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

Deok-Jong Ahn, Won-Kwon Jung, Jin-Kook Choi, Myeong-Hwan Jang, Tae-Ryong Kwon, Yeon-Hwa Shin and Sang-Chul Lee

Punggi Ginseng Experiment Station, Gyeongbuk Provincial ATA, Youngju 750-870, Korea

1Division of Plant Bioscience, Kyungpook National University, Taegu 702-701, Korea

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 (PN) was compared between Treatment and Non-treatment of LBM in 3 Year Old Ginseng. PN in control plot recorded 2.94 μmol (CO2) m⁻²s⁻¹ at the first day of experiment, which was similar until the last day of experiment. However, The PN in LBM recorded 2.23 μmol (CO2) m⁻²s⁻¹, which was lower than that in control plot. As time goes by, The PN in LBM was gradually increased up to 3.21 μmol (CO2) m⁻²s⁻¹ and finally, it was similar with that in control plot at 7th day as a 3.20 μmol (CO2) m⁻²s⁻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.
Comparison of Photosynthesis between Treatment and Non-treatment of Lime Bordeaux Mixture in 3 Year Old Root in Panax ginseng C. A. Meyer

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

<table>
<thead>
<tr>
<th>Growing location</th>
<th>Classification</th>
<th>Soil physical properties</th>
<th>Mean precipitation (mm)</th>
<th>Mean temperature (℃)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E 128°32'24.8&quot; N 36°48'34.6&quot;</td>
<td>cold mountainous</td>
<td>Fine silty, mixed, mesic family of Typic Fragiudults</td>
<td>1366 ± 318.4a</td>
<td>11.5 ± 0.2</td>
</tr>
</tbody>
</table>

Values represent mean ± SD (Standard deviation).

Net photosynthesis ($P_N$)

The $P_N$ was measured on intact leaves 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 CO2 concentration was maintained at 400 μmol CO2 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:

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

Where, $A_n$ = net photosynthesis (μmol CO2 m$^{-2}$ s$^{-1}$); $U_e$ = mole flow rate of air entering the leaf chamber (μmol s$^{-1}$); $C_e$ = mole fraction of CO2 in the chamber (μmol CO2 mol$^{-1}$ air); $C_c$ = mole fraction of CO2 entering the chamber (μmol CO2 mol$^{-1}$ air); $s$ = leaf area (cm$^2$); and $E$ = transpiration rate (mmol H2O 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

<table>
<thead>
<tr>
<th>Type of LBM</th>
<th>copper sulphate (g)</th>
<th>quicklime (g)</th>
<th>Water (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-8</td>
<td>8</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

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 (CO2) 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 (CO2) 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 (CO2) m$^{-2}$s$^{-1}$, and it was similar with that in control plot at 7th day as a 3.20 μmol (CO2) 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 leaves 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 m² 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

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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Root length (cm)</th>
<th>Tap root diameter (mm)</th>
<th>Root weight (g/plant)</th>
<th>Ratio of rusty root (%)</th>
<th>Root yield (kg/3.3 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBM</td>
<td>26.4 ± 0.6 a</td>
<td>15.7 ± 1.1</td>
<td>18.8 ± 3.2</td>
<td>1.8 ± 1.0</td>
<td>1.06 ± 0.18</td>
</tr>
<tr>
<td>Control (Agrochemicals)</td>
<td>26.0 ± 0.7</td>
<td>15.5 ± 0.5</td>
<td>21.1 ± 3.3</td>
<td>1.8 ± 0.7</td>
<td>1.18 ± 0.20</td>
</tr>
</tbody>
</table>

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

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

**Acknowledgement**

This study was supported by a grant from Regional Support Program of Rural Development Administration, Korea.

**Literature Cited**


(Received 30 May 2013 ; Revised 19 June 2013 ; Accepted 21 June 2013)