

Study on the Response of Korean Ginseng (*Panax ginseng* C.A. Meyer) to the Herbicide 2,4-D Application

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Abstract □ Various rates of 2,4-D were sprayed on 2 and 3 year old ginseng plants as foliar spray to define the critical concentration. No apparent plant injury was noticeable for those ginseng plants when application concentration of 2,4-D doubled the recommended dosage (70 ml/10a). Neither abnormal foliar change occurred nor any inhibition in leaf and stem growth was resulted for the plants treated with 2,4-D concentrated two times of the recommended dosage. When the rates of 2,4-D application were increased greater than this level, injury ratings increased linearly with the rates of 2,4-D application and plant growth was inhibited.

Ethylene gas was not produced from the ginseng plant treated with 2 times concentrated 2,4-D, however the ginseng plants produced 0.03 to 0.09 ppm ethylene gas when the rate of application were increased 3 and 4 times, respectively. On the other hand the soybean treated with the recommended amount of 2,4-D produced ethylene gas of 10-20 times higher compared with ginseng plants and died. Photosynthesis ability of the ginseng leaf was significantly decreased by 2,4-D foliar application but it was recovered 4 weeks after 2,4-D foliar treatment.

The herbicide 2,4-D was applied to 2,3 and 4 years old ginseng plants as foliar spray with the rates of 0.5, 1.0, 1.5 and 2.0 times of the recommended dosage to define the effects of 2,4-D on the plant growth and root yield of the ginseng. There were no significant differences in the leaf and stem growth between untreated and 2,4-D treated plant. Berry maturing of 3 and 4 year old ginseng was not influenced by 2,4-D. The root weight of 4 years old ginseng plant was not reduced by application of 2,4-D concentrated 2 times of the recommended dosage. Application time of the herbicide 2,4-D had no effects on the leaf or stem growth of 2,3 and 4 year old year old ginseng plants.

When the ginseng seedling was treated with 2,4-D, detrimental phenomena as stem bending and decoloration of seedling leaf margin occurred, but stem bending was recovered in a few days.

Keywords □ *Panax ginseng* C.A. Meyer, 2,4-D, herbicide.

Introduction

Weed control in ginseng planting is more difficult than in other crops because the ginseng is a perennial crop and has to be cultivated under the artificial shading. Ginseng plants have been known to be affected rather easily by the chemical herbicides and any herbicide which is selectively safe for the ginseng plant has not been found upto now. As hand weeding is the only practical means of eliminating weed after crop establishment, a selective herbicide would greatly simplify the control of weeds in ginseng plantings and reduce labor costs asso-

ciated with growing the crops. 2,4-D is an auxin type herbicide that at low concentration brings about growth response similar to IAA. At high concentration 2,4-D is herbicidal and is commonly used to control broadleaf weeds in grasses. This compound cause epinastic bending in leaves, a cessation of growth in length and increased radial expansion. After several days of application tumor may form, followed by a softening and collapse of tissue. In 1987 exploratory exposure of the Korean ginseng plant to 2,4-D suggested that this herbicide might safely be used for control of susceptible weeds in ginseng plantings. In 1988 this study was initiated

to define the growing response of the Korean ginseng treated with 2,4-D.

Material and Method

The experiments were carried out at the experiment field at the Agricultural college, Chungnam National University and at a farmers ginseng field in Keumsan county of Chung nam province for 2 years from 1988 to '89. The ginseng plants used in the experiments were 2 and 3 year old plants which were cultivated in plastic pot at the experiment field and 2,3 and 4 year old plants which were cultivated at farmers field with the traditional cultivating method.

The herbicide used in these experiments was 2,4-Dichlorophenoxy acetic acid (40%) and its recommended dosage for the weed control was 70 ml/10a. To determine the critical dosage for ginseng plantings, 2,4-D was applied as foliar spray at 40 days after emergence of ginseng plant. Rates were 70, 140, 210, 280, 350, 420, 490, 560 ml/10a and check. Plot size was 0.45 square meter and the treatments were replicated 4 times in a RCB design.

To measure ethylene gas production from the ginseng plant treated with 2, 4-D, 2 year old ginseng was planted in pot and the pot was put into a glass jar. 2,4-D was sprayed on the ginseng plant at the rates of 70, 140, 210, 280 ml/10a and control, and top of the jar was sealed with a plastic cap. Air sample was taken from the jars 24 and 48 hours after 2,4-D treatment and analyzed with a gas analyzer.

2,4-D was applied to 3 year old ginseng plant as foliar spray at the rates of 0, 70, 140 and 210 ml/10a after 40 days of emergence and photosynthesis amount of the ginseng leaf was measured after 1 and 4 weeks of 2,4-D treatments.

To find the effects of 2,4-D treatment on the plant growth and root yield of ginseng, it was applied to 2, 3 and 4 year old ginseng as foliar spray at the rate of 0, 35, 70, 105 and 140 ml/10a after 40 days of emergence of the ginseng plant. Plant growth was observed 10 and 20 days after the treatment and root yield of 4 year old ginseng was

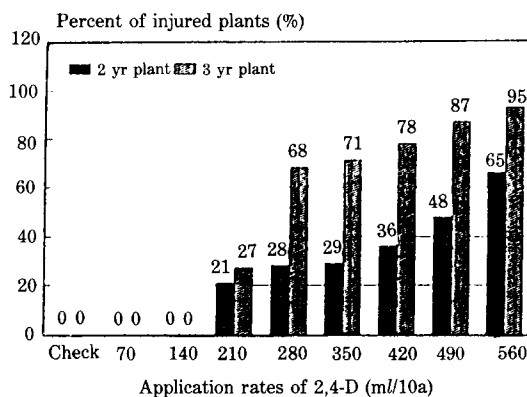


Fig. 1. Crop injury of the ginseng plants by 2,4-D foliar application.

measured at late September. And 2,4-D was sprayed on 2,3 and 4 year old ginseng plant at 1, 5, 10, 15 and 25 days after emergence of the ginseng plant at rate of 70 ml/10a to find the effects of application time of 2,4-D on the plant growth and root yield of the ginseng plants.

Size of the experimental units of the above experiments was 1.5 square meter and the treatments were replicated 4 times in a RCB design.

Results and Discussion

The ginseng plant, treated with 2,4-D at the rate of 70 ml/ or 140 ml/10a, did not show any symptom of a crop injury (Fig. 1). However, when the application rates of 2,4-D were 210 ml/10a or above, margin of the ginseng leaflets turned to white and wilted. Percentage of the injured plants increased with the increase of the rate of 2,4-D application. The rate of crop injury by 2,4-D treatment was higher at 3 year old ginseng than at 2 year old ginseng. Leaf length of 2 year old ginseng plant was significantly decreased by 490 ml/10a 2,4-D foliar application, but the leaf width or stem diameter did not show any significant change as shown in table 1. 2,4-D application at the rate higher than 350 ml/10a decreased stem length of 2 years old ginseng. 2,4-D application induced a significant epinastic growth of petiole. Petiole angle to the stem of 2 year old ginseng plant was significantly increased with foliar

Table 1. Effects of application rates of 2,4-D herbicide on the plant growth of 2-year old ginseng. (1989)

Plant growth characters	Rates of 2,4-D application (ml/10a)								
	Non	70	140	210	280	350	420	490	560
Leaf length	6.6a	6.5ab	6.3ab	6.0ab	6.1ab	6.1ab	6.0ab	5.9ab	4.9c
Leaf width	3.2	3.3	3.4	3.0	2.9	3.1	2.7	3.1	2.7
Stem diam.	2.1	2.1	2.0	1.9	1.8	1.9	1.8	1.9	1.8
Stem length	7.2a	6.9ab	6.4ab	6.3ab	6.4ab	5.9b	5.9b	6.1ab	3.2c
Petiol angle	28f	41e	49de	52cd	57bc	65ab	65ab	66ab	69a

Remarks: Recommended application rate of 2,4-D is 70 ml/10a. Mean separation within treatments by LSD 5% level. Leaf length (cm) Leaf width (cm) Stem length (cm) Stem diameter (mm) Petiol angle to stem (degree)

Table 2. Effects of application rates of 2,4-D herbicide on the plant growth of 3-year old ginseng. (1989)

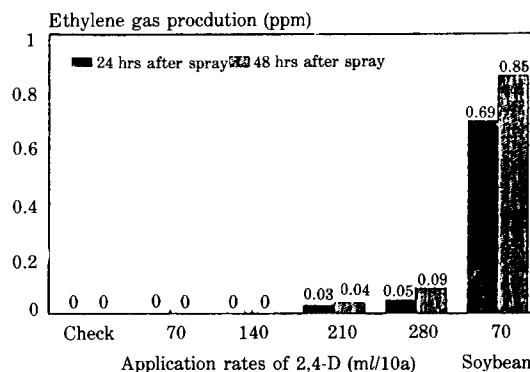
Plant growth characters	Rates of 2,4-D application (ml/10a)							
	Non	70	140	210	280	350	420	490
Leaf length	8.2a	7.5ab	7.5ab	7.5ab	7.1bc	6.9bc	6.6c	6.5c
Leaf width	3.6	3.4	3.8	3.4	3.2	3.5	3.5	3.4
Stem diam.	2.4	2.3	2.6	2.4	2.4	2.5	2.4	2.1
Stem length	13.6a	12.9ab	12.1ab	11.5bc	11.0bc	10.2cd	9.2cd	8.2d
Petiol angle	63c	65bc	74abc	77ab	76ab	78a	82a	81a

Remarks: Recommended application rate of 2,4-D is 70 ml/10a. Mean separation within treatments by LSD 5% level.

application of 2,4-D. The plant growth reaction of 3 year old ginseng as affected by 2,4-D application was same as 2 year old ginseng (Table 2).

The herbicide 2,4-D is commonly used to control broadleaf weed and cause epinastic bending of leaves, a cessation of growth in length, increased in radical expansion, and softening and collapses of tissue. Though the ginseng is a broadleaf plant, a cessation of lengthwise growth of leaf and stem, radial expansion, or softening and collapsing of tissue were not observed by 2,4-D application at 2 or even 3 times higher concentration of the recommended dosage, but epinastic bending of the leaf petiole was induced by 2,4-D application at the same rate of dosage.

However, when ginseng seedling was exposed to herbicide 2,4-D at the rate of 70 ml/10a, leaf and stem tissues were soften and collapsed in 24 hours after 2,4-D treatment, but tissue softening and collapsing recovered after 72 hours of treatment then the stem was significantly elongated.

**Fig. 2.** Effect of 2,4-D foliar application on the ethylene gas production from the ginseng plant.

Ginseng plants that 2,4-D was applied at the rate of 70 and 140 ml/10a did not produce ethylene gas, but the ginseng plants that 2,4-D was treated at higher rate of 210 or 280 ml/10a produced 0.03 and 0.04 ppm ethylene gas, respectively. On the other hand, the soybean plant applied with 2,4-D of the recommended dosage produced ethylene gas of 10 to 20 times higher than the ginseng plants treated

with 3 to 4 times concentrated 2,4-D.

Photosynthesis ability of the ginseng leaves reduced significantly after foliar application of the herbicide 2,4-D in 1 week after the treatment. The higher concentrated 2,4-D treatment resulted the more decrease in the photosynthesis amount of the ginseng plants, but the differences among treated plants were not significant (Fig. 3). However, photosynthesis ability of the ginseng leaf treated with 2,4-D was recovered in 4 weeks after treatment, and then no significant difference was found in photosynthesis ability between untreated plants and

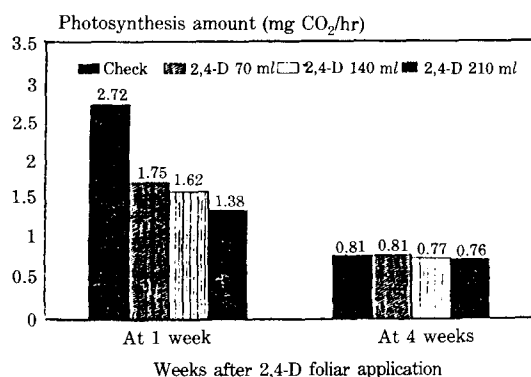


Fig. 3. Effect of 2,4-D foliar application on photosynthesis amount of the ginseng leaves at 1 and 4 weeks after treatment.

2,4-D treated plants.

When herbicide 2,4-D was applied as foliar spray to 2, 3 and 4 year old ginseng plants with the rate of 0, 35, 70, 105 and 140 ml/10a, leaf and stem growth of the ginseng plants did not change (Table 3 and 4).

Root length, root diameter and number of branch roots of the 4 year old ginseng treated with 2,4-D for 2 years was slightly greater than the control plant, although the difference was not significant (Table 5). And also, root weight of 2,4-D treated plants was slightly greater than the control plants with slight difference. Foliar application of 2,4-D on the ginseng plants had little effect on berry maturing.

Application time of the herbicide 2,4-D after sprouting of the ginseng plant was found to have no effects on leaf or stem growth of 2, 3 and 4 year old ginseng plants. And also, the root growth and berry maturing was not influenced by application time of the herbicide 2,4-D (Table 6,7 and 8).

There was no apparent plant injury to ginseng from foliar application of 2 times concentrated 2,4-D. Not an abnormal foliar change occurred in those plants that were treated nor was there any visual contrast in root or top of plant that were treated and those that were not.

Table 3. Effect of the application rates of 2,4-D herbicide on the leaf growth of Korean ginseng. (1989)

Day after treatment	2,4-D Rates	Leaf-length (cm)			Leaf-width (cm)		
		2-year	3-year	4-year	2-year	3-year	4-year
10 days	Non	7.89ns	8.48ns	13.50ns	3.80ns	3.50ns	5.78ns
	35	7.58	8.75	13.03	3.72	3.59	5.55
	70	7.89	8.46	12.88	3.93	3.55	5.63
	105	7.89	8.38	14.01	3.89	3.40	5.88
	140	7.72	8.24	14.06	3.79	3.45	5.76
20 days	Non	8.51ns	8.7ns	13.98ns	3.98ns	3.61ns	5.83ns
	35	8.26	8.79	13.26	3.97	3.70	5.71
	70	8.29	8.54	13.51	3.94	3.63	5.70
	105	8.18	8.43	14.16	3.93	3.72	6.12
	140	8.00	8.43	14.21	3.88	3.66	6.08

Remarks: Mean separation within treatments by DMR 5% level. The unit of 2,4-D application rates is ml/10a. Recommended dosage of 2,4-D herbicide is 70 ml/10a.

Table 4. Effect of the application rates of 2,4-D herbicide on the stem growth of Korean ginseng. (1989)

Day after treatment	2,4-D Rates	Stem-length (cm)			Stem-diameter (mm)		
		2-year	3-year	4-year	2-year	3-year	4-year
10 days	Non	8.7ns	20.3ns	38.2ns	1.95ns	3.43ns	6.32ns
	35	8.6	21.5	36.2	1.97	3.42	6.13
	70	8.5	20.8	36.4	1.97	3.33	6.29
	105	8.6	20.9	37.1	1.94	3.36	6.49
	140	7.9	21.2	38.2	1.94	3.23	6.19
20 days	Non	10.8ns	20.8ns	39.2ns	2.20ns	3.50ns	6.69ns
	35	9.9	22.8	37.6	2.17	3.53	6.49
	70	9.7	21.1	38.5	2.10	3.36	6.53
	105	10.5	21.7	38.5	2.18	3.52	6.73
	140	9.9	21.6	39.4	2.09	3.42	6.72

Remarks: Recommended dosage of 2,4-D herbicide is 70 ml/10a. Mean separation within treatments by DMR 5% level. The unit of 2,4-D application rates is ml/10a.

Table 5. Effect of the application rates of 2,4-D herbicide on the root growth and berry maturing of 4-years old Korean ginseng. (1989)

Rate of 2,4-D application	Root length	Root diam.	Branch root	Root weight	Berry maturing
Control	21.5 (cm)	1.56 (cm)	2.70 (ea)	17.3 (g)	19.9 (ea)
35 ml/10a	23.8	1.60	2.75	17.8	15.4
70 ml/10a	23.0	1.63	2.95	18.5	20.3
105 ml/10a	23.3	1.63	2.83	19.3	13.2
140 ml/10a	23.9ns	1.67ns	2.98ns	19.7ns	13.7ns

Remarks: Recommended application rate of 2,4-D herbicide is 70 ml/10a. Mean separation within treatment by DMR 5% level.

Table 6. Effects of the application time of 2,4-D herbicide on the leaf growth of Korean ginseng. (1989)

Day after sprouting	Leaf-length (cm)			Leaf-width (cm)		
	2-year	3-year	4-year	2-year	3-year	4-year
Control	7.68ns	8.85ns	13.53ns	3.82ns	3.76ns	5.82ns
1 day	7.70	9.33	13.36	3.74	4.05	5.88
5 days	7.28	8.78	13.69	3.39	3.62	5.91
10 days	7.68	9.01	13.30	3.65	3.69	5.59
15 days	7.69	8.67	13.39	3.54	3.64	5.71
25 days	8.01	9.16	13.53	3.84	3.95	5.69

Remarks: Application rate of 2,4-D herbicide is 70 ml/10a. Mean separation within treatment by DMR 5% level

Table 7. Effects of the application time of 2,4-D herbicide on the stem growth of Korean ginseng (1989)

Day after sprouting	Stem-length (cm)			Stem-diameter (mm)		
	2-year	3-year	4-year	2-year	3-year	4-year
Control	8.7ns	22.7ns	39.3ns	2.07ns	3.44ns	6.82ns
1 day	9.0	23.7	37.6	2.19	3.67	6.32
5 days	7.6	22.8	37.9	2.12	3.40	6.81
10 days	8.4	23.4	36.6	2.02	3.47	6.08
15 days	8.6	22.7	37.0	1.99	3.29	6.40
25 days	8.5	23.4	36.3	2.12	3.64	6.25

Remarks: Application rate of 2,4-D herbicide is 70 ml/10a. Mean separation within treatments by DMR 5% level

Table 8. Effects of the application time of 2,4-D herbicide on the root growth and the berry maturing of 4-years old Korean ginseng. (1989)

Day after sprouting	Root length	Root diam.	Branch root	Root weight	Berry maturing
Control	23.4 (cm)	1.67 (cm)	3.23 (ea)	18.7 (g)	29.3 (ea)
1 day	23.2	1.60	2.91	16.5	28.2
5 days	23.5	1.70	3.25	17.9	29.2
10 days	23.0	1.53	2.75	15.8	25.9
15 days	24.5	1.67	3.19	20.2	25.2
25 days	23.4ns	1.66ns	2.98ns	17.2ns	27.9ns

Remarks: Application rate of 2,4-D herbicide is 70 ml/10a. Mean separation within treatments by DMR 5% level.

General reaction of the ginseng plants to the herbicide 2,4-D was quite different from common broadleaf plants and the ginseng plant was selectively safe to herbicide 2,4-D. Considering the experi-

ment results above, herbicide 2,4-D could be used safely in ginseng plantings aged above 1 year to control the broadleaf weeds effectively.