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Original Research Article

Comparison of Photosynthesis between Treatment and Non-treatment of Lime Bordeaux Mixture in 3 Year Old Root in *Panax ginseng* C. A. Meyer

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Abstract - Korean ginseng has been used for thousands of years as an important medicinal plant. Lime-Bordeaux mixture (LBM) was made with copper sulfate and quicklime, which was sprayed instead of pesticides in ginseng field. Net photosynthesis (P_N) was compared between Treatment and Non-treatment of LBM in 3 Year Old Ginseng.
P_N in control plot recorded 2.94 μmol (CO_2) $m^{-2}s^{-1}$ at the first day of experiment, which was similar until the last day of experiment. However, The P_N in LBM recorded 2.23 μmol (CO_2) $m^{-2}s^{-1}$, which was lower than that in control plot. As time goes by, The P_N in LBM was gradually increased up to 3.21 μmol (CO_2) $m^{-2}s^{-1}$ and finally, it was similar with that in control plot at 7th day as a 3.20 μmol (CO_2) $m^{-2}s^{-1}$).

Key words - Korean ginseng, Photosynthesis, Lime-Bordeaux mixture

Introduction

Korean Ginseng, is a perennial plant of the Araliaceae family and has been used for thousands of years as an important medicinal plant. The growth of ginseng plants requires 4 to 6 years of cultivation under shaded conditions, and ginseng cultivation is affected by the soil environment due to the long cultivation period in the same soil (Jin *et al*., 2009).

One major problem is the complication of disease caused by different pathogenic fungi during the long cultivation period. The most common pathogenic fungi in ginseng include gray mold by *Botrytis cinerea,* alternaria blight by *A. panax,* anthracnose by *Colletotrichum gloeosporioides,* Sclerotinia white rot by *Sclerotinia sp.,* phytophthora blight by *Phytophthora cactorum,* and root rot by *Cylindrocarpon destructans* (Cho *et al.*, 1986; Li, 1994). Therefore, the control of these types of diseases is of great importance to ginseng growers.

Nowadays, Synthetic pesticides for disease control were replaced with alternative pest controls, such as Bordeaux mixture and lime sulfur.

Lime-Bordeaux mixture (LBM) has been used instead of pesticides in ginseng field. In this experiment, LBM was made and sprayed in the field of ginseng for eco-friendly cultivation. There was a few reports about photosynthesis on ginseng (Lee, 2007a & 2007b; Park *et al*., 1986; Lee *et al.*, 1980)

The objective of this study was to be compared with net photosynthetic rates in Treatment and Non-treatment of Lime Bordeaux Mixture with 3 year old Ginseng.

Materials and Methods

Research sites and plant materials

Research site was located in Youngju, the central region of Korea (Table 1).

Seeds of *P. ginseng* were germinated in 2009 and transplanted in 2010. Each ginseng was grown in three replicates of a 27-row plot, 5.4 m long and 20 cm between rows. There were 7 hills for each row with one seedling per hill.

Net photosynthesis was measured in 2011.

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Table 1. Ecological Classification and Meteorological Data during cultivation Period (2009~2011) of the Growing Location

Growing location	Classification	Soil physical properties	Mean precipitation (mm)	Mean temperature (℃)
E 128°32′24.8″ N 36°48′34.6″	cold mountainous	Fine silty, mixed, mesic family of Typic Fragiudults	1366 ± 318.4[a]	11.5 ± 0.2

[a]Values represent mean ± SD (Standard deviation).

Net photosynthesis (P_N)

The P_N was measured on intact leafs on every individual. The P_N was measured with a broad-leaf cuvette from the Licor-6400 Portable Photosynthesis System (Licor Lincoln, NE, USA). The leaf was sealed and the CO_2 concentration was maintained at 400 μmol CO_2 levels. Five replications were done for each tree. Differences in the seasonal P_N were averaged for all measurements of each replicate, and the standard deviations were compared. Net photosynthesis was then calculated as :

$$A_n = \frac{U_e(C_e - C_c)}{100_s} - C_cE$$

Where, A_n = net photosynthesis (μmol CO_2 m^{-2} s^{-1}) ; U_e = mole flow rate of air entering the leaf chamber (μmol s^{-1}), C_e = mole fraction of CO_2 in the chamber (μmol CO_2 mol^{-1} air) ; Cc = mole fraction of CO_2 entering the chamber (μmol CO_2 mol^{-1} air) ; s = leaf area (cm^2) ; and E = transpiration rate (mmol H_2O $m^{-2}s^{-1}$).

Chlorophyll content

Chlorophyll content was analyzed using SPAD-502 plus chlorophyll meter (Minolta Camera Co. Ltd., Japan). The SPAD-502 meter was demonstrated to be a useful tool for nondestructively assessing foliar status, particularly for relative comparison purposes.

Lime-Bordeaux Mixture (LBM)

LBM was made with copper sulfate and quicklime at the ratio of 8 g to 8 g per one litter (Table 2) and sprayed on ginseng leaf on July 1.

Table 2. Concentration of copper sulphate and quicklime for LBM used

Type of LBM	copper sulphate (g)	quicklime (g)	Water (L)
8-8	8	8	1

Fig. 1 shows comparison of ginseng leaf between treatment and non-treatment of Lime Bordeaux Mixture.

Results and Discussion

Fig. 2 shows changes of P_N as affected by the day after spraying LBM. P_N in control plot recorded 2.94 μmol (CO_2) $m^{-2}s^{-1}$ at the first day, which was similar until the last day in through of experiment. However, The P_N in LBM recorded 2.23 μmol (CO_2) $m^{-2}s^{-1}$ at the first day of experiment, which was lower than that in control plot. As time goes by, The P_N in LBM gradually increased up to 3.21 μmol (CO_2) $m^{-2}s^{-1}$, and it was similar with that in control plot at 7th day as a 3.20 μmol (CO_2) $m^{-2}s^{-1}$.

SPAD of ginseng leaf in control plot was 35 level at the first day, which was higer than that in LBM and it was similar level at 7th day after treatment (Fig. 3). In contrast, SPAD in LBM demonstrated a general increase from the first day to the fourth day. At the fifth day of treatment, SPAD in LBM was 39 level, which was higher than that in control plot.

The significant effect of spraying LBM could be attributed to the differences in P_N (Fig. 2). It is considered that the chalky powder on the surface of ginseng leafs decrease the ability of photosynthesis.

Underground growth characteristics and root yield by spraying in 3 year old ginseng were presented in Table 3. The

result showed a little differences but had no significant differences statistically. Root yields per 3.3 m^2 were 1.06 kg and 1.18 kg in the treatment of LBM and agrochemicals, respectively.

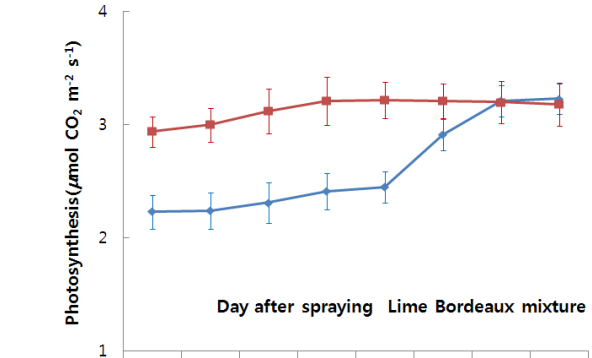
Lee *et al*. (2010 & 2012) reported the ginseng yield in the plot of spraying LBM was decreased compared with that in the plot of spraying chemicals. The result was in agreement with this experiment. It is considered that the temporary decline of photosynthesis in LBM treatment could be one of major causes of yield decrease.

This is the first report that describes the photosynthesis

(A)

(B)

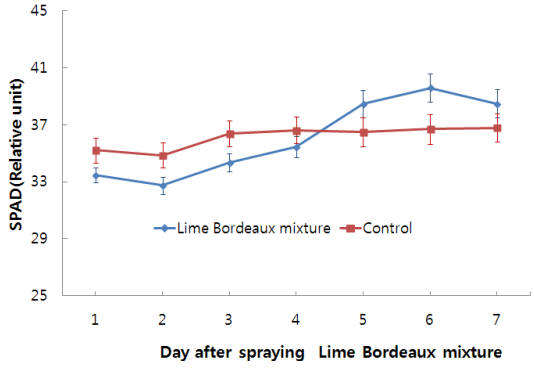
Fig. 1. Comparison of ginseng leaf between Treatment and Non-treatment of Lime Bordeaux mixture. A; Ginseng leaf in treatment of Lime Bordeaux mixture. B; Ginseng leaf in non-treatment of Lime Bordeaux Mixture.



	1	2	3	4	5	6	7	8
Lime Bordeaux mixture	2.23	2.24	2.31	2.41	2.45	2.91	3.21	3.23
Control	2.94	3.00	3.12	3.21	3.22	3.21	3.20	3.18

* Bar represents mean ± SD, n=20

Fig. 2. Changes of photosynthesis as affected by the day after spraying Lime - Bordeaux mixture.



* Bar represents mean ± SD, n=20

Fig. 3. Changes of SPAD as affected by the day after spraying Lime - Bordeaux mixture.

Table 3. Underground growth characteristics and root yield by spraying LBM and agrochemicals in 3 year old ginseng

Treatment	Root length (cm)	Tap root diameter (mm)	Root weight (g/plant)	Ratio of rusty root (%)	Root yield (kg/3.3 m^2)
LBM	26.4 ± 0.6[a]	15.7 ± 1.1	18.8 ± 3.2	1.8 ± 1.0	1.06 ± 0.18
Control (Agrochemicals)	26.0 ± 0.7	15.5 ± 0.5	21.1 ± 3.3	1.8 ± 0.7	1,18 ± 0.20

[a]Values represent mean ± SD.

rates by spraying LBM. Further research is needed to elucidate the mechanism of LBM effects on photosynthesis rates.

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