KNOWLEDGE TRANSFER	**Document:** Effect of Using Spunbond in Tomato (*Solanum lycopersicon*) Production During the Dry Season	
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Effect of Using Spunbond in Tomato (*Solanum lycopersicon*) Production During the Dry Season

1. Introduction

Tomatoes (*Solanum lycopersicon)* are a high-value crop and a major problem in tomato production worldwide, especially in areas where tomatoes are grown commercially, is the tomato yellow leaf curl disease caused by tomato yellow leaf curl virus (TYLCV) which is transmitted by whitefly (*Bemisia* sp.). This disease was first observed in Thailand in 1973 (Attathom *et al.*, 1990). Whiteflies are tropical species, and most abundant in warm climates and in greenhouses because they reproduce rapidly and can attain very high densities. They can transmit plant viruses, which can be quite damaging to vegetable crops (Cohen and Nitzany, 1966; Rubinstein and Czosnek, 1997). The virus often severely damages tomatoes grown at the beginning of the hot-dry season in Thailand (Li *et al,* 2021). Serious infections will result in stunting with small, curled leaves, premature flower drop and embryo abortion resulting in 100% loss of fruit production (Lapidot *et al*., 1997). The use of spunbond has previously demonstrated to increase the tomato profitability during the early growth season (Reiners and Nitzsche, 1993). It extends the production season in order for farmers to maximize yield. In addition to increasing the rentability of tomato production, spunbond covers can protect the plants from insect populations. Indeed, with the spunbond cover whiteflies cannot transmit viruses such as TYLCV (Natwick and Durazo, 1985).

Spunbond is a nonwoven fabric textile cover, very light, porous to water and allows 70-80% of the light to be transmitted. It has been considered in cold countries as a prevention method against frost. The temperatures under the cover can reach levels to hasten the emergence of plants. However, in some cases where the outside temperatures are very high, the cover can capture and hold heat that could negatively impact the crops (Reiners and Nitzsche, 1993). In addition, it has a fair strength and durability, it is degradable in the soil after utilization (Kramov *et al.*, 2019). Other benefits of spunbond row covers include the reduction of blossom-end-rot diseased fruits (Alexander and Clough, 1998) and reduction in pesticide use

(Orozco-Santos *et al.*, 1995). It also reduces spore dispersal by preventing soil splash on plant leaves and reducing leaf wetness (Martin, 2013).

2. Objectives

This study aims to evaluate the production (yield), visual disease incidence and severity of tomato grown under row cover of spunbond in the dry season.

3. Materials and methods

The research was conducted at KT Farm in Chiangmai, Thailand, during the dry season from February 2021 until June 2021. Seeds were obtained from East-West Seed Thailand. Two varieties were used: one intermediate resistant and one susceptible cultivar to tomato yellow leaf curl virus (TYLCV), Petchompoo 2 (BVC 15135) (V1) and Thep PraThan (V2), respectively. The experiment was designed in randomized complete block design (RCBD) with three (3) replicates. Each variety was grown receiving both treatments. The control treatment had tomatoes grown in the open field (e.i. No spunbond) (T1), and the second treatment had tomatoes grown under spunbond cover for 55-60 days after sowing (T2). The vegetable seedlings were raised in seed trays and transplanted to the raised beds on March 11th, 2021. Spacing between plants (26,660 plants/hectare), crop protection and fertilization were based on KT crop guide recommendation.

The varieties were sprayed with Lambda-cyhalothrin (1mL/L) before the spunbond were applied to avoid trapping insects inside the cover. No other insecticide was applied later on the experiment. The spunbond covers were removed from the field 25 days after transplanting (April 5th, 2021).

Fruits were harvested for 5 weeks and graded as marketable or non-marketable (de-formed, disease and insect damage according to the U.S. Department of Agriculture (1958). The fruit number per replicate was recorded. The total yield was calculated in ton per hectare and the average fruit weight was calculated using the number of fruit per replicate divided by the total yield.

The disease severity was monitored by observing for tomato yellow leaf curl virus (TYLCV). Disease severity for TYLCV was assessed with the grading system shown in Table 1 during vegetative and fruiting stage. The plants were observed for TYLC virus symptoms two weeks after the spunbond were removed.

Table 1: Scale for monitoring the disease severity

Severity grade	Description	Symptoms
1	Symptom less	Symptoms absent
2	Very mild Symptoms	Very mild symptoms up to 25% leaves
3	Mild Symptoms	Appearance of disease between 26-50% leaves
4	Moderate Symptoms	Symptom between 51-75 leaves
5	Severe symptoms	Severe disease infection at 75% leaves
6	Very Severe symptoms	Above 75% leaves

For more information on the experiment, here is the link to the protocol.

4. Results & discussion

4.1 Yield

Table 2 shows that there is an interaction between treatment and variety for both the marketable yield and the number of fruit per plant. The marketable yield (tonne per ha) of tomato plants grown under open field or spunbond conditions differ for both cultivars (Table 2). The marketable yield is higher when the tomatoes are grown under spunbond covers. The number of fruit per plant is also higher when the tomatoes were grown with spunbond covers. When the tomatoes were grown under open field conditions, the Thep Prathan variety had a significantly lower number of fruits per plant compared to the Petchompoo 2 variety.

Table 2: Marketable yield of 2 different tomato cultivars grown in open field and spunbond conditions.

Variety	Treatment	Marketable yield (tonne/ha)	No. of fruits/plant	Average fruit weight (g)	Yield Mean (tonne/ha)
Petchompoo 2	Open field	31.7 b	35b	34.3	37.8
	Spunbond	44.0 a	49a	33.5	
Thep Prathan	Open field	11.6 c	13c	34.9	25.6
	Spunbond	39.6 ab	46a	32.6	
F-Test (P<0.05)	Treatment (T)	**	**	ns	
	Variety (V)	**	**	ns	
	TxV	*	**	ns	
$LSD_{0.05}$ (TxV)		9.4	7.2	-	

The higher yields resulting from the use of spunbond can be attributable to more vigorous growth of the plant because of moisture conservation and higher soil temperature. This could be due to temperature difference, where the temperatures under the cover are higher and the air movement is slightly reduced (Lapidot *et al.*, 1997). The spunbond row cover also reduces the amount of solar radiation reaching the plants. However, in a study conducted on cucumber plants, the reduction was too small to disturb the photosynthesis process. The increase in air and soil temperature and a better light distribution under the cover lead to more vigorous plant growth (Kalisz *et al.*, 2018). Another reason for the increase in marketable yield under spunbond cover could be attributed to the plant not being exposed to direct sunlight. The latter causes sunscald on the areas of the tomato fruit that are directly under sunlight and thus they ripen unevenly (Mulholand *et al.*, 2003). The air temperature under the spunbond was higher from 0.7 to 5°C (data not shown). In addition, the illuminance measured with a lux meter

was lower in average by 50% (data not shown). The open field tomatoes from Thep Prathan had significantly lower yield than the Petchompoo 2 variety, 31.7 tonnes/ha compared to 11.6 tonnes/ha for the Petchompoo 2 variety (Table 2). The use of spunbond over a susceptible cultivar helped in preventing the growth of the virus. This could be a possible reason why a significant difference is observed in marketable yield between the two treatments (with spunbond and no spunbond) in the susceptible variety. The marketable yield in open field differed between cultivars, whereas the marketable yield under spunbond cover did not differ between the cultivar. However, the marketable yield was different between the growing conditions. The marketable yield of tomatoes grown under spunbond represents 78.8% of the total yield whereas the marketable yield of tomatoes grown in open fields represents 71.7%. When comparing between the varieties, Petchompoo 2 produced 77.1% of marketable fruits whereas Thep Prathan produced 73.4%. The average fruit weight was not affected by the row cover (Table 2). There was no significant difference between the treatment nor the cultivar. Other studies have also reported no effect on the fruit weight, but another has found a 5-10% reduction in pepper weight with the row covers (Alexander and Clough, 1998).

4.2 Virus Scoring

Data was collected 14 days after the spunbonds were removed (April 19th, 2021). Each plant was observed and assigned a score (Table 1).

The disease incidence was calculated using the number of plants affected divided by the total number of plants (expressed as a percentage). The disease incidence is higher in open fields compared to treatments with spunbond for both varieties (Figure 3). However, the disease incidence was much higher, almost doubled in the Thep Prathan variety for both treatments. The disease incidence was considerably reduced with the use of spunbond covers.

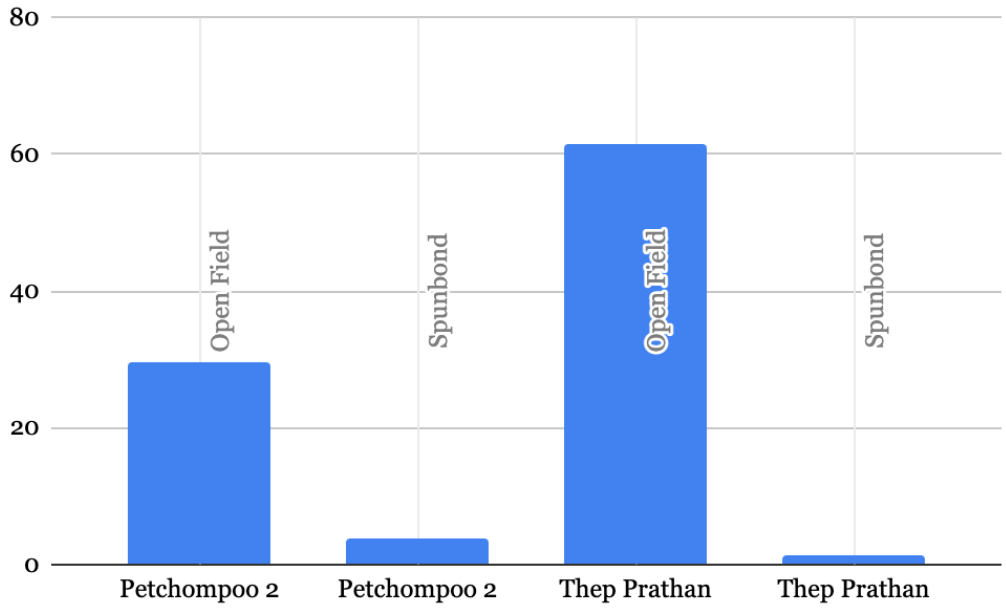


Figure 1: The disease incidence (%) of both cultivars for each treatment, expressed as a percentage.

One of the major symptoms of the TYLCV is the severe stunting of growth of the tomato plants (Lapidot *et al.*, 1997). Figure 2 and 3 shows the visual difference between the tomato plants grown under open field and with spunbond covers for the two cultivars. When Petchompoo 2 and Thep Prathan are grown in an open field, the plant growth is not as developed as the plants grown with spunbond covers. The difference is even greater in the Thep Prathan variety. The difference between the varieties might be due to the genetic resistance of Petchompoo 2. Indeed, the cover helped in reducing the disease severity but the genetic resistance of the variety also played a role. Thep Prathan being more susceptible, it relied more on the cover to help prevent the spread of the virus. Spundbond covers can effectively reduce the symptoms and or the presence of the disease by keeping the insect population that could possibly transmit the virus away from the crops.

Figure 2: Petchompoo 2 (IR) variety 72 days after transplant a) in open field and b) 39 days after spunbond was removed

Figure 3: Thep Prathan (S) variety 72 days after transplant a) in open field and b) 39 days after spunbond was removed

4.3 Cost

The cost of labor and equipment is higher of 27 Thai baht per m^2 when spunbond are used (Table 3). Mainly due to the cost of labor to install the spunbond covers and the cost to purchase the material. Improving the cost efficiency of spunbond can be done by 1) using

cheaper materials or any other material farmers might have that do not need to be purchased, 2) increasing the yield per unit area by choosing better varieties (Waterer, 2003) and 3) growing higher value crops.

Table 3: Labour and input costs, and equipment for 1m^2 of land, in American Dollars (USD)

	Activities	1m^2 (USD)	
		Open field	Spunbond
A. Labor Cost	Land Plowing (Machine)	0.17	0.17
	Bed rising (Machine)	0.06	0.06
	Rise beds	0.33	0.33
	Mulching	0.11	0.11
	Drip irrigation	0.43	0.43
	Trellis	0.43	0.43
	Spunbond set up	0	0.58
	Harvest	0.36	0.36
	Care of plant - Watering	1.09	1.09
	Care of plant - Fertilization	0.09	0.09
	Care of plant - Trellis	0.43	0.43
B. Input cost	Seed	0.03	0.03
	Fertilizer	0.06	0.06
	Insecticide	0.09	0.09
	Plastic mulch	0.09	0.09
	Drip irrigation	0.8	0.8
	Bamboo for trellis	0.42	0.42
	Rope for trellis	0.05	0.05
	Spunbond	0	0.28
	Total	5.05	5.91

The cost of investment can be compared with the net income to determine the return for the producer. The average selling price of tomatoes for the month of June 2021 was 0.72 USD/kg (link) The average price per kilogram from 2017-2021 is 0.68 USD, which suggests that the market prices are not fluctuating much. Thus, it is almost impossible to get a positive return. Table 4 shows that none of the varieties under whether they are grown in open field or under spunbond row cover can get a return on their investments.

Table 4: Return of investment over 1m^2 of cultivated area, in american dollars (USD)

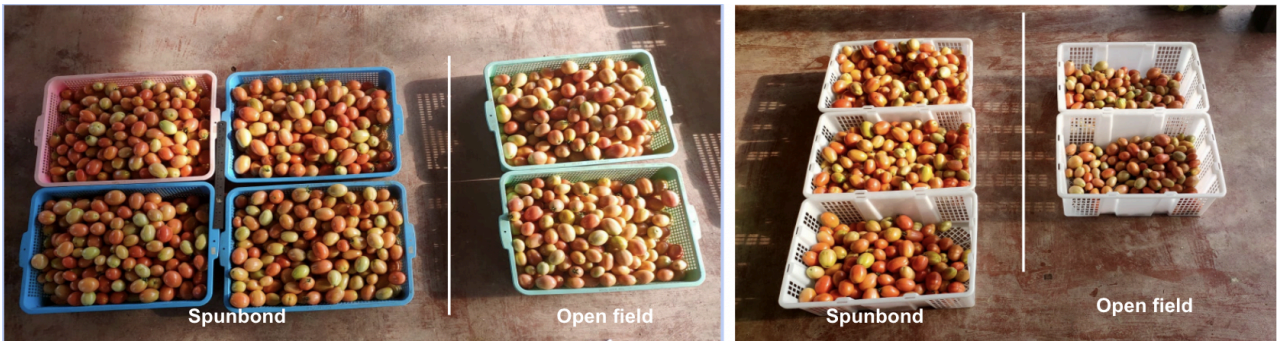
Varieties	Treatments	Yield (kg/m^2)	Cost of investment	Net income	Return
			(USD/m^2)		
Petchompoo 2	Open field	3.2	5.05	2.4	-2.7
	Spunbond	4.4	5.91	3.3	-2.7
Thep PraThan	Open field	1.2	5.05	0.9	-4.2
	Spunbond	4.0	5.91	3.0	-3.0

5. Conclusion

The main goal of using spunbond row cover is to reduce the insect vectors transmitting viral diseases. This study has demonstrated that the use of spunbond can reduce the disease incidence and thus increase the marketable yield of tomato production. Depending on the market preferences, the use of spunbond covers might be more beneficial and reasonable to use if the Thep PraThap fruits are favored by the market. Indeed, the susceptible varieties can produce similar yields as the resistant variety when using spunbond row covers. Because Petchompoo is more resistant to the virus, and the more tolerant a variety is, it is less impacted by the spunbond. So the use of spunbond with resistant variety is most likely to never be profitable unless the market price is really high. However, the susceptible variety has more potential as the spunbond can significantly increase the yields. Even Though the light was greatly reduced with the use of spunbond during the first week of growing, it did not seem to have an negative impact on the yield. Although the cost of equipment and labor is higher when spunbond is used, it can generate higher yields and thus higher revenues for a susceptible variety. However this study did not prove that the farmers can get a return on their investment. Improving the cost efficiency of spunbond covers can also help in achieving higher profits.

Spunbond row cover can be practical and economical management tools for producing tomatoes under the dry season conditions.

Annex 1: Tomatoes harvested from Petchompoo 2 and Thep PraThan variety.



Annex 2: Tomato production under the different growing conditions; Open field and Spunbond condition.

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