Reviews

Herbicides Available for Commercial Cabbage Producers during 1965-94

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Summary. Through cooperation of state agricultural research stations, U.S. Dept. of Agriculture-Cooperative States Research Service (USDA-CSRS) Interregional Project Four (IR-4), manufacturers and grower organizations, new herbicide labels for cabbage have been granted recently. Labels for the herbicides consist of national, regional, and state need and state emergency use labels. These herbicides provide adequate choices of labels for cabbage producers in the major commercial production areas. Starting with only three herbicides available in 1965 to a choice of 10 herbicides in 1994, growers can be more effective in control of weeds in cabbage.

A very common comment by growers of crops that are grown on a limited number of acres is that there are not sufficient herbicides to provide control of the different weed species that compete with their crop. Manufacturers of herbicides are reluctant to invest a large amount of resources to develop an herbicide for a crop that will not result in a large volume of herbicide use. The IR-4 Project (headquartered at Rutgers Univ.) was established under the USDA–CSRS framework to assist in labeling of pesticides for minor-acreage crops. The cooperation of the Agricultural Research Service (USDA-ARS), faculty and staff of land grant universities, chemical manufacturers and formulators, the IR-4 Project staff, individual growers and grower organizations has resulted in many herbicide labels for many minor crops. In order to ensure a reasonable probability of obtaining a label, most herbicides evaluated were previously approved for use on major feed or fiber crop species. The purpose of this overview is to demonstrate with a long-term treatment of one species (cabbage), what can be accomplished in providing choices of herbicides on a state and national basis.

Geographical basis of information

The information presented in this study is based on the experience of the author in his field research where the objective was to provide an effective weed control program for cabbage producers in Illinois and Wisconsin. Therefore, the research and outreach informationprovided is from the Univ. of Illinois from 1965 to 1985 and from the Univ. of Wisconsin-Madison from 1986 to 1994, which corresponds to when I was a member of the faculty of these two institutions.

After it was established that cabbagewould tolerate a level of an herbicide that was adequate for weed control, field research was conducted to determine if the herbicide would control a weed species not controlled by other herbicides or would fill a void previously not met by other herbicides. For example, pyridate was shown to control some broadleaf weeds as a postemergenceapplication,withahigh level ofcabbage tolerance. There was a need for a postemergence broadleaf herbicide after the cancellation of nitrofen in 1981. The manufacturer of pyridatewas making progress toward registrationin maize and peanuts and, after 8 years of research in cabbage, pyridate was labeled for use in 1993.

Herbicides labeled for use over 30 years

Fourteen herbicides that were labeled for cabbage use from 1965 to 1994 are listed in Table 1. Eleven of the herbicideshadnationallabelsfor use in cabbage. An example ofa national herbicide label that was added is sethoxydim for postemergence control of grass weeds. Although trifluralin controls many grass weeds, some species, such as wild proso millet (*Panicum wiliaceum* L.),maygerminatelater in the growing season, and sethoxydim could be used tocontrol these grass weeds during the latter part of the growing season. An herbicide that was not labeled nationallywasCDAA,which was used under aNorth-Central regional label, including Illinois and Wisconsin. At the time, it was labeled it was the most effective. economical herbicide available to the

Table 1. *Herbicides labeled for use in cabbage during 1965-94.*

Herbicide	Years labeled
CDAA	1965-84
CDEC	1965–68
Clomazone	1990-94
DCPA	1965-94
Glyphosate	1983-94
Sethoxydim	1989-94
Trifluralin	1966-94
Metolachlor	1989-94
Napropamide	1986-94
Nitrofen	1968-81
Nitralin	1 970–74
Oxyfluorfen	1989-94
Paraquat	1989-94
Pyridate	1 993–94

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growers of cabbage. Clomazone was used in Wisconsin under a state emergency use label (Section 18) for control of velvetleaf *(Abutilon theophrasti* Medic.) because no effective control of this weed was available in 1990. Metolachlor was used under a third-party Wisconsin state local need label (Section 24c) for the control of yellow nutsedge(*Cyperus esculentus* L.),which isaseriousweedthat was not controlled on a significant number of acres. The metolachlor third-party label was assignedto the Wisconsin Kraut Growers Assn., an organization of Wisconsin cabbage growers that assumed the liability for any potential field injury. A state emergency use label can be issued when there is a critical need for an herbicide for a weed problem in a crop for which an adequate registered treatmentis not available. A local state need label can be issued for an herbicide when a residue tolerance for the crop species use has been established. The use must be for a continuing unsolved weed problem that may not be present in a large geographical area.

Table 2. *The number of berbicides a cabbage grower could choose from during 1965-94.*

Year	No. choices
1965	3
1966-67	4
1968	5
1969	4
1970-74	5
1975-81	4
1982	3
1983-84	4
1985	3
1986-88	4
1989	8
1990-92	9
1993-94	10

Table 3. *The initial year that 32 potential cabbage herbicides, which have not been registered for use in cabbage, were evaluated.*

Year	No. compounds
1965	2
1966	4
1967	2
1968	2
1969	1
1970	1
1971-83	0
1984	1
1985	4
1986	6
1987	5
1988	1
1989	0
1990	2
1991	0
1992	1
1993-94	0

Trifluralin has been used widely for weed control in cabbage in Illinois and Wisconsin, where it will control many annual grasses and some annual broadleaf weeds in direct-seeded and tranplanted cabbage. Nitrofen was used extensively from 1968 to 1981 for annual broadleaf control in direct-seeded andtransplantedcabbage.From 1982 to 88,therewas no effective broadleaf herbicide registered for cabbage production.Withtheregistrationofoxyfluorfen in1989 for use in transplanted cabbage, and pyridate in 1993 for use in direct-seeded and transplanted cabbage, a more-efficienttotalweedcontrolprogramwas available. With the approval of sethoxydim in 1989 for postemergence control of grassweeds,several effective postemergencechoicesfor control were provided. Manygrowersalsocultivateoneor more times to remove weeds not controlled ormissedby herbicides.

The herbicides from which a grower could choose during the 30-year period of 1965 to 1994 are listed in Table 2.

With a low of three herbicide choices in 1965, 1982, and 1985 to a high of 10 in Wisconsin in 1993-94, growers can control weeds that compete with their cabbage crop much more effectively.

Many potential herbicides were evaluated that are not available for use in cabbage.

Thirty two chemical compounds wereevaluated as herbicide candidates for cabbage in my program that have not been registered for use. The years that these compounds were evaluated initially in field studies are in Table 3.

Thesedataindicatethatthere were numerous chemicals with potential as cabbage herbicides in the mid-1960 decade to the mid-1980 decade. These chemical compounds were not registered for cabbage because of insufficient control of target weeds, an unacceptable level of cabbage phytotoxicity, or the chemical manufacturer's unwillingness to seek approval for use in cabbage.

Forexample, alachlor adequately controlledyellow nutsedge in cabbage and would have met with grower acceptancefor crop safety. However, a label was obtained for use of a closely relatedcompound(metolachlor), and the manufacturer of alachlor would not pursuealabelforuseincabbage.Bifenox was evaluated for postemergence controlofbroadleafweedsinthe mid-1980s to replace nitrofen. Although excellent field efiicacy and crop safety was obtained, the manufacturer was not interested in pursuing a label for cabbage.

The current situation relative to cabbage herbicides

Wisconsin cabbage producers could choose from 10 herbicides for production of their crop during the 1994 growing season. These choices were a combination of national, state need (with field liability assigned to a state grower organization), and state ernergencyuse labels. Each of the herbicides has a specific use for which it either provides control of a major weed species or is effective under specific cultural conditions. The proper combination of herbicides and cultivation has in part helped to maintain a viable Wisconsin cabbage industry.

Future weed control in cabbage

Through the cooperative efforts of many groups concerned with minor acreage crop production, numerous herbicide labels have been obtained. It is essential that similar type efforts be sustained for a continued safe and economical food supply.

Due to increased environmental concerns about herbicides (and all pesticides), it is essential that those concernedwithweed control in minor acreage crops should look to all avenues of efficacious weed control. In the future, we shall probably need to use an increased coordination of different types of weed control components, including herbicides, biological active weed control agents, and cultivation.

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