# Weed flora of agricultural area in Korea

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# 우리나라 農耕地의 主要 雜草分布 現況

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## ABSTRACT

Weed flora and floristic composition were reviewed in lowland rice field and upland crop area.

For lowland rice field weed flora was not much changed since 1971. About 29 weed species belonged to 18 families were occurred. However, floristic composition of dominant weed species has greatly changed mainly due to introduction of herbicides. The predominant weed species in 1971 when herbicide was not used were *Rotala indica*, *Eleocharis acicularis*, *Monochoria vaginalis*, *Echinochloa crus-galli*, while these for in 1991 were *Eleocharis kuroguwai*, *Sagittaria pygmaea*, *S. trifolia*, *Echinochloa crus-galli* and *M. vaginalis*, respectively. In 1981 weed survey, *E. crus-galli* was no longer troblesome weed. However, this species became important again thereafter by introduction of herbicide mixtures with pyrazolate, bensulfuron-methyl or pyrazosulfuron-ethyl.

For upland crop area, 216 weed species belonged to 46 families were recorded. One hundred and sixtyfive of these were grown in winter crop area while 189 weed species occurred in summer crop area, respectively. Among these, 138 weed species were grown in both crop seasons. In general, summer crops had less number of weed species compared to winter crops. Even though the dominant weed species varied by crop the most common weeds were *Chenopodium album*, *Alopecurus aqualis*, *Stellaria alsine* and *S. media* for winter crops and *Digitaria sanguinalis*, *Portulaca oleracea*, *Chenopodium album* and *Acalypha australis* for summer crops, respectively.

Key words : weed flora, lowland, upland, weed shift.

## Introduction

The weed vegetation of a particular area is determined by various factors which are themselves interrelated. These factors are largely classified as climatic, physiographic and biotic factors. Climatic factors include light (intensity, quality, day length), temperature (extremes, range, average frost-free period), water (amount, percolation, runoff, evaporation), wind (velocity, duration) and physiographic factor include edaphic (soil factors including pH, fertility, texture, structure, organic matter content, $CO_2$, $O_2$, water drainage) and biotic factors include plants (competition, disease, toxins, stimulants, parasitism) and animals (insects, grazing animals, soil fauna, man). However, the weed vegetation is most strongly affected by the biotic factor, particularly by human activity through the cultural practices.

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Several workers confirmed the effect of cultural practice on weed growth : cultivar grown (DeDatta, 1981 ; Kim et al., 1981 ; Kim et al., 1982 ; Chang, 1970), the weeding regime (Kim, 1979, 1980b ; Kim et al., 1981), land preparation (Kim et al., 1975 : Kim, 1990), and moisture regime (Smith et al, 1977 ; Swain, 1973 ; DeDatta, 1980).

Some species, however, are able to flourish under a wide range of conditions and it is this adaptabilty which is an important factor in their success as dominant weeds. Kim and Moody (1989) summarized the adaptability mechanisms of several paddy weeds.

The ultimate purpose of weed research is to obtain the maximum crop yield but still least input cost. The paper was discussed mainly on weed flora situation in agricultural area. For better understanding, information on technology development of rice cultivation and herbicide use was included.

## Technology development of rice cultivation

The percentage of food self-sufficiency in Korea was only about 43% in 1990 (RDA, 1991). However, rice and barley which were the main staple food crops were produced more than the demand while self-sufficiencies for wheat and soybean were 0.1% and 20.1%, respectively (RDA, 1991).

Until middle of 1980 research efforts of food crops were mainly focused on productivity increment through active varietal improvement and cultivation technology development.

Maintenance of the world highest yield and achievement of self-sufficiency of rice were the

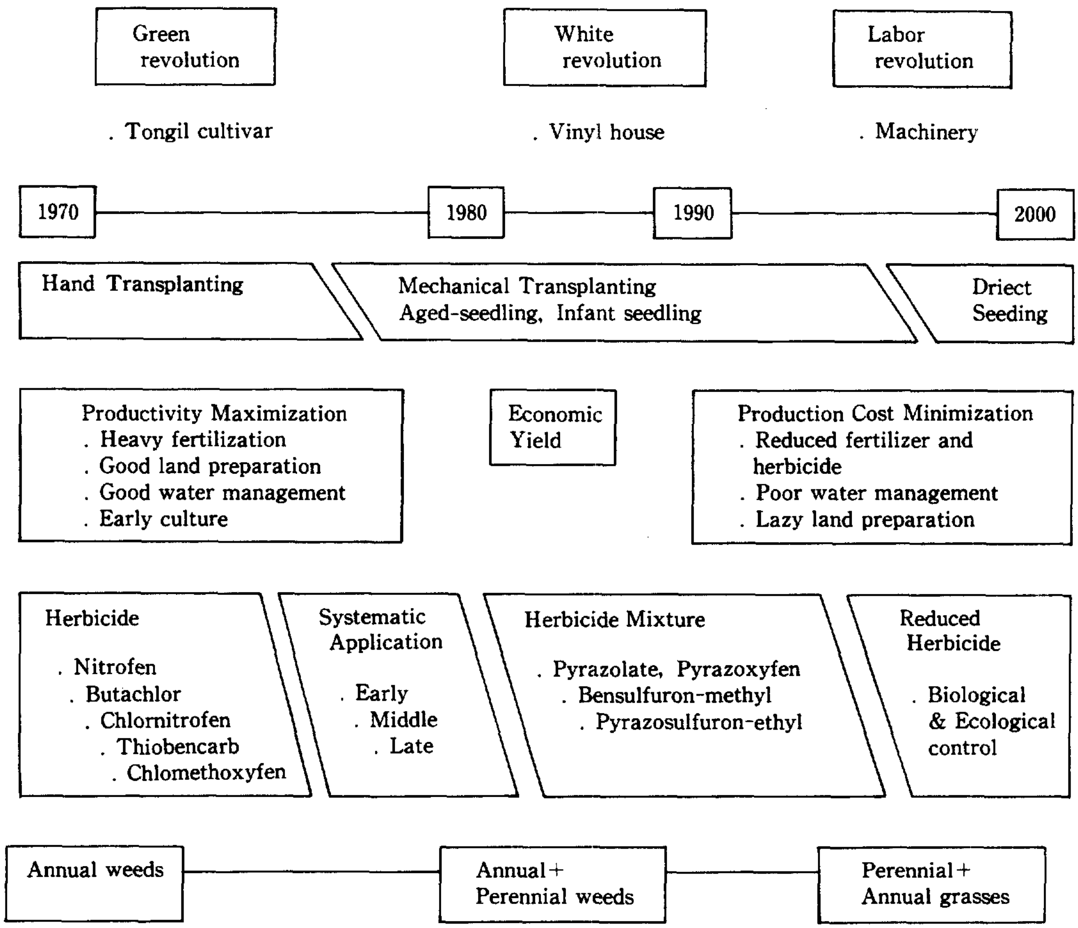


**Fig. 1.** Chronological events attributed to weed shift in paddy rice

important resultants of the active research activity. Recent international socio-economic situation made a significant change in agricultural research activity in Korea. Research efforts were mainly focused on better grain quality in varietal improvement program and low production cost in cultivation technology development program to meet international market competition.

In brief history, Korea has achieved two agricultural revolutions, green revolution in 1970s by Tongil rice variety and white revolution in 1980s by introduction of polyethylene film(vinyl). Another agricultural revolution is expected in the nearest future, "labor revolution". This might be achieved by full mechanization and full automation in farm operation. Chronological events of important cultural technologies for rice crop was given in Fig. 1.

In economic basis, in fact, Korea agricultures are still very behind compared to the advanced countries. Most of the crops are still need labor intensively as shown in Table 1. However, reduced input in cultural practices are generally resulted in stimulated weed growth and thus weed research has become more important with developing technologies of low production cost.

Rice has been a staple crop for more than thousand years in Korea. Cultivation method was also changed with time starting from primitive direct seeding method to transplanting method to maximize the productivity and the stability(Kim, 1990). Until early of 1980's all the rice area was transplanted by hand and therafter this area was replaced by mechanical transplanting using aged seedling(30~35 day-old seedling). Until recent years the cultivation target was the maximun yield while this for these days was the economic yield that minimize the production cost. Maximum yield also required the maximum input such as heavy fertilization, good tillage operation, good water management, good weed control, etc. All these cultural practices significantly affect the occurrence of weed growth. Some important chronological events that attributable in weed shift was given in Fig. 1. In 1990 infant seedling(8~10 day-old) was firstly introduced for the mechanical transplanting method to reduce labor hours and this technology has rapidly been replaced the aged seedling technology.

About 88% of rice area was transplanted by machine in 1991. Among this area about 22% was occupied by infant seedling. Furthermore, the area of the infant seedling in 1992 was 33% which was over value than the government expectation(RDA, 1992).

The most conspicuous traits were the growth

**Table 1.** Planted area, yield and labor requirement of major crops in Korea(RDA, 1991)

| Crop | Planted area (1000 ha) | Yield (kg/10a) | Labor hour (hr/10a) |
|---|---|---|---|
| Rice | 1,244 | 451 | 59.4 |
| Barley | 115 | 254 | 41.9 |
| Soybean | 152 | 178 | 80.0 |
| Corn | 31 | 630 | 115.0 |
| Potatoes | 73 | 1,782 | 135.8 |
| Garlic | 43.6 | 783 | 216.7 |
| Red pepper | 64.9 | 198 | 250.2 |
| Onion | 12.9 | 4,404 | 211.0 |
| Sesame | 58.3 | 71 | 108.0 |
| Vegetables | 317 | - | - |
| Cucumber | 7.0 | 3,001 | 330.0 |
| Strawberry | 6.9 | 972 | 342.2 |
| Apple | 48.8 | 2,169 | 375.4 |
| Pear | 9.1 | 1,960 | 406.6 |
| Peach | 12.3 | 1,555 | 343.8 |
| Orange | 19.3 | 2,715 | 248.6 |
| Grape | 15.0 | 1,431 | 344.7 |
| Persimmon | 9.9 | 836 | 217.6 |

**Table 2.** Important weed species at the direct-seeded rice (Kim, 1990).

| | | |
|---|---|---|
| Echinochloa sp<br>Barnyard grass | $C_4$ | annual grass |
| Oryza sativa sp. spontanes<br>Red rice. Weedy rice | $C_3$ | annual grass |
| Leptochloa sp.<br>Sprangle top | $C_4$ | annual grass |
| Setaria sp.<br>Foxtail, Bristle grass | $C_4$ | annual grass |
| Eleusine sp.<br>Yard grass, Silver crabgrass | $C_4$ | annual grass |
| Digitaria sp.<br>Crabgrass, Finger grass | $C_4$ | annual grass |
| Sesbania exaltata<br>Hamp sesbania | $C_3$ | annual broadleaf |
| Aęschynomene indica<br>Indian joint-vetch, Sensitive joint-vetch | $C_3$ | annual broadleaf |

amount due to extreme seeding rate. Shallow irrigation depth is useally needed for mechanical transplanting. Young and weak seedling, clipped root and shallow irrigation depth usually enhance weed growth as reported by Kim(1989).

Direct seeding method will eventually be taken over the mechanical transplanting even though this has been practiced only a limited area so far. The most important problems for direct seeding are generally known as three factors : weeds, lodging and crop standing(Hewing, 1975 ; Gacjeon, 1983 ; Hwanjeong, 1991).

Rice of direct seeding method starts from seed stage and thus weeds emerge faster than rice, absorb the available nutrients earlier, resulting in flourished weed growth. A very small advantage to one species during seedling establishment results in a very significant vested right to this species in later competition with other species. Entirely different environment in direct seeding method cause weed shift mainly to C4 grass(Table 2).

Poor water management and poor tillage operation which tend to wide practice for minimum input also enhanced the weed growth, particularly C4 grasses such as *Echinochloa* species, weedy rice, etc (Fig. 2 and Fig. 3). Occurrence of weedy rice was closely related to seeding date where early seeding

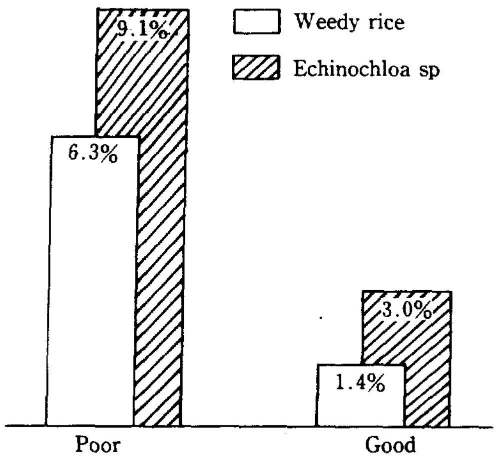


**Fig. 2.** Effect of water mangement on the occurrence of weedy rice and Echinochloa species at the farmer's fields(35 sites).

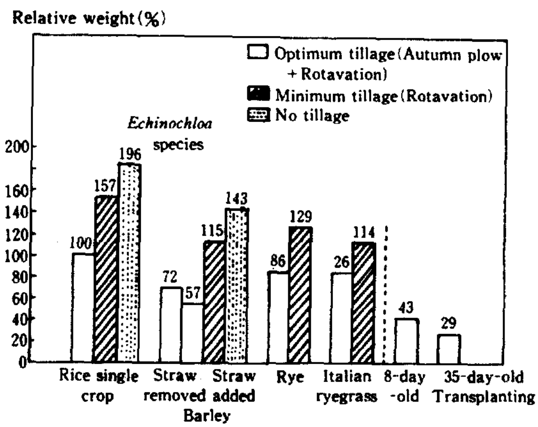


**Fig. 3.** Effect of crop selection and tillage operation on the growth of *Echinochloa* species in rice based double cropping system(YCES, 1990).

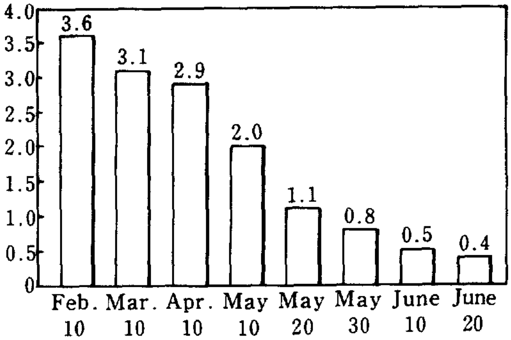


**Fig. 4.** Occurrence of weedy rice as affected by seeding date in direct-seeded rice.

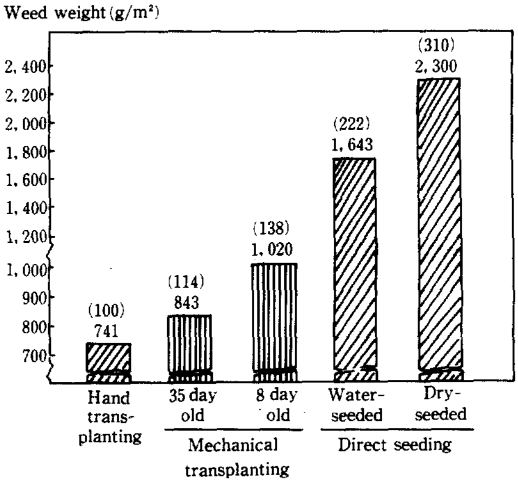


**Fig. 5.** Weed biomass as affected by seeding or transplanting method of rice at heading stage(YCES 1990).

**Table 3.** Yield loss due to weed competition in various rice cultivation methods(Kim, 1990)

| Cultivation method | Yield loss(%) |
|---|---|
| Hand transplanting | 10~ 20 |
| Mechanical transplanting | |
| · Aged seedling(35-day-old) | 25~ 30 |
| · Infant seedling(8-day-old) | 30~ 35 |
| Direct seeding | |
| · Water seeded | 40~ 60 |
| · Dry seeded | 70~100 |

enhanced the growth of weedy rice(Fig. 4).

Due to the above facts the weed growth drastically increased with change in cultivation method from transplanting to direct seeding(Fig. 5) and also yield loss due to weed competition exhibited same order with weed growth(Table 3). Comparing to conventional hand transplanting increment of weed growth for mechanical transplanting and direct seeding were 14~38%, and 122~210%, respectively. Among mechanical transplanting infant seedling had more weed growth by 21% than aged seedling. Similarily, dry seeded direct seeding was harvested 140% more weed weight than water seeded direct seeding.

Yield losses due to weed competition in different cultivation methods were 10~20% for hand transplanting, 25~30% for aged seedling mechanical transplanting, 30~35% for infant seedling mechnical transplanting, 40~60% for water direct seeding, and 70~100 for dry direct seeding, respectively.

## Herbicide Use

Herbicide application and chioce are the most important factors among cultural practices on ecology of weed growth. Herbicide application directly affect the weed growth and thus herbicide regime will be the most important cultural practice in general. Annual consumption of herbicide was about 5,510 M/T in 1990. About 46% of this was used in rice crop and rest were used for upland crops and orchard(Table 4).

For rice crop in irrigated area herbicide has been used about 150% since 1983(about 115% for total rice area) without much variations among years.

For upland crops herbicide application was far

**Table 4.** Consumption of agrochemicals in Korea in 1990(ACIS, 1991).

| Chemical | Consumption (M/T) | Percentage |
|---|---|---|
| Total | 25,082 | 100 |
| Fungicide | 7,778 | 31.0 |
| · Rice | (3,085) | (12.3) |
| · Horticultural crop | (4,693) | (18.7) |
| Insecticide | 9,332 | 37.2 |
| · Rice | (5,344) | (21.3) |
| · Horticultural crop | (3,988) | (15.9) |
| Herbicide | 5,509 | 22.0 |
| · Paddy rice | (2,535) | (10.1) |
| · Upland and orchard | (2,974) | (11.9) |
| Growth regulators | 733 | 2.9 |
| Others | 1,730 | 6.9 |

**Table 5**. Percentage of herbicide application area by crop(ACIA, 1983-1991).

| Year | Rice | | Upland crops | Orchard |
|---|---|---|---|---|
| | Irrigated | Total | | |
| 1983 | 158 | 119 | 22 | 51 |
| 1984 | 145 | 110 | 27 | 63 |
| 1985 | 138 | 107 | 31 | 73 |
| 1986 | 147 | 115 | 36 | 95 |
| 1987 | 147 | 116 | 38 | 89 |
| 1988 | 143 | 113 | 35 | 95 |
| 1989 | 145 | 114 | 38 | 119 |
| 1990 | 152 | 120 | 43 | 163 |

**Table 6**. Diversity indice of herbicidal usage by crop (ACIS, 1983-1991).

| Year | Paddy rice | Upland crops | Orchard |
|---|---|---|---|
| 1983 | 53.1 | 86.1 | 90.6 |
| 1984 | 51.6 | 90.3 | 86.2 |
| 1985 | 45.2 | 83.7 | 90.0 |
| 1986 | 47.3 | 87.0 | 87.6 |
| 1987 | 44.5 | 89.7 | 87.4 |
| 1988 | 34.3 | 88.7 | 84.7 |
| 1989 | 27.5 | 82.5 | 84.0 |
| 1990 | 19.9 | 77.8 | 73.6 |

behind to rice crop even though the area increased with year. Only 43% of upland crops was applied herbicide in 1990. Orchard area, on the other hand, was rapidly increased in herbicide application from 51% in 1983 to 163% in 1990(Table 5).

For herbicide application it is recommendable that particular herbicide should not be used to a given area continually. However, most of Korea farmers have preferentially used to a particular herbicide as indicated by diversity index of herbicide in Table 6. For rice crop, this value was gradually decreased from 53.1 in 1983 to 19.9 in 1990.

Until release of several new promising herbicide mixtures the diversity index maintained higher than 40 that imply high reliance to a particular herbicide, butachlor(Table 7). However, the situation for upland crops and orchard crops was more serious where the herbicide choice was almost totally relied on alachlor for upland crops(Table 8) and on paraquat for orchard crops(Table 9), respectively. Herbicide selection on these crops should be diversified as soon as possible to minimize the adversal effect such as resistant strain development as reported by several workers(Watanabe et al., 1982 ; Kato, and Okuda, 1983 ; Hanioka, 1983, 1989 a b c ; Usami et al., 1989 ; Asano, 1990 a b). Current recommendations for herbicide application were given in Table 10 for transplanted rice.

## Weed flora in lowland rice field

About 350 species in more than 150 genera and 60 plant families have been reported as weeds of rice (Akobundu and Fagade, 1978 ; Barrett and Seaman, 1980 ; DeDatta, 1977 ; Holm et al., 1977 ; Horng and Leu, 1977 ; Matsunaka, 1970 ; Noda, 1977 ; Pancho et al., 1969 ; Ronoprawiro et al, 1973 ; WARDA, 1979 ; Smith, 1983). Species of Gramineae are the most common, with more than 80 reported as weeds of rice.

Species of Cyperaceae rank next in abundance with more than 50 reported as weeds of rice. Other families with 10 or more species reported as weeds of rice include Alismataceae, Asteraceae, Fabaceae, Lythraceae, and Scrophulariaceae(Smith, 1983).

About 15 species were recognized as the troublesome weeds that resulted in significant yield loss due to competition. *Echinochloa crus-galli* is the most troublesome weed of rice and followed by *E. colona* in the world(Holm et al., 1977). *E. colona* tends to grow along the equator, but *E. crus-galli* has a greater range from north to south. Other rice field weeds of world importance are *Cyperus difformis*, *C. rotundus*, *C. iria*, *Fimbristylis littorolis*, *Monochoria vaginalis*, *Sphenochlea zeylanica*, ete. (Smith, 1983).

Nationwide weed survey was carried out in 1971 and 1981 by RDA (rural development administration) research institute, three crop experiment stations and 9 provincial RDAs. In 1990 and 1991, regional weed survey in rice area was conducted by Kyonggi and Chungbuk provincial RDA.

Before 1970 herbicide was not used in rice crop and thus weed survey in 1971 was eliminated the effect of herbicide.

During 10 years from 1971 to 1980 could be considered as the period that herbicides which effective to annual weeds were intensively used. In the late stage of this period butachlor was preferentially used mainly for controlling of *Echinochloa* species, *Mono-*

**Table 7**. Important herbicides for lowland rice and their relative usage(ACIA, 1983-1991). (unit ; %)

| Herbicide | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| Butachlor | 71.7 | 70.9 | 66.1 | 67.9 | 65.5 | 56.7 | 48.8 | 38.9 |
| Thiobencarb | 11.6 | 9.3 | 9.7 | 3.8 | 2.6 | 2.6 | 2.9 | 2.9 |
| Piperophos/Dimethametryn | 5.4 | 5.2 | 4.1 | 2.3 | 0.5 | 2.3 | 2.8 | 2.5 |
| Bifenox | 2.1 | 0.6 | 0.9 | 1.0 | 0.8 | 0.1 | 0 | 0 |
| Nitrofen | 1.3 | 1.1 | 1.0 | - | - | - | - | - |
| Chlornitrofen | 1.3 | 1.7 | 0.8 | 0.9 | 0.6 | 0.5 | 0.4 | - |
| Thiobencarb/Naproanilide | 1.2 | 2.0 | 1.6 | 1.1 | 0.3 | 0.5 | 0.5 | 0 |
| Molinate/Simetryne | 0.9 | 1.3 | 1.2 | 2.0 | 1.5 | 1.8 | 1.3 | 0.6 |
| Chlomethoxyfen | 0.9 | 1.2 | 1.4 | 1.7 | 1.7 | 1.4 | 0.7 | 0.4 |
| Perfluidone | 0.7 | 0.5 | - | 0.1 | 0.1 | 0 | 0 | 0.1 |
| Butachlor/Pyrazolate | 0.4 | 2.4 | 4.0 | 7.2 | 8.0 | 7.7 | 4.6 | 7.9 |
| Butachlor/Chlomethoxyfen | 0.2 | 1.0 | 4.9 | 4.0 | 6.5 | 7.4 | 5.9 | 4.0 |
| Pretilachlor | - | 0.3 | 2.0 | 4.5 | 6.6 | 8.8 | 11.6 | 9.7 |
| Pretilachlor/Naproanilide | - | 0.1 | 1.1 | 1.0 | 0.3 | 0.2 | 0.1 | - |
| Pyrazoxyfen/Piperophos | - | - | - | 0.2 | 2.5 | 0 | 0 | 0 |
| Oxadiazon | 0.3 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 |
| Pyrazoxyfen/Butachlor | - | - | - | - | - | 0.2 | 0.3 | 1.1 |
| Bensulfuron-methyl/Butachor | - | - | - | - | - | 0.6 | 15.0 | 18.0 |
| Bensulfuron-methyl/Quinclorac | - | - | - | - | - | - | 2.3 | 3.7 |
| Bensulfuron-methyl/Mefenacet | - | - | - | - | - | - | 0.3 | 3.1 |
| Bensulfuron-methyl/Pretilachlor | - | - | - | - | - | - | - | 2.2 |
| Pyrazosulfuron-ethyl/Molinate | - | - | - | - | - | - | - | 0.6 |
| Pyrazosulfuron-ethyl/Thiobencarb | - | - | - | - | - | - | - | 0.3 |
| Pyrazosulfuron-ethyl/Butachlor | - | - | - | - | - | - | - | 0.2 |
| Pyrazosulfuron-ethyl/Quinclorac | - | - | - | - | - | - | - | 0.7 |
| Quinclorac/Bentazon | - | - | - | - | - | - | 0.8 | 0.8 |
| Total | 98.0 | 98.0 | 99.4 | 98.2 | 98.0 | 96.7 | 98.5 | 98.3 |
| Diversity index | 53.1 | 51.6 | 45.2 | 47.3 | 44.5 | 34.3 | 27.5 | 19.9 |

**Table 8**. Important herbicides for upland crops and their relative usage(ACIA, 1983-1991). (unit ; %)

| Herbicide | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| Alachlor | 92.9 | 95.0 | 91.5 | 93.3 | 94.7 | 94.2 | 90.8 | 88.1 |
| Butachlor | 3.3 | 1.8 | 1.7 | 1.5 | 1.5 | 1.0 | 2.0 | 1.4 |
| Nitrofen | 0.7 | 0.02 | 0 | 0 | 0 | - | - | - |
| Chlornitrofen | 0.5 | 0.8 | 1.3 | 0.6 | 0.1 | 0.3 | 0.2 | 0.2 |
| Trifluralin | 0.4 | 0.51 | 1.3 | 1.1 | 0.3 | 0.2 | 0.1 | 0.1 |
| Pendimethalin | 0.4 | 0.01 | 0.4 | 0.8 | 1.0 | 1.6 | 3.2 | 4.4 |
| Linuron | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 |
| Simazine | 0.3 | 0.5 | 2.1 | 0.8 | 0.4 | 0.3 | 0.4 | 0.5 |
| Napropamide | 0.2 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 0.5 |
| Methabenzthiazuron | - | 0.1 | 0.3 | 0.4 | 0.4 | 0.4 | 0.6 | 0.6 |
| Metolachlor | - | - | - | - | - | - | 0.1 | 1.6 |
| Alachlor/ Pendimethalin | - | - | - | - | - | - | 0.2 | 0.5 |
| Total | 99.1 | 99.1 | 99.0 | 99.0 | 99.0 | 98.8 | 98.3 | 98.1 |
| Diversity index | 86.1 | 90.3 | 83.7 | 87.0 | 89.7 | 88.7 | 82.5 | 77.8 |

*choria vaginalis*, *Rotala indica*, *Eleocharis acicularis*, etc. Later 10 years from 1981 to 1990 herbicide mixtures were introduced even though the reliance to butachlor maintained still high. In recent, several mixtures with sulfonylurea compounds such as bensulfuron-methyl and pyrazosulfuron-ethyl were

**Table 9**. Important herbicides for orchard and their relative usage (ACIA, 1983-1991). (unit ; %)

| Herbicide | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| Paraquat | 95.1 | 92.7 | 94.8 | 93.5 | 93.3 | 91.7 | 91.4 | 85.3 |
| Glyphosate | 4.2 | 5.4 | 3.5 | 4.9 | 6.1 | 7.6 | 7.4 | 9.1 |
| Oxyfluorfen | 0.4 | 1.5 | 0.6 | 0.4 | 0.3 | 0.3 | 0.2 | 0.1 |
| Bromacil | 0.1 | 0.1 | 0.3 | 0.1 | 0.2 | 0.3 | 0.4 | 0.3 |
| Glufosinate | - | - | - | - | - | - | 0.4 | 4.9 |
| Terbuthylazine | - | - | - | - | - | - | - | 0.2 |
| Total | 95.1 | 99.7 | 99.2 | 98.9 | 99.9 | 99.9 | 99.8 | 99.9 |
| Diversity index | 90.6 | 87.2 | 90.0 | 87.6 | 87.4 | 84.7 | 84.0 | 73.6 |

**Table 10**. Recommendation of herbicide application for the conventional hand transplanting and mechanical transplanting of lowland rice in Korea.

| Early | | Middle | Late |
|---|---|---|---|
| 2DBT-7DAT[a] | | 10-15DAT | 23-30DAT |
| Soil (Incorporation) | | Soil, Foliar | Foliar |
| Single | Mixture | | |
| · thiobencarb | · thiobencarb/naproanilide | · piperophos/dimethametryn | · MCPA |
| · chlornitrofen | · butachlor/chlomethoxyfen | · molinate/simetryne | · 2, 4-D |
| · butachlor | · butachlor/naproanilide | · molinate/simetryne/ MCPB | · bentazon |
| · oxadiazon | · butachlor/pyrazolate | · mefenacet/ bensulfuron-methyl | · quinclorac/ bentazon |
| · perfluidone | · pretilachlor/naproanilide | · pyrazosulfuron-ethyl/ thiobencarb | |
| · chlomethoxyfen | · pyrazoxyten/piperophos | · bensulfuron-methyl/ thiobencarb | |
| · bifenox | · butachlor/ bensulfuron-methyl | · dimepiperate/ bensulfuron-methyl | |
| · pretilachlor | · bifenox/perfluidone | · pyrazosulfuron-ethyl/ molinate | |
| · mefenacet | · pyrazoxyfen/butachlor | · pyrazosulfuron-ethyl/ quinclorac | |
| | · mefenacet/pyrazolate | · bensulfuron-methyl/ quinclorac | |
| | · pyrazosulfuron-ethyl/ butachlor | · mefenacet/ bensulfuron-methyl/ dymron | |
| | · bensulfuron-methyl/ pretilachlor | | |
| | · oxadiazon/ bensulfuron-methyl | | |
| | · pyributicarb/ bensulfuron-methyl | | |

a) DBT ; days before transplanting, DAT ; days after transplanting

released (Table 11). Other sulfonyl urea compounds, chlorsulfuron, metsulfuron-methyl, and cinosulfuron are under evaluation.

Sulfonyl urea compounds are generally known that herbicidal efficacy to grass weeds are relatively low (Guh et al., 1988 ; Pyon et al., 1988 ; Takeda et al., 1985 ; Yuyama et al., 1987a b ; Swisher and Weimer, 1986).

Results of weed survey were well responded to use of herbicides as mentioned above. Similarity coefficient between years in terms of floristic composition with the degree of dominance was about only 37~39 between 1971 and 1981 or 1991 while this for 1981 and 1991 was 62 (Table 12). Diversity index of floristic composition was lower in 1981 and 1991 compared to 1971 (Table 12). These results indicate that herbicide introduction made a significant change in dominant species and diversified the floristic composition and the degree of dominance.

Ecogeographically, Korea is broadly divided into three regions, Middle region which include four provinces, Kyonggi, Kangweon, Chungbuk and

**Table 11**. List of herbicide mixtures for lowland rice in Korea (ACIS, 1991)

| No | Herbicide mixture (active ingredient, %) | | Application time (DAT)[a] |
|---|---|---|---|
| 1 | thiobencarb/naproanilide | (7/7) | 5- 7 |
| 2 | butachlor/chomethoxyfen | (3/3) | 5 |
| 3 | butachlor/naproanilide | (4/6) | 3- 5 |
| 4 | piperophos/dimethametryn | (4.4/1.1) | 5-10 |
| 5 | pretilachlor/naproanilide | (2/7) | 3- 7 |
| 6 | molinate/simetryn | (5/1.2) | 10-15 |
| 7 | molinate/simetryn/MCPB | (9/1.5/0.8) | 13-17 |
| 8 | bifenox/perfluidone | (3.5/2.5) | 3- 5 |
| 9 | pyrazolate/butachlor | (6/3.5) | 3- 5 |
| 10 | pyrazolate/mefenacet | (4/3) | 5- 7 |
| 11 | pyrazoxyfen/butachlor | (6/3.5) | 3- 5 |
| 12 | pyrazoxyfen/pretilachlor | (6/1) | 3- 5 |
| 13 | pyrazoxyfen/piperophos | (6/3) | 3- 7 |
| 14 | bensulfuron-methyl /butachlor (0.17/2.5) | | 5- 7 |
| 15 | 〃 /oxadiazon (0.13/0.8) | | 5- 7 |
| 16 | 〃 /pyributicarb (0.13/3.0) | | 5- 7 |
| 17 | 〃 /mefenacet (0.17/2.5) | | 5-12 |
| 18 | 〃 /dimepiperate (0.13/7) | | 5-10 |
| 19 | 〃 /thiobenacarb (0.13/5) | | 5-10 |
| 20 | 〃 /pretilachlor (0.17/1.0) | | 5- 7 |
| 21 | 〃 /mefenacet/dymron (0.13/3.5/1.5) | | 10-15 |
| 22 | 〃 /quinclorac (0.17/0.1) | | 10-15 |
| 23 | pyazosulfuron-ethyl /butachlor (0.07/2.5) | | 5- 7 |
| 24 | 〃 /thiobencarb (0.07/5) | | 5-10 |
| 25 | 〃 /molinate (0.07/5) | | 7-15 |
| 26 | 〃 /quinclorac (0.07/1.0) | | 10-15 |
| 27 | bentazon /quinclorac (10/1.0) | | 15 |

a) days after transplanting

**Table 12**. Similarity coefficient between years in terms of floristic composition with the degree of dominance.

| Year | 1971 | 1981 | 1991 |
|---|---|---|---|
| 1971 | (0.208) a | 39.3 | 36.5 |
| 1981 | | (0.111) | 62.0 |
| 1991 | | | (0.117) |

a) diversity index

Chungnam provinces, Honam region which include two provinces, Chonbuk and Chonnam provinces, and Yeongnam region which include two provinces, Kyongbuk and Kyongnam provinces, respectively.

Regional variation, in general, was also became less by herbicide introduction as shown in Table 13 where high similarity coefficient was recorded in 1981 than 1971. The similarity coefficient again decreased in 1991 except the value between Middle region and Yeongnam region. This inconsistency and lower similarity coefficient between 1981 and 1991 might possibly due to the differential herbicide selection.

In fact, harvested weed species was not much changed since 1971. About 29 weed species belonged to 18 families were recorded (Table 14). However,

**Table 13**. Similarity coefficient of floristic composition among regions

| Region | Nationwide | Middle | Honam | Yeongnam |
|---|---|---|---|---|
| Nationwide | | 70.3 (86.3) | 76.9 (77.9) | 71.2 (85.2) |
| Middle | 85.1 | *1971 (1981)* | 59.6 (68.7) | 47.5 (76.4) |
| Honam | 69.0 | 55.7 *1991* | | 60.0 (69.1) |
| Yeongnam | 79.6 | 83.6 | 50.5 | |

**Table 14.** Main weeds and their dominances in paddy field in Korea.

| Family | Scientific name | | Life Cycle | Dominance(%) 1971 | 1981 | 1991 |
|---|---|---|---|---|---|---|
| Alismataceae | *Sagittaria pygmaea* Miquel | | P | 1.6 | 17.5 | 15.6 |
| | *S. trifolia* L. | | P | 0.5 | 9.0 | 13.2 |
| Callitrichaceae | *Callitrche fallox* Petrov | | A | 1.8 | - | - |
| Commelinaceae | *Aneilema japonica* Kunth. | | A | 2.5 | 4.4 | 2.5 |
| Cyperaceae | *Cyperus difformis* L. | | A | 7.8 | 0 | 2.3 |
| | *C. serotinus* Rottb. | | P | 0.8 | 8.5 | 4.6 |
| | *Eleocharis acicularis* Roem et Schult | | P | 11.8 | 1.6 | 0.2 |
| | *E. congesta* Don. | | A | 0.1 | 0.2 | - |
| | *E. maritimus* L. | | P | 2.2 | 3.4 | 19.6 |
| | *Fimbristylis miliacea* Vahl. | | A | - | 0.3 | 0.6 |
| | *Scirpus hotarui* Ohwi | | A | 0.8 | 1.3 | 6.0 |
| | *S. maritimus* L. | | P | 0 | 0.3 | 0.2 |
| Eriocaulaceae | *Eriocaulon sieboldianum* Murata | | A | 0.1 | 0.2 | - |
| Gramineae | *Echinochloa crus-galli* Beauv. | | A | 7.1 | 2.3 | 12.2 |
| | *Leersia japonica* Makino | | P | - | 2.1 | 1.3 |
| Leguminosae | *Aeschynomene indica* L. | | A | - | 0.1 | 0.5 |
| Lemnaceae | *Spirodela polyrhiza* Schleider | | P | 0.6 | 0.3 | - |
| Lobeliaceae | *Lobelia chinensis* Lour. | | P | 0 | 0.3 | - |
| Lythraceae | *Rotala indica* Koehne | | A | 40.7 | 6.0 | 2.2 |
| Marsileaceae | *Marsilea quadrafolia* L. | | P | 0.1 | 0.1 | - |
| Onagraceae | *Ludwigia prostrata* Roxb. | | A | - | 3.0 | 2.6 |
| Polygonaceae | *Polygonum hydropiper* L. | | A | 1.9 | 2.7 | 1.1 |
| Pontederiaceae | *Monochoria korsakowii* Regel et Maak | | A | 0.1 | 0.7 | - |
| | *M. vaginalis* Presl. | | A | 11.3 | 22.2 | 11.2 |
| Potamogetonaceae | *Potamogeton distinctus* Benn. | | P | 3.5 | 9.0 | 3.3 |
| Salviniaceae | *Salvinia natans* All. | | A | 0.3 | 0 | - |
| Scrophulariaceae | *Gratiola juncea* Roxb. | | A | 1.0 | 0.2 | - |
| | *Lindernia procumbens* Philcox | | A | 3.4 | 3.9 | 0.7 |
| Umbelliferae | *Oenathe javanica* Dc. | | P | - | 0.4 | 0.1 |
| 18 families | 29 species | annual(A) | 17 | 78.9 | 47.5 | 41.9 |
| | | perennial(P) | 12 | 21.2 | 52.5 | 58.1 |

greater difference was shown in the degree of dominance. In general, perennial weed species were rapidly increased by herbicide introduction : the degree of dominance occupied by perennial weeds was 21%, 53% and 58% for 1971, 1981 and 1991, respectively (Fig 6).

Particularly, *Eleocharis kuroguwai* were drastically increased since 1981 and became the most troblesome weed in 1991 survey(Fig 7). The second most importand weed species was *Sagittaria pygmaea* followed by *S. trifolia*, *Echinochloa crus-galli* and *Monochoria vaginais* which was the most important weed species in 1981 having its importance value of 22.2%. *Rotala indica* which was the most widely distributed in 1971 was no longer important with in 1981 and in 1991. Rapid increment of *E. kuroguwai*,

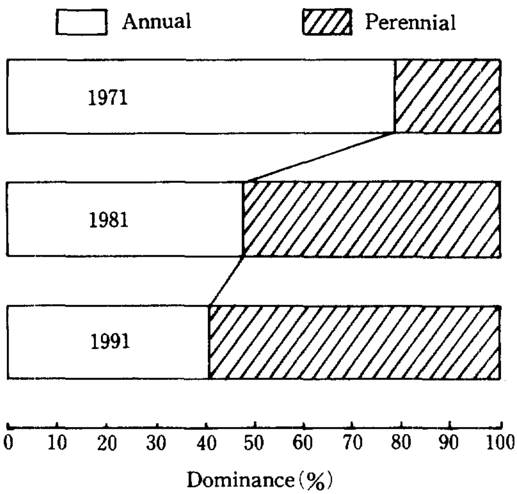


**Fig. 6.** Changes in dominance by year.

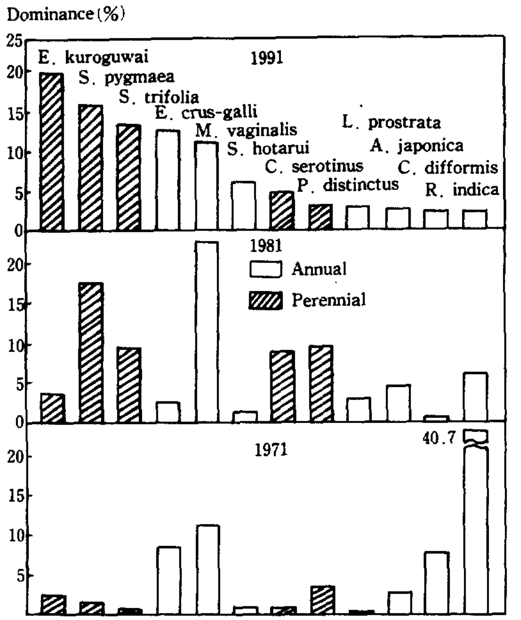


**Fig. 7.** Changes in dominant weed species in Korea.

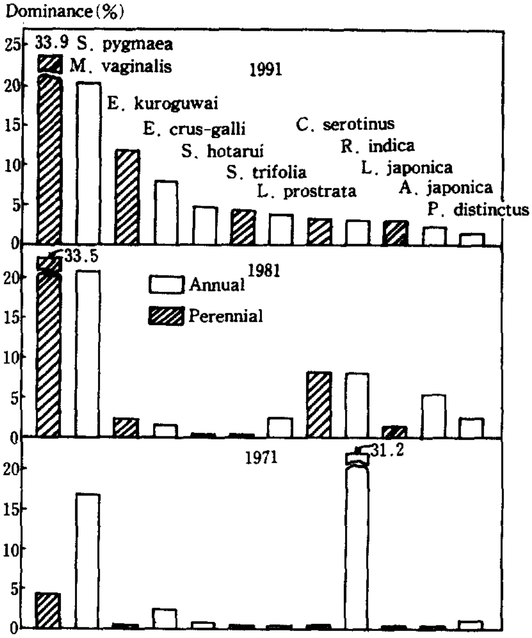


**Fig. 8.** Changes in dominant weed species in Honam region.

*S. trifolia* and *E. crus-galli* during past 10 years was nicely coincided with releasing of herbicide mixtures of pyrazolate or sulfonylurea compounds.

There were some regional variation in terms of the dominant weed species and their importance. Honam region, for example, *Sagittaria pygmaea* was the most important weed species since 1981 (Fig 8) while these for Middle region (Fig 9) and Yeongnam region (Fig 10) were *E. kuroguwai*, *S. trifolia* and *E. crus-galli*, in order. Distribution pattern of these species was differed somewhat from each other. *E. kuroguwai* and *S. trifolia* were sporadically distributed while *E. crus-galli* was relatively widely and evenly distributed. In case of *E. kuroguwai* and *S. trifolia* were once infested to a particular field, all the field will heavily be infested within a couple of years.

In accordance with minimum input of cultural practices and existing herbicide mxtures above three weed species will be the most troublesome weeds in transplanted lowland rice area for a while. Some other detailed informations by region on floristic importance were given in Table 15.

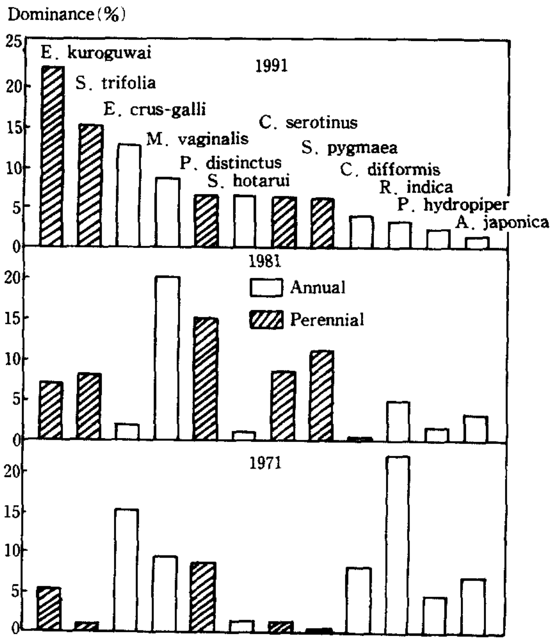


**Fig. 9.** Changes in dominant weed species in Middle region.

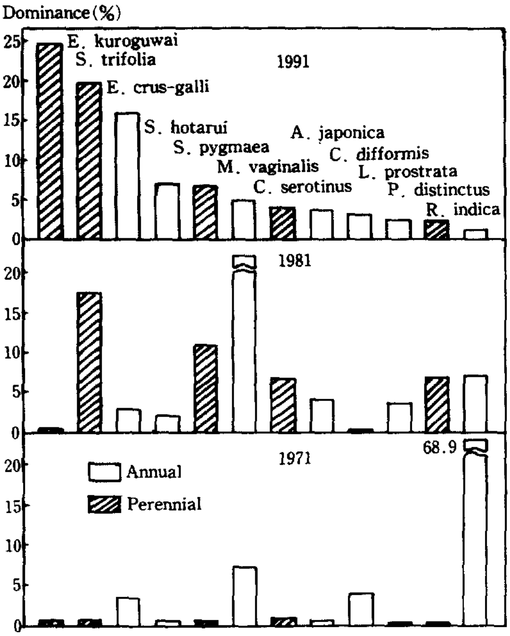


**Fig. 10.** Changes in dominant weed species in Yeongnam region.

### Weed flora in upland crops

Arable land in the world reaches about 1.5 billion hectares. 1.36 billion hectares of these are belonged to upland. Approximately 200 weed species are known as the troublesome weeds in upland crops (Takematsu and Takeuchi, 1983). Some of the serious weeds are *Eleusine indica*, *Sorghum halepense*, *Imperata cylindrica*, *Portulaca oleracea*, *Chenopodium album*, *Digitaria sanguinalis*, *Convolvulus arvensis*, *Avena fatua*, *Amaranthus* sp. *Paspalum cojugatum*, *Rottboellia exaltata*, etc. Unlike to lowland, upland is cultivated by various crops and thus diversed weed species are grown.

Nationwide weed survey in upland crop area was carried out for 3 years from 1988 to 1990 by wheat and barley institute, RDA. Weeds were surveyed seasonally, ecogeographically and regionally. Two hundred and sixteen weed species belonged to 46

**Table 15.** Regional dominant weeds and their dominances in association with investigated years.

| Weed species | Nationwide | | | Middle Region | | | Honam Region | | | Yeongnam Region | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1971 | 1981 | 1991 | 1971 | 1981 | 1991 | 1971 | 1981 | 1991 | 1971 | 1981 | 1991 |
| *M. vaginalis* | 11.3 | 22.2 | 11.2 | 9.5 | 20.3 | 8.7 | 16.9 | 20.7 | 20.3 | 7.4 | 23.4 | 4.7 |
| *S. pygmaea* | 1.6 | 17.5 | 15.6 | 0.1 | 13.3 | 6.1 | 4.5 | 33.5 | 33.9 | 0.3 | 11.8 | 6.8 |
| *P. distinctus* | 3.5 | 9.0 | 3.3 | 8.7 | 15.3 | 6.4 | 1.2 | 2.4 | 1.4 | 0.5 | 6.7 | 2.2 |
| *S. trifolia* | 0.5 | 9.0 | 13.2 | 0.8 | 8.1 | 15.3 | 0.3 | 0.3 | 4.1 | 0.4 | 17.4 | 19.8 |
| *C. serotinus* | 0.8 | 8.5 | 4.6 | 1.3 | 10.3 | 6.3 | 0.6 | 8.1 | 3.5 | 0.6 | 6.8 | 4.0 |
| *R. indica* | 40.7 | 6.0 | 2.2 | 22.1 | 4.9 | 3.3 | 31.2 | 8.0 | 3.0 | 68.7 | 6.9 | 0.2 |
| *A. japonica* | 2.5 | 4.4 | 2.5 | 7.1 | 3.4 | 1.6 | 0.3 | 5.2 | 2.1 | - | 4.2 | 3.7 |
| *L. procumbens* | 3.4 | 3.9 | 0.7 | 4.4 | 3.2 | 0.8 | 5.6 | 5.1 | 0.2 | 0.1 | 3.6 | 1.2 |
| *E. kuroguwai* | 2.2 | 3.4 | 19.6 | 5.4 | 6.9 | 22.4 | 0.5 | 2.3 | 11.7 | 0.6 | 0.4 | 24.8 |
| *L. prostrata* | - | 3.0 | 2.6 | - | 2.0 | 1.6 | - | 2.4 | 3.7 | - | 3.7 | 2.4 |
| *P. hydropiper* | 1.9 | 2.7 | 1.1 | 5.5 | 1.6 | 2.2 | 0.1 | 3.2 | - | - | 3.6 | 1.0 |
| *E. crus-galli* | 7.1 | 2.3 | 12.2 | 15.4 | 1.9 | 12.8 | 2.4 | 1.7 | 8.0 | 3.4 | 2.7 | 15.9 |
| *L. japonica* | - | 2.1 | 1.3 | - | 2.9 | 0.7 | - | 1.5 | 3.0 | - | 1.1 | 0.3 |
| *E. acicularis* | 11.8 | 1.6 | 0.1 | 7.2 | 2.3 | 0.4 | 16.6 | 2.6 | - | 11.7 | 1.4 | 0.3 |
| *S. hotarui* | 0.8 | 1.3 | 6.0 | 1.4 | 0.9 | 6.4 | 1.0 | 0.3 | 4.8 | - | 2.1 | 6.9 |
| *M. korsakowii* | 0.1 | 0.7 | - | - | - | - | 0.2 | 0.8 | - | - | 1.9 | - |
| *S. maritimus* | 0 | 0.3 | 0.2 | - | 0.3 | 0.5 | 0 | 0.1 | - | - | 0.2 | 0.2 |
| *G. juncea* | 1.0 | 0.2 | - | 0.1 | 0.1 | - | 2.7 | 0.2 | - | 0.1 | 0.1 | - |
| *S. natans* | 0.3 | 0 | - | 0.3 | 0 | - | 0.3 | - | - | 0.3 | - | - |
| *E. sieboldianum* | 0.1 | 0.2 | - | 0.1 | 0.6 | - | 0.2 | 0.1 | - | 0.1 | 0.1 | - |
| *A. indica* | - | 0.1 | 0.5 | - | 0.1 | 0.3 | - | 0.3 | - | - | 0.1 | 1.2 |
| *S. polyrhiza* | 0.6 | 0.3 | - | 0.3 | 0.4 | - | 0.3 | 0.1 | - | 1.3 | 0.5 | - |
| *M. quadrifolia* | 0.1 | 0.1 | - | - | 0.1 | - | - | - | - | 0.2 | 0.1 | - |
| *L. chinensis* | 0 | 0.3 | - | 0.1 | 0.3 | - | - | 0.1 | - | - | 0.4 | - |
| *O. javanica* | - | 0.4 | 0.1 | - | 0.4 | 0.2 | - | 0.7 | - | - | 0.3 | - |
| *E. congesta* | 0.1 | 0.2 | - | 0.1 | 0.3 | - | - | - | - | 0.1 | 0.2 | - |
| *F. miliacea* | - | 0.3 | 0.6 | - | 0.1 | 0.3 | - | 0.3 | 0.2 | - | 0.3 | 1.3 |
| *C. difformis* | 7.8 | 0 | 2.3 | 10.1 | 0 | 3.7 | 9.1 | 0 | 0.1 | 4.2 | 0 | 3.1 |
| *C. fallox* | 1.8 | - | - | - | - | - | 6.0 | - | - | - | 0.1 | - |

**Table 16.** Systematic botanical distribution of weed species in upland crop fields and non-cultivated area (MST, 1991).

| No | Family | Species number | No | Family | Species number |
|---|---|---|---|---|---|
| 1 | Compositae | 37 | 24 | Phytolaccaceae | 2 |
| 2 | Gramineae | 32 | 25 | Primulaceae | 2 |
| 3 | Polygonaceae | 13 | 26 | Commelinaceae | 2 |
| 4 | Leguminosae | 13 | 27 | Aizoaceae | 1 |
| 5 | Labiatae | 13 | 28 | Asclepiadaceae | 1 |
| 6 | Cyperaceae | 11 | 29 | Moraceae | 1 |
| 7 | Scrophulariaceae | 8 | 30 | Oxalidaceae | 1 |
| 8 | Cruciferae | 7 | 31 | Lobeliaceae | 1 |
| 9 | Rosaceae | 7 | 32 | Conabinaceae | 1 |
| 10 | Euphorbiaceae | 7 | 33 | Araceae | 1 |
| 11 | Caryophyllaceae | 6 | 34 | Violaceae | 1 |
| 12 | Amaranthaceae | 5 | 35 | Portulacaceae | 1 |
| 13 | Chenopodiaceae | 4 | 36 | Equisetaceae | 1 |
| 14 | Convolvulaceae | 4 | 37 | Pteridaceae | 1 |
| 15 | Umbelliferae | 3 | 38 | Eriocaulaceae | 1 |
| 16 | Ranunculaceae | 3 | 39 | Crassulaceae | 1 |
| 17 | Solanaceae | 3 | 40 | Lyhraceae | 1 |
| 18 | Rubiaceae | 3 | 41 | Papaveraceae | 1 |
| 19 | Plantaginaceae | 3 | 42 | Geraniaceae | 1 |
| 20 | Borraginaceae | 2 | 43 | Acanthaceae | 1 |
| 21 | Onagraceae | 2 | 44 | Cucurbitaceae | 1 |
| 22 | Liliaceae | 2 | 45 | Vitaceae | 1 |
| 23 | Meuispermaceae | 2 | 46 | Fumariaceae | 1 |
| | | | | Total | 216 |

families were recorded in upland crop area in Korea (Table 16). One hundred and sixtyfive of these were grown in winter crop area while these for summer crop area were 189 species (Table 17). One hundred and thirtyeight species were grown in both winter and summer crops.

Among crops garlic and orchard had the highest number of weed species while corn had the least number (Table 18). In general, summer crops had less number of weed species compared to winter crops.

Among 10 upland crops and non-crop area corn field had the highest total similarity coefficient in terms of floristic composition and followed by potatoes, sesame, red pepper, pulse, etc while wheat & barley had the least value (Table 19). Winter crops had generally least similarity values compared to summer crops.

For crop pairs, red pepper and sesame had the highest similarity coefficient having value of 39.4% followed by sesame and corn (29.6%), red pepper and corn (27.2%), respectively (Table 19).

Diversity index of floristic composition which indicate the degree of dominance distribution was the

**Table 17.** Number of weed species distributed in the cultivation area of winter and summer crops (MST, 1991).

| Classification | Family | Species |
|---|---|---|
| Winter crop | 39 | 165 |
| Summer crop | 41 | 189 |
| Total | 46 | 216 |
| Both | 34 | 138 |

**Table 18.** Number of weed species in different crop fields (MST, 1991).

| Summer Crop | Species | Winter Crop | Species |
|---|---|---|---|
| Red Pepper | 56 | Wheat & Barley | 77 |
| Sesame | 52 | Onion | 66 |
| Corn | 45 | Garlic | 86 |
| Pulse | 64 | Vegetable | 67 |
| Potatoes | 54 | Orchard | 84 |
| Orchard | 78 | Neighbor | 96 |
| Neighbor | 93 | | |

**Table 19.** Similarity coefficient between crops in terms of floristic composition.

| Crop | Wheat & Barley | Onion | Garlic | Vegetables | Sesame | Red pepper | Corn | Pulse | Potatoes | Orchard | Neighbor (Non-crop) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat & Barley | (5.4) | 13.9 | 9.3 | 1.2 | 0 | 0 | 3.0 | 2.7 | 3.0 | 3.0 | 3.0 | 39.1 |
| Onion | | (0.9) | 13.9 | 1.2 | 0 | 0 | 5.0 | 2.7 | 4.0 | 4.4 | 4.6 | 49.7 |
| Garlic | | | (1.2) | 1.2 | 0 | 0 | 5.0 | 2.7 | 4.0 | 4.4 | 4.6 | 45.1 |
| Vegetables | | | | (0.2) | 7.5 | 7.5 | 7.5 | 7.5 | 8.7 | 7.5 | 3.8 | 53.6 |
| Sesame | | | | | (6.7) | 39.4 | 29.6 | 13.4 | 22.0 | 13.2 | 8.0 | 133.1 |
| Red pepper | | | | | | (5.3) | 27.2 | 13.4 | 22.0 | 13.2 | 8.0 | 130.7 |
| Corn | | | | | | | (11.0) | 14.4 | 20.4 | 17.2 | 12.6 | 141.9 |
| Pulse | | | | | | | | (1.0) | 17.7 | 17.1 | 11.7 | 103.3 |
| Potatoes | | | | | | | | | (2.3) | 18.8 | 13.6 | 134.2 |
| Orchard | | | | | | | | | | (1.8) | 20.6 | 119.4 |
| Neighbor (non-crop) | | | | | | | | | | | (3.4) | 90.5 |

(  ) ; diversity index

**Table 20.** The most important five weed species and their dominance in several winter crops (MST, 1991).

| Crop | Weed species | Dominance (%) |
|---|---|---|
| Wheat & Barley | *Alopecurus aqualis* | 21.6 |
| | *Stellaria alsine* | 6.7 |
| | *Chenopodium album* | 3.0 |
| | *Stellaria media* | 2.7 |
| | *Galium spurium* | 2.6 |
| | Diversity index | 5.4 |
| Onion | *Chenopodium album* | 5.5 |
| | *Alopecurus aqualis* | 5.2 |
| | *Stellaria media* | 4.7 |
| | *S. alsine* | 3.0 |
| | *Rorippa islandica* | 2.1 |
| | Diversity index | 0.9 |
| Garlic | *Chenopodium album* | 9.0 |
| | *Alopecurus aqualis* | 4.0 |
| | *Rorippa islandica* | 3.1 |
| | *Capsella bursa-pastoria* | 2.9 |
| | *Stellaria alsine* | 2.3 |
| | Diversity index | 1.2 |
| Vegetables | *Portulaca oleracea* | 3.7 |
| | *Digitaria sanguinalis* | 2.6 |
| | *Chenopodium album* | 1.2 |
| | *Cyperus amuricus* | 1.2 |
| | *Amaranthus lividus* | 1.0 |
| | Diversity index | 0.2 |

highest at corn (11.0) followed by wheat & barley (5.4) and red pepper (5.3) while the least values were given at vegetables (0.2) and onion (0.9), respectively (Table 19). In general, the higher the diversity index, the more important of a particular species.

**Table 21.** The most important five weed species and their dominance in several summer crops (MST, 1991).

| Crop | Weed species | Dominance (%) |
|---|---|---|
| Sesame | *Digitaria sanguinalis* | 21.2 |
| | *Portulaca oleracea* | 13.0 |
| | *Cyperus amuricus* | 6.4 |
| | *Acalypha australis* | 3.4 |
| | *Setatia virdus* | 2.1 |
| | Diversity index | 6.7 |
| Red pepper | *D. sanguinalis* | 17.3 |
| | *P. oleracea* | 12.7 |
| | *C. amuricus* | 8.0 |
| | *A. australis* | 3.0 |
| | *Echinochloa crus-galli* | 1.9 |
| | Diversity index | 5.3 |
| Corn | *D. sanguinalis* | 31.1 |
| | *E. crus-galli* | 7.9 |
| | *Chenopodium album* | 5.0 |
| | *P. oleracea* | 5.0 |
| | *A. australis* | 4.4 |
| | Diversity index | 11.0 |
| Pulse | *P. oleracea* | 6.7 |
| | *D. sanguinalis* | 6.7 |
| | *C. album* | 2.7 |
| | *Persicaria hydropiper* | 2.3 |
| | *Commelina communis* | 1.6 |
| | Diversity index | 1.0 |
| Potatoes | *P. oleracea* | 10.5 |
| | *D. sanguinalis* | 9.8 |
| | *C. album* | 4.0 |
| | *C. amuricus* | 1.7 |
| | *P. hydropiper* | 1.6 |
| | Diversity index | 2.3 |
| Orchard | *D. sanguinalis* | 7.8 |
| | *P. hydropiper* | 7.0 |
| | *P. oleracea* | 5.4 |
| | *C. album* | 4.4 |
| | *Artemisia priceps* | 4.3 |
| | Diversity index | 1.8 |
| Neighbor (non-crop) | *A. princeps* | 11.3 |
| | *Erigeron canadensis* | 10.7 |
| | *D. sanguinalis* | 8.0 |
| | *C. album* | 4.6 |
| | *P. hydropiper* | 4.1 |
| | Diversity index | 3.4 |

**Table 22**. Major predominant weed species in different crop lands(MST, 1991)

| Classification | Scientific name |
|---|---|
| Summer annual | *Portulaca oleracea* L. |
| | *Digitaria sanguinalis* (L.) Scop. |
| | *Chenopodium album* L. var. centrorubrum Makino |
| | *Persicaria hydropiper* (L.) Spach |
| | *Commelina communis* L. |
| | *Acalypha australis* L. |
| | *Cyperus amuricus* Maxim |
| | *Echinochloa crus-galli* P, Beauv. |
| | *Polygonum aviculare* L. |
| | *Chenopodium ficifolium* Smith |
| | *Setaria viridus* (L.) P, Beauv. |
| | *Oxalis corniculata* L. |
| | *Mazus japonicus* (Thunb.) Kuntze |
| | *Eleusine indica* (L.) Gaerthn. |
| | *Persicaria blumei* Gross |
| | *Digitaria violascens* Link |
| | *Amaranthus viridis* L. |
| | *Echinochloa crus-galli* P. Beauv. var caudata Kitagawa |
| | *Eclipta prostrata* L. |
| | *Amaranthus retroflexus* L. |
| | *Kummerovia striata* (Thunb.) Schindl |
| | Sub-total 22 species(66.7% dominance) |
| Over wintering annual | *Stellaria media* (L.) Villars |
| | *Erigeron canadensis* L. |
| | *Capsella bursa-pastoris* (L.) Medicus |
| | *Rorippa islandica* (oed.) Borb. |
| | *Alopecurus aequalis* Sobol. var. amurensis Ohwi |
| | Sub-total 5 species(15.2% domianace) |
| Perennial | *Equsetum arvense* L. |
| | *Artemisia princeps* Pamp |
| | *Calystegia japonica* Thunb |
| | *Plantago asiatica* L. |
| | *Ixeris dentata* (Thunb.) Nakai |
| | *Viola mandshurica* W. Becker |
| | Sub-total 6 species(18.1% dominance) |
| | Total 33 species |

The most important five weed species by each crop were given in Table 20 for winter crops and in Table 21 for summer crops, respectively. Even though the dominant weed species varied by crop the most common weed species in winter crops were *Chenopodium album*, *Alopecurus aqualis*, *Stellaria alsine* and *S. media* while these for summer crops were *Digitaria sanguinalis*, *Portulaca oleracea*, *Chenopodium album*, and *Acalypha australis*. In non-crop area neighboring the crops, on the other hand, *Artemisa princeps* and *Erigeron canadensis* was the most important weeds(Table 21). Other detailed weed species occurring in upland crop land was given in Table 22.

## 摘 要

우리나라 農耕地에 發生되는 主要 雜草分布現況과 變化 樣相을 究明하기 위해 最近에 報告된 硏究結果를 土臺로 논과 밭을 中心으로 分析하였다.

1. 논의 경우 1971年, 1981年, 1991年, 3回에 걸쳐 雜草分布 樣相을 調査한 結果 主要 問題雜草의 種類는 18科 29種으로 年次間에 큰 差異를 보이지 않았으나, 優占草種의 構成樣相은 年次間에 큰 差異를 보였다. 1971年에는 一年生雜草의 構成比率은 79%였고 優占草種은 마디꽃(41%), 쇠털골(12%), 물달개비(11%), 알방동사니(8%), 피(7%), 等이었다. 1981年에는 多年生雜草의 發生比率이 53%로 크게 增加하였고 이때의 主要 優占草種은 물달개비(22%), 올미(18%), 벗풀(9%), 가래(9%), 너도방동사니(9%), 마디꽃(6%), 等이었으며 피의 優占度는 2.3%로 매우 낮아졌다. 1991年에는 多年生雜草가 58%이었고 主要 問題雜草는 올방개(20%), 올미(16%), 벗풀(13%), 피(12%), 물달개비(11%), 올챙고랭이(6%) 等으로 올방개와 피의 發生이 急速度로 增加하였다.
2. 主要 優占草種의 構成 內容은 地域的으로도 差異를 보였는데 湖南地方에서는 1991年 現在까지 올미가 全體 發生量의 30% 以上을 차지하는 가장 重要한 雜草인데 反해 中部地方과 嶺南地方에서는 1991年 現在 올방개, 벗풀, 피가 가장 問題雜草로 認識되었다.
3. 1981年 發生 比率이 2.3%이었던 피가 最近에 急速度로 發生量이 增加하고 있는데 이는 最近의 耕耘整地 作業의 省略化 및 省力化와, 물管理 不徹底의 栽培 環境變化와 아울러 除草劑 푸마시 以後의 一發處理劑 使用面積 擴大와 密接한 關係가 있었다.
4. 밭 作物栽培地에 發生되는 雜草는 46科 216種이었는데, 冬作物 보다 夏作物 地帶에 24種이 더 많이 發生되었다. 作物種類別로는 果樹園과 마늘 栽培地가 約 85種의 雜草가 分布되어 가장 많은 雜草가 자라는 作物이었고 참깨, 감자 및 풋고추 栽培地는 45~56種의 雜草가 發生되어 比較的 적은 作物栽培地였다. 主要 優占 草種으로는 冬作物 栽培地의 경우 둑새풀, 명아주, 벼룩나물, 별꽃, 갈퀴덩굴, 속속이풀, 냉이, 방동사니 等이었고 夏作物 栽培地는 바랭이, 쇠비름, 깨풀, 강아지풀, 방동사니, 명아주, 망초, 쑥 等이었다


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