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Antagonistic Interaction between Quinclorac and Bensulfuron-methyl on Growth of the Rice Plants

Kwon, Oh-Yeon* and Yong-Woong Kwon*

Quinclorac과 Bensulfuron-methyl의 混合處理에서 벼의 生長에 대한 除草劑間 拮抗作用

권오연* · 권용웅*

ABSTRACT

Field and pot expeiments were carried out to evaluate the interaction between quinclorac and bensulfuron-methyl on growth of the rice plants(*Oryza sativa* L. cv. Choocheongbyeo) at 20, 45, 65 days-old stages.

Quinclorac and bensulfuron-methyl showed antagonistic interaction at both stages, which were detected by the Chisaka's method[2] at isobles of 10% growth inhibition. The antagonism indices were -0.63 and -1.67 at 20 and 65 days-old seedling stages, respectively.

Leaf-rolling of rice occurred when quinclorac was applied at 600g ai/ha or more at 20 days-old seedling stage, while it occured at the dose of 900g ai/ha at 65 days-old stage. Bensulfuron-methyl reduced plant height and dry weight as well as tiller production at both stages.

Leaf-rolling of rice was reduced when mixture of quinclorac and bensulfuron-methyl was applied due to antagonism of the two herbicides. High temperatures increased the phytotoxicity of bensulfuron -methyl, while the phytotoxicity caused by quinclorac alone was not responsive to temperature. The antagonistic effect between quinclorac and bensulfuron-methyl increased at low temperature as tested by the Colby's method[3].

Key words : quinclorac, bensulfuron-methyl, rice, phytotoxicity, antagonism, temperature.

INTRODUCTION

Sulfonyl-urea herbicides have shown a broad herbicidal spectrum, crop safety and favorable toxicity at an extremely low rate of application, but poor control of barnyardgrasses[2,6,7,8,9]. Quinclorac, developed by BASF Atkirengesellschaft in 1985[10,11], has been used to control barnyardgrass in paddy field[5], and it's selectivity between rice and barnyardgrass may result from a lower uptake by the roots of rice[12].

* 서울대학교 농과대학 Dept. of Agronomy, Seoul National University, Suwon 441-744, Korea

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Recently mixture of the two herbicides had been used by farmers in Korea for broader control spectrum of weeds, but phytotoxicity occurred in a few cases in farmers' fields. Also, the mixture of quinclorac and a sulfonyl-urea herbicide, CGA 142462 caused severe phytotoxicity to the rice plants which were grown at lower temperature. It was suggested that temperature may play an important role on development of the phytotoxicity[13]. This phytotoxicity of quinclorac mixtures may occur by early application at lower temperature regime or late application under high temperature[1].

The objectives of the present study were to determine the interaction between quinclorac and bensulfuron-methyl on the growth of 20, 45 days-old and 65 days-old rice plants and to examine the effect of temperature on the interaction between two herbicides.

MATERIALS AND METHODS

1. Pot Experiments

(1) Interaction between quinclorac and bensulfuron-methyl

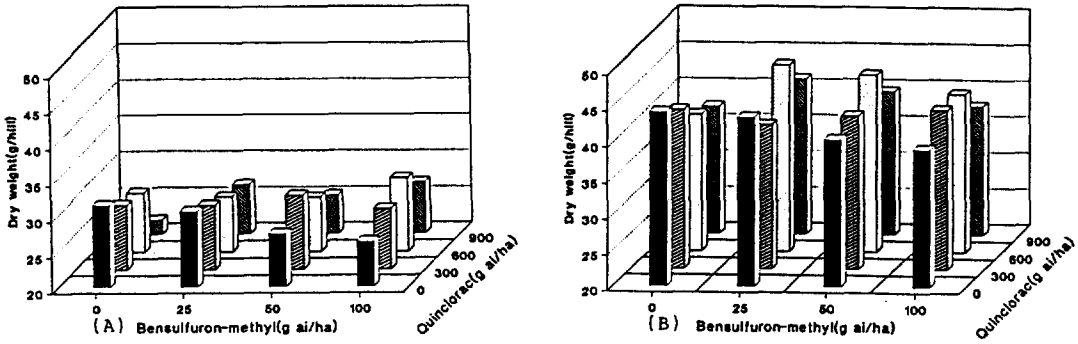
Ten and 55 days-old rice seedlings(cv. Choo cheongbye) were transplanted in 1/5,000a Wagner pots and 1,500cm^2 plastic pots, respectively 3 seedlings for each pot. The pots were irrigated to 3cm depth, and the pots were kept in a green house. At 10 days after transplanting(DAT), full combinations of the application rates for quinclorac (0, 300, 900g ai/ha) and bensulfuron-methyl(0, 25, 50, 100g ai/ha) were treated to the pots. The total dry weight and leaf-rolling were measured at 45 days after herbicide application(DAA). The interaction between quinclorac and bensulfuron-methyl on the growth of rice was evaluated by the Chisaka's method[2] at isoboles of 10% growth inhibition.

(2) Effect of temperature on the interaction between quinclorac and bensulfuron-methyl

Three 35 days-old seedlings were transplanted in each 1/5000a Wagner pot. The plants were grown in growth chambers(E-15, Conviron Co., Canada) where temperatures were set to be 30/20, 23/17 and 20/10℃ (Day/Night) with 12 hours photoperiod. At 10 DAT, quinclorac at 600g ai/ha, bensulfuron-methyl at 102g ai/ha, and their mixtures of the same doses were applied to the pots. Dry weight of the rice plants was measured at 25DAA. The interaction of two herbicides was evaluated by the Colby's method[3].

2. Field Experiment.

Thirty-five days-old seedlings were transplanted by 3 plants per hill in 3.0×3.33m plots. Quinclorac



Treated to 20 days-old rice plants

Treated to 65 days-old rice plants

Fig. 1. Total dry weight of the rice plants as affected by application of quinclorac and bensulfuron-methyl singly or in mixtures. Dry weight was measured at 45days after herbicide application.

at 0, 300, 600, 900g ai/ha, bensulfuron-methyl at 51g ai/ha and their mixtures were applied at 12DAT. Plant height and number of tillers per hill were measured at 20, 30 and 40 DAA. The interaction between two herbicides was tested by the Colby's method[3].

RESULTS AND DISCUSSION

1. Interaction between quinclorac and bensulfuron-methyl.

Total dry weight was more reduced by single application of quinclorac or bensulfuron-methyl than the application of their mixtures at both stages of 20 and 65 days-old plants. The phytotoxity of 20 days-old plants was particularly low when 300g ai/ha quinclorac was treated with 50g ai/ha bensulfuron-methyl. Phytotoxicity of 65 days -old plants was least when the mixture of 600g ai/ha quinclorac and 25g ai/ha bensulfuron-methyl was applied(Fig. 1).

The dose inhibiting rice growth by 10% was estimated to be 584.8 and 517.7g ai/ha for 20 and 65 days-old rice plants for quinclorac, respectively, while those for bensulfuron-methyl were 43.2 and 84.2g ai/ha for the respective ages. The above results indicate that 20 days-old plants were more sensitive to bensulfuron-methyl than 65 days-old plants, while the sensitivity of rice plants to quinclorac was same for different ages(Fig. 2).

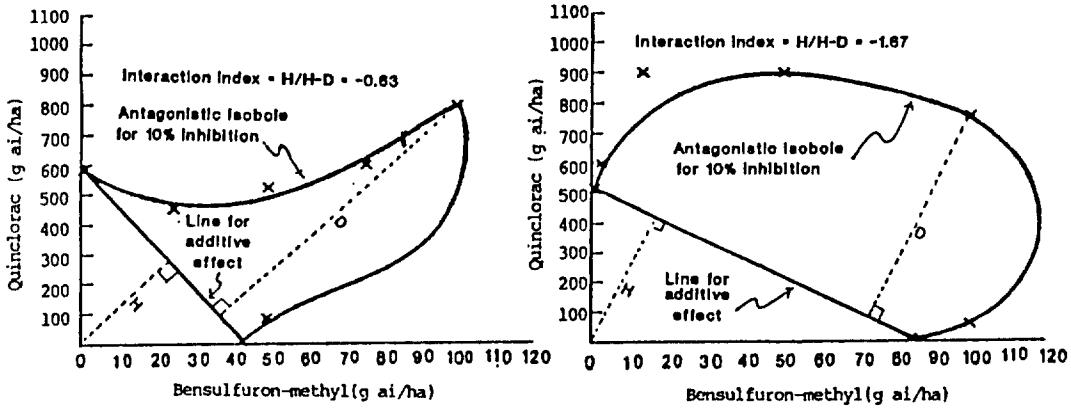
Quinclorac and bensulfuron-methyl have shown antagonistic effects on growth of the rice plants. The antagonistic indices were -0.63 and -1.67 for the 20 and 65 days-old plants, respectively. The highest antagonism was observed when the mixture of quinclorac at 796 a ai/ha and bensulfuron -methyl at 100g ai/ha was applied to 20 days-old plants, while it occurred for 65 days-old plants with quinclorac at 760.3g ai/ha and bensulfuron-methyl 100g ai/ha(Fig. 2).

2. Occurrence of leaf-rolling

Leaf-rolling occurred when quinclorac was applied at a rate above 600g ai/ha to 20 days-old rice plants and 900g ai/ha to 65 days-old rice plants. Leaf-rolling caused by quinclorac was reduced with increased dose of bensulfuron-methyl, suggesting that there exists antagonistic effect of bensulfuron-methyl on leaf-rolling induced by quinclorac(Fig. 3)

3. Temperature effect on the interaction between quinclorac and bensulfuron-methyl

The phytotoxicities of bensulfuron-methyl and



Treated to 20 days-old rice plants

Treated to 65 days-old rice plants

Fig. 2. Antagonism of quinclorac and bensulfuron-methyl in phytotoxicity to the rice growth in dry weight.

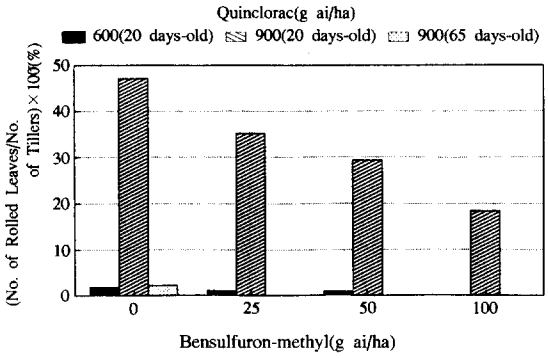


Fig. 3. Occurrence of rolled-leaves of the rice plants as affected by treatment of quinclorac and bensulfuron-methyl to 20 and 65 days-old rice plants. Rolled leaves were counted at 45 days after herbicide application.

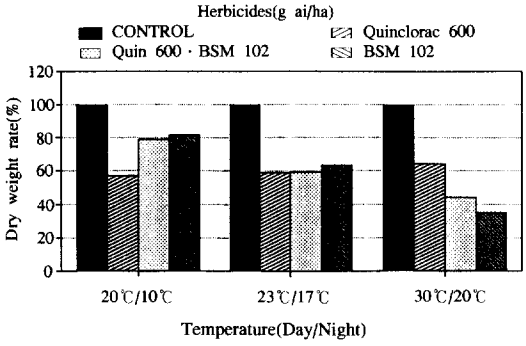


Fig. 4. Effect of temperature on the phytotoxic reduction in total dry weight of the rice plants. Herbicides were treated to 45 days-old rice plants and total dry weight was measured at 25 days after herbicide application.

the mixture of quinclorac and bensulfuron-methyl increased at higher temperatures, while the phytotoxicity of quinclorac alone did not respond to the temperatures treated(Fig. 4). Consequently the phytotoxicity of the mixture under higher temperature conditions was considered mainly due to bensulfuron-methyl.

The antagonism between quinclorac and bensulfuron-methyl was greater at lower temperature (Table 1). The result suggests that phytotoxicity caused by application of the mixture of quinclorac and bensulfuron-methyl would occur more often under higher temperature condition.

4. Interaction between quinclorac and bensulfuron-methyl on plant height and tillering under field condition.

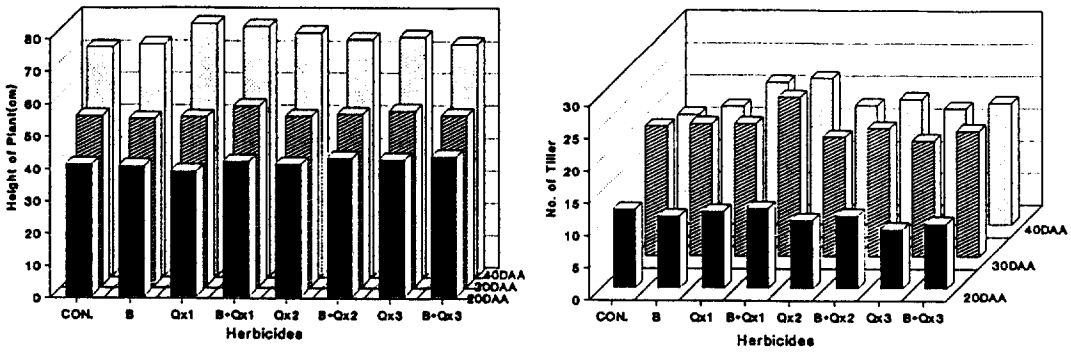
The number of tillers and plant height were more reduced by the application of quinclorac or bensulfuron-methyl alone than by the application of their mixture. The number of tillers decreased with the increased dose of quinclorac, while plant height increased(Fig. 5). Reduced tillering caused by quinclorac might partly be compensated with increased plant height during rice plant growth.

The result of analyses by Colby's method of the interaction between quinclorac and bensulfuron

Table 1. Effect of temperature on the interaction between quinclorac and bensulfuron-methyl on dry weight increase of rice plants as tested by Colby's method.

Herbicide	Growth temperature (℃, day/night)		Bensulfuron-methyl 0 g ai/ha	Bensulfuron-methyl 102 g ai/ha
Quinclorac 600 g ai/ha	20/10	CONTROL	0.00	18.31
		Observed value	42.90	21.15
		Expected value	42.90	53.36
		Difference	0.00	32.21**
	23/17	CONTROL	0.00	36.70
		Observed value	40.89	40.62
		Expected value	40.89	62.54
		Difference	0.00	21.92**
	30/20	CONTROL	0.00	64.69
		Observed value	35.89	55.83
		Expected value	35.89	77.36
		Difference	0.00	21.53**

1) ** : Significant difference at the 1% level of probability according to Chi-square test.



B : Bensulfuron-methyl 51g ai/ha.
Qx1 : Quinclorac 300g ai/ha.
Qx2 : Quinclorac 600g ai/ha.
Qx3 : Quinclorac 900g ai/ha.

Fig. 5. Effect of quinclorac and bensulfuron-methyl mixtures on plant height and tillering of transplanted rice under field condition.

-methyl on plant height and tillering is shown in Table 2. The antagonistic effect on plant height was found until 30 DAA, except for the mixture of quinclorac at 900g ai/ha and bensulfuron-methyl at 51g ai/ha at 30 DAA. The highest antagonism was observed with the mixture of 300g.ai of quinclorac and 51g.ai of bensulfuron-methyl per hectare.

摘 要

本 硏究는 논 除草劑로서 近來에 合劑化된 bensulfuron-methyl과 quinclorac, 두 除草劑 成分이 藥害面에서 벼의 生長에 미치는 相互作用 效果를 밝히고자 수행하였다. Quinclorac은 0, 300, 600, 900g ai/ha수준, bensulfuron-methyl은 0, 25, 50, 100g ai/ha수준에서 組合 處理하였으

Table 2. Interaction computed by Colby's method of quinclorac with bensulfuron-methyl treated at the tillering stage of rice plants on plant growth as observed on 20, 30 and 40 days after application.

Bensulfuron-methyl (g ai/ha)		Quinclorac									
		0	300 g ai/ha			600 g ai/ha			900 g ai/ha		
		Observed value	Observed value	Expected value	Difference	Observed value	Expected value	Difference	Observed value	Expected value	Difference
20 Days after application											
Height	0	0.00	4.88	4.88	0.00	0.24	0.24	0.00	3.90	3.90	0.00
	51	1.29	2.20	6.11	8.31**	4.88	1.05	5.93**	6.10	2.61	3.49*
Tiller	0	0.00	2.21	2.21	0.00	13.19	13.19	0.00	24.73	24.73	0.00
	51	8.27	1.88	10.29	12.18**	7.37	21.46	14.09**	17.61	30.95	13.34**
30 Days after application											
Height	0	0.00	0.38	0.38	0.00	0.17	0.17	0.00	3.11	3.11	0.00
	51	1.78	5.93	2.15	3.78**	1.16	1.95	3.11*	0.44	1.33	0.89NS
Tiller	0	0.00	2.04	2.04	0.00	7.80	7.80	0.00	10.58	10.58	0.00
	51	1.84	22.35	3.84	18.51**	0.94	5.96	5.02*	0.57	8.74	8.17
40 Days after application											
Height	0	0.00	10.16	10.16	0.00	6.08	6.08	0.00	4.36	4.36	0.00
	51	1.19	9.00	11.23	2.23NS	3.25	7.20	3.95NS	1.40	5.50	3.06NS
Tiller	0	0.00	29.82	29.82	0.00	9.11	9.11	0.00	6.51	6.51	0.00
	51	7.87	33.49	35.34	1.85NS	14.26	16.26	2.00NS	11.72	13.87	2.15NS

1) Height : Plant height(cm). 2) Tiller : No. of tillers. 3) NS : Non-significant.
4) ** : Significant difference at the 1% Level of probability according to Chi-square test.
5) * : Significant difference at the 5% Level of probability according to Chi-square test.

며, 벼는 추청벼 10, 35, 55日苗를 供試하고 온실, 생장상 및 포장에서 실험하였다. 除草劑間의 相互作用性은 Chisaka 및 Colby의 성적분석 방법을 이용하였으며, 그 결과는 다음과 같이 요약된다.

1. 벼 總乾物重을 10% 減少시키는 藥量은 quinclorac 단제처리의 경우 幼苗期(파종후 20일 : 3.5엽기)에는 584.8g ai/ha, 分蘖期(파종후 65일 : 7엽기)에는 517.7g ai/ha로 벼의 生育期에 따른 차이가 작았으나 bensulfuron-methyl 단제처리의 경우에는 유묘기에는 43.2g ai/ha, 분얼기에는 84.2g ai/ha으로 벼의 생육기에 따라 약제에 대한 耐性이 크게 달랐다.
2. Quinclorac과 bensulfuron-methyl을 벼의 幼苗期와 分蘖期에 混合處理하였을 경우 總 乾物重을 10% 감소시키는 等效果線을 얻은 결과 相互作用指數(antagonism index)는 -0.63과 -0.67로서 拮抗作用效果가 인정되었으며, quinclorac과 bensulfuron-methyl간에 최대의 拮抗效果를 나타낸 混合比率은 유묘기에는 796 : 100g ai/ha, 분얼기에는 760.3 : 100g ai/ha로서 유묘기에 길항효과가 컸다.
3. 地上部 생장에 대한 拮抗作用效果에 있어서 유묘기에는 地上部 乾物重 減少가 quinclorac 600g ai/ha에 bensulfuron-methyl 100g ai/ha를 混合處理한 구에서 quinclorac 600g a.i/ha과 bensulfuron-methyl 100g a.i/ha의 각 단제처리구보다 작았으며, 相互作用指數(antagonism index)는 -0.79이었다. 分蘖期때는 quinclorac 600g ai/ha에 bensulfuron-methyl 25g ai/ha를 혼합처리한 구가 無 處理區에 비해 지상부 건물중이 증가되었으며, 상호작용지수(antagonism index)는 -1.33이었다.
4. Quinclorac의 auxin적 活性에 의해 발생되는 筒葉은 幼苗期 처리시에는 quinclorac 600g ai/ha단제 처리구에서 개체당 평균 0.22개의 分蘖(1.87%)에서 발생하였으며, quinclorac 900g a.i/ha의 단제처리구에서는 개체당 5.44개의 分蘖(47.10%)에서 발생하였다. 또한 分蘖期 처리시에는 quinclorac 900g ai/ha의 단제처리구에서 개체당 평균 0.22개의 분얼(2.2%)에서 筒葉이 발생하였다.
5. Quinclorac과 bensulfuron-methyl을 混合處理하였을 때는 bensulfuron-methyl의 處理量이 增加할수록 筒葉 발생이 급격히 減少하여 유묘기에 quinclorac 600g ai/ha과 bensulfuron-methyl 100g ai/ha를 혼합처리한 구에서는 筒葉發生이 없었으며, quinclorac 900g a.i/ha과 bensulfuron-methyl 100g a.i/ha을 혼합처리한 구에서는 개체당 1.78개의 분얼(18.45%)에서만 筒葉이 발생하였다. 그리고 분얼기에서는 拮抗效果가 잎의 發育面에서도 충분히 나타나 모든 혼합처리에서 筒葉이 발생되지 않았다.
6. 藥劑處理效果의 溫度反應에서는 quinclorac 600g ai/ha 單劑處理區에서는 溫度가 낮을수록, bensulfuron-methyl 102g ai/ha 단제처리구에서는 溫度가 높을수록 總 乾物重 減少가 심해졌으며, 이들의 混合處理區에 있어서는 溫度가 낮을수록 總 乾物重 減少가 작아졌다. 또한 quinclorac 600g a.i/ha과 bensulfuron-methyl 102g a.i/ha을 혼합처리하였을 때 低溫條件에서의 quinclorac 600g ai/ha 단제처리나, 高溫條件에서 bensulfuron-methyl 102g ai/ha단제처리보다 總 乾物重 減少가 적었다.

溫度에 따른 相互作用性 變化는 總 乾物重의 實測値와 期待値의 차이가 低溫條件에서 -32.44, 適溫條件에서 -21.92, 高溫條件에서 -21.53으로서 溫度가 낮아질수록 拮抗效果가 컸다.

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