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Effect of Bed Soil with Polypropylene Spunbonded Fabrics on Rice Seedling Production

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Abstract : The study of this experiment is focused on labor saving of healthy rice seedling production using PSF (polypropylene spunbonded fabrics) as thermal protection material. Several factors such as different compositions of nursery soil and PSF materials were tested to produce healthy rice seedlings. The inner thermal protection material in PE film (polyethylene film) showed 0.9~1.7°C higher than that of PSF 40~100 gm^{-2}. The light transmittance-ratio also showed similar trends. It is considered that the appropriate PSF material density was 40 gm^{-2} in accordance with economic values and healthy rice seedlings. Plant height and dry weight according to various nursery soil showed the rang-es of 8.5~14.2 cm and 5.5~10.0 mg , respectively. In composition of nursery soil, artificial soil combined with paddy soil was effective in producing healthy seedling for rice seedling production. The total sugar content also showed the difference between PSF 40, 60 gm^{-2} PE film (0.43~ 0.52 mg FW g^{-1}) and PSF 80, 100 gm^{-2} (0.28~0.35 mg FW g^{-1}) and it showed the same tendency among varieties as well as various nursery soil. These results demonstrate that PSF 40 gm^{-2} economically affordable, and can be recommended as thermal protection material for producing good healthy rice seedling.

Keywords : nursery soil, polypropylene spunbonded fabric, rice

Demand for labor saving in rice cultivation is presently increasing under the circumstances of shortage of farm-labor and the increase of aged farmers. Labor force in the preparation of nursery bed in rice seedlings presents much labor for rice cultivation.

Development of the appropriate techniques in raising rice seedling affects much to the whole cultivation process. As part of measures, the following researches have been developed and have been spread to the farmhouses. For example, the laying of a plastic seedling tray on sacks placed over the nursery bed and dried nursery bed using PSF as thermal protection material can save the labor of taking off rice seedling trays from nursery (Kim *et al.*, 2000).

Lately, the method of using PSF in raising rice seedling instead of PE film is gaining interest at the Southern part of Korea, thus it makes necessary to carry out experiments of the possibility for the usage of PSF in various conditions. The activities of labor saving with PSF instead of PE film are needed (Kim *et al.*, 1997). But the research for effectiveness and the systematic utilization ways of PSF and for the appropriate use are still limited. The traditional raising nursery method using PE film needs the labor for holding poles and ventilation to drop temperature (Yun *et al.*, 1990).

However the use of PSF in nursery doesn't need the effort of ventilation. So it is effective for labor saving (Kim *et al.*, 2000: Hong *et al.*, 2000). Although PSF is convenient for nursery management and timesaving, uncertainty for healthy seedlings production are still under question. The effects of nursery soil with PSF on getting good seedling need certain answers in rice cultivation.

In this study, in order to further the basic information of healthy rice seedling production, we compare rice seedlings characteristics using kinds of commercial bed soil and the mixing of paddy soil and commercial bed soil.

MATERIALS AND METHODS

The experiment was conducted at the experimental field in Kyungpook National University and KPATA (Kyong-buk Provincial Agricultural Technology Administration Station), Daegu. Rice seed were provided by KPATA. Seeds were pre-germinated in 2~3 mm seedling for 48 hours in tap water in the dark at 32°C and 130 g (dry weight base) of pre-germinated seeds were sown in a seedling tray (58×28×3 cm). Four kinds of commercial soil were used as nursery soil and different densities of PSF of 40, 60, 80 and 100 gm^{-2} were applied as thermal protection materials on nursery bed. The experiment was laid out in a randomized complete block design with three replications. Ratio of floodlights were measured by auto illumination intensity meter (Manual no. 8809, INS). Management practices in rice cultivation by R.D.A recommended method was employed for the experiment and measurement of plant height, leaf age, dry weight and

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top dry weight/seedling height were taken at 30 days after seeding. The plants sampled were dried in a dry oven at 80°C for two days. For analyzing mineral elements, dried samples were retreated with 5 ml of 60% nitric acid (HNO_3) and the mineral nutrient contents were determined using the ICP (Inductively coupled plasma) spectrophotometer.

Starch and sugar content of plant leaf of 30 day old seedling were determined by the methods of Keppler and Decker (1974). The starch level of a leaf discs (1 cm in diameter) taken at 1 hr before light on when the starch level was the lowest and at 10 hr after exposure to light was the highest. The same leaves were used for both samplings. Three leaf discs were extracted with 1 ml boiling HEPES buffer (pH 7.4) for 2 mins, homogenated, and then centrifuged 10 min at 14,000 rpm and divided into soluble and insoluble fraction. The insoluble fraction, containing starch, was re-extracted two times with 80% methanol until the insoluble matter was free from soluble fraction. Starch was digested with amyloglucosidase (BM) and released glucose was determined enzymatically by the methods of Keppler and Decker (1974). Standard curve was run with amylopectin.

Growth Characteristics in Rice Seedlings by Different Bed Soils and the Content of Bed Soil.

To investigate the effect of different bed soil on seedling growth characteristics in rice four commercial bed soil, one and three sheets of newspaper as substitute of bed soil were used in this experiment. The tested nursery soil were (CBS) commercial bed soil, (PS) paddy soil, (S) sandy soil, CBS+S (1:1) and CBS+PS (1:1) and three Japonica rice varieties, "Hwayoungbyeo", "Ilmibyeo", and "Geuroobyeo" were tested. Pre-germinated seeds were sown on April 14 and 24 for "Hwayoungbyeo", May 4 and 14, for "Ilmibyeo", May 24 and June 24 for "Geuroobyeo", and nursery were protected with PE film and PSF 40 gm^{-2}. Growth characteristics were investigated in 30 day old seedlings. Other evaluation carried out, was to see the effect of different PSF as covering materials on seedling growth characteristics in rice. Pre-germinated seeds were sown on April 25 for Hwayoungbyeo, May 25 for Ilmibyeo and PSF densities with 40, 60, 80 and 100 gm^{-2} were applied to find out the effect on seedling growth. Sugar content of the leaf of 15 day old seedlings were analyzed.

RESULTS AND DISCUSSION

Fig. 1 illustrates the changes of soil temperature in nursery protected with PE film and PSF. The mean temperature in PE film was 18.2°C. It was 5.7°C higher than the external temperature, 12.5°C. The inner temperature in PSF 40 gm^{-2} was 15.4°C and 15.9°C in PSF 60 gm^{-2}, which was 2.9°C,

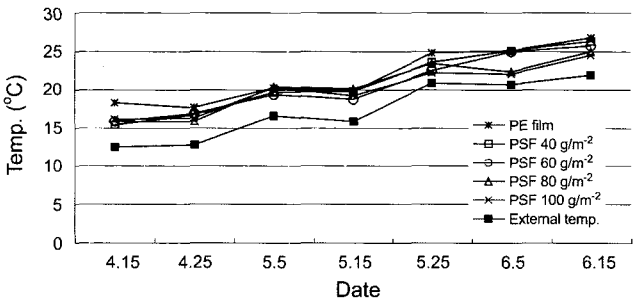

Fig. 1. Changes of temperature in PE film and kinds of PSF. PE film : Polyethylene film, PSF: Polypropylene spunbonded fabric.

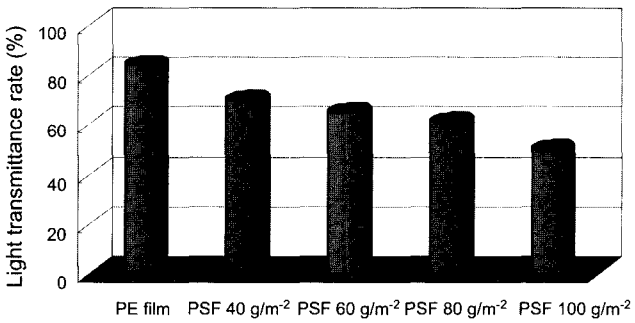

Fig. 2. Light transmittance in PE film and kind of PSF. PE film: Polyethylene film, PSF: Polypropylene spunbonded fabric.

and 3.4°C higher than in the external temperature. The difference between the inner temperature of PSF 40 gm^{-2} and PSF 60 gm^{-2} was 0.5°C. The external mean temperature from April to mid June was 17.3. The inner temperature measured were 21.8 in PE film, 20. 9°C in PSF 40 gm^{-2}, 20.6°C in PSF 60 gm^{-2}, 20.5°C in PSF 80 gm^{-2} and 20.1°C in PSF 100 gm^{-2}. Averaging the inner temperature during 30 days showed 4.5°C higher in PE film and by 3.6~2.8°C in PSF 40~100 gm^{-2} than that in the external temperature. The difference of the inner temperature among different densities of PSF was 0.8°C. The thick PSF produced low inner temperature thus, resulting to less light transmittance. Hwang *et al.*, (2000) reported that microclimate showed differences in rice nursery bed with covered materials and this explanation agrees with our results.

Light transmittance in PE film and PSF are shown in Fig. 2. Light transmittance through the PE film, PSF 40 gm^{-2}, PSF 60 gm^{-2}, PSF 80 gm^{-2} and PSF 100 gm^{-2} were 84%, 70%, 65%, 61% and 50%, respectively. Although the light transmittance was higher in PE film than in PSF, but when PSF 40 gm^{-2} was used, the light transmittance was about 70% so it did not affect the growth of the seedlings. PSF also stands to be most suitable covering material for seedlings growth during that period. According to Kim *et al.*, (2000) who reported that light transmittance was 103.2 Klux in the external atmosphere, 85.5 Klux in PE film and 72.0 Klux in

PSF. Hong *et al.*, (2000) also reported that light strength was proportional to light quantity and light was transmitted by 90% in PE film and 65% in PSF. These findings were similar to our results shown in Fig. 2.

Table 1 presents seedlings growth characteristics as affected by different bed soil in rice. Different commercial bed soils and the possibility of substituting newspaper for bed soils were investigated. As seen in Table 1, the growth characteristics in different commercial bed soils compared to newspaper (1 and 3) treatments observed high values. This indicates that newspaper cannot substitute for bed soil for growing healthy seedlings. Newspaper at top dry weight/seedling height were high but showed no significant importance to the production of rice seedlings, because when newspaper substituted for seed bed soil, the roots of the seedlings penetrated into the soil and this made it very difficult to transplant due to low seedling establishments rate. Plant height showed the difference of 2.7 cm whilst, top dry weight showed the difference of 2.5 mg/seedling among CBSs. The significance of these results shows that the suitable bed soil recommended for healthier rice seedlings are the commercial bed soil, which presents favourable soil properties. Kim *et al.*, (1996) reported that different results were observed in emergence and establishment rate by nitrogen application but in leaf number there were not significant differences in emergence and establishment rate between nursery soils. This finding is in agreements with the results obtained in Table 1 of our experiments, but with respect to plant height showed significant differences by the kinds of bed soil.

The influence of PSF on seedling growth as affected by different seeding dates and the different bed soils in rice (15 days after seeding) are shown in Table 2. Two rice varieties Hwayoungbyeo seeded on the April 25, Ilmibyeo May 25 was grown in the two different commercial bed soils. Plant height, numbers of leaves and top dry weight/seedling height showed no significant differences irrespective of the different seeding dates. PSF and PE film in the two different bed soils showed the same results in the treatments even though plant height of CBS in PE film was longer by 0.6 than that of CBS+PS seeded on April 25 and by 2.0 cm seeded on May 25. Compared between PSF 40 gm^{-2} and 60 gm^{-2}, in plant height, number of leaves and top dry weight/seedling height of the seedling seeded on April 25 had similar results in the two bed soils treatments. Seeding dates May 25 in PSF CBS plant height was higher than PSF CBS+PS, plant height was tall enough for machine transplanting. May 25 growth characteristics showed similarities

Table 1. Seedling growth characteristics as affected by different bed soils in rice (30 days after transplanting).

Kinds of bed soils	Plant height (cm)	Number of leaves	Top dry weight (mg/seedling)	Top dry weight/ seedling height (mg/cm)
CBS P	11.5±1.3	2.6±0.2	9.5±1.3	0.83±0.10
CBS B	14.2±1.9	2.6±0.3	10.0±0.5	0.70±0.01
CBS N	13.2±1.7	2.8±0.2	8.5±1.5	0.64±0.10
CBS H	13.6±1.5	2.8±0.3	7.5±0.3	0.55±0.04
newspaper 1	9.1±1.0	2.3±0.2	5.5±1.3	0.60±0.14
newspaper 3	8.5±0.9	2.2±0.2	6.5±2.5	0.76±0.29

CBS: commercial bed soil, Seeding date April 24

Table 2. Influences of PSF on seedling growth as affected by different seeding dates and bed soils in rice (15 days after seeding).

Seeding date	Bed soils	Plant height (cm)					Number of leaves					Top dry weight/ seedling height (mg/cm)				
		PSF ($g \cdot m^{-2}$)				PE film	PSF ($g \cdot m^{-2}$)				PE film	PSF ($g \cdot m^{-2}$)				PE film
		40	60	80	100		40	60	80	100		40	60	80	100	
4.25‡	CBS†	9.4	9.2	7.0	7.9	11.1	1.9	1.7	1.3	1.6	2.9	0.69	0.65	0.71	0.63	0.94
	CBS+PS	8.6	9.1	7.4	8.2	10.5	1.9	1.9	1.6	1.7	2.7	0.76	0.71	0.74	0.67	0.90
5.25	CBS	23.2	22.1	22.6	22.1	17.3	3.2	3.1	2.7	2.9	3.7	0.67	0.68	0.60	0.63	0.66
	CBS+PS	18.2	19.0	21.9	20.7	15.3	3.2	3.0	3.0	2.8	3.6	0.77	0.57	0.64	0.60	0.68

†CBS: commercial bed soil, ‡PS: paddy soil,‡:Hwayoungbyeo; §:Ilmibyeo.

Table 3. Seedling growth characteristics as affected by different seeding dates and bed soils in Hwayoungbyeo (30 days after seeding).

Seeding date	Bed soils	Plant height (cm)		Number of leaves		Top dry weight (mg/seedling)	
		PSF 40 g · m^{-2}	PE film	PSF 40 g · m^{-2}	PE film	PSF 40 g · m^{-2}	PE film
4. 14	CBS	16.8a	16.2a	2.9a	2.9a	2.0a	1.9a
	CBS+PS	15.3a	15.8a	3.0a	3.1a	2.3a	1.9a
	S	11.5c	13.0b	2.9a	3.0a	1.0c	1.6a
	PS	13.1bc	15.3ab	3.3a	2.9a	1.5b	1.7a
	CBS+S	14.7ab	14.4ab	2.9a	3.1a	2.2a	1.8a
4. 24	CBS	18.6a	18.9a	3.0a	3.2a	2.4ab	2.4ab
	CBS+PS	16.8a	16.3b	3.1a	3.0a	2.6a	2.6a
	S	12.1c	12.0e	3.0a	2.9a	1.1c	1.4c
	PS	13.9c	13.2d	3.3a	3.1a	1.9b	2.2ab
	CBS+S	15.7b	15.2c	3.0a	3.0a	2.0b	2.1bc

[z]The same letters in each column are not significantly different at the 5% level by DMRT.
[†]CBS: commercial bed soil, PS: Paddy soil, S: Sandy soil.

compared to April 25 but, with a slight difference this attributes, to the fact that in May the temperature is high and that causes damage to the seedlings when PE film are used the labor intensity are also high, but with PSF time-saving can be achieve, so it is more convenient to use PSF as a covering material for seedling raising production.

Table 3 shows seedlings growth characteristics as affected by different seeding date and bed soils in Hwayoungbyeo. Seeding date at April 14, PSF 40 gm^{-2} CBS and CBS+PS in plant height had the same results based on these observations, we suggest that CBS and CBS+PS can be used to produce quality good seedlings, while in PE film had significant differences in plant height among the different bed soils treatment. April 14 and April 24 seeding dates presented similar results in the number of leaves and top dry weight in the different bed soils and the covering materials. The optimum plant height for machine transplanting is between 15~20 cm for medium seedlings and looking at the results in April 14 and April 24 in the following bed soils CBS and CBS+PS in PSF 40 gm^{-2} and PE films falls in this range meaning that they are both applicable to produce good quality seedlings when used. Bed soils, (S, PS and CBS+S) showed low plant height in respect to the optimum medium seedlings.

Fig. 3 shows total sugar content as affected by PSF densities as thermal protection in two different bed soil on 15 days after seeding in Hwayoungbyeo (April 25). Total sugar content of the seedling drastically decreased under the PSF density thicker than 60 gm^{-2}. However, bed soil did not affect the total sugar content. The same tendency was observed in CBS+PS treatment. PE film and PSF 40, 60 gm^{-2} in total sugar content was high.

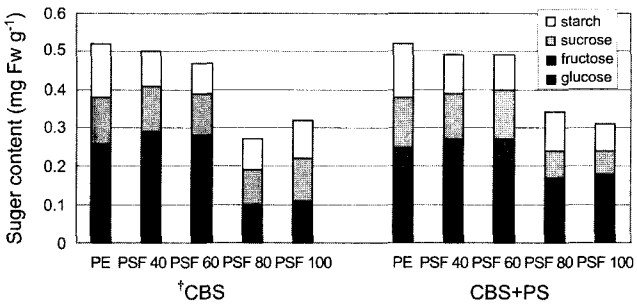

Fig. 3. Sugar content as affected by different bed soils in PSF on 15 days after seeding in Hwayoungbyeo (April 25). CBS: commercial bed soil, PS: paddy soil.

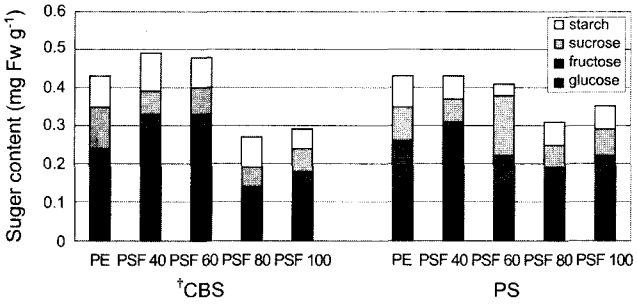

Fig. 4. Sugar content as affected by different bed soils in PSF on 15 days after seeding in Ilmibyeo (May 25). CBS: commercial bed soil, PS: paddy soil.

Total sugar content as affected by different bed soils in PSF on 15 days after seeding in Ilmibyeo May 25 are shown in Fig. 4. Similar tends of total sugar content were observed. Conclusion to this results shows PSF 40 gm^{-2} when used as thermal protection is good for improving rice seedling production irrespective of the varieties, seeding dates and the different bed soils. Comparison among protection materials

Table 4. Seedling growth characteristics as affected by different seeding dates and bed soils in Ilmibyeo (30 days after seeding).

Seeding date	Bed soils	Plant height (cm)		Number of leaves		Top dry weight (mg/seedling)	
		PSF 40 g · m^{-2}	PE film	PSF 40 g · m^{-2}	PE film	PSF 40 g · m^{-2}	PE film
5. 4	CBS†	19.6a	18.9ab	3.2a	2.9ab	2.1a	2.2a
	CBS+PS	18.8ab	19.4a	3.1a	2.5b	2.2a	2.2a
	S	13.8c	14.1c	2.9ab	3.2a	1.8ab	1.7b
	PS	16.0c	15.0bc	2.9ab	2.5b	1.8ab	2.1ab
	CBS+S	17.7b	18.7ab	2.5b	2.9ab	1.7b	1.8ab
5. 14	CBS	24.3ab	23.3a	3.5a	3.5a	2.7ab	2.9a
	CBS+PS	25.2ab	22.1a	3.4a	3.5a	3.0a	2.8ab
	S	20.1b	19.9b	3.1a	3.2a	2.3b	2.4b
	PS	24.5ab	21.9ab	3.2a	3.3a	2.7ab	2.7ab
	CBS+S	25.8a	21.7ab	3.3a	3.4a	2.3b	2.5ab

The same letters in each column are not significantly different at the 5% level by DMRT.
†CBS: commercial bed soil, PS: Paddy soil, S: Sandy soil.

Table 5. Seedling growth characteristics as affected by different seeding dates and bed soils in Geuroobyeo (30 days after seeding).

Seeding date	Bed soils	Plant height (cm)		Number of leaves		Top dry weight (mg/seedling)	
		PSF 40 g · m^{-2}	PE film	PSF 40 g · m^{-2}	PE film	PSF 40 g · m^{-2}	PE film
5. 24	CBS†	20.9ab	24.1a	3.2ab	2.9a	3.4a	3.5a
	CBS+PS	21.6a	21.6b	3.4a	3.0a	3.2ab	3.1bc
	S	18.0b	18.4c	2.7c	2.6b	2.5c	2.4d
	PS	21.1ab	21.4b	2.9bc	2.8ab	3.1ab	3.2b
	CBS+S	21.0ab	20.8b	3.0bc	2.9a	2.8ab	2.8bc
6. 4	CBS	21.1b	24.4a	3.3a	3.4a	3.3a	3.3a
	CBS+PS	22.0a	22.1b	3.3a	3.3ab	3.0ab	3.2a
	S	18.5b	18.9c	2.7b	2.8b	2.9b	2.9b
	PS	22.6a	23.0ab	3.3a	3.2ab	3.2ab	3.3a
	CBS+S	20.8ab	21.9b	3.3a	3.3ab	3.2ab	3.0ab

The same letters in each column are not significantly different at the 5% level by DMRT.
†CBS: commercial bed soil, PS: Paddy soil, S: Sandy soil.

in two bed soils of CBS and CBS+PS in respect to plant height, top dry weight, total sugar content and inorganic elements (Table 6) reveals that PSF 40 gm^{-2} should be recommendable as the suitable thermal protection material for producing good quality of rice seedlings.

Table 4 shows growth characteristics of seedlings as affected by different seeding dates and different bed soils in Ilmibyeo. Seedling characteristics such as plant height, leaf number and top dry eight were not significantly different between CBS and CBS+PS. Sand soil as bed soil affected plant height and top dry weight regardless seeding dates and protection materials. Paddy soil reduced significantly plant height and top dry weight under PSF 40 gm^{-2} compared to CBS and CBS+PS.

Table 5 shows seedlings growth characteristics as affected by different seeding dates and different bed soils in Geuroobyeo as late season cultivation. Seedlings sown on May 24 and June 4 in PSF 40 gm^{-2} at the different bed soils had similar results in growth characteristics except in sandy bed soil. Seedling sown on June 4 with PSF 40 gm^{-2} and PE film showed similar results in top dry weight. Generally top dry weight was influenced by seeding dates meaning that similar results could be obtained in the different thermal protection materials treatments at late season culture. Top dry weight of the three varieties Hwayoungbyeo, Ilmibyeo and Geuroobyeo irrespective of the different seeding dates shown in 3,4

Table 6. Changes of inorganic elements as affected by different bed soils in three rice varieties.

Variety	Bed soil	T-N		P		K		Ca		Mg		Si	
		PSF	PE film	PSF	PE film	PSF	PE film	PSF	PE film	PSF	PE film	PSF	PE film
		%, dry wt											
Hwayoungbyeo	CBS	1.63	1.47	1.18	1.01	0.38	0.33	0.13	0.14	0.28	0.25	5.09	5.11
	CBS+PS	1.68	1.53	0.97	1.10	0.33	0.39	0.13	0.15	0.21	0.25	4.30	4.32
	S	0.97	1.28	0.93	1.11	0.25	0.30	0.13	0.15	0.24	0.26	4.13	4.41
	PS	1.34	1.54	0.97	1.03	0.31	0.29	0.17	0.16	0.22	0.23	4.29	4.49
	CBS+S	0.85	0.86	1.02	0.98	0.33	0.30	0.15	0.13	0.25	0.23	5.01	5.18
Ilmibyeo	CBS	1.45	1.43	1.39	1.10	0.47	0.36	0.21	0.17	0.38	0.32	5.6	5.52
	CBS+PS	1.40	1.39	1.25	1.06	0.42	0.32	0.22	0.25	0.36	0.32	5.53	5.03
	S	1.09	0.76	1.07	1.00	0.36	0.26	0.27	0.20	0.35	0.32	4.59	4.45
	PS	0.80	0.92	0.95	1.08	0.27	0.31	0.21	0.24	0.31	0.36	5.54	5.59
	CBS+S	0.95	1.01	1.27	0.98	0.44	0.35	0.27	0.19	0.37	0.30	5.47	5.69
Geuroobyeo	CBS	1.21	1.25	1.41	1.10	0.45	0.32	0.22	0.24	0.39	0.36	5.98	4.87
	CBS+PS	1.23	1.20	1.04	1.12	0.3.8	0.37	0.24	0.21	0.35	0.36	5.44	4.98
	S	0.98	1.23	1.01	1.08	0.40	0.32	0.25	0.22	0.29	0.33	4.98	4.89
	PS	0.83	1.28	0.99	1.09	0.30	0.31	0.28	0.29	0.35	0.39	5.08	4.78
	CBS+S	0.91	0.92	1.13	0.97	0.46	0.43	0.19	0.21	0.32	0.37	5.55	5.25

Seeding date: April 14 (Hwayoungbyeo), May 4 (Ilmibyeo), May 24 (Geuroobyeo)
†CBS: commercial bed soil, PS: paddy soil, S: sandy soil.

and 5 at the PSF 40 gm^{-2} with different bed soils had similar results. Seedlings sown on April 24 showed a slight increase in top dry weight than those on May 4. Seedlings on May 14 and May 24 showed similar results in top dry weight irrespective of seeding dates. CBS and CBS+PS in PSF 40 gm^{-2} and PE film at different seeding dates were suitable for producing good rice seedlings in both treatments. Therefore, based on the results obtained instead of using CBS only, we recommend CBS+PS as bed soil for good healthy seedlings.

Changes of inorganic elements as affected by different bed soils in three rice varieties are shown in Table 6. Total nitrogen content in PSF 40 gm^{-2} in CBS was 1.63% and 1.68% in CBS+PS in top dry weight. Similar results are also seen in these two bed soils, in PE film and among the varieties. But S, PS and CBS+PS total nitrogen were lower than CBS and CBS+PS in PSF 40 gm^{-2} and PE film. Phosphorus content in PE film and the different bed soils presented similar results in the three varieties. In PSF 40 gm^{-2} the phosphorus content in CBS Geuroobyeo was 1.41%, dry weight and for Ilmibyeo 1.39%, dry weight were higher in phosphorus content than in the rest of bed soils treatments. In PE film similar results are shown with slight differences in phosphorus observed in PSF 40 gm^{-2} at the different bed soil treatments. Different results are also shown in the different bed soils in the three varieties, but in the case of CBS and CBS+PS in PSF 40 gm^{-2} and PE film similar results were seen in potassium content. Mg and Si contents much differences were not seen at the different bed soils and the covering material among the three varieties. Ca content showed different results in Hwayoungbyeo with low Ca content as compared to Ilmibyeo and Geuroobyeo. Generally inorganic elements were affected by the different bed soils and in the three varieties. During the seedling-raising period, temperature and light intensity in nursery bed are very important to obtain healthy seedlings (Yun *et al.*, 1990). The temperature in PSF covering material during low temperature was higher than that of PE film (Hong *et al.*,1996). This is expected in PSF because it brings forth better heat insulation, better dehumidification and better air permeability compared to PE film. The other reason is that in conventional raising method with PE film, high temperature in nursery bed frequently caused serious damage especially when seeding dates are delayed. From our experiment results obtained in total sugar content and growth characteristics compared among the covering materials PSF 40, 60 gm^{-2} and 80,100 gm^{-2} proof that to achieve healthy production seedling rice PSF 40 gm^{-2} comes out to be the most suitable covering material. (Hong *et al.*, 1996) also reported a considerable reduction in labor

hours and cost by 28% and 48% respectively when PSF is used for nursery. Labor saving eliminates the repetition of opening and covering operations in PSF nursery method due to insulation responses of PSF against the unreliable conditions during the nursery period. We can attribute this findings with results obtain from our experiments where its shows with PSF 40 gm^{-2} as covering material and the seedbed commercial bed soil 50% and paddy soil 50% healthy seedlings were produced. This experiments finds the solution in order to avoid the damages in raising nursery and to reduce labor saving and cost in rice production.

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REFERENCES

Hong, K. P., J. Y. Kim, D. J. Kang, Y. G. Kim, W. K. Joung, G. W. Song, and Z. R. Choe. 2000. Nursing method with polypropylene spunbonded fabric in rice. Korean J. of Crop Sci., 45(2) : 118-122.

Hwang, K. H., J. T. Lee, J. I. Yun, K. M. Shim, and S. O. Hur. 2000. Microclimate in rice nursery bed covered with various materials. Korean. J. of Agricultural and Forest Meteorology, 2(3) : 87-94.

Kepper, D. and K. Decker. 1974. Methods of enzymatic analysis. In: Bergmeyer HU(ed). Verlag, Weinheim Academic Press, Inc. New York and London. 3 : 1127-113.

Kim, J. H., C. G. Lee, J. K. Kim, W. H. Yang, H. S. Han, Y. S. Kang, and S. C. Kim. 2000. Determination of critical early seeding date for raising seedling of rice using spunbonded polyester fabrics. Treatises of Crop Researches, 1 : 187-190.

Kim, J. Y., K. P. Hong, D. J. Kang, N. D. Kang, and W. K. Shin. 1997. Covering effects of polypropylene spunbonded nonwoven on growth and labor saving in rice raising seedling. Korean J. of Crop Sci., 42(2) : 88-89.

Kim S. S., M. G. Choi, S. Y. Lee, C. H. Yoo, S. Y. Cho, and B. T. Jun. 1996. Effects of nitrogen fertilization rate at different nursery soils on seedling characters and endosperm consumption. Korean J. Crop Sci., 41(5) : 514-520.

Song, Y. J., S. J. Kwon, B. R. Ko, J. S. Na, and S. T. Lee. 1998. Comparison of seedling quality under different shading degree, opening time and seed pretreatment at box raising seedling with non-woven fabric in rice. Korean J. of Crop Sci., 43(1) : 111-112.

Yun, S. H., B. W. Lee, B. C. Kim, and J. T. Lee. 1990. Diurnal variation of CO_2 concentration and air temperature in polyethylene film covered rice seeded subjected to various ventilation methods. Korean J. of Crop Sci., 35(6) : 543-547.

Yun, Y. D., W. H. Yang, Y. H. Kwag, and S. H. Park. 1986. Rice seedling establishment for machine transplanting. VI. Effect of mulching materials on raising rice seedling at tray for machine transplanting. Korean J. of Crop Sci., 31(1) : 9-15.