WEED POPULATION SHIFTS IN CROP FIELD IN SHANGHAI APPROPRIATE CONTROL STRATEGIES

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Summary. A survey carried out in 1981 showed that the percentages of weed infestation areas in different crop fields in Shanghai was 68.2%, 75% and 78.8% in wheat, rape and rice field respectively, A similar carried out in 1991/1992 showed that this value was 91.6%, 94% and 84.8% respectively.

The flora also shifted significantly between 1981 and 1991/1992, some major weeds including *Alopecurus aequalis*, *Malachium aquaticaum* and *Cyperus difformis* were successfully controlled, while the more herbicide-tolerant weeds including *Backmannia syzigachne*, *Polypogon fugax*, *Juncellus serotina* and *Sagittaria pygmeae*, increased their infestation rate to 34%, 21%, 19.8% and 30.8% respectively. These changes are due to repeated rice-wheat rotation, reduced tillage and repeated application of single herbicide such as CHLOROTOLURON in wheat fields and NITROFEN in rice fields. They will be well managed by selecting suitable cropping systems, high active or mixed herbicides and effective integrated weed control systems according to the weed flora in fields.

INTRODUCTION

MCP was introduced successfully to control broad-leaf weeds and sedge weeds in rice seed-beds in Shanghai in 1965-1967, 2 years later NITROFEN was tested and extended to control *Echinochloa crus-galli*, *Cyperus difformis* and some annual broad-leaf weeds in rice seed beds and transplanting fields. Controlling weeds in rice fields with these herbicides is more economic and efficacious than hand weeding, and farmers adopted these herbicides rapidly, opening the first page in history of chemical weed control in Shanghai (1). But MCP can not control *Echinochloa crus-galli* and NITROFEN is not efficacious enough for controlling this weed too, so some years *Echinochloa crus-galli* became a more serious problem weed. SATURN and MACHETE were introduced for controlling E*chinochloa crus-galli* in rice fields in 1981-1982, but these two herbicides are not efficacious for controlling perennial weeds in rice fields. CHLOROTOLURON was introduced for controlling *Alopecurus aequalis*, *Malachium aquaticum* in wheat and barley fields in Shanghai, and some years later *Galium aparine*, *Backmannia syzigachne* and *A. japonicum* became problem weeds. The shifts of field weed population became a new problem after ten years. In 70% of fields where herbicides are used to control weeds in Shanghai now, the problem is more and more serious, but little attention is paid to it.

MATERIALS AND METHODS

Investigation with five-scale visualization method was conducted in 5000 field plots in 1981 and the same field plots in Shanghai suburbs in 1991, 50 fields were disposed for one crop in every village (3).

The effects of three cropping systems on field weed population shifts was tested in 1985-1988 in QinDon farm, where every treatment is 0.1 ha. The effects of herbicides on weed population shift in fields were tested with small plots in QinDon farm and 5.4 state farm and experiment

farm of Shanghai Academy of Agricultural Science, every small plot 20 meter square, three replication.

RESULTS AND DISCUSSION

According to author's survey with five-scale visualization in 1981-82,the percentages of weed infestation areas in wheat, rape and rice fields in suburbs of Shanghai were 68%, 75% and 78% respectively, the percentages of over-medium infestation areas were 34%, 50% and 42% respectively. However in 1991, the percentages of weed infestation areas reached 91%, 94% and 84.8%, respectively, the percentage of over-medium infestation areas reached 79.6%, 86% and 54% respectively, the percentages of weed infestation areas increased by 19%, 25.6% and 6% respectively, the over-medium infestation areas increased by 45.6%, 36% and 12% respectively from 1981 to 1991 (Tables 1 and 2).

Table 1. Variation of weed population in wheat fields in Shanghai

Weed species	Infestation area (%) May 1981					Infestation area (%) May 1990				
	1	2	3	4	5	1	2	3	4	5
Alopecurus japonica	16.8	4.4	0.3	0	0	20.5	8.5	4.0	9.0	5.0
Backmania syzigachne	45.2	7.6	1.7	0.2	0	27.0	17.0	8.5	4.5	3.5
Sclerochloa kengiana	29.4	12.0	5.9	1.7	0.4	23.2	11.6	9.6	4.8	2.4
Polypogod frugar	36.3	6.9	1.3	0.8	0.2	41.5	12.5	7.5	5.0	4.0
Alopecurus aequalis	35.1	19.7	10.1	4.3	1.4	42.5	7.5	4.5	1.5	0.5
Malachium aquiticum	52.9	28.3	6.3	1.2	0	71.5	7.5	1.5	0	0
Total weed infestation date		68.23		34			91.6		79.6	

Table 2. Weed population shifts in rice fields in Shanghai

Weed species	Infestation area (%) 1981.10					Infestation area (%) 1990.10				
	1	2	3	4	5	1	2	3	4	5
Echinochloa crus-galli	49.2	38.8	10.0	10.0	1.2	57.6	23.2	5.6	2.4	2.8
Cyperus difformis	67.2	10.4	0	0	0	28.8	2.4	0	0	0
Monochoria vagenalis	45.2	2.8	0.8	0.8	0	52.0	7.2	0.4	0	0
Rotala indica	40.0	10.8	1.6	1.6	0	26.0	4.0	0.8	0	0
Ammannia baccifora	52.4	0.8	0	0	0	40.8	2.0	0.4	0	0
Eclipta album	52.4	0.8	0	0	0	45.8	4.0	0	0	0
Sagittaria pygmaea	9.6	3.2	0	0	0	16.8	11.6	4.8	0.8	0
Juncellus serotina	14.4	2.0	0.4	0	0	35.2	20.4	10.0	1.2	1.6

The population composition of weed communities also changed greatly since 1981, all this change was induced by the following factors:

Single type herbicides were used continuously. Some herbicide-sensitive weeds were controlled, for example, the CHLOROTOLURON-sensitive weeds, *Alopecurus equalis*, *Malachium aquaticum*, the NITROFEN and MACHETE-sensitive weeds *Cyperus difformis*, *Echinochloa crus-galli* and *Rotala indica* were controlled successfully (Figs 1 and 2), the percentage of infestation areas of those weeds decreased 21.5%, 26.8% and 8%, 18%, 7.6% respectively, while the infestation areas of the CHLOROTOLURON-tolerant weeds, *A. japonicus*, *Backmannia syzigachne*, *Polypogon fugax* and the NITROFEN and MACHETE-tolerant weeds *Juncellus serotinum*, *Sagittaria pygmaea* increased by 34%, 21.8%, 19.8% and 14%, 30.8% respectively from 1981 to 1991 (Tables 1 and 2).

Continuous rice-wheat rotation cropping system was extended. The crop system of paddy-rice with upland crop (cotton, corn or soybean) as an efficacious, economic and safe method for weed control. For example, the infestation areas of *A. japonicus*, *B. syzigachne* and *Saggitaria pygmaea*, *Echinochloa crus-galli* in paddy rice-wheat with upland crop (cotton, corn or soybean) rotation cropping system are reduced by 50-90% as compared to those in continual rice-wheat rotation cropping system. It was proven that the germination rate of *A. japonicus*, *Backmannia syzigachne*, *Sclechloa Kengiana* was 39.3%, 83% and 62.7% repectively in rice-wheat rotation field after seed buried in soil for 2 years, but the germination rate of these weeds was 0-1.7% only in cotton-wheat rotation fields (Fig. 3).

Wheat-wheat continuous cropping system was practiced year by year. According to the test data the blossom and seed ripening of weeds in wheat fields almost coincide with those of wheat, so all of the weed seeds are falling into soil while we harvest wheat. The weed infestation will get serious in wheat-wheat continuous cropping field year by year, but if we plant green manure, all weeds will be killed while we harvest crop and at the same time, the weed seeds are not ripe yet. Almost no ripe weed seeds are left in soil, so the weed infestation in most years will be reduced compared with wheat-wheat continuous cropping fields (Fig. 4).

No-tillage system was developed and introduced. Weed plants can be killed by cultivation. The tubers and rhizomes of perennial weeds will be turned up to soil surface by a plow and cultivations in autumn, the tubers will be killed by minus zero temperature in winter. According to the author's test, the tuber of juncellus serotina will be killed by low temperature at -3 to -5°C in 2-3 days. The plow and cultivation are the traditional and efficacious way for weed control in fields for long period, but in recent years the development of rural enterprises gave rise to a large-scale transferring of labor power from crop production to industry and side-line occupation, the no-tillage system was rapidly adopted by farmers, this is one of the causes of more and more serious weed infestation, especially in the case of perennial weeds.

A safe effective and economical weed control could only be achieved by integrated weed management. The following suggestion may be preferable in this regard:

The planting areas of upland crops like cotton, corn and soybean, green manure crops should be enlarged and a scientific cropping system, including the rotation of upland crop (cotton, corn, soybean), with paddy crop (rice) or wheat-green manure-rape be established.

The use of mixed herbicides is helpful to control a broad spectrum of weed species according to different population composition of field weed communities, but the antagonism between different herbicides should be noticed. The mixture of CHLORSULFURON + CHLOROTOLURON can be used in grass weeds dominating fields such as *Alopecurus aequalis*,

A. japonicus, *Bacmannia syzigachne* and broad leaf weed *Galium aparine* dominating field. Otherwise, PUMA can be applied at first and BENTAZON later. MACHETE + LONDAX mixture can be used for the control of annual weeds, such as: *Echinochloa crus-galli*, *Monochoria vaginalis* and perennial weeds, such as: *Juncellus serotina* and *Sagittria pygmaea*, otherwise, MACHETE can be applied at first and BENTAZON, MCP later.

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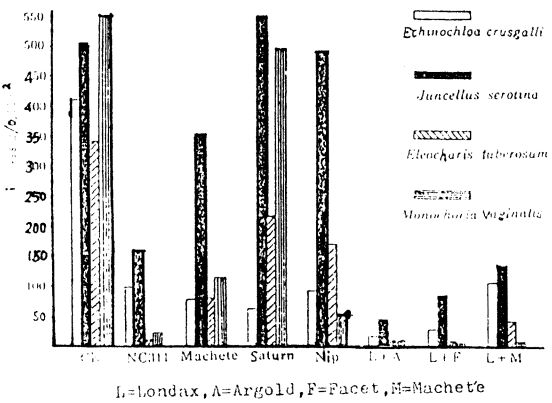

Figure 1. Effects of herbicides on weed populations shifts in rice fields

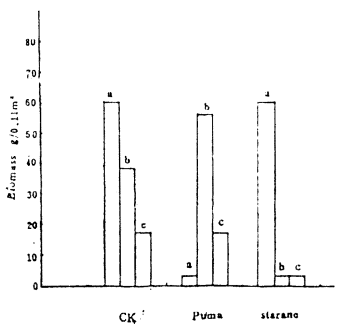

Figure 2. Effects of herbicide treatment on weed populations
a. *Alopecurus aequalis*;
b. *Malachium aquaticum*;
c. *Galium aparine*.

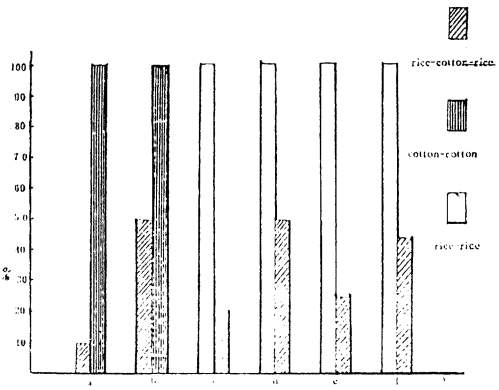

Figure 3. Effects of crop rotation on weed populations
a. *G. aparine*; b. *?. sanguinalis*;
c. *A. acqualis*; d. *M. aquaticum*;
e. *C. difformis*; f. *E. crus-galli*.

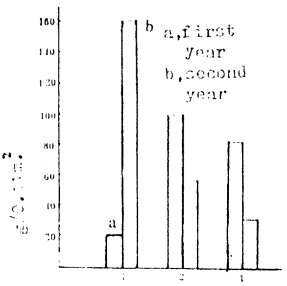

Figure 4. Effects of crop rotation on *Alopecurus aequalis* infestation
1. wheat-rice-wheat;
2. wheat-rice-rape;
3. wheat-rice-green manure.