Effect of New Herbicides(CGA 82725 & DOWCO 453) on Membrane Permeability in Bean Leaf Tissue

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새로운 除草劑가 강남콩잎의 細胞膜 透過性에 미치는 影響

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ABSTRACT

Leakage of electrolytes from leaf discs of treated bean (*Phaseolus velgaris* L.) plant was the criterion used to investigate the effect of four herbicides on the permeability of leaf-cell membrane.

CGA 82725 (2-propynyl 2-((3, 5-dichloro-2 pyridinyl) oxy) phenoxy prpanate) at 10^{-3}M increased significantly cell membrane permeability within 1 h after 12 h treatment. Significant increase in cell membrane permeability was also detected at 10^{-2}M of DOWCO 453 (Haloxy-methyl 2-(4 (3-chloro- 5-(trifuluoromethyl)-2-pyridinyl) phenoxy) propanate. The effect of dinoseb (2-(1-methylpropyl)-4, 6-dintrophenol) on cell premeability was detected at 10^{-4}M after 12h. The highest conductivity measurement was obtained from paraquat (1, 1'- dimethyl-4, 4'-bipyridinium ion). Increase in cell membrane permeability was not always associated with injury symptoms such as appearance of necrotic area in leaves.

Key words: membrane permeability, Phaseolus vulgaris

INTRODUCTION

Herbicides may affect the structure of membranes either directly or indirectly. For herbicides to be phytotoxic, they must move through membrane in the roots or the shoots. Plant membranes are involved as structural components of the cell and also function in cell permeability, ion transport, electron transport, and enzyme activity.

Since membrane lipids are intimately associated with many of the menbrane functions, any alternation of the lipid components could have a profound effect on membrane function or structure. Many studies suggest that herbicides interfere with membrane permeability probably through interaction with the lopoidal component of the membrane[3,4]. This interference can influence the transport of solutes across the membrane whether the solutes are endogenous compounds or herbicides. Therefore, in order to determine the mode of action of herbicide it is very important to investigate the effects of herbicides especially on permeability of cell membrane.

The electrolytic conductivity technique was first used for measuring cell membrane permeablity by Vanstone *et al.*[8] However, this method has been widely used to determine tissue demage caused by

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cold temperature.[7] In present study I determined the effect of two new herbicides on the permeability of leaf-cell membrane to investigate the mode of action of two herbicides.

MATERIALS AND METHODS

Seeds of bean (*Phaseolus vulgaris* L. CV. 'Green Bush Snap') were planted in pots and placed in a growth chamber at 20+2 C day, 21+2 C night temperature with a 16h photoperiod, and light intensity of 20 Klux. Plants were sprayed to run off with specific herbicides at the fully expanded primary leaf stage (7 days after emergence). Herbicide treatments applied were paraquat, CGA 82725, DOWCO 453, and Dinoseb at 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5} M of each herbicide.

Twelve-hour after treatment, 30 discs of 7mm diameter were punched from bean leaves. Cutting across major veins was avoided to minimize the conductivity contributed by cut surfaces. Discs were rinsed for one min. in 250ml of distilled water to remove contents of cut cells, then incubated in 25ml of distilled water in flask in a water bath at 26 C. The flasks were shaken gently during incubation. At 1-h intervals during 6h incubation, beginning at one hour, electrolyte leakage was measured with a modified wheaton bridge with a pipette-type conductivity cell. Changes in electrical conductance were taken as an indication of solute leakage from leaf discs. All experiments had three replications.[5]

RESULTS AND DISCUSSION

The electrolytic conductivity test was used here to monitor leakage of electrolytes in the ambient solution of herbicide-treated bean leaf dicses.

CGA 82725 at 10^{-3}M increased significantly cell membrane permeability within 1h after 12h treatment. Significant increase in cell membrane permeability was also detected at concentration of 10^{-2}M of DOWCO 453 (Table 1). However, dinoseb which was known to increase in cell membrane permeability[3,4,5] demonstrated the significant increase in cell membrane permeability at lower concentration (10^{-4}M). Prendeville and Warren[5] showed that dinoseb at 10^{-4}M causes cell membrane permeability. Paraquat which was known to increase in cell membrane permeability[3,4,5,8] showed the significant increase in cell membrane permeability at 10^{-5}M (Table 2).

These results suggested that the effects of CGA 82725 and DOWCO 453 on cell membrane permeability were not the primary action of site. Because the range concentration (CGA 82725 10^{-3}M, DOWCO 453 10^{-2}M) which showed the effect on membrane permeability was too high to cause the primary action compared with dinoseb and paraquat.[1] Oat root growth test has already showed that 10ppm (2.86×10^{-5}M) of both herbicides was sufficient to induce herbicidal action[2]. Therefore, the effects of CGA 82725 and DOWCO 453 on cell membrane permeability may be considered a secondary action of the herbicides.

These studies also showed that any herbicidal injury symptoms caused by paraquat or dinoseb were not observed in the leaves which were treated with CGA 82725 and DOWCO 453. Predeville and Warren[5] reported that increase in cell membrane permeability was always associated with injury symptoms such as appearance of necrotic area in the leaves. However, these observations indicated that appearance of visible injury symptons was not always of prerequite for herbicidal activities on leaf cell membrane permeability. Herbicides which caused the visible injury symptons might affect membrane integrity as evidenced by rupture and disintegration of membrane envelops. These herbicides may have acted directly on the membrane by binding to membrane lipids and modifying permeability.[4] If membranes were affected over longer period of time without injury symptoms, herbicides may have indirectly influenced membrane structure by affecting lipid biosynthesis.[6] Therefore, CGA 82725 and DOWCO 453 may indirectly affect lipid biosynthesis or modify membrane permeability at high concentrations.

Table 1. Solution conductivity as a measure of electrolyte leakage from bean leaf disks exposed to various concentrations of three herbicides for certain incubation periods after a standard 12-hour period.

Herb.	Conc.	Exposure time					
		1hr	2hr	3hr	4hr	5hr	6hr
	(M)	umhos					
Dinoseb	10^{-2}	17.0	20.3	23.0	26.0	27.0	28.0
	10^{-3}	17.5	19.3	21.6	24.0	25.6	28.0
	10^{-4}	15.0	19.3	21.6	23.3	25.0	25.6
	10^{-5}	13.3	14.6	16.6	17.0	18.0	19.0
	0	14.3	17.6	18.0	20.0	20.0	20.0
	LSD (P= 0.05)	1.5	2.8	3.0	3.8	3.6	3.5
CGA 82725	10^{-2}	28.0	30.6	33.0	35.6	37.6	38.6
	10^{-3}	24.3	25.6	28.0	30.0	31.6	32.6
	10^{-4}	15.6	17.3	20.0	21.3	23.0	23.3
	10^{-5}	15.0	17.0	19.3	20.0	21.6	22.3
	0	14.3	17.6	19.0	20.0	20.0	20.0
	LSD (P= 0.05)	6.6	7.1	7.1	7.1	6.6	6.6
DOWCO 453	10^{-2}	14.3	15.6	17.0	18.3	18.6	19.3
	10^{-3}	11.3	12.6	13.6	14.6	15.0	15.0
	10^{-4}	11.0	12.0	13.3	13.6	14.6	14.6
	10^{-5}	12.3	13.3	14.0	15.0	15.3	15.6
	0	11.6	13.0	14.3	15.0	15.6	15.6
	LSD (P= 0.05)	2.2	2.3	2.7	2.4	2.5	2.5

Table 2. Solution conductivity as a a measure of a electrolyte leakage from bean leaf exposed to various concentrations of paraquat for certain incubation periods after a standard 12-hour period.

Paraquat conc.	Exposure time			
	2h	4h	6h	8h
(M)	umhos			
0	10d*	12d	14d	17d
10^{-5}	26C	30C	33C	35C
10^{-4}	38b	43b	47b	51b
10^{-3}	45a	48a	55a	60a

* Values within column followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

摘　　要

本 實驗은 新種 除草劑인 CGA 82725와 DOWCO 453의 殺草機構中 하나의 機作으로 思料되는 細胞膜透過性에 미치는 影響을 調査하였다.

1. CGA 82725는 10^{-3} M 濃度에서 細胞膜透過性을 增加시켰다.

2. DOWCD 453은 10^{-2} M 濃度에서 細胞膜透過性을 增加시켰다.

3. Paraquat와 Dinoseb은 10^{-5}M과 10^{-4} M 에서 細胞膜透過性을 增加시켰다.

4. 細胞膜透過性 增加와 잎에 나타나는 necrosis現象과는 항상 一致하지는 않는다.

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