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Shading Effect of Different Colored Polyethylene net on Seeding Growth of *Panax ginseng* C. A. Meyer.

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ABSTRACT : This study was carried out to investigate spectral irradiance characteristics of blue, yellow, and blue-black colored polyethylene (PE) shading net and the effect on growth characteristics and yield in ginseng seedling. The spectral irradiance (μmol/m²/s/㎚) showed the peak at 498 ㎚ in both of blue and blue-black PE shading net, and 606 ㎚ under yellow PE one. The intensity of blue light in blue shading was more strong than that of blue-black shading, control. Blue shading was increased by 17% and 23% in accumulated quantum for daytime, 0.5 ℃ and 0.2 ℃ in maximum temperature on June 2 than that of yellow and blue-black shading, respectively, but heat injury ratio of the former was lower than that of the latter. Chlorophyll content and stem length in blue shading were decreased more significantly than those of yellow and blue-black shading. The specific leaf weight was higher under blue and yellow shading than that of blue-black shading. Ginseng seedling harvested in blue shading was increased by 13~17% in the number of root, and 17~20% in root weight per ㎡ compared to yellow and blue-black shading owing to the increase of survived plant, and the decrease of specific leaf weight, heat injury ratio, and stem length.

Key words **:** *Panax ginseng*, blue and yellow shading, spectral irradiance, quantum, growth characteristics, root weight

INTRODUCTION

Growth of ginseng (*Panax ginseng* C. A. Meyer) is affected by light intensity and quality, and the color and the thickness of PE shading net when PE net is utilized for shading material. The optimal range of light transmission ratio was 8~10% even if it was dependent upon air temperature (Cheon *et al.*, 1991). Sunlight penetrated through blue colored PE shading net results in the higher blue light with composition rate of 455~492 ㎚. In general, blue light mainly causes phototropism, stomatal movements, inhibition of stem elongation, and chloroplast movements in mesophyll cell. Red light of 622~780 ㎚ increases photosynthesis rate, but bring about severe leaf bleaching and heat injury in summer season (Lee *et al.*, 1999; Mok *et al.*, 1994). Several studies with ginseng have been conducted on the effect of light quality on growth, photosynthesis, and chloroplast rearrangement in mesophyll cell (Lee *et al.*, 1999; Mok *et al.*, 1994; Yang *et al.*, 1993).

Nowaday the fourfold blue-black PE shading net made by the ratio of blue 3 to black 1 was recommended as a optimal shading material. The twofold black PE shading net was added to the existing shading net in order to decrease heat injury ratio increased during summer season, but there has been few study that tried to examine ginseng seedling in the nursery. In addition, some farmer have been using yellow PE shading net without a experimental background. Therefore, it needs to examine the effect of PE shading net colors on the growth of ginseng seedling. The objective of this study was to investigate spectral irradiance characteristics of blue, yellow, and blue-black colored PE net and their effect on growth of ginseng seedling.

MATERIAL AND METHODS

This study was practiced from November 2004 to November 2005 at the experimental farm of National Institute of Crop Science in Jungpyong county, Korea. Variety used in this study was Jakyeongjong (*Panax ginseng* C. A. Meyer), a Korean conventional variety. Commercial compost (Samhyopnoongsan Co., Korea) of 1,500 ㎏/10a was applied for the nursery bed before sowing. Stratified seed was sowed at the early November 2004, and seeding density with one seed per hole was 3.3×3.3 ㎝. Soil physical and chemical properties of the experience field were showed as in Table 1 and 2, respectively. Experiment plot was arrayed by randomized block design with 2 replications and each plot size was 16.2 ㎡.

Shading facility, type A-1, was set up at the April 15, 2005. shading materials were fourfold polyethylene net of blue, yel-

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Table 1. Soil physical properties of experiment field before sowing.

Bulk density (g/cm³)	Air phase (%)	Solid phase (%)	Liquid phase (%)	Porosity (%)
1.366	36.9	51.5	11.6	48.5

Table 2. Soil chemical properties of experiment field before sowing.

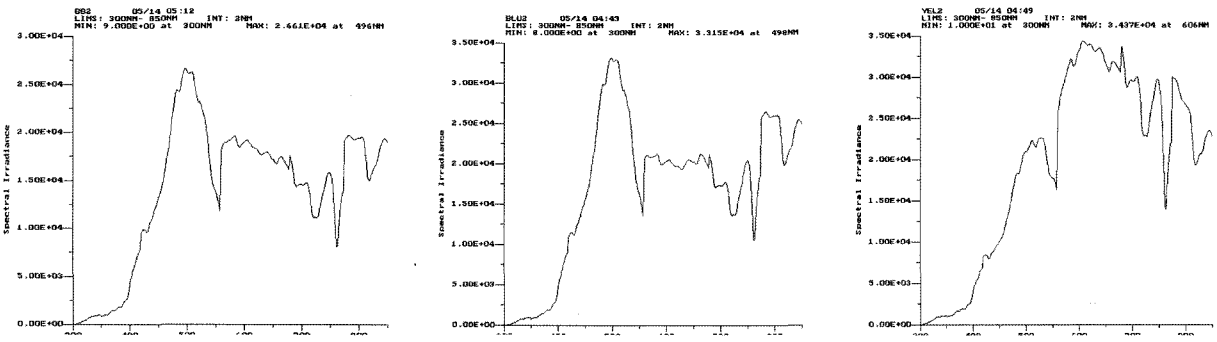
pH (1 : 5)	OM (g/kg)	P_2O_5 (mg/kg)	Ex. Cation (cmol/kg^{-1})			EC (dS/m)
			K	Ca	Mg	
7.0	5.9	57	0.07	6.49	2.10	0.27

low, and blue-black, respectively. Blue-black PE shading net was weaved by the rate of blue 3 to black 1. Both blue and yellow PE shading of fourfold were compared to the conventional shading net such as blue-black PE shading net. The black twofold PE shading net was added to existing PE shading net from June 18 to Autumn 31 in order to lower light transmittance ratio during summer season. Spectral irradiance was measured on June 14, and June 21, respectively, with Spectroradiometer (Li-1800, Licor, USA). Quantum and air temperature at the hight of 10 cm on the ground was measured with Datalogger (Li-1400, Licor, USA) recording at the interval of 15 minutes on June 2 and August 4, respectively. Growth characteristics of above-ground and underground part was investigated on August 31 and November 11, respectively. Seedling harvested were classified as first, second, and off-grade on the basis of root weight and root length per plant; first grade was above 0.89 g and 15 cm, and second grade was above 0.60 g and 10 cm, respectively. The number of available seedling was counted to the sum of the first and second grade.

RESULT AND DISCUSSION

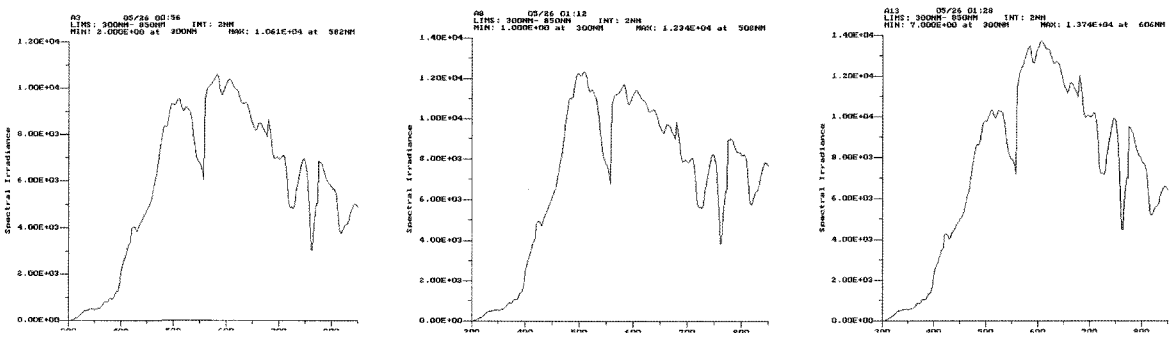
Comparison of spectral irradiance, quantum and air temperature by different colored PE shading net

The spectral irradiance of blue and blue-black shading PE net showed the peak at 498 nm, and the blue light intensity from blue shading net was more strong than that of blue-black



<Blue-Black> <Blue> <Yellow>

Fig. 1. Changes of spectral irradiance (μmol/m²/s/nm) by the colors of PE shading net on June 14 before double shading.



<Blue-Black> <Blue> <Yellow>

Fig. 2. Changes of spectral irradiance (μmol/m²/s/nm) by the colors of PE shading net on June 2 after double shading.

shading. The spectral irradiance of yellow PE shading net showed the peak at 606 ㎚, and it's intensity was more distinct than that of blue and blue-black shading (Fig. 1). From the additions of the black twofold PE shading net to existing shading net during summer season, the spectrum pattern of blue shading was distinctly changed more than that of yellow shading owing to the remarkable decrease of blue light (Fig 2).

Accumulated quantum measured by the interval of 15 minutes from 6:00 to 18:00 on June 2 was 7,489, and 6,401, and 6,079 μmol/m^2/sec in blue, yellow, and blue-black shading, respectively (Fig. 3). Accumulated quantum from blue shading on June 2 was more 17% and 23% than that of yellow and blue-black shading, respectively. It was considered that the quantum increased during spring season had a positive effect on seedling growth. Descending order in air temperature by shading colors from 14:00 to 15:00 on June 2 was blue, blue-black, and yellow shading. Air temperature from blue shading was increased by 0.2℃ and 0.5℃ more than that of blue-black and yellow shading. Cheon *et al.* (1991) has reported that there were positive correlation between air temperature and light transmission ratio. Though accumulated quantum from yellow shading was higher than that of blue-black shading, yellow shading showed lower air temperature than that of blue-black shading. That was considered to be the reason why the energy of yellow light in sunlight spectrum was lower than that of blue light (Taiz & Zeiger, 2002).

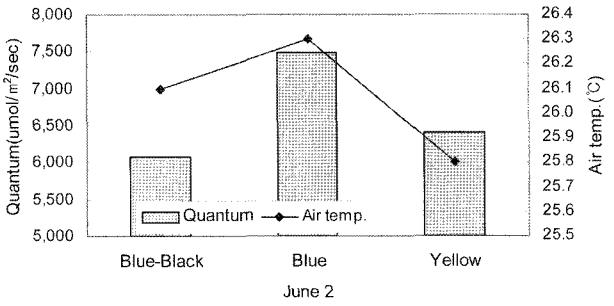


Fig. 3. Accumulated quantum for daytime and maximum temperature by the colors of PE shading net on June 2 before double shading.

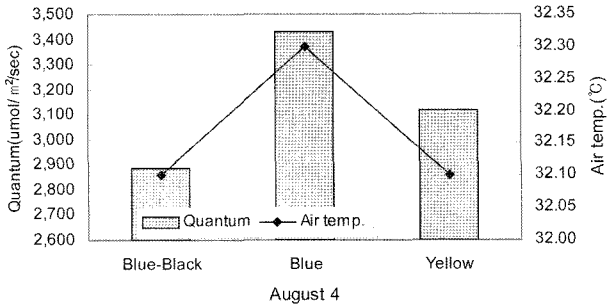


Fig. 4. Accumulated quantum for daytime and maximum temperature by the colors of PE shading net on August 4 after double shading.

As shown in Fig. 4, quantum was decreased by addition of the black twofold PE shading net to existing shading during summer season. The order of accumulated quantum measured on August 4 after the double shading was the same as that of June 2 before double shading. Air temperature from yellow shading measured from 14:00 to 15:00 on August 4 was deceased by 0.2℃ more than that of blue shading, but which was similar to that of blue-black shading.

Effect of different colored PE shading net on seedling growth

Growth characteristics in above-ground part of the seedling changed by shading colors were shown in Table 3. Chlorophyll content from blue shading was decreased more than that from yellow shading even though it was decreased by the increase of quantum. Chlorophyll content was decreased by higher light intensity (Cheon *et al.*, 1991; Lee *et al.*, 1984), and blue light decreased chlorophyll content more than that of yellow light (Lee *et al.*, 1999). Stem length from blue shading decreased stem length more than that of yellow shading as the report of Park *et al.* (1989). Leaf area in blue shading was decreased more than that of yellow shading, but there were no significant difference between blue, yellow and blue-black shading. Specific leaf weight was increased by the increase of quantum, but there were no significant difference between blue and yellow shading. Cheon *et al.* (1991) reported that there were positive correlation between specific leaf weight and light transmission ratio. Heat injury ratio showed no significant difference between blue and yellow shading except blue-black shading. This result was considered that strong blue light in the early growth stage from April to May resulted in the increase of heat tolerance (Cheon *et al.*, 2003).

As shown in Table 4, the number of survived plant, root weight and the rate of available seedling per ㎡ from blue shading were increased more than that of yellow and blue-black shading, respectively. Growth of *Rhizoctonia solani* Kuhn that brought about damping-off in ginseng seedling was effected by light irradiation (Kim & Chung, 1992). Park *et al.* (1989) reported that blue light was more effective than yellow light in the growth of 3-year old ginseng.

In conclusion, it was considered that the reason why blue shading showed higher yield than yellow and blue-black shading was that blue shading increased the number of survived plant, while decreased specific leaf weight, heat injury ratio, and stem length.

Table 3. Growth characteristics in above-ground part of ginseng seedling by the colors of PE shading net.

Treatment	Chlorophyll con.(㎎/g)				SLW♩ (㎎/㎠)	Stem length (㎝)	Leaf length (㎝)	Leaf width (㎝)	Heat injury ratio (%)
	a	b	a/b	Total					
Blue 3 + Black 1♪	1.07[a]	0.48[a]	2.24[a]	1.55[a]	4.50[b]	8.45[a]	3.82[a]	1.71[a]	11.7[a]
Blue 4	0.94[c]	0.44[a]	2.15[a]	1.38[c]	5.23[a]	7.56[c]	3.79[a]	1.75[a]	3.4[b]
Yellow 4	1.00[b]	0.46[a]	2.18[a]	1.46[b]	5.22[a]	8.11[b]	3.92[a]	1.78[a]	3.8[b]

* Mean with same letters are not significantly different in DMRT (p = 0.05).
♩ SLW: specific leaf weight, Investigation date: August 30.
♪ No. of stacked layer in PE shading net.

Table 4. Yield by the colors of PE shading net in ginseng seedling.

Treatment	No. of survived plant (ea/3.3m²)	Total root wt. (g/3.3m²)	Root wt. per plant (g)	Root length (㎝)	First grade		Second grade		Ratio of vailable seedling (%)
					No. (ea/3.3m²)	Ratio (%)	No. (ea/3.3m²)	Ratio (%)	
Blue 3 + Black 1	642[b]	348[b]	0.54[a]	15.8[a]	35[b]	5.2[b]	195[a]	29.7[a]	34.8[b]
Blue 4	726[a]	406[a]	0.56[a]	14.7[a]	87[a]	11.6[a]	232[a]	31.8[a]	43.4[a]
Yellow 4	621[b]	337[b]	0.55[a]	15.8[a]	28[b]	4.6[b]	183[a]	29.4[a]	34.0[b]

* Mean with same letters are not significantly different in DMRT(p = 0.05).

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