

# 數種 Phenoxy 除草劑에 對한 水稻 品種別 新根 및 分蘗數 反應

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Varietal Responses to Phenoxy Herbicides on Number of New Root and Tiller in Rice plant

## 摘要

Propanil, MCPA, 2, 4, 5-T와 Silvex 의 10 個 濃度 水準을 水耕液과 葉面撒布로 台中在來 1 號, Caloro, PI 245717 및 Bluebonnet 50의 水稻 品種을 使用 新根數 및 分蘗數를 調査하였다.

酸化 phenol系 제초제는 草長이나 根長에 對하여 보다 分蘗數나 根數增加에 더 影響을 주었다. MCPA 만이 使用量범위내에서 分蘗數 增加가 可能하였다. Silvex는 新根生成을 促進하는데 必要한 水準 보다도 높은 水準에서 分蘗을 促進 시켰다.

除草劑에 對한 品種間 反應은 除草劑 投與部分에 따라 달랐다. 耐肥性이 強한 品種 일수록 除草劑의 促進效果가 큰 傾向이었다. Propanil은 酸化 phenol系 除草劑의 20배의 高 濃度에서도 水稻生育에 아무런 影響이 없었다.

## INTRODUCTION

In the previous paper the effects of phenoxy herbicides (MCPA, 2, 4, 5-T and Silvex) and propanil on the plant height and root length of four rice varieties were reported<sup>(13)</sup>.

Silvex increased plant height of Taichung Native 1 in foliar spray and decreased root length of Bluebonnet and PI 245717 when applied via root at all levels. All phenoxy herbicides over 4 ppm decreased plant height in all varieties tested when applied to root.

In this paper the effects on organ differentiation that is, number of new root and tiller were reported.

The results strongly suggest that phenoxy herbicide has a close relation to nitrogen metabolism of rice.

## MATERIALS AND METHODS

The same samples of previous report<sup>(13)</sup> were used for investigation of number of new root and tiller two weeks after herbicide treatment.

Four rice varieties, Taichung Native 1, Caloro, Bluebonnet 50 and PI 245717 were grown by water culture based on Kirkby et al<sup>(10)</sup>.

After 40 days-growing three phenoxy herbicides, MCPA (2, methyl- 4, chloroph-

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enoxy acetic acid), 2,4,5 - T (2,4,5 - trichloro phenoxy acetic acid) Silvex(2,4,5-trichlorphenoxy propionic acid) and propanil (3,4 - dichloropropioanilide) for comparison were applied at 10 levels by foliar spray and root administration.

## RESULTS

Number of new Roots; Effects of herbicide on number of new roots were shown in Table 1 and 2. Propanil had no effect on new root formation. But 10 ppm of propanil on Bluebonnet showed inhibition of new formation in root application. When applied via foliage PI 245717 was inhibited over 4 ppm. Phenoxy herbicides in contrast with propanil had great increase in new root formation.

Maximum increase, 1300%, was observed at 0.2 ppm of silvex in Taichung when applied to root. In MCPA the highest increase was shown in Taichung at the lowest concentration. The effect of foliar spray was lower than in root application. Maximum increase in foliar spray was 470% in silvex. Taichung variety had the maximum value in the case of root application. But the herbicide concentration was 0.8 ppm which is 4 times higher than in root application.

Varietal response were clearly different. Taichung, Caloro, PI 245717 and Bluebonnet were in decreasing order of response in new root formation in root application and foliar spray. In silvex and MCPA, a sharp decrease in the effect by the increased herbicide concentration was found in Taichung

Table 1. The effect of herbicides on number of new root of rice (Root administration, % increase, control: 100)

concentration	ppm	0.2	0.4	0.6	0.8	1.0	2.0	4.0	6.0	8.0	10.0
Propanil	C	128	110	100	122	90	100	100	120	100	100
	T	95	90	80	95	100	100	95	90	95	100
	B	110	100	105	95	100	92	92	100	114	100
	P	100	650	110	98	100	95	105	100	95	70
MCPA	C	600	420	560	502	540	75	-	-	-	-
	T	1200	122	367	133	0	0	0	-	-	-
	B	200	150	67	84	46	67	0	-	-	-
	P	255	150	100	91	60	25	0	0	-	-
2,4,5-T	C	-	-	-	-	-	-	-	-	-	-
	T	560	233	100	40	-	-	-	-	-	-
	B	50	83	125	-	-	-	-	-	-	-
	P	175	166	75	-	-	-	-	-	-	-
Silvex	C	750	700	850	1050	600	550	467	400	-	-
	T	1300	650	500	280	467	420	0	0	0	0
	B	67	200	125	100	115	80	30	0	0	0
	P	230	75	100	250	236	100	105	38	40	50

C : Caloro T : Taichung B : Bluebonnet P : PI245717 - : dead

Table 2. The effect of herbicides on number of new root of rice (foliar spray, %increase, control: 100)

Herbicide	ppm	0.2	0.4	0.6	0.8	1.0	2.0	4.0	6.0	8.0	10.0
Propanil	T	110	109	120	90	100	120	115	100	101	70
	B	110	112	100	101	100	101	101	99	70	40
	P	118	120	95	100	105	107	60	70	0	0
MCPA	T	378	289	313	361	320	50	40	70	-	-
	B	246	100	167	105	70	0	0	167	0	0
	P	175	153	133	166	200	70	60	40	0	0
2,4,5-T	T	150	60	0	0	0	0	-	-	-	-
	B	133	99	43	33	0	-	-	-	-	-
	P	110	50	70	30	30	-	-	-	-	-
Silvex	T	100	173	214	470	250	333	150	161	173	117
	B	190	160	90	133	127	142	226	117	125	0
	P	120	140	150	217	147	200	217	100	157	40

T: Taichung Native 1 B: Bluebonnet P: PI 245717 -: dead

but not in Caloro. MCPA had inhibition effect in new root formation in the high concentration range from either foliar or root application. Comparing with root application foliar spray gave somewhat greater fluctuation in percent effect. Main reason of this fluctuation will be attributed to spray which could not give exact amount of herbicide in each levels as in root application.

Number of tiller; Effect of herbicides on number of tiller were shown in Table 3 and 4. Propanil did not show any effect on tillering. High stimulating effect was found in MCPA and silvex in root application or foliar spray. In the case of 2,4,5-T applied via root, Taichung and PI 245717 were completely inhibited while Bluebonnet was stimulated. In foliar spray no effect was found in 2,4,5-T. It is difficult to evaluate 2,4,5-T effect due to the effect of oil used as spray mixture as previously mentioned. MCPA was strongly stimulative to the 2 ppm level and over this level inhibited in all varieties

in root application. The highest percentage increase was 880 at 0.2 ppm of MCPA.

In the case of foliar spray all levels showed increase effect in all varieties but Bluebonnet. Contrasting to MCPA, silvex had a trend to give stimulating effect at high concentration.

Varietal response to herbicide in tillering was also clear in root administration. Silvex was most effective in PI 245717 showing 600% as maximum while other varieties showed below 300%. In foliar spray Taichung had the highest response by 500% in silvex. In Taichung silvex was more effective in foliar spray and MCPA was more effective in root administration while in PI 245717, silvex was more effective in root application and MCPA was more effective in foliar spray.

## DISCUSSION

Propanil had no effect on new root form-

Table 3. The effect of herbicides on number of tiller of rice  
(Root administration, % increase, control: 100)

Herbicide	ppm	0.2	0.4	0.6	0.8	1.0	2.0	4.0	6.0	8.0	10.0
Propanil	C	100	100	100	100	100	100	100	100	100	100
	T	100	100	100	100	100	100	100	100	100	100
	B	100	100	100	100	100	100	100	100	100	100
	P	100	100	100	100	100	100	100	100	100	100
MCPA	C	334	220	182	180	140	100	-	-	-	-
	T	100	880	360	467	320	240	0	0	0	0
	B	300	240	240	180	240	160	100	-	-	-
	P	100	220	180	260	200	220	100	0	0	0
2,4,5-T	C	-	-	-	-	-	-	-	-	-	-
	T	0	0	0	0	-	-	-	-	-	-
	B	150	100	100	-	-	-	-	-	-	-
	P	0	0	0	-	-	-	-	-	-	-
Silvex	C	100	100	100	100	100	100	200	200	-	-
	T	100	100	200	132	268	80	132	0	67	0
	B	100	100	100	100	234	100	140	200	100	200
	P	100	100	600	100	250	100	220	400	300	300

C : Caloro T : Taiching Native 1 B : Bluebonnet P : PI 245717 - : dead

Table 4. The effect of herbicides on number of tiller of rice  
(foliar spray, % increase, control: 100)

Herbicide	ppm	0.2	0.4	0.6	0.8	1.0	2.0	4.0	6.0	8.0	10.0
Propanil	T	100	100	100	100	100	100	100	100	100	100
	B	100	100	100	100	100	100	100	100	100	100
	P	100	100	100	100	100	100	100	100	100	100
MCPA	T	234	332	300	234	220	234	380	340	150	360
	B	100	200	100	100	100	100	100	370	100	100
	P	250	180	366	100	140	260	200	180	180	234
245-T	T	100	100	100	100	100	-	-	-	-	-
	B	100	100	100	100	-	-	-	-	-	-
	P	100	100	100	100	-	-	-	-	-	-
Silvex	T	100	133	100	100	100	100	500	100	200	220
	B	100	100	100	200	100	100	100	100	100	100
	P	100	140	100	100	140	100	200	160	100	300

T : Taichung Native 1 B : Bluebonnet P : PI245717 - : dead

ation and tillering. In the field test no varietal difference in response to propanil was observed (16).

Phenoxy herbicides had more stimulative effect in new root formation and tillering than in plant height and root length in either root administration or foliar spray. Kinetin and IAA balances in plant affect the formation of new buds (3). Phenoxy herbicides in rice may change the hormonal balance in a way to increase the tiller number and new roots. It is not clear from the present experiment whether the stimulation effect on tillering and new root formation inhibits plant height and root length. Even though there were evidences that plant height was associated with tillering (17). The study on this subject in connection with hormonal balance is hard to determine.

The effect on growth pattern was different between herbicides. MCPA had the same trend in the effect on tillering and on the new root formation with its concentration change while silvex required higher concentration for tillering than for the new root formation. From this result it could be concluded that MCPA can be expected to increase tiller number around usual applicable range but silvex can be expected to be effective only for new root formation at the same range.

The classification of rice variety is not a easy one(2) and the degree of nitrogen responsiveness is also difficult to be determined. But they can be grouped with some relative boundaries (1, 17). Varietal response to the phenoxy herbicides showed some relation to varietal nitrogen response. It can be said that Taichung Native 1, Caloro, PI 245717 and Bluebonnet 50 were in the decreasing order of nitrogen response in field condition (8, 9, 14, 18). From previously

mentioned results Taichung, Caloro PI 2457-17, and Bluebonnet stimulated tiller and new root formation in the decreasing order. It can be concluded that of high response to phenoxy herbicides. High nitrogen response variety in community (field condition) has usually low nitrogen response in the isolated condition (17, 18).

Nitrogen response of rice is not yet elucidated in relation with nitrogen and carbohydrate metabolism. According to above result high nitrogen response variety may have low nitrogen assimilation power in its genetic characteristics. However nitrogen responsiveness depends not only nitrogen assimilation power but also on carbohydrate metabolism. Since nitrogen responsiveness is measured by dry matter yield in connection with nitrogen level. It is well known that phenoxy herbicides stimulate protein synthesis. Jarvis et al (7) reported the effect of 2,4-D on the RNA synthesis. Wort et al (19) observed that low concentration of 2,4-D increased protein content but depressed the content of reducing sugars and 13 free amino acids while MacLeod (11) found that MCPA increased amino acids and sugars at toxic level. By these results phenoxy herbicides in stimulating levels may increase protein synthesis. Consequently it could be possible that high nitrogen response variety is stimulated in protein synthesis by phenoxy herbicides. In Schrader pointed out the importance of growth regulator in carbon nitrogen that  $^{14}\text{CO}_2$  was more incorporated into amino acids by 2,4-D treatment (16). It is clear that there are close relationship among nitrogen response proteins synthesis, phenoxy herbicides, and growth pattern.

Taichung and Caloro are short grain varieties. PI 245717 and Bluebonnet 50 are long

grain varieties. Taichung is indica and Caloro is Japonica variety. Taichung was more sensitive of increasing trend of tiller number observed in field condition is supported by this experiment. There is another factor of application time. MCPA and 2, 4-D were applied 15 to 25 days after transplanting (5, 6, 12) in field. Nursery life is about 40 to 45 days. In this experiment herbicides were treated about 15 days earlier than in field experiment.

Yield increase in MCPA plot (4) might be related with increasing tiller number. There is other possibility of MCPA effect on high yield of rice as a growth stimulant as indicated by this experiment. It is the effect on new root formation. By the stimulation of new root development rice root can overcome the harmful reduction status of rootzone.

Further studies are required for the elucidation of the above mentioned five possible ways of phenoxy herbicides on rice yield.

### SUMMARY

The effects of propanil, MCPA; 2, 4 5-T and silvex on the number of new root and tiller on Taichung Native 1, Caloro, PI 245717 and Bluebonnet 50 by root administration and foliar spray at 10 levels of concentration were investigated. Phenoxy herbicides changed the growth pattern in the way of increased number of tillers and new roots rather than plant height or root length. It was suggested that MCPA is only possible to increase tillering around applicable range. Silvex stimulated tillering at higher level than that required to stimulate new root formation. Varietal response on herbicides were different along with herbicide feeding part. There was trends that the higher nitrogen

response varieties also have a greater response to stimulating effect of herbicide. Propanil had no effect on growth and no injury even about 20 times of higher concentration of phenoxy herbicide.

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