Status of RDA[1)] Researches on Weed Control for Rice Nurserybed

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農振廳[1)]의 못자리 雜草防除 研究 現況

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ABSTRACT

Research situation and recent research activities of the RDA of Korea were reviewed and summarized for rice nurserybed.

Sixty five percent of total 784 weed research items were carried out as rice research while only 6 percent was belonged to nurserybed within rice research. The floristic composition based on the degree of dominance significantly affected by herbicide properties, type of nurserybed and seeding itself. Herbicidal phytotoxicity of currently used several herbicides was greatly dependent upon the covering, absorption, germination, and irrigation regimes.

The new safening agent "CGA 123 407" (4,6-dichloro-2-phenyl-pyrimidine) permited the safe application of pretilachlor (2-chloro-2',6-diethyl-N-(2-propoxyethyl) acetanilide) as a pre-emergence herbicide without reducing herbicidal efficacy. Several new herbicides, pyrazolate (4-(2,4-dichlorobenzoyl)-1,3-dimethylpyrazol-5-yl-p-toluenesulphonate), SL-49 (1,3-dimethyl-4-(2,4-dichlorobenzoyl)-5-phenacyloxy-pyrazole) MY-93 (S-(1-methyl-1-phenethyl)-piperidine-1-carbathioate) and DPX-84 ((methyl 2- ((4,6-dimethoxypyrimidin-2-yl) amino-carbonyl) aminosulfonylmethyl)) benzolate)) performed satisfactorily in terms of safety and herbicidal efficacy for both surface covered and surface pressed nurserybed after herbicide application and thus expected very significant contirbutions not only for all kind of nurserybeds but also for direct seeding.

Key words: rice nurserybed, weed control, herbicide, safener.

INTRODUCTION

Rice nurserybed can be divided into three types in accordance to water regime; upland nurserybed type, semiirrigated nurserybed type and lowland nurserybed type. The period of nurserybed is usually 30 to 45 days depending upon the transplanting methods either by machine or by hand and this period considered very important time for good rice harvest and thus, referred as "one-half in rice cropping" in old saying.

Before the releasing of new rice cultivar "Tongil" (Indica/Japonica), lowland nurserybed type was

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1) RDA: Rural Development Administration of Korea.

predominantly practiced for rice crop when Japonica type rice cultivars were cultivated throughout the nation. Since that time, early of 1970's, semiirrigated nurserybed type rapidly increased as the acreage of hybrid rice expanded and also as the polyethylene film became available. Similarily, herebicide also firstly introduced to rice crop in that time starting with nitrofen and butachlor.

Due to changed rice environment in nurserybed by introducing different cultural practices such as cultivar, fertilizer, herbicide, water management and surface covering regimes, weed community greatly differed in floristic composition and in weed occurrence with similar trend in transplanted lowland rice field reported by Kim (1983) and Kim et al. (1983).

Recently, farmers tended to reduce the labor input and to omit some tedious or laborious operations by replacing less laborious simple operations such as simply pressing the surface of nurserybed instead of soil covering after seed sowing that caused several adversal effects on rice growth and on herbicidal phytotoxicity.

The paper reviewed research results related in rice nurserybed and analyzed some factors affecting herbicidal phytotoxicity.

MATERIALS AND METHODS

Research Situation.

All available research items related to weed research conducted under Rural Development Administration (RDA) were collected from 1961 to 1984. These data further analyzed by crop and by research area.

Weed Ecology.

Weed community dynamics as affected by nurserybed type, herbicide and sowing regimes summarized mainly based on the results carried out by the Yeongnam Crop Experiment Station since 1970.

To know the general economical aspects of weeds, rice seeds of Cheongcheongbyeo (Ind./Jap.) were sown on April 29, 1981 at the rate of 90 g/m^2.

Factors Affecting Herbicidal Phytotoxicity.

Covering regime. Three different covering regimes on surface of nurserybed after rice seeding were used at the semirrigated nurserybed. These were sand covered method (recommending practice), pressed method and uncovered method. For this test rice cultivar of Milyang 23(Ind./Jap.) was sown on May 1, 1985 at the rate of 90 g/m^2. For herbicide application, butachlor (2-chloro-2',6'-diethyl-N-(butoxymethyl)-acetanilide), thiobencarb (S-(4-chlorobenzyl)-N, N-dietyl thiocarbamate) and pyrazolate (4-(2,4-dichlorobenzoyl)-1,3-dimetryl-pyrazol-5-yl-p-toluene sulphonate) / butachlor were applied 1 day before seeding at the rate of 1.8kg ai/ha, 2.1kg ai/ha and 2.9kg ai/ha, respectively.

Absorption and Germination regimes. Effect of absorption portion (emerging shoot and root) and germination regime(pregerminated or intact) on herbicidal phytotoxicity were evaluated by the laboratory test in 1984 using rice cultivar of Milyang 42(Ind./Jap.) for absorption regime and Gayabyeo(Ind./Jap.) for germination regime, respectively.

For absorption regime, pregerminated rice seeds were placed both at herbicide solutions(0, 5, 10, 50, 100 ppm) and on the soil surface that was saturated by a particular herbicide concentrated as 0, 5, 10, 50 and 100 ppm. The former considered as shoot and root absorption while the latter considered as root absorption. On the other hand, two kinds of rice seeds, pregerminated and intact, were placed at the given herbicide solutions (0, 5, 10, 50, 100 ppm) for testing the germination regime.

Herbicides used for these test were butachlor, thiobencarb, pyrazolate, nitrofen (2,4-dichlorophenyl-4-nitrophenylether), bentazon/(3-isopropylphenyl-4-nitrophenylether), bentazon (3-isopropyl-1H-2,1,3-benzothiadiazine-(4)-3H-one-2,2-dioxide)

Irrigation regime. Soojeongbyeo(Ind./Jap.) was sown on May 23, 1982 at the semiirrigated nurserybed having three different covering regimes same as mentioned above and four different irrigation regimes. These were canal irrigation, flooding once(irrigated up to above the nurserybed for 24 hours just after herbicide application but before seed sowing), flooding twice(repeated flooding on the other day) and flooding three times. Before starting first irrigation butachlor was applied at the rate of 1.8kg ai/ha.

Antidote "CGA 123 407" and new promising herbicide. Antidote CGA 123,407 (4,6-dichloro-2-phenyl-pyrimidine), newly developed by CIBA-GEIGY, tested for two years (1984-'85) at the rates of 150 and 300 g ai/ha with pretilachlor (2-chloro-2',6'-diethyl-N-(2-propoxyethyl) acetanilide) (at the rate of 600 g ai/ha) and compared with several herbicides such as butachlor (1.8 kg ai/ha), thiobencarb (2.1kg ai/ha), and chlornitrofen (2,4,6-trichlorophenyl-4-nitrophenyl ether) (2.7kg ai/ha). This experiment was undertook at the semiirrigated nurserybed using rice cultivar of Chilseoungbyeo (Ind./Jap.).

Beside of this test, newly developed promising herbicides were also evaluated at the pressed covering method in semiirrigated nurserybed. These herbicides were pyrazolate (at the rate of 3.0kg ai/ha), pyrazoxyfen (1,3-dimethyl-4-(2,4-dichlorobenzoyl)-5-phenacyloxy-prazole) (2.4 kg ai/ha), dimepiperate (S-(1-methyl-1-phenethyl)-piperidine-1-carbathioate) (2.4 kg ai/ha), DPX-84 ((methyl 2-)) (4,6-dimethoxypyrimidin-2-xy) aminocarbonyl) aminosulfonylmethyl ((benzoate)) (51 g ai/ha) and FOE-1976 (2-(benzothiazol-2-yloxy)-N-methylacetoanilide) (2.1 kg ai/ha).

All field experiments used randomized complete block design with three replications while complete randomized design with five replications were used for laboratory tests. Except when stated otherwise the cultural practices, sampling method and chemical names for all experiments were followed to the standard cultivation method of rice (YCES, 1985), RDA(1983), Shibuya index(1984), Farm chemical handbook(1983) and short review of Herbicide (1982).

RESULTS AND DISCUSSION

Research Situation

Sevenhundred-eighty four research items were conducted as weed research from 1961 to 1984 under Rural Development Administration(RDA) (Table 1). Sixtyfive percent of these were belonged to rice research. Among rice research, however, only six percent (30 research items) devoted to nurserybed. These results implied that research efforts so far leaned upon transplanted paddy rice while research for nurserybed was relatively disregarded.

Table 1. Research items on weed control by crop

(RDA, '61-'84)

Crop	Rice			Wheat Barley	Other	Total
	Nursery	Paddy	Total			
No. of items	30	478	508	123	153	784
(%)			(65)	(16)	(19)	(100)
	(6)	(94)	(100)			

Table 2. Situation of weed research in association with research area

(RDA, '61-'84)

Research Area	Herbicide				Weed			
	Screening usage	Action mechanism	Others	Sub-total	Survey	Biology	Competition	Sub-total
No. of items	588	66	44	698	21	48	17	86
(%)	(75)	(8)	(6)	(89)	(3)	(6)	(2)	(11)
	(84)	(10)	(6)	(100)	(24)	(56)	(20)	(100)

On the other hand, most of weed research(75%) concentrated to herbicide screening or usage while research on herbicide mode of action and weed biology were 8% and 11%, respectively(Table 2). Based on the above data it can be concluded that research efforts were too much emphasized on herbicide itself.

Weed Ecology

Floristic composition based on the degree of dominance was greatly dissimilar between 1971 and 1981 in transplanted paddy rice field while kind of weed flora were not much differed (Kim, 1983). According to his report, similarity coefficient of floristic composition between 1971 and 1981 exhibited approximately 27% for nationwide while these were 35%, 30% and 15% for Middle, Honam and Yeongnam Regions, respectively. One of the most important factors for changing dominant weed species analyzed as the introduction of herbicide since early of 1970's.

The situation for rice nurserybed showed similar trend as mentioned above. Comparing to 1972 or 1973, floristic composition of dominant weed species drastically altered during past 10 years showing their similarity coefficient of 7-14% in case of semiirrigated nurserybed(Table 3).

Table 3. Similarity coefficient of weed flora in association with year (YCES, 1972-'83)

Year	1972	1973	1983
1972	–	60	14
1973		–	7
1983			–

The important dominant weed species for 1972 were *Cyperus difformis, Eleocharis acicularis, Echinochloa crus-galli* and *Monochoria vaginalis* while *Cyperus serotinus* was the most important weed species and followed by *E. crus-galli, M. vaginalis, Polygonum hydropiper, Aneilema japonica* and *Ludwigia prostrata* for 1983 (Fig. 1). As indicated above figure, most of the important weed species in 1972 could be easily controlled by herbicides such as butachlor or nitrofen while this was not for the species in 1983 by these herbicides.

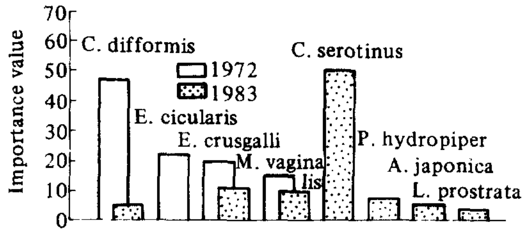

Fig. 1. Degree of dominance of important weed species in rice-nursery between 1972 and 1983.

Weed occurrence was also affected by the type of nurserybed and seeding regime. The highest weed biomass harvested from the upland-type nurserybed followed by semiirrigated-type and lowland-type nurserybed(Fig. 2). The reason for the least weed

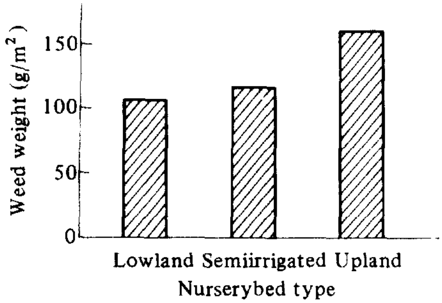

Fig. 2. Weed occurrence in association with nurserybed-type. (Kim et al, 1982).

biomass in lowland-type nurserybed could be postulated that high CO_2 concentration and organic acids evolved under the flooded condition usually inhibited or retarded the seed germination and the growth of weeds.

Dominant weed species grown in association with nurserybed types were given in Fig. 3. The most common weed species among these nurserybed types was *C. difformis* and *E. crus-galli.* Some other important weed species except the common weed species were *C. serotinus, Eleocharis acicularis, M. vaginalis* for lowland-type and semiirrigated-type nurserybeds and these were *Digitaria adscendens, Cyperus iria, polygonum lapathifolium* and *Capsella bursa-pastoris* for upland-type nurserybed.

Rice sowing itself resulted in a greater weed

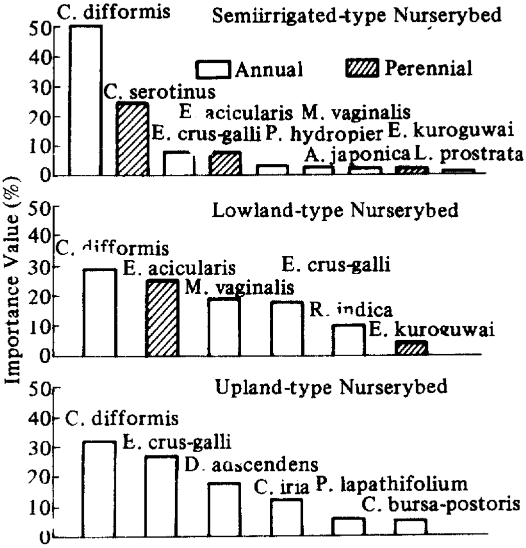

Fig. 3. Dominant weed species in association with nurserybed-type (YCES, 1971 and '83).

suppression not only for the total occurrence but also for the floristic composition and this effect enhanced with increase of seeding rate. For recommending seeding rate, 80-90 g/m^2, approximately 75% of total weeds in terms of density and weight were suppressed comparing to the plot of no rice seeded(Fig. 4). Due to greater competition between

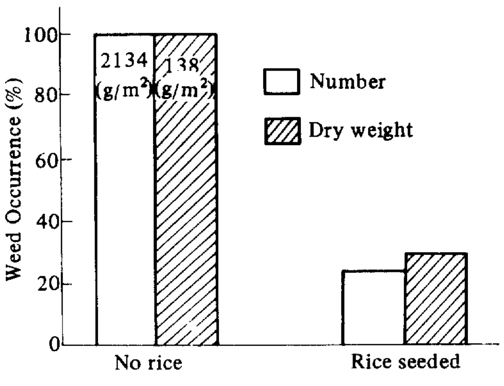

Fig. 4. Weed occurrence as affected by rice seeding in semiirrigated nurserybed (kim et al. 1982).

E. crus-galli and rice seeking common resources for their growth, the growth of *E. crus-galli* significantly inhibited by rice seeding while *C. serotinus* became predominated due possibly to shade tolerance (Fig. 5).

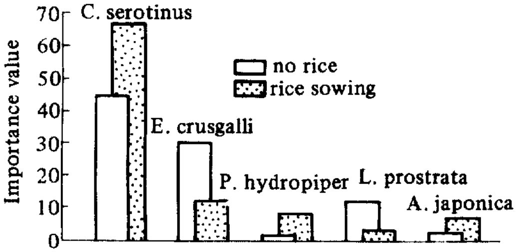

Fig. 5. Importance values of some weeds in rice-nursery as affected by rice sowing (kim et al. 1982).

Factors Affecting Herbicidal Phytotoxicity

Covering Regime. According to the standard management of rice crop(RDA, 1984) for the extension workers, nurserybed emphasized to cover the surface after rice seeding with sand, paddy soil, or some other covering materials in semiirrigated nurserybed type for the sake of better crop standing and for raising healthy seedling. However, majority of farmers had not followed this recommendation due to laborious and tedious operation and hence, some modified or reduced techniques were widely practiced. One of these, for example, was surface covering regime after seeding such that either pressed or uncovered practice. General figures for these methods were compared diagramatically in Fig. 6.

Farmers generally wanted to finish all operations within a day such as building nurserybed, herbicide application, weeding, pressing the surface and covering the polyethylene film for temperature keeping. Sometimes, these alternative techniques resulted in poor crop standing, reduce the biomass and the percentage of healthy seedling and also the incidence of herbicidal phytotoxicity as shown in Table 4. Regardless of hardening periods of the nurserybed surface the highest crop biomass harvisted at the sandcovered nurserybed comparing to other two methods. Pressed method was superior a little bit to uncovered method at the zero hardening plot while this was not for the plot that harden-

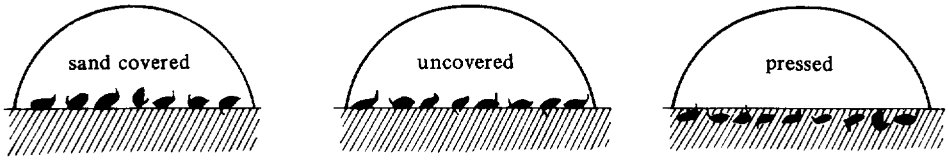

Fig. 6. Diagrammatic features of rice seeds in association with nurserybed managements.

ed for one day. This could possibly due to damage of pregerminated rice seed during pressing operation against the hardened soil surface.

Absorption pattern of herbicide also affected by covering regimes. As shown in Fig. 6, rice seed in pressed method will be contacted to herbicide layer both in emerging shoot and in root while this could be mainly in root portion for other two methods. Therefore, the degree of herbicidal phytotoxicity will be varied depending upon herbicide used and covering method. In general, the least herbicidal phytotoxicity exhibited at the uncovered method and the highest phytotoxicity obtained from the pressed plot while sandcovered plot showed the intermediate response between these two regardless of differential hardening periods of nurserybed surface (Table 5). Among three used herbicides, phytotoxic effect was the highest for thiobencarb followed by butachlor and pyrazolate/butachlor was the highest in safety(Table 5). However, there was no sharp trend between differential hardening periods.

Table 4. Effect of covering regime of seedbed on rice growth (YCES, 1985)

Treatment	Crop standing (%)	Healthy seedling (%)	Plant height (cm)	Leaf stage	Crop biomass (g/m^2)	Index
Seedbed drying, 0 day						
Sandcovered	83 b	64a	12.4a	4.1a	490.0a	100
Pressed	83 b	61a	11.0a	4.0a	414.7 b	85
Uncovered	91a	55 b	11.3a	4.2a	375.7 c	77
Seedbed drying, 1 day						
Sandcovered	79 b	65a	13.4a	4.4a	399.0a	100
Pressed	83 b	62a	11.6 b	4.0a	313.0 b	78
Uncovered	90a	46 b	10.4 c	4.0a	316.0 b	79

Absorption and Seed Germination Regime: The fuction of soil-acting pre-emergence herbicides is to prevent or retard the growth of weed and rice seedlings. They, and other herbicides, maybe

Table 5. Growtn retardation of rice due to herbicide application (YCES, 1985)

Treatment	Butachlor(6G)	Thiobencarb(7G)	Pyrazolate/ Butachlor(9.5G)
Seedbed drying, 0 day			
Sandcovered	32a	68a	12 b
Pressed	34a	71a	17a
Uncovered	19 b	22 b	4 c
Seedbed drying, 1 day			
Sandcovered	35a	33a	9 b
Pressed	44 b	71 b	17a
Uncovered	32a	31a	4 c

* Herbicide dosage; 30kg/ha in product

inhibitory in one or more of the phases of seedling growth; (i) early germination; (ii) seedling establishment at the expense of endosperm reserves; (iii) growth of the seedling after the seed reserves are exhausted (Audus, 1979).

Inhibitory effects on the early germination phase are generally accompanied by a failure of the mobilization of the seed reserves. The carbamates, thiobencarb, chlorpropham and barban, as well as dichlobenil and propachlor retard the germination of grass seeds and inhibit the induction by gibberellin of α-amylase synthesis in rice (Takahashi and Ishizuku, 1985) or barley endosperm tissue (Mann et al. 1967; Devlin and Cunningham, 1970). Amiben and bromoxynil also reported as the inhibitor of germination and the development of amylase activity in intact seeds of barley(Audus, 1979). Several papers reported that the primary action of thiobencarb and butachlor was considered the inhibition of protein biosynthesis (Kimura et al. 1971; Takahashi and Ishizuka, 1985).

For rice nurserybed, pre-germinated seeds were usually sown. Using of pregerminated seeds implies two advantages; one is better competition against weeds by head starting while the other is reducing

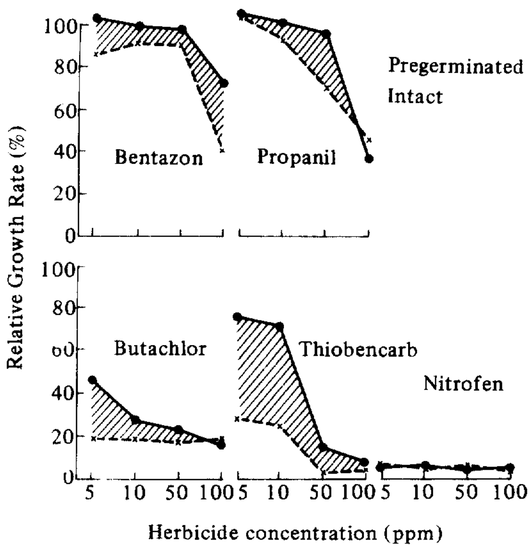

Fig. 7. Effect of germination regime on herbicidal phytotoxicity of rice. (YCES, 1984).

the incidence of phytotoxic effect from herbicide that had the inhibition of gibberellin induced α-amylase biosynthesis as their primary action.

As shown in Fig. 7 the treatment of pre-germination definitly exhibited good reducing effects from herbicidal phytotoxicity not only for the inhibitors of protein biosynthesis, butachlor and thiobencarb, but also for the inhibitors of photosynthesis, bentazon and propanil except for nitrofen that inhibit noncyclic electron transport and coupled photophosphorylation in chloroplasts and also they act as electron transport inhibitors in mitochondria (Ashton and Crafts, 1981). However, bentazon and propanil showed the least phytotoxic effect on rice germination. Based on the above results, it can be considered that bentazon and propaanil mainly affected for the early germination phase while butachlor, thiobencarb, and nitrofen were affected not only for the early germination phase but also seedling establishment at the expense of endorsperm reserves and the growth of seedling after the seed reserves were exhausted.

The pattern of absorption or penetration of herbicides into plant greatly varied depending upon the properties of herbicides and the nature of plant surface which is one the important factors on selectivity between the susceptible and the tolerant species. Butachlor, thiobencarb and pyrazolate which used for absorption test were mainly absorbed through emerging shoot and partly through root (Takematsu, 1982). As given in Fig. 8, these herbicides hardly affected the growth of rice seedling when these were absorbed through the root. However, the growth of rice seedling greatly retarded when the seedling were contacted to both emerging shoot and root. This situation can be easily applied to the rice nurserybed as given in Fig. 6. and be explained why the least growth retardation was obtained from the uncovered nurserybed that had the least opportunity to contact the emerging shoot against herbicide layer while this was the highest for the pressed nurserybed that exposed both emerging shoot and root to herbicide as mentioned in Table 5. The difference

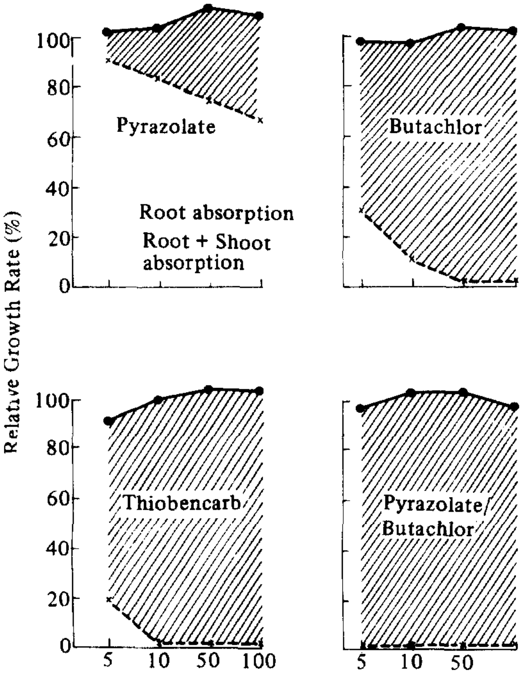

Fig. 8. Effect of absorption portion of herbicide on rice growth. (YCES, 1984).

between sand covered and uncovered methods in growth retardation could possibly explained by slight upward movement of herbicide moldcule in sand covered method through the capillary attraciton. However, this capillary attraction will be varied depending upon the nature of covering materials.

Irrigation Regime: For the primitive mean, farmers had tried to reduce butachlor phytotoxicity through rinsing several times the soil surface after herbicide application. In fact, this operation enhanced the rice growth by reducing herbicidal phytotoxicity for all three different covering regimes (Table 6) and this effect increased with increase in rinsing times without arising the significant reduction in herbicidal activity (Table 7).

The enhancing effect of rice growth was the greatest at the pressed nurserybed while this was the least for the uncovered nurserybed. For the conventional canal irrigation method, sand covered method resulted in the poorest weed suppression while no difference was recorded between pressed and uncovered nurserybed methods(Table 7). This was probably due to contamination of sand material with weed seeds. However, this rinsing operation could not be recommendable.

Table 6. Total biomass of rice in association with covering regime and irrigation regime (YCES, 1982)

Irrigation Regime	Sand covered	Pressed	Uncovered
Canal irrigation	58.7c(100)	41.0d(100)	57.7c(100)
Seedbed rinse			
– Once	71.3b(121)	56.4c(137)	57.0c(98)
– Twice	98.8a(170)	71.9b(175)	70.9b(122)
– Three times	101.8a(173)	88.4a(215)	82.7a(143)

* Relative growth rate(%)
* Average of three replications.
* Herbicide =1.2kg ai/ha, butachlor(6G).
* Rice cultivar = Soojeongbyeo.

Table 7. Weed suppression rate as affected by covering regime. (YCES, 1982)

Irrigation Regime	Sand covered	Pressed	Uncovered
Canal irrigation	68 a	87 a	87 a
Seedbed rinse			
– Once	62 a	82 a	89 a
– Twice	68 a	85 a	85 ab
– Three times	65 a	80 a	78 b

* Average of three replications.
* Herbicide =1.2kg ai/ha, butachlor(6G)
* Rice cultivar = Soojeongbyeo.

Antidote "CGA 123 407" and New Promising Herbicides. Organic herbicides represent the most effective weapon available to farmers worldwide in their war against weeds. Many of the currently available herbicides that are useful in managing difficult-to-control weeds are not sufficiently selective. In addition, the selective control of weeds that are botanically related to crops has always been a problem. To overcome these problems several approaches have been tried, with varying degrees of success. These are the development of new herbicides that are more selective and the overcoming the problem of the limited selectivity by mechanically, genetically, or chemically. Among these, an approach that has attracted considerable interest is the enhancement of crop tolerant to herbicides chemically with the use of herbicide antidotes that concept was firstly introduced by Hoffman(1962). The appropriate use of herbicide antidotes could permit; (1) the use of higher rates of herbicides with marginal selectivities resulting in more effective weed control; (2) the use of nonselective herbicides for selective weed control; (3) the use of herbicides under conditions where crop damage is liable to occur, such as with susceptible crop varieties or adverse weather or soil conditions; and (4) the protection of valuable crops that have been accidentally treated with a nonselective herbicide(Hatzios, 1983).

To date, five compounds are available as herbicide antidotes for rice crop; NA(1,8-Naphthalic anhydride), R-25788 (N,N-Dially-2, 2-dichloro acetamide), CGA-43089 ((α-) (Cyano-methoxy) imino) benzene acetonitrile)), CGA 123 407 (4,6-dichloro-2-phenyl-pyrimidine) and Mon-4606 (benzyl-2-chloro-4-(trifluoromethyl)-5-thiazole carboxylate) (in Hatzios, 1983; Quadranti and Ebner, 1983). Among these, CGA 123 407 was newly developed by CIBA-GEIGY Ltd. This new safening agent, CGA 123 407, permits the safe application of pretilachlor as a pre-emergence herbicide in rice nurserybed. As shown in Table 8, pretilachlor was not inhibited at all in the growth of rice seedling regardless of applied time when this herbicide was used with safening agent "CGA 123 407" while this was the worst when pretilachlor was used alone in sand covered rice nurserybed. Herbicidal efficacy

Table 8. Phytotoxic effects of several herbicides in rice nurserybed (YCES, 1984)

Treatment	Visual phytotoxicity (1 – 9) June 7	June 12	June 18	Crop Standing (no/m^2)	Plant Height (cm)	Leaf Number	Dry weight (mg/plant)	Total Biomass (g/m^2)	Relative Biomass (%)	Growth Retardation (%)	Weed Suppression (%)
Pretilachlor/CGA 123'407											
' 1 day before seeding	1.3	2.0	1.7	3245a	13.1a	4.1a	21.5b	69.8a	100a	0	100
' 1 day after seeding	1.0	1.7	1.3	3026ab	13.8a	4.5a	22.5b	68.1a	98a	2	94
pretilachlor (2%)	7.3	8.7	8.0	1868d	12.4b	4.4a	22.5b	42.0d	60d	40	100
butachlor (6%)	3.3	3.3	4.0	2905b	13.2a	4.2a	22.0b	64.0b	92b	8	97
chlornitrofen (9%)	2.7	2.3	2.0	3132a	13.6a	4.2a	22.0b	68.9a	99a	1	91
thiobencarb (7%)	6.3	4.7	5.3	2320c	13.7a	4.5a	23.5a	59.2c	85c	15	100
Untreated control (hand weeding)	–	–	–	3151a	13.6a	4.1a	22.0b	69.3a	100a	0	100

* Herbicide dosage was 30kg/ha in product.
* Rice cultivar = Gayabyeo.
* Average of three replications.

Table 9. Effect of antidote "CGA 123 407" on rice growth (YCES, 1985)

Treatment	Phytotoxi - city (1–9)	Crop standing (%)	Plant height (cm)	Leaf number	Dry weight (mg/plant)	Total Biomass (g/m^2)	Relative Biomass (%)	Growth retardation (%)
Pretilachlor(2G) (600g ai/ha) 1 DBS	8.5	8	4.7	2.7	12.3	3.2	7	93
Pretil./CGA 123407(2.5G) (750g ai/ha) 1 DBS	1.3	85	10.3	3.6	15.6	43.7	97	3
Pretil./CGA 123407(2.5G) (750g ai/ha) 1 DBS	1.7	83	10.0	3.6	16.1	44.2	98	2
Butachlor(6G) (1.8kg ai/ha) 1 DBS	5.3	39	5.2	2.9	12.6	16.2	36	64
Thiobencarb(7G) (2.1kg ai/ha) 1 DBS	5.6	40	5.4	3.0	12.8	16.9	37	63
Hand weeding (2X)	–	87	10.5	3.7	15.7	45.1	100	0

* Sowing date ; May 22, 1985
* Rice cultivar ; Chilseoungbyeo.
* Average of three replications.

of pretilachlor was not affected by CGA123407. Growth enhancing effect of CGA123407 was also extended to the pressed nurserybed upto the rate of 1.5 kg ai/ha that considered the worst situation (Table 9).

Actually, herbicides should not required any particular knowledge to use for farmer's stand point and hence, ultimately, herbicides should have high selectivity between crop and weeds regardless of variable application methods or environmental situations. It is the most hopeful event if we can achieve this goal by simply developing new herbicides without requiring any complementary means. Several herbicides, quite recently, were developed to meet above targets. These were pyrazolate, pyrazoxyfen, dimepiperate, DPX-84 and FOE 1976. Among these, pyrazolate, pyrazoxyfen, dimepiperate, and DPX-84 exhibited high safety in both sandcovered and pressed nurserybeds (Table 10) and some of further detailed agronomic traits or characters affected by pyrazolate and pyrazoxyfen were given in Table 11 and Table 12, respectively.

Table 10. Effect of new promising herbicides on rice growth (YCES, 1985)

Herbicide	Relative Rice Growth	
	Sand covered	Pressed
Pyrazolate (3.0 kg ai/ha)	98	99
Pyrazoxyfen (2.4 kg ai/ha)	95	101
Dimepiperate (2.4 kg ai/ha)	95	85
DPX – 84 (51 g ai/ha)	100	90

Table 11. Effect of several herbicides on rice growth (YCES, 1985)

Treatment	Crop standing (%)	Healthy seedling (%)	Plant height (%)	Leaf stage	Crop Biomass (g/m²)	Index
Sandcovered						
Pyrazol./Buta(9.5G)	94a	88a	11.8a	4.2a	636.0a	100
Butachlor(6G)	93a	82 b	12.0a	4.5a	576.4 b	91
Pyrazolate(10G)	95a	87a	12.5a	4.1a	620.1a	98
Untreated control	97a	89a	11.8a	4.2a	634.4a	100
Pressed						
Pyrazol./Buta(9.5G)	92a	73a	10.0a	4.5a	361.4 b	64
Butazol./Buta(6G)	88a	64 b	10.1a	4.5a	329.5 b	59
Pyrazolate(10G)	97a	80a	10.3a	4.6a	557.0a	99
Untreated control	96a	74a	9.9a	4.2a	561.7a	100

* Herbicide dosage ; 20 kg/ha in product.
* In a column in each covering regime, means followed by a common letter are not significantly different at the 5% level by LSD.

Table 12. Effect Pyrazoxyfen on rice grown (YCES, 1985)

Treatment	Crop standing (%)	Healthy seedling (%)	Plant height (%)	Leaf stage	Crop Biomass (g/m²)	Index
Sand covered						
Pyrazoxyfen (8G)	75a	63a	12.5a	3.8a	426.2a	95
Pyrazoxyfen (10G)	86a	69a	12.1a	4.4a	455.4a	102
Untreated control	81a	65a	12.9a	4.3a	447.7a	100
Pressed						
Pyrazoxyfen (8G)	77a	57a	10.5a	3.9a	346.1a	101
Pyrazoxyfen (10G)	78a	47 b	12.1a	4.3a	242.0 b	70
Untreated control	83a	62a	11.3a	4.0a	343.7a	100

* Herbicide dosage ; 30 kg/ha in product.
* In a column in each covering regime, means followed by a common letter are not significantly different at the 5% level by LSD.

On the other hand, weeds were almost completely supressed by these herbicides because of relative high dosages. Based on these results, it was considered that these herbicides will be made very significant contributions not only to nurserybed but also the direct seeding.

摘　　要

水稻 못자리 雜草防除 體系樹立을 위해 1961年부터 1984年까지 農村振興廳에서 實施한 못자리 雜草防除試驗을 要約 整理하고 最近 嶺南作物試驗場에서 遂行한 硏究結果를 中心으로 問題點과 對策을 檢討하였다.

1. 1961年부터 '84年까지 農村振興廳 산하 시험연구기관에서 수행된 雜草防除試驗 항목수는 784건이었으며, 이중에서 65%가 水稻作에 관한 항목이었고, 수도시험중에서 못자리에 관한 연구는 30건으로 전체 水稻硏究의 6%에 불과하였다.

2. 못자리에 發生되는 優占雜草는 지난 10년동안 크게 달라졌는데, 1972년에는 알방동산이, 쇠뜨기, 피의 順으로 優占하였는데 1983年에는 너도방동산이가 가장 많이 發生되었고, 除草劑에 比較的 耐性을 가진 사마귀풀, 여뀌바늘, 여뀌의 發生이 增加되였다. 한편 못자리에 發生되는 雜草의 種類와 發生量은 못자리 양식과 볍씨 播種方法에 따라서도 크게 달라졌다.

3. 못자리에서 볍씨 播種區는 볍씨 播種으로 基因된 被覆效果로 雜草發生이 抑制되었는 데, 雜草發生本數로 본 抑制率은 79%, 雜草重量으로 본 抑制率은 76%였다.

4. butachlor, thiobencarb, pyrazolate/butachlor에 대한 복토방법별 藥害反應은 상면진압>복토>무복토 순으로 컸으며 除草劑 種類別로는 pyrazolate/butachlor가 가장 藥害가 적었다.

5. 除草劑 吸收部位와 藥害와의 관계에 있어서는 뿌리부위로 吸收시킬 경우 藥害는 거의 발생되지 않았으나, 뿌리부위와 幼芽部로 동시에 吸收시킨 경우 약해는 크게 發生되었으며, 除草劑 種類別로는 pyrazolate가 가장 안전하였다.

6. 볍씨 최아유무와 除草劑 藥害와의 관계에 있어서는 제초제 種類間의 차이가 있으나, 대체로 무최아 볍씨보다 최아볍씨가 除草劑 藥害가 경감되었다.

7. butachlor 藥害는 못자리 상면을 換水해줌으로써 경감되었는데, 경감효과는 회수를 증가시킬수록 컸다.

8. 除草劑 pretilachlor의 약해는 해독제 CGA 123 407에 의해 除草效果 變動없이 完全히 방지되었다.

9. 最近에 開發된 新除草劑 中에서 pyrazolate, pyrazoxyfen dimepiperate, DPX-84는 床面 鎭壓方法에서도 藥害가 거의없이 除草效果가 매우 높은 優良除草劑였다.

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