STUDY ON WEED CONTROL IN NO-TILLAGE SUMMER CORN IN NORTH CHINA

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Summary. The importance of the weed control in summer corn under the no-tillage cropping system in north China are discussed. The main weed species in the crop for the region were investigated and soil-treated herbicides for control of these weeds were selected. A herbicide application method with reduced spraying volume and improved sprayers was developed and discussed.

INTRODUCTION

Rural labor is becoming less available in north China due to the rapid development of the rural industry and sideline production. In Beijing suburbs, about 85% of the labour force worked on farms in 1970's compared with 30% in 1990. Therefore, cropping techniques for saving labor were urgently needed for the development of agriculture, especially under the double-cropping system. For several years the techniques for no-tillage cropping have been rapidly developed and extended into summer corn in north China. The advantages of this are: (i) saving labor and energy; (ii) enabling seeding 3-7 days earlier; (iii) improving corn resistance to drought and waterlogging; and (iv) increasing corn yield by 500 kg/ha. Chemical weed control is one of the key parts of no-tillage cropping because of the weed problems and the large labor requirement of conventional weed control methods.

The objective of this work is to: (i) investigate the weed species and weed seed distribution in no-tillage summer corns; (ii) select suitable herbicides for controlling the weeds; and (iii) develop an efficient herbicide application method by improving the currently available application equipments.

METHODS

Weed species in summer corn were investigated for several times during the growing season of summer corn in north China where summer corn and winter wheat are annually cropped. Weed species were recorded and their interference levels were estimated and classified visually. Soil samples were collected from 0-5, 5-10, 10-20 cm depth in both no-till and traditionally flowed fields to investigate the weed seed distribution and content. Emerged weed seeds in the samples were determined by recording emerged seedlings at 25-28°C in a greenhouse.

Experiments were conducted in both parts and in the field to determine the inhibition level of atrazine on wheat. Fresh weight of leaves and roots were recorded.

Herbicides were selected by comparing their efficacy to the weeds and safety to the winter wheat crop.

Currently used spray equipment was improved by changing the nozzles to fit the application system. Pot and field experiments were conducted to compare the corn yield, the weed control percentage and the working efficiency between the reduced volume application method and the traditional application method.

RESULTS AND DISCUSSION

The investigation results showed that there were 134 species and 30 families of weeds in north China (Table 1). Common crabgrass (*Digitaria sanguinalis*) was the major weed species in corn.

Table 1. The main weed species in North China

Common name	Scientific name	Interference level[a]
Common crabgrass	*Digitaria sanguinalis*	+++
Green bristlegrass	*Setaria viridis*	++
Barnyard grass	*Echinochloa crusgalli*	+++
Goosegrass	*Eleusine indica*	++
Copper leaf	*Acalapha australis*	++
Redroot amaranth	*Amaranthus retroflexus*	+++
Purslane	*Portulaca oleracea*	++
Lambsquarters	*Chenopodium album*	++
Black nightshade	*Solanum nigrum*	++
Ivy glorybind	*Calystegia hederacea*	++
Rice galingale	*Cyperus iria*	++
Japanese hop	*Humulus scandens*	++
Yerbadetajo	*Eclipta prostrata*	++

[a] + = light; ++ = middle; +++ = heavy.

Weed seeds were mostly distributed in 0-10 cm in the soil in summer corns where the no-tillage was carried out continuously for several years (Table 2). This suggests that the soil treated herbicides might give a good control of the weeds in such a weedy field. Mixtures of atrazine+acetochlor, atrazine+butachlor or atrazine+alachlor were the ideal soil treated herbicides for controlling both of the grasses and broad-leaved weeds in no-tillage corns (Table 3). Atrazine was less effective against the dominating weed common crabgrass (Table 4). Moreover, atrazine would inhibit the growth of the rotation crop winter wheat if its residue in the soil after corn harvest is greater than 0.05 mg/kg (Table 5). The soil residue analysis results after corn showed that the atrazine residue was less than 0.05 mg/kg and no inhibition effect on the growth of winter wheat was observed when the herbicide mixtures atrazine+acetochlor, atrazine+butalchlor or atrazine+alachlor were applied at an atrazine dosage of 0.6 kg ai/ha. However, when atrazine was applied alone at a dosage of 1.2 kg/ha, its residue may cause injury to winter wheat in part of the fields because of its uneven distribution caused by incorrect application methods (Tables 3, 4 and 6). Results in Table 6 indicated that the weed control percentage was the same when using the low volume (60 L/ha) application method as for the normal volume (600 L/ha). However, the working efficiency was increased twofold when the low volume application method was used, and the water, energy, and labor for herbicide application could also be conserved.

Sufficient soil moisture is the premise for achieving good weed control efficiency with soil-treated herbicides. As meteorological reports over the past 40 years show there will be over 10 mm rainfall within 10 days of sowing summer corn in north China. Beside this, there are also irrigation systems in most areas of this region. These conditions promote the adoption of trial

results of herbicide selection and the reduced spaying volume application method in no-tillage summer corn.

Table 2. Distribution and content (%) of the emerged weed seeds in the soil under the double cropping system by corn and wheat

Tillage methods	Tillage frequency	Soil depth (cm)		
		0-5	5-10	10-20
No-tillage	No-tillage only in summer corn	45	40	15
Plowed		31	11	58
No-tillage	No-tillage both in corn and wheat	76	20	4
Plowed		22	27	51

Table 3. Weed control percentage of different herbicide mixtures in summer corn

Herbicide mixture (kg ai/ha)	Common crabgrass	Annual broad-leaved	Total (%)	Corn yield	
				t/ha	ssr
Atrazine 1.2	73.1	96.7	80.1	7.92	a
Acetochlor 0.68	86.0	95.2	88.7	7.23	abc
Atrazine 0.60 + Acetochlor 0.73	92.5	99.2	94.5	7.93	a
Atrazine 0.60 + Butachlor 0.676	91.0	97.8	93.0	7.53	ab
Atrazine 0.60 + Alachlor 0.675	86.6	98.0	90.0	7.88	a
Hand weeding twice	93.5	100.0	95.4	7.70	ab
No-weeding	0.0	0.0	0.0	6.26	c

Table 4. Efficacy of different herbicides to weeds and corn in ppm

Herbicide	Common crabgrass ED90	Barnyard grass ED90	Red root amaranth ED90	Corn IC10
Atrazine	0.246	0.07	<0.06	>3.44
Acetochlor	<0.05	<0.05	0.08	1.03
Butachlor	0.10	0.11	>0.18	1.85
Alachlor	0.19	0.10	0.11	3.29

Table 5. Inhibition of atrazine to winter wheat.

Winter wheat	Concentration of atrazine (mg/kg)					
	0.00	0.01	0.03	0.05	0.10	0.15
Plant height (cm)	17.00	17.60	17.70	17.70	15.10	10.00
Inhibition rate (%)	0.00	-3.50	-4.10	0.00	11.20	41.20
Sten weight (g/5 plants)	3.27	3.33	3.38	3.27	1.62	0.78
Inhibition rate (%)	0.00	-1.80	-3.40	0.00	50.50	76.10
Root length (cm)	18.00	19.20	18.90	17.50	16.40	12.50
Inhibition rate (%)	0.00	-6.70	-5.00	2.70	8.90	30.50
Root weight (g/5 plants)	2.55	2.53	2.49	2.26	0.77	0.49
Inhibition rate (%)	0.00	8.60	2.40	11.40	69.80	80.80

Table 6. Weed control percentage and atrazine residue in soil after corn by different herbicide application and tillage methods

Tillage methods	Treatment (kg ai/ha)	Spraying volume (L/ha)	Residue (mg/kg)	Weed control (%)
mulched+no-tillage	Atrazine 0.6+Butachlor 0.56	600	0.025	90.7
	Atrazine 1.2	600	0.050	91.5
	Atrazine 1.8	600	0.065	95.7
unmulched+no-tillage	Atrazine 0.6+Butachlor 0.56	600	0.025	90.5
	Atrazine 1.2	600	0.045	84.9
	Atrazine 1.8	600	0.075	95.4
mulched+no-tilage	Atrazine 0.6+Butachlor 0.56	60	0.018	86.3
	Atrazine 1.2	60	0.035	93.6
	Atrazine 1.8	60	0.074	96.4
unmulched+no-tillage	Atrazine 0.6+Butachlor 0.56	60	0.024	82.4
	Atrazine 1.2	60	0.051	90.2
	Atrazine 1.8	60	0.087	96.7

Fan nozzles are normally used for applying herbicides in China but do not give a spraying volume as low as 60 L/ha. In order to get satisfactory weed control, a nozzle needed to be selected to which produced a low volume. After comparing betwwen nozzles even flat fan nozzles were selected and used to replace the former fan nozzles. A self-cleaning filter was developed and installed onto the boom sprayers to prevent the nozzles from blocking. As a result, the herbicide application method with reduced spraying volume and improved sprayers was rapidly extended in north China where winter wheat is grown after summer corns.

REFERENCES

1. Lu, X.Y, Li, S.R. and Wu, L.L. 1992. Chinese Pest Sci. & Manag. No.1, 19-23.
2. Buhler, D.D. 1991. Weed Techn. 5, 66-71.

3. Ferris, I.G. and Haigh, B.M. 1987. Chinese J. Chromatog. Sci. 25, 170-173.