as follows: *Apis mellifera*, *Eristalis tenax*, *Halictus ligatus*, *Eristalis arbustorum*, *Halictus rubicundus*, *Halictus confusus*, *Dialictus nymphaearum*, *Syritta pipiens*, *Bombus terricola*, *Hoplits producta*, *Dialictus nymphaearum*, *Syrtta pipiens*, *Bombus impatiens*. All remaining species, 113, ranked lower or were judged to be of little or no value as onion pollinators.

Bohart et al. (2) listed 6 species as important pollinators for Utah seed onion plots. These are as follows: *Apis mellifera*, *Syritta pipiens*, *Eristalis tenax*, *Halictus farinosus*, *Eristalis fuscata*, *Bembix amoena*. Three species, the honey bee, *Apis mellifera*, and 2 flies, *Eristalis tenax* and *Syritta pipiens*, are important pollinators in New York and Utah plots. Differences at the species level for *Halictus* and *Eristalis* can be expected due to the great distance between the 2 study areas. Solitary bees made up 67% of the important species in the East while only 17% in the West. A complete list of the insects collected has been mimeographed and is available (4).

Onions in New York State are attractive to a great number of insects. We conclude that reported low seed yields are not due to a shortage of pollinators.

**Literature Cited**


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**Response of Radish to High CO2¹**

G. N. Knecht²

University of Arizona, Tucson

Abstract. Growth of both plant tops and roots of radish (*Raphanus sativa* L. cv. Cherry Belle) was increased under elevated CO2 conditions in plastic, environmentally-controlled growth chambers. The root-shoot ratio was also favorably influenced by CO2 enrichment of the plant environment.

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Plant responses to increased CO2 levels in the growing environment have been investigated and reported by many workers during the past 5 decades. If one considers the “source/sink” aspect of photosynthesis and photosynthetic storage, it follows that increased photosynthesis due to added CO2 will be reflected by a positive response at the “sinks” of the plants. Madsen et al. (4) reported increased leaf thickness and increased fresh wt in tomato leaves when CO2 levels were increased to 2000 ppm.

Increases in fruit yield of tomato plants