high percentage of dandelion. The same treatments were applied on several dates throughout the fall until mid-November. Percent control ratings indicated that treatments applied on 9/24 produced greater than 90% weed control by 11/17, and the control levels of subsequent applications dropped dramatically with each date (Table 3). The following spring however, this trend reversed; the September application had less than acceptable control while mid and late October treatments generally resulted in the best dandelion control. Dandelion seedlings germinating in September and early October avoided earlier herbicide applications and thus contributed to the lack of control in the spring. Formula 40 controlled somewhat fewer weeds than other herbicides, with less than 90% control from the mid and late October application dates.

In the fall of 1987, we repeated the same study and increased the number of application dates into December. Thus far, percent control data appears similar to that of the 1986-87 study (data not shown). Ratings taken in the spring will reflect the final performance of these late season herbicide treatments.

The 1986-87 study suggests that good dandelion control can result from herbicides applied through late October, even when the plants are not actively growing. The 1987-88 study may confirm this conclusion and indicate what can be expected from herbicide applications made as late as mid-December.

## Non-phenoxy Herbicides

The recent linking of 2,4-D to non-Hodgkins lymphoma in agricultural workers (1) has prompted the EPA to re-examine the herbicide for possible health risks. These events, in addition to negative public opinion toward 2,4-D, have contributed to the need for alternative means of broadleaf weed control in turf. 2,4-D, along with 2,4-DB, dicloroprop, MCPP, and MCPA are all phenoxy-carboxylic acid herbicides, a group whose primary mode of action involves a "growth regulating" effect in plant shoots. Researchers are now channeling efforts into developing "non-phenoxy" herbicides as possible replacements for 2,4-D, should its registration be cancelled.

In August of 1987, a trial was established at the Fairview Driving Range to compare the efficacy of several common herbicides containing 2,4-D to that of some experimental and newly registered non-phenoxy herbicides on buckhorn plantain (Plantago lanceolata L.). Visual estimates of weed cover were taken prior to treatment and bi-weekly thereafter to evaluate percent weed control.

Eight weeks after treatment, all phenoxy herbicides resulted in at least 95% weed control (Table 4). Several non-phenoxy herbicides also performed well including fluroxypyr at 0.5 lb ai/A, clopyralid at 0.5 lb ai/A, and BAS 514 at 1.0 lb ai/A all of which controlled better than 93% of the plantain. Triclopyr ester was not effective, reducing weed cover by only 17%. Break-thru also failed to produce acceptable results when mixed with dicamba or triclopyr, but addition of 0.1 or 0.125 lb ai/A clopyralid produced 98-100% control.

An additional non-phenoxy herbicide study was conducted in cooperation with Dow Chemical Company and dealt with dandelion and white clover control. Four herbicides were examined in various combinations: triclopyr amine, clopyralid, dicamba, and Break-thru. In general, peak dandelion control

occurred at six weeks after application with the highest rated treatments, triclopyr amine + clopyralid at .38 + .25 and .5 + .25 lb ai/A, attaining about 95% control (Table 5). Nearly all treatments resulted in 100% white clover control with the exception of Break-thru + triclopyr amine and Break-thru + clopyralid (Table 5).

Results from these preliminary studies suggest that several non-phenoxy herbicides provide the same degree of weed control as phenoxy products. With respect to buckhorn plantain, dandelion, and white clover, excellent results were obtained with clopyralid and combinations of clopyralid, triclopyr, and dicamba. Additional research in this area is warranted, particularly if registration for 2,4-D is cancelled. Future studies will include screening of these and any new experimental non-phenoxy herbicides on a range of common turf weeds.

## Reference

1. Hoar, Sheila K. et. al., 1986. Agricultural herbicide use and risk of lymphoma and soft-tissue sarcoma. J. Amer. Med. Assoc. 256:1141-1147.

TABLE 4. Phenoxy versus non-phenoxy herbicides: Narrow leaf plantain control

| Herbicide (lbs ai/A) | % Control 2 WAT* | 4 WAT | 6 WAT | 8 WAT |
|---|---|---|---|---|
| Turflon D 1 + .5 | 21 | 68 | 87 | 100 |
| Triclopyr ester + clopyralid .25 + .25 | 69 | 96 | 97 | 100 |
| Break-thru + triclopyr + clopyralid .125 + .125 + .1 | 77 | 98 | 100 | 100 |
| Break-thru + clopyralid .125 + .125 | 39 | 77 | 98 | 100 |
| Weedone DPC amine 2.0 | 63 | 79 | 83 | 99 |
| Super Trimec .75 + .75 + .18 | 63 | 88 | 91 | 99 |
| Weedone DPC amine 1.5 | 39 | 79 | 83 | 98 |
| Break-thru + clopyralid .125 + .1 | 49 | 82 | 87 | 98 |
| Turflon II amine 1 + .5 | 34 | 66 | 71 | 96 |
| Weedestroy triamine .5 + .5 + .5 | 59 | 49 | 83 | 96 |
| Clopyralid .5 | 27 | 74 | 94 | 96 |
| Trimec 1 + .5 + .12 | 0 | 62 | 85 | 95 |
| Break-thru + triclopyr .125 + .125 | 31 | 44 | 51 | 72 |
| Break-thru + dicamba .125 + .125 | 11 | 57 | 71 | 65 |
| Triclopyr ester .5 | 21 | 25 | 25 | 17 |
| Check | 4 | 4 | 0 | 0 |
| $LSD_{.05}$ | 37 | 33 | 23 | 16 |

*Weeks after treatment
Treatments applied 8/31/87; 9:30 am; 67°F; NW wind 0-5 mph; 58% RH; sunny.

TABLE 5. Non-phenoxy herbicides: dandelion and white clover control.

| Herbicide | Rate (lbs ai/A | % dandelion control | | | | % white clover control | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2 WAT* | 4 WAT | 6 WAT | 8 WAT | 2 WAT | 4 WAT | 6 WAT | 8 WAT |
| Triclopyr amine + clopyralid | 0.38 + .062 | 19 | 13 | 21 | 0 | 0 | 96 | 95 | 100 |
| | 0.38 + 0.125 | 7 | 80 | 82 | 0 | 6 | 100 | 100 | 100 |
| | 0.38 + 0.25 | 14 | 63 | 96 | 87 | 15 | 100 | 100 | 100 |
| | 0.5 + .062 | 10 | 63 | 50 | 0 | 11 | 96 | 100 | 100 |
| | 0.5 + .125 | 32 | 83 | 73 | 42 | 22 | 100 | 100 | 100 |
| | 0.5 + 0.25 | 59 | 93 | 94 | 88 | 11 | 100 | 100 | 100 |
| Triclopyr + clopyralid + dicamba | 0.5 + 0.3 + 0.1 | 43 | 98 | 95 | 84 | 18 | 98 | 100 | 100 |
| Triclopyr + clopyralid + dicamba | 0.25 + .125 + 0.1 | 11 | 56 | 17 | 0 | 33 | 93 | 98 | 100 |
| Triclopyr + Breakthru | .125 + .125 | 17 | 17 | 13 | 0 | 0 | 96 | 78 | 84 |
| Triclopyr + Breakthru + dicamba | .125 + .125 + .125 | 30 | 54 | 56 | 0 | 22 | 99 | 100 | 100 |
| Breakthru + dicamba | .125 + .125 | 32 | 72 | 65 | 10 | 8 | 99 | 87 | 95 |
| Breakthru + clopyralid | .125 + .125 | 0 | 0 | 0 | 0 | 3 | 87 | 78 | 47 |
| Control | --- | 0 | 6 | 0 | 0 | 13 | 43 | 44 | 33 |
| $LSD_{.05}$ | | 34 | 43 | 37 | 20 | 40 | 12 | 13 | 18 |

*weeks after treatment

Herbicides applied 6/25/87; 8:30 a.m.; 74°F; RH 71%; wind S 0-8 mph; partly sunny