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Nursing Method with Polypropylene Spunbonded Fabric in Rice

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ABSTRACT : An extensive investigation has been made for the possible utilization of polypropylene spunbonded fabrics in rice seedling nursery. Considering the cropping systems available in southern part of Korea, sowing dates were fixed at April 5 and April 20 for single cropping and May 6 and May 26 for double cropping. Nursery period was fixed to 35 days for each sowing date. Four different thickness of polypropylene spunbonded fabrics, 40, 60, 80, 100 g/m^2, were tested in rice seedling nursery. The temperature and light intensity were not significantly different among the thickness of polypropylene spunbonded fabrics. Light intensity was significantly reduced in polypropylene spunbonded fabric (72.2 Klux) compared with polyethylene film (85.5 Klux), however, the reduced light intensity was enough for seedling growth. The temperature in the polypropylene spunbonded fabric covering during low air temperature was higher than that in polyethylene film tunnel. At transplanting, the rice seedlings grown in polypropylene spunbonded fabric condition was shorter (17 cm) but healthier than those in polyethylene film (23 cm). The estimated possible nursery periods using the polypropylene spunbonded fabric covering may start from April 1 at Chinju (plain area in Southern Korea, 20 m altitude) and April 15 at Susang (mountainous area, 430 m altitude). Labour hours and cost were reduced by about 28% and 48%, respectively.

Keywords : polypropylene spunbonded fabric, seedling growth, light intensity, labour hours.

In Korea, mechanical transplanting method of rice was introduced in mid 1970s. For mechanical transplanting, 35-day old seedlings (35DOS) and 8-day old seedlings (8DOS) were widely used, but 35DOS was widely spread in Korea because 8DOS requires more even paddy preparation and early transplanting (Kim *et al.*, 1993; Hoshikawa, 1992).

During the seedling raising period, temperature and light intensity in nursery bed are very important to obtain healthy seedlings (Yun *et al.*, 1990). In conventional raising method with polyethylene film, high temperature in nursery bed frequently caused serious damages, especially when seeding dates are delayed. It is expected that polypropylene spunbonded fabric (PSF) can bring forth better heat insulation, better dehumidification and better air permeability compared with polyethylene film.

A seedling raising method using polypropylene spunbonded fabric, initially developed for vegetable crops, has been introduced to rice nursery in expectation of obtaining healthy rice seedling and saving labor and covering-material cost.

MATERIALS AND METHODS

Four different thickness of polypropylene spunbonded fabric (40, 60, 80, and 100 g/m^2) were tested. Due to variability of temperature and light intensity during rice nursery periods, sowing dates were fixed at April 5, April 20 for single cropping and at May 6, May 26 for double cropping.

In each sowing date, pre-germinated seeds (130 g) were sown into seedling tray (30 × 60 cm), and the other agronomic practices were similar to conventional polyethylene film rice nursery method. Sprouted seed which had 1cm length of coleoptile were arranged into nursery bed, and covered with polypropylene spunbonded fabric (PSF). The results were compared with conventional polyethylene rice nursery. The covered PSF was taken off on 10 days before transplanting. In view of possible reuse of the polypropylene spunbonded fabric, the fabric used in previous crop year was also compared with polyethylene film. The nursery trays were kept according to the protective semi-irrigated rice nursery bed preparation method proposed by Kyongnam provincial Agricultural Research and Extension Services (ARES).

The six cultivars, Dongjinbyeo, Hwasungbyeo, Tamjinbyeo, Youngnambyeo, Hwayoungbyeo, Ilmibyeo, were sown at April 20 in 1998 and 1999 to the responses of rice seedling with polypropylene spunbonded fabric. To estimate possible nursery period using polypropylene spunbonded fabric covering, rice seed was sown from Feb. 15 in Chinju (20 m altitude) and Mar. 15 in Susang (430 m altitude) with 15 days interval.

Thirty five-day old seedling under different nursery meth-

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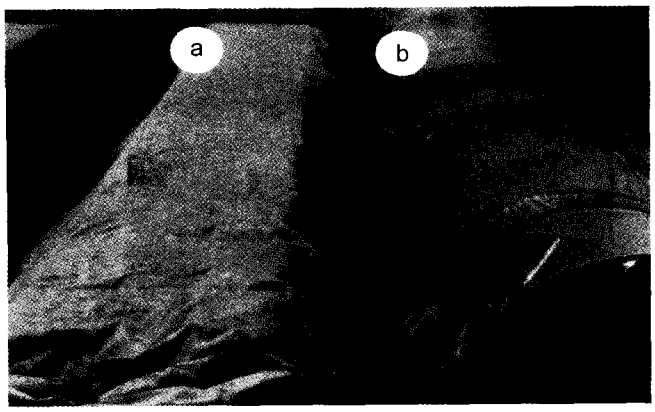

Photo 1. Rice nurseries with polypropylene spunbonded fabric (a) and conventional method (b).

ods was transplanted at 30 × 14 cm planting density on May 30 in 1999.

Temperature were regularly measured 10 o'clock during nursery period by digital thermometer (Optic Stow Away Temperature logger, USA). Mature seedling ratio and seedling quality, plant height, number of leaves, and dry weight of seedling were measured for 35-day old seedlings. This experiment was carried out for 3 years at Kyongnam provincial ARES. The scenery of rice nurseries covered with polypropylene spunbonded fabric and polyethylene film were shown in Photo 1.

RESULTS AND DISCUSSION

Light intensity and temperature under the different covering materials

Light intensity and temperature under the covering methods are shown in Table 1. Light intensity measured in sunny day in late May, 1997 was 103.2 Klux above the covering, 85.5 Klux in polyethylene film tunnel, and 72.0 Klux in polypropylene spunbonded fabric and 59.1 Klux in reused polypropylene spunbonded fabric. When second-hand polypropylene spunbonded fabric, used in the previous crop year, was reused for covering, light intensity was significantly reduced but temperatures were not much different between old and new polypropylene spunbonded fabrics. The light intensity, however, seemed not to be short for rice nursery. As shown in Table 1, the maximum and minimum temperatures in conventional polyethylene film covering were higher than those in polypropylene spunbonded fabric. Considering the temperatures measured under the PSF seemed to be within the temperature ranges suitable for rice nursery.

Table 1. Light intensity and temperature according to different covering materials to heat insulation for seedling raising period.

Covering materials	Light intensity	Maximum temperature	Minimum temperature
	Klux	----------°C----------	
PEF†	85.5	30.9	14.3
PSF (40 g/m^2)	72.0	26.4	12.0
Reused PSF (40 g/m^2)	59.1	27.6	11.2
Atmosphere	103.2	25.3	10.3

†PEF; Polyethylene film, PSF; Polypropylene spunbonded fabric. Temperature was measured from April 5 to May 20 in 1997.

Changes in temperature at different altitudes

Fig. 1. shows the changes in temperature inside polypropylene spunbonded fabric covering in two districts, Chinju (20m altitude) and Susang (430 m altitude). Compared with polyethylene film tunnel seed bed, the temperature in the polypropylene spunbonded fabric covering was high at low temperature periods and was low at high temperature periods, which indicates the temperature holding capacity of the polypropylene spunbonded fabric covering is superior to the polyethylene film covering. The polypropylene spunbonded fabric covering was able to prevent seedling damages caused by extreme temperature (low and high), which were fre-

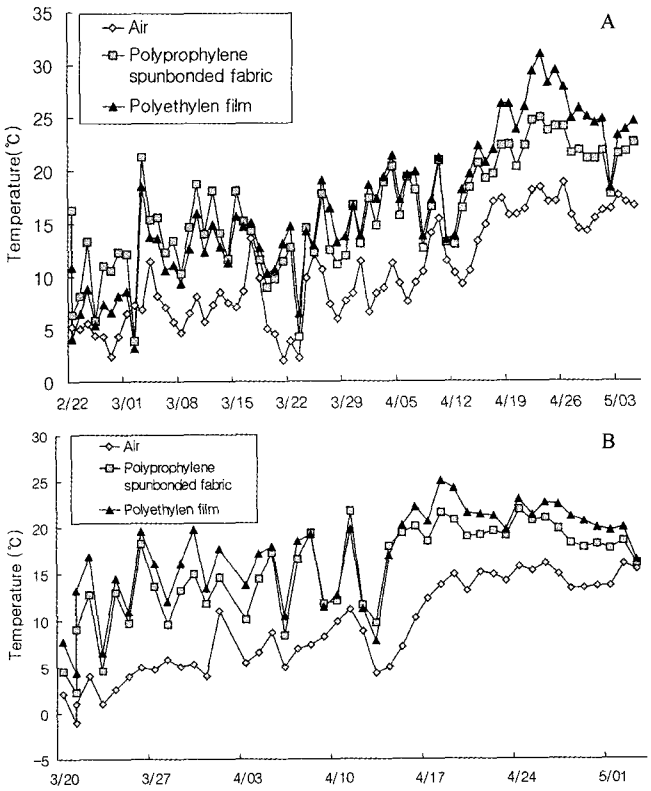

Fig. 1. Changes in temperature at different altitudes. A; Chinju (20 m altitude), B; Susang (430 m altitude).

Table 2. Seedling establishment percent and performance of seedlings grown in different nursery methods at Chinju. Seeding date was on April 20, 1997. (n=60)

Covering materials		Mature seedling ratio	Plant height	Leaf age	Dry weight	D.W./Plt.ht.
		%	cm	leaves	mg/seedling	mg/cm
PSF	40 g/m^2	98.2 ± 0.35†	17.5 ± 0.12	3.2 ± 0.00	20.0 ± 0.40	1.1 ± 0.03
	60	97.4 ± 0.80	17.3 ± 0.17	3.4 ± 0.06	26.4 ± 0.29	1.5 ± 0.00
	80	98.7 ± 0.25	17.1 ± 0.12	3.2 ± 0.03	19.6 ± 0.35	1.2 ± 0.03
	100	98.6 ± 0.27	16.8 ± 0.07	3.3 ± 0.03	21.9 ± 0.33	1.3 ± 0.00
Reused PSF, 40 g/m^2		98.7 ± 0.37	18.9 ± 0.12	3.3 ± 0.00	23.6 ± 0.34	1.2 ± 0.03
Conventional method		98.9 ± 0.06	23.3 ± 0.35	3.3 ± 0.07	20.3 ± 0.35	0.9 ± 0.03

†Mean ± standard error.

quently observed during the nursery period.

Performance evaluation of seedlings raised in different nursery methods

Seedling establishment percent and performance of seedlings raised by the different nursery methods are shown in Table 2. There were no differences in seedling establishment percent and in the number of leaves per plant. There was no difference in plant height among the different thickness of PSF, but the plant height of seedlings grown in polyethylene film nursery was taller than those in PSF.

Effects of sowing dates on performance of seedlings in different nursery methods

The performance of seedlings according to different sowing dates was shown in Table 3. When seed was sown on May 6 and May 26 for double cropping, plant height was similar between polypropylene spunbonded fabric and polyethylene film nursery methods, however, plant height was significantly reduced in PSF nursery method when seed was sown on April 5 and April 20 for single cropping, but the plant height was tall enough for machinery transplanting. Thus, it is concluded that seedling performance in different sowing date in different nursery methods satisfies for machine transplanting.

Responses of cultvars to different nursery methods

The responses of six rice cultivars to the polypropylene spunbonded fabric covering are shown in Table 4. Seedling establishment was successful in both covering. Most cultivars grown under the polypropylene spunbonded fabric covering were shorter, but more suitable for machine-transplanting than those under polyethylene film covering. There was no interaction between cultivars and covering materials.

Performance of seedlings raised by different nursery methods at different altitudes

Seedling establishment and performance of rice seedling at transplanting time in two different altitudes were summarized in Table 5. The estimated possible nursery periods using polypropylene spunbonded fabric covering may start from March 26 in Chinju and April 1 in Susang. And these

Table 3. Performance of seedling raised in different nursery methods at different sowing dates in 1997 at Chinju.

Seeding date	Covering materials	Mature seedling ratio	Plant height	Leaf age	The first leaf sheath length	Dry weight	D.W./ Plt.ht.
		%	cm	leaves	cm	mg/seedling	mg/cm
April 5.	Conventional	99.1 ± 0.47†	18.6 ± 0.19	3.5 ± 0.15	3.9 ± 0.12	13.7 ± 0.12	0.7 ± 0.00
	PSF	99.2 ± 0.53	16.3 ± 0.18	3.6 ± 0.10	2.1 ± 0.03	16.1 ± 0.46	1.0 ± 0.00
April 20.	Conventional	98.9 ± 0.06	23.3 ± 0.35	3.3 ± 0.07	4.2 ± 0.09	20.3 ± 0.35	0.9 ± 0.03
	PSF	98.2 ± 0.35	17.5 ± 0.12	3.2 ± 0.00	2.6 ± 0.20	20.0 ± 0.40	1.1 ± 0.03
May 6.	Conventional	98.0 ± 0.13	21.2 ± 0.07	3.2 ± 0.03	5.2 ± 0.10	22.8 ± 0.29	1.1 ± 0.03
	PSF	98.0 ± 0.43	22.0 ± 0.03	3.2 ± 0.03	3.7 ± 0.12	19.7 ± 0.20	0.9 ± 0.00
May 26.	Conventional	97.4 ± 0.46	28.8 ± 0.13	3.9 ± 0.03	2.2 ± 0.07	19.8 ± 0.28	0.7 ± 0.03
	PSF	97.9 ± 0.50	28.0 ± 0.12	4.0 ± 0.03	2.3 ± 0.06	23.8 ± 0.39	0.9 ± 0.03

†Mean ± standard error.

Table 4. Comparisons of seedling quality of rice cultivars according to different covering materials in 1998 and 1999 at Chinju.

Cultivars	Covering materials	Mature seedling ratio	Plant height	Leaf age	Dry weight	D.W./plt. ht.
		%	cm	leaves	mg/seedling	mg/cm
Dongjinbyeo	PSF	98.9a*	16.4b	4.5a	26a	1.6a
	PEF	99.7a	25.9a	4.0a	29a	1.1b
Hwasungbyeo	PSF	99.4a	17.7b	4.4a	26b	1.5a
	PEF	99.4a	27.3a	4.2a	35a	1.3a
Tamjinbyeo	PSF	99.4a	17.4b	4.4a	24a	1.4a
	PEF	99.9a	27.2a	4.1a	29a	1.1b
Youngnambyeo	PSF	98.9a	16.6a	4.6a	20a	1.2a
	PEF	99.5a	19.8a	3.9a	23a	1.2a
Hwayoungbyeo	PSF	99.6a	15.7b	4.3a	22b	1.4a
	PEF	99.5a	25.0a	4.0a	31a	1.2a
Ilmibyeo	PSF	99.8a	14.4b	4.2a	18a	1.3a
	PEF	100a	25.4a	3.8a	19a	0.8b
Average	PSF	99.3a	16.4b	4.5a	23b	1.4a
	PEF	99.7a	25.1a	4.0a	28a	1.1b

*Within cultivars, same character on each column indicates no significant difference at 5% by t-test.

Table 5. Comparisons of plant height at transplanting time and mean-/extremely low-temperature during nursery period as influenced by different sowing dates and different altitude in 1999.

Location	Seeding date	Plant height at transplanting time	Transplanting possibility	Accumulation temperature for 35 days	Extremely low temperature during nursery period
		cm		°C	°C
Plain area (Chinju, 20 m altitude)	Feb. 15	4.3	None	-	-9.1
	Mar. 1	4.1	None	-	-4.1
	Mar. 15	7.1	None	351	-3.4
	Mar. 26	11.2	Good	444	-1.3
	Apr. 1	14.6	Good	474	-0.5
	Apr. 15	13.1	Good	610	0.7
Mountainous area (Susang, 430 m altitude)	Mar. 15	5.4	None	283	-6.6
	Apr. 1	11.9	Good	441	-0.8
	Apr. 15	11.8	Good	555	3.2

Table 6. Estimated starting date of rice nursery periods using polypropylene spunbonded fabric covering based on air temperature.

Lacation	Items	1999	1998	1997
Chinju	Mean air temperature	Mar. 28	Mar. 21	Mar. 31
	Extremely low temperature	Mar. 31	Mar. 21	Apr. 1
Susang	Mean air temperature	Apr. 4	Mar. 25	Apr. 8
	Extremely low temperature	Apr. 15	Apr. 4	Apr. 10

periods were similar between the polypropylene spunbonded fabric and polyethylene film tunnel.

It is generally accepted that the possible rice nursery period can be determined by the summation of mean air temperature and extremely low temperature during the nursery period (in general for 35 days). Based on this condition, the sum of temperature were estimated 441°C at Susang and 444°C at Chinju and extremely low temperature showed similarity in two districts (-0.8°C at Susang and -1.3°C at Chinju).

In order to acquire more safety for rice nursery, the sum of mean air temperature should be increased up to 450°C and the extremely low temperature to -0.5°C. Therefore the safety nursery period estimated was April 1 in Chinju and April 15 in Susang (Table 6). According to average air temperature of 5 years ('95~'99), rice nursery period was Mar. 29 in Chinju and April 14 in Susang. This estimates were 20 days earlier than ordinary nursery period using polyethylene film covering.

Performance of rice transplanting and grain yield

There was no difference in most characters judging the performance of transplanted rice seedlings as shown in Table 7, however, dry-off leaf length observed on 8th day

Table 7. Performance of rice transplanting and grain yield according to different covering materials in nursery bed.

Covering materials	Missing hills	Dry-off leaf length	Culm length	Number panicles per plant	Number spikelets per panicle	Ripened grain ratio	1,000 grain weight	Milled rice yield
	%	cm	cm			%	g	kg/10a
PSF	1.7a*	1.4b	80a	13.0a	81a	76.8a	20.1a	480a
PEF	1.2b	2.8a	85a	12.4a	81a	75.3a	20.3a	453a

*Same character on each column indicates no significant difference at 5% by t-test.

Table 8. Effects of labor and material cost saving by using polypropylene spunbonded fabric in nursling of rice.

Covering materials	Working hours	Material costs (Won)
	---------- per 10a ----------	
Conventional	7.5 (100)	6,200 (100)
polypropylene spunbonded fabric (40 g/m^2)	5.4 (72%)	3,200 (52%)

after transplanting was significantly shorter in the polypropylene spunbonded fabric covering. This might indicate shorter days for recovering from transplanting damage. Yield components and grain yield were not significantly different between polypropylene spunbonded fabric and ordinary polyethylene film coverings.

Effect of new nursery methods on labor saving

The effect of polypropylene spunbonded fabric nursery method on labor saving was shown in Table 8. Labor and material cost was saved by 28% and 48% in PSF nursery method. This savings resulted from elimination of repeated opening and covering operations in PSF nursery method, due to insulation effect of PSF against the fluctuation of temperature during the nursery periods.

Due to shortage of farming labor and increase of farming wage, rice cultivation method and technique in Korea has been changed. A new seedling raising method using polypropylene spunbonded fabric will be helpful to reduce labor and cost in rice cultivation.

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