招請講演
Invited Lecture

A Study of the Mode of Action of CGA 82725 and DOWCO 453

Kim, Jae Cheol*

새로운 除草劑 CGA 82725와 DOWCO 453의 作用特性에 關하여

金 載 喆*

CGA 82725 and DOWCO 453 are selective post emergence herbicides that provide excellent activity against a wide range of annual and perenial grasses. The main site of activity of both herbicides is the meristem tissue.

To investigate the mode of action of two new herbicides, four preliminary bioassays were conducted. Results of two test, growth inhibition and membrane permeability, were related to the two herbicidal action, but results of other two test, inhibition of photosynthesis and inhibition of photosynthetic pigments, did not show these herbicidal responses.

Average growth rates of oat roots were significantly inhibited at a range of concentration (0.1, 1, 10, 100ppm) of CGA 82725 DOWCO 453 within 12 hour after treatment. The greatest inhibition of growth occurred between 6 hour and 12 hour over a 24 hour period. Initial cessation of growth induced by CGA 82725 and DOWCO 453 was at 10 and 100 ppm within 12 hour period while oat root growth was stopped by 1 ppm of both herbicides within 18 hour period. These data suggested that the primary site of action of these herbicides could be inhibition of growth.

CGA 82725 at 10^{-3}M increased significantly in cell membrane permeability within 1 hour after 12 hour treatment. Significant increase in cell membrane permeability was also detected at concentration of 10^{-2}M of DOWCO 453. The range of concentration (CGA 82725 10 M, DOWCO 453 10 M) which increased significantly in cell membrane permeability was too high to cause the primary action of herbicides. Oat root growth test has already showed that 10 ppm (2.86×10^{-5}M) of both herbicides was sufficient to induce herbicidal action. Therefore the effects of CGA 82725 and DOWCO 453 on cell membrane permeability may be considered a secondary action of the herbicides.

To identify the growth inhibition induced by these herbicides, cell division, cell enlargement, and oxygen uptake were studied.

CGA 82725 and DOWCO 453 of 10 ppm cause approximately 40% and 50% inhibition of cell division in oat roots within 6 hours treatment. Both herbicides of 1 ppm caused significant inhibition of cell division in oat roots after 12 hours treatment. The greatest inhibition of cell division of oat root tips occured during first 6 hours of treatment at 10 and 100 ppm. This results were closely associated with the results of root growth test. Therefore inhibition of cell division may bring growth inhibition.

This study also showed there was a uniform decrease in prophase, metaphase, and anaphase as treatment time increased in both herbicides. Any disruption of chromosome movement, or any multinucleate cells, such as caused by trifluralin, were nor found in mitosis. These observations indicated that inhibition of cell division could be occur at G1, S, or G2 stage in cell cycle.

CGA 82725 and DOWCO 453 of 100 ppm re-

*全北大學校 農科大學.

* Dept. of Horticultural Science, Jeonbug National University, Jeonju 520, Korea.

duced significantly cell enlargement of oat coleoptiles by 70% and 40%, respectively, but at 10 ppm cell enlargement was not significantly reduced for CGA 82725 and DOWCO 453, respectively. This inhibition of cell enlargement may be a secondary effect on growth.

Study of oxygen uptake showed that CGA 82725 and DOWCO 453 did not increase or decrease oxygen uptake by pea root tips. Therefore, the herbicidal action of these herbicides were not associated with respiratory assembly.

The rate of progression of G2 cells into mitosis was significantly inhibited in all range of concentrations of CGA 82725 and DOWCO 453 between 4 hours to 8 hours period. This indicated that many cells which were going to enter mitosis from G2 were apparently inhibited by these herbicides. The rate of incorporation of 3H-TdR into interphase cells in treated oat was higher than control within 8 hours period. After 12 hours treatment, the rate of incorporation of 3H-TdR into interphase cells decreased and then increased within 16 hours period. Labeled dividing cells which entered mitosis thru G2 were inhibited approximately 50% at 4 hours after treatment with 10 ppm of these herbicides. After 16 hours treatment, no labeled dividing cells were observed in mitosis while interphase cells still incorporated radioactive precursors into DNA more than control at 10 ppm treatment. This indicated that progression of interphase cells from S to M stage may completely inhibited. Therefore, the primary site of herbicidal action in the mitotic cycle may be the G2 period.

10 ppm of CGA 82725 and DOWCO 453 inhibited approximately 20% to 40$ and 10% to 20% of DNA synthesis over a 24 hours period. 100 ppm of CGA 82725 and DOWCO 453 showed approximately 50% to 75% and 40% to 60% inhibition of DNA synthesis. CGA 82725 and DOWCO 453 at 10 ppm showed approximately 15% to 30% inhibition of RNA synthesis over 24 hours respectively. 100 ppm of CGA 82725 and DOWCO 453 inhibited approximately 20% to 80% and 20% to 50% RNA synthesis over 24 hours.

CGA 82725 and DOWCO 453 at 100 ppm caused more than 90% inhibition of protein synthesis during 1 to 8 hours treatment. During this period, the rate of cell division was also decreased more than 90% at same concentration. CGA 82725 and DOWCO 453 at 10 ppm caused approximately 20% to 30% and 10% to 30% inhibition of protein synthesis over 24 hours period.

Inhibition of DNA synthesis may be a secondary effect because the 3H-TdR incorporation was continous even after cell division was inhibited completely but the rate of 3H-TdR incorporation into DNA was decreased as treatment time increased. Inhibition of RNA synthesis may be a secondary effect because RNA synthesis was continuous over 24 hours, therefore the lack of RNA for DNA synthesis would not be showed, but the rate of RNA synthesis was inhibited over 24 hours treatment. Inhibition of specific protein synthesis in G2 might be a primary action of CGA 82725 and DOWCO 453. Specific protein synthesized in early G2 can be associated with the G2 → M transition while protein synthesized in G1 might be connected with the G1 → S transition of cell cycle. This study indicated that G1 → S transition might not be inhibited or partially inhibited but G2 → M transition was rapidely inhibited within 12 hours period and was completely blocked after 16 hours period.

The conclusions based on the results of these studies are:

1. DOWCO 453 and CGA 82725 inhibited cell division which caused the inhibition of plant growth. Inhibition of growth can be a primary cause of these herbicide.

2. The primary site of action of these herbicides may be G2 stage in interphase of cell cycle.

3. The possible primary cause of growth inhibition may be considered to be inhibition of specific protein synthesis in early G2 stage. Further studies on the identification of specific protein should be needed.

4. Inhibition of DNA, RNA, protein, and cell enlargement can be secondary effects of these herbicides.