Korean J. Crop Sci. 43(2) : 124~127(1998)

Occurrence of Weedy Rice as Affected by Cultural Practices

Sang Yeol Kim*, Yang Son*, Woon Goo Ha*, Sung Tae Park*, and Soon Chul Kim*

ABSTRACT

Since weedy rice problems have emerged with the recent advent of direct seeding cultivation in Korea, the establishment of effective control strategies for weedy rice is considered to be one of the urgent issues to be solved for widely practiced direct seeding rice cultivation. A three year experiment was conducted to investigate the occurrence pattern of weedy rice in four different rice cultivation practices: high ridged dry seeding, wet drill seeding, water seeding, and machine transplanting. The highest weedy rice occurrence of 11.0% was observed in high ridged dry seeding practice followed by 9.6% in wet drill seeding, 6.4% in water seeding practice, and 0.2% in machine transplanting practice, respectively. The same trend was observed when we examine the occurrence of contamination of panicle and rice grain by weedy rice. More contamination was observed in high ridged dry seeding than any other practices. It was also found that the possible emergence depths from the soil surface was deeper in both in ridged dry seeding and wet drill seeding practice (0~5 cm from the soil surface) than those in water seeding (0~4 cm), and machine transplanting practice (0~3 cm). The highest yield reduction of 19.5% was observed in high ridged dry seeding practice followed by 13.0% in wet drill seeding, 6.3% in water seeding practice. The reduction may have occurred to the competition between weedy rice and cultivated rice, These findings suggest that among the four cultural practices examined, the machine transplanting practice is the most effective method to control and reduce the weedy rice occurrence and weedy rice seed in soil.

Key words : weedy rice, occurrence ecology, direct seeded rice, yield reduction.

Weedy rice has rapidly increased and become a severe weed problem especially in fields where continuous direct seeding has been practiced. So far, about 0.5 to 35% of rice field in the southern part of Korea is infested with weedy rice (Kim, 1997) and of further expansion of its population is expected with increase in direct seeding cultivation area.

In Korea, weedy rice has already been considered as the second most trouble some weed next to *Echinochloa crus-galli* in direct seeded rice fields (Kim, 1997). Though morphology of weedy rice and cultivated rice are similar still gross morphological differences exist.

In general, weedy rice plants are taller, and produce more tillers than most commercial cultivars (Diarra et al., 1985a; Kim, 1989). Weedy rice shows higher germination than cultivated rice at low temperatures (Son, 1996; Jeong, 1998) and grain shatters more easily (Watanabe et al., 1996; Park et al., 1997). In addition, weedy rice remains viable in soil for many years (Craigmiles, 1978). All these characteristics make weedy rice a potential problem weeds in direct seeded rice. Infestation of weedy rice in cultivated rice reduced not only rice grain yield but also grain quality (Diarra et al., 1985b). Weedy rice density of 5 plants per m² reduced grain yield by 22% (Kwon et al., 1991).

Control of weedy rice by herbicides is difficult because biochemistry and physiology of weedy rice and cultivated rice are almost the same. So far, no effective control technology of weedy rice by herbicides has been established in Korea although advanced control technology was established in the United State (Smith, 1981). Up to the present, weedy rice can be reduced to some extent by cultural practices such as land preparation and delayed seeding (Kim, 1997), transplanting rice (Kim, 1998), and water management (Smith, 1981).

Establishment of weedy rice control strategies is considered to be one of the most urgent issues needed for further dissemination of direct seeding cultivation technology in Korea. In spite of its seriousness and importance, research on the occurrence pattern of weedy rice under different environmental conditions is limited. An understanding of the occurrence pattern of weedy rice in different environments may help researchers develop strategies to control weedy rice. The objective of this research was to investigate weedy rice occurrence pattern and its influence on rice grain yield under four different rice cultivation methods: high ridged dry drill seeding, wet drill seeding, water seeding and machine transplanting.

MATERIALS AND METHODS

A field experiment was conducted at the National Yeongnam Agricultural Experiment Station from 1995 through 1997. The experiment soil was clay loam with pH 5.6 and 2.73% organic matter. Four rice cultivation methods, i.e., high ridged dry drill seeding, wet drill seeding, water seeding, and machine transplanting were employed. The field was divided into 4 plots for each cultivation method. The plot 27.8 m long and 7 m wide, was subdivided into two plots (27.8×3.5 m each, 97.3 m²) ; one for purple rice and the other for a cultivated rice, 'Naepoongbyeo'. A purple rice plot for each cultivation method was included in order to differentiate cultivated

* National Yeongnam Agricultural Experiment Station, RDA, Milyang 627-130, Korea.
Received 30 Mar. 1998.

rice and weedy rice easily in the purple rice plot during early growth stages. The position of cultivated rice and purple rice plot in each cultivation method was changed alternatively every year. For the direct seeding method, seeds of Naepoongbyeo and purple rice at 50 kg/ha were seeded with a row spacing of 25 cm in high ridged dry seeding and 30 cm in wet drill seeding. Dry seeds were used in dry seeding while pregerminated seed (1~2 mm long) was used for wet seeding. For water seeding, seed soaked in tap water for 24 hours was broad-cast-seeded field at 50 kg/ha in flooded condition at 10 cm water depth. Seeds were sown on May 5 for all cultivation methods in 1996 and 1997 but on May 17 in 1995. For machine transplanted rice, 30 days old seedlings were transplanted on June 6 in 1995 and June 5 in 1996 and 1997 after grown in seedling trays in greenhouses.

One hundred fifty kg N/ha as urea was applied for high ridged dry seeding. Fifty percent of nitrogen was applied as preplant incorporation, 30% at the 5th leaf stage and 20% at panicle formation stage. On the other hand, 110 kg N/ha was used for other three cultivation methods. Phosphorus at 70 kg/ha was applied basally and potassium at 80 kg/ha was applied as 80% basal and 20% at panicle formation stage, regardless of cultivation methods. All plots were flooded after seedling emergence and they remained flooded untill rice matured in the fall.

For general weed control, all plots were treated with pyrazosulfuron/molinate at 3 kg/ha at 25 days after seeding. Weeds not controlled by the herbicide treatment were removed by hand.

Weedy rice free plot of cultivated rice was also maintained in 1997 to calculate yield reduction due to competition with weedy rice. At early seedling stage of rice, since separation of weedy rice and cultivated rice plant was difficult, numbers of purple rice plant occurring in cultivated rice plot, and cultivated and weedy rice plant in purple rice plot were recorded and converted to weedy rice occurrence percentage. However, after panicle exertion, weedy rice plants were considered for other data collection because weedy rice and cultivated rice could be distinguish only after that time.

Panicle number of cultivated rice and weedy rice per m^2 for high ridged dry seeding and wet drill seeding methods were recorded. For water seeding method, panicle number of 50×50 cm^2 were recorded and then these values were converted into number of panicle/m^2. In 1995, panicle number of weedy rice was not recorded because of its low occurrence and thus seed of weedy rice at 10 kg/ha were broadcasted in all plot after harvest.

After heading, one hundred weedy rice plants from three cultivation methods each were randomly selected and their emergence depths were measured from the culm base to soil surface after digging soil in 1997. For transplanting rice, measurement of only 32 weedy rice plants was made due to limited number of weedy rice occurrence in the purple rice planted plot and the absence of weedy rice occurrence in the cultivated rice planted plot.

At harvest, three 4.5 m^2 samples of each plot was harvested and grain was mechanically threshed for yield determination. Rough rice yield was based on grain weight adjusted to 14% moisture. After dehulling, rice grains of cultivated rice and purple rice were separated based on color of dehulled grain and percent weedy rice contamination in rice grain was calculated. Since at harvest, matured weedy rice grain shattered earlier than cultivated rice and purple rice, about 10% of the shattered grain was not included for calculation of percent weedy rice contamination. Results of Naepoongbyeo and purple rice was combined and average data were presented. Data were analyzed using Least Significant Differences (LSD).

RESULTS AND DISCUSSION

Weedy rice occurrence

Weedy rice occurrence patterns trial in four rice cultivation methods were significantly different according to cultivation methods. In machine transplanting rice, weedy rice did not occur even after first two years' experiment but they only began to occur from the third year trial. However, the population of weedy rice was as low as 0.6% (Table 1). In addition, weedy rice did not occur in the cultivated rice plot but it occurred only in the purpled rice plot (data not shown). On the other hand, in high ridged dry seeding, even though the weedy rice occurrence was low with 0.1% at the first year but it increased rapidly from the second year. As similar trend of weedy rice occurrence was observed in wet and water seeded rice. Based on average of weedy rice infestation after the three year trial, weedy rice population in high ridged dry seeding was greatest at 11.0%, followed by wet drill seeding at 9.9%, water seeding at 6.4%. The machine transplanting rice showed the least weedy rice occurrence of 0.2%.

Panicle contamination showed a similar trend as the occurrence pattern. Weedy rice infestation increased rapidly, especially in direct seeding cultivation. Panicle contamination in high ridged dry seeding and wet drill seeding in 1997 increased by 26.4% and 21.2% as compared with that in 1996 while increases in water seeding and transplanting rice was only 8.2% and 0.8%, respectively (Table 2). This is consistant with the report of Kim (1997) that continuous direct seeding cultivation rapidly increased weedy rice population. The difference in occurrence of weedy rice could be explained by the different cultivation environments associated. In high ridged dry seeding and wet drill seeding methods, the field remained dry for about 25 days after seeding until rice seedlings emerged. Under such conditions most weedy rice germinated faster than the cultivated rice since weedy rice seed in soil had already absorbed enough moisture for germination. This enhanced weedy rice occurrence in both high ridged dry seeding and wet drill seeding methods. Choi et al. (1995) also found higher weed occurrence in direct seeded rice as compared with water

Table 1. Occurrence pattern of weedy rice as influenced by rice cultivation methods.

Cultivation method	Weedy rice occurrence (%)			
	'95	'96	'97	Average
High ridged dry seeding	0.1	15.1	17.7	11.0
Wet drill seeding	0.1	14.9	14.6	9.9
Water seeding	0.2	10.8	8.2	6.4
Machine transplanting	0.1	0.0	0.6	0.2
LSD(0.05)	ns†	4.4	4.6	–

† not siginifcant.

Table 2. Panicle contamination of weedy rice as influenced by rice cultivation methods.

Cultivation method	Panicle contamination of weedy rice(%)			
	'95	'96	'97	Average
High ridged dry seeding	–†	10.5	36.9	23.7
Wet drill seeding	–	9.7	30.9	20.3
Water seeding	–	6.4	14.6	10.5
Machine transplanting	–	0.0	0.8	0.4
LSD(0.05)	–	5.1	7.2	–

† not recorded.

seeding and transplanting rice.

On the other hand, with water seeding method, the field was subjected to flooding from seeding time to seedling emergence. When soil is submerged, gas exchange, especially for oxygen between soil and air is impaired (Ponnamperma, 1973). This might have suppressed the weedy rice germination and thereby lower weedy rice occurrence as compared with high ridged dry seeding and wet drill seeding methods. Similarly, in transplanting rice, a combination of delayed seeding and water flooding further inhibited weedy rice occurrence as showed by lowest panicle contamination percentage in Table 2. Observation of seedling emergence of weedy rice before transplanting showed that 17 weedy rice plants/m^2 from previous shattered grain occurred in cultivated rice plots and 3 weedy rice plants/m^2 in purple rice plots (data not shown). Removal of weedy rice in advance before transplanting also partly contributed to lower or no weedy rice occurrence in transplanting rice plot. The results suggest that transplanting cultivation method is a good cultural tool that can reduce weedy rice occurrence and thereby lower weedy rice seed number in soil when a field is infested with weedy rice. Choi et al. (1995) and Kim (1997) found similar or different weed and weedy rice occurrence patterns according to different rice cultivation methods. Recent work by Kim (1998) also showed that rotation to transplanting rice cultivation in the third year after 2 years of direct seeding cultivation was most desirable to reduce weedy rice infestation. Discrepancy of weedy rice occurrence and panicle contamination patterns between 1996 and 1997 in Table 1 and Table 2 could be due to observation of different rice plants.

Emergence depth of weedy rice

Emergence depths of weedy rice seedlings from soil was influenced by cultivation environments of rice growth. In high ridged dry seeding and wet drill seeding methods, most weedy rices emerged from a depth of 0~5 cm while they emerged from 0~4 cm in water seeding and 0~3 cm in transplanting rice (Table 3). However, 93% of weedy rice occurred mostly from 0~3 cm depths regardless of cultivation methods. This result indicates that water flooding probably inhibited seed germination of weedy rice greater than 3 cm soil depth and thereby reduced weedy rice occurrence as shown in Table 1 and Table 2. Flooding rice fields to a depth of 1.3 cm to 5.2 cm inhibited weedy rice emergence regardless of seeding depths while saturated to dry field conditions permit germination of weedy rice as deep as 10 cm in the soil (Smith, 1973).

Rice grain contamination and yield reduction

Table 4. Rice grain contamination of weedy rice as influenced by rice cultivation methods.

Cultivation method	Contamination of weedy rice grain (%)			
	'95	'96	'97	Average
High ridged dry seeding	–†	1.8	18.6	10.2
Wet drill seeding	–	1.9	14.8	8.4
Water seeding	–	1.5	5.8	3.7
Machine transplanting	–	0.0	0.1	0.1
LSD(0.05)	–	1.2	4.9	–

† not recorded.

Table 3. Emergence depth of weedy rice from soil as influenced by rice cultivation methods.

Cultivation method	Distribution of emerged weedy rice (%)				
	0~1 cm	1~2 cm	2~3 cm	3~4 cm	4~5 cm
High ridged dry seeding	39	37	17	6	2
Wet drill seeding	34	36	23	6	1
Water seeding	51	34	9	1	0
Machine transplanting	72	19	9	0	0

Table 5. Yield reduction as influenced by rice cultivation methods in 1997.

Cultivation method	Milled rice yield (ton /ha)		Yield reduction (%)
	With weedy rice	Weedy rice free	
High ridged dry seeding	4.75	5.07	19.5
Wet drill seeding	4.52	4.70	13.0
Water seeding	4.66	4.89	6.3
Machine transplanting	–†	5.03	–

† weedy rice did not occur in the cultivated rice plot throughout experimental period.

Weedy rice contamination in rice grain had a similar trend to that of weedy rice occurrence pattern; high ridged dry seeding was 10.2%, wet drill seeding was 8.4%, water seeding was 3.7% and machine transplanting rice was 0.05% (Table 4).

In the field, weedy rice competes with cultivated rice for the same resources such as water, light and nutrients and thereby reduce rice grain yields. Yield reduction of cultivated rice due to weedy rice in high ridged dry seeding was greatest at 19.5% when 36.9% of weedy rice panicles contaminated cultivated rice, followed by wet drill seeding of 13.0%, and water seeding of 6.3% (Table 5). Similar rice yield reduction due to weedy rice was observed by Kwon et al. (1991) and Diarra et al. (1985b). These results indicate that transplanting practice significantly suppressed weedy rice infestation, reduced weedy rice interference and thereby reduced weedy rice contamination in rice grain and yield reduction. Therefore, change in cultural practices from direct seeding to transplanting will be one of the efficient ways to reduce weedy rice problems. Greater yield reduction in high ridged dry seeding than that in transplanting rice was related to high weedy rice occurrence.

REFERENCES

Choi, C. D., B. C. Moon, S. C. Kim, and Y. J. Oh. 1995. Ecology and growth of weeds and weedy rice in direct-seeded rice field. Kor. J. Weed Sci. 15(1): 39-45.

Craigmiles, J. P. 1978. Introduction. In E. F. Eastine, ed. Red Rice Research and Control, Texas Agric. Exp. Stn. Bull. pp. 5-6.

Diarra, A., R. J. Smith, Jr., and R. E. Talbert. 1985a. Growth and morphological characteristics of red rice (*Oryza sativa*) biotypes. Weed Sci. 33: 310-314.

________ , ________ , and ________. 1985b. Interference red rice (*Oryza sativa.*) with rice (*O. sativa*). Weed Sci. 33: 644-649.

Jeong, N. J. 1998. Report of Crop Experiment Station (in press)

Kim, C. K. 1998. Report of Crop Experiment Station (in press)

Kim, J. C. 1989. Physio-ecological characteristics of red rice (local name "Salebyeo", *Oryza sativa* L.) spontaneously occurring in Korea and its competition with cultivated rice (*Oryza sativa* L.) 1. Germinative, morphological and growing characteristics and dry matter productive ability of red rice. Res. Rept. RDA(R) 31(3): 34-45.

Kim, S. C. 1997. Weed control technology, In High Yielding Rice Cultivation Technology. Rural Development Administration. pp. 101-141.

Kwon, S. L., R. J. Smith, Jr., and R. E. Talbert. 1991. Interference of red rice (*Oryza sativa*) densities in rice (*O. sativa*). Weed Sci. 39: 169-174.

Park, K. H., M. H. Lee, S. C. Kim, and K. U. Kim. 1997. Growth habit of weedy rice and its possible chemical control. In Proceedings of the 16th Aisan-Pacific Weed Science Society Conference, 8-12 September 1997, Kuala Lumpur, Malaysia, pp. 238-242.

Ponnamperma, F. N. 1972. The Chemistry of submerged soil. Adv. Agron. 24: 29-96.

Smith, R. J., Jr. 1981. Control of red rice (*Oryza sativa* L.) in water-seeded rice. Weed Sci. 29: 663-666.

________ and W. T. Fox. 1973. Soil water and growth of rice and weeds. Weed Sci. 21: 61-63.

Son, Y. 1996. Report of National Yeongnam Agriculture Experiment Station. pp. 287-300.

Watanabe, H., M. Azmi, and I. Md. Zuki. 1996. Ecology of weedy rice (*Oryza sativa* L., locally called padi angin) and its control strategy. In H. Watanabe, M. Azmi and I. Md. Zuki ed. Ecology of Major Weeds and Their Control in Direct Seeding Rice Culture of Malysia. pp. 112-116.