TARC Note

Effects of Cultural Treatments on Growth of Vegetables under Subtropical Climate

In Okinawa located in the subtropical zone, the summer climate is characterized by high temperature, strong solar radiation, long sunshine duration and frequent typhoons, while the winter climate is warm, but has long spells of rainy weather and short sunshine duration (Fig. 1). To know the relation between such climate and vegetable growth, some experiments were carried out at Ishigaki Island of Okinawa Prefecture.

In summer, three different cultural treatments, i.e., shading, covering, and mulching, were given to vegetables. For the shading, two layers of black cheesecloth were spread over a frame constructed on a field where cabbage (cv. YR Kinshu), eggplant (F_1 Kisshin), and sweet pepper (Suigyoku No. 2) were planted on July 5, 1982. The light intensity under the shading was ca. 30% of that of the unshaded control. As shown in Fig. 2, maximum air temperature, leaf temperature, and soil temperature were markedly lowered by the treatment. Transpiration rate and wilting index of the crops were also decreased (Table 1). Although the light intensity was reduced to only 30% of the control CGR of cabbage and sweet pepper was not decreased at least at an early stage of growth (Fig. 3).

The covering treatment was given by covering with white cheesecloth and one kind of covering material (material A) on crop rows (planted on July 8, 1982). In another plot, one kind of covering material (material B) was spread at the height of 40 cm above crop rows. In the control plot, seed germination and growth of young plants were seriously inhibited by high temperature and drought, and in the plot of covering material B plant growth was severely retarded by low light intensity (Table 2). On the contrary, in the plots of covering material A and cheesecloth, edible amaranthus and Chinese cabbage showed good growth (Table 3). Particularly, edible amaranthus was harvested twice. Thus, the appropriate covering was effective to pro-

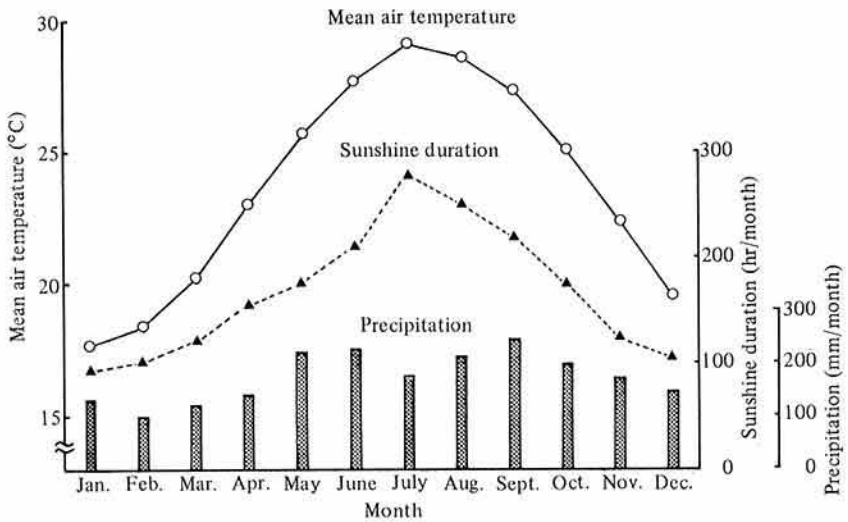

Fig. 1. Climatic condition at Ishigaki Island[3]

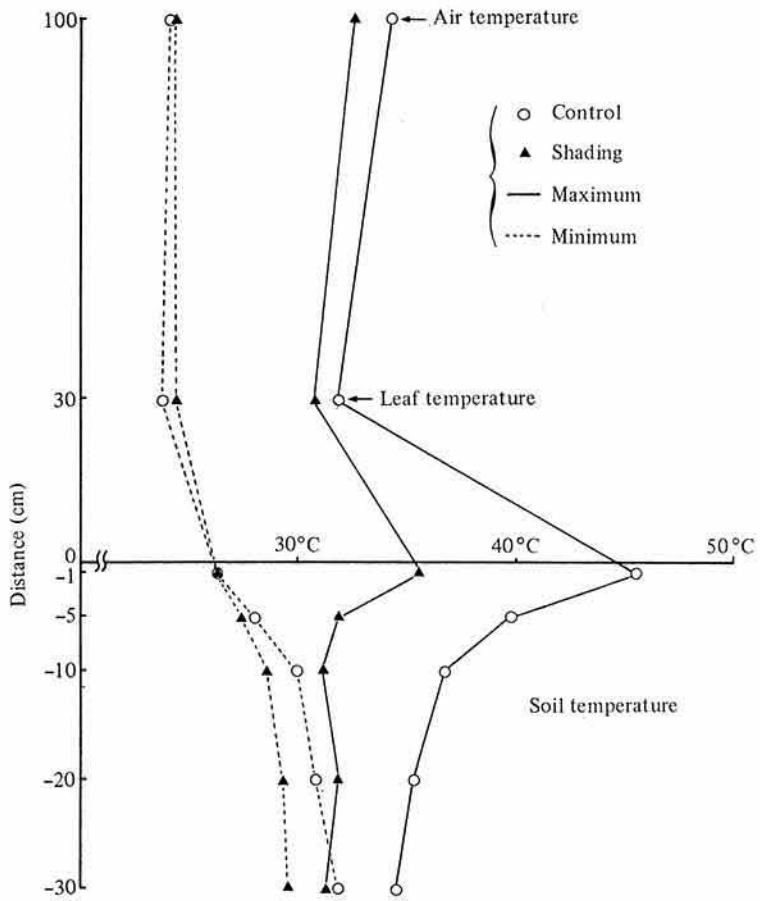

Fig. 2. Vertical distribution of temperature above and below soil surface (July 26–27, 1982)

Table 1. Effect of shading on transpiration rate and wilting index of vegetable crops

Vegetable	Transpiration rate[a,b]		Wilting index[c]	
	Control	Shading	Control	Shading
Cabbage	16.94	7.92	0.5	0
Eggplant	18.14	9.72	0	0
Sweet pepper	5.12	1.80	2.0	0.5

a) Measured at 14:00~14:30 on July 27, 1982.
b) $\mu g/cm^2/sec$.
c) Rated from 0 (normal) to 3 (severe wilting).

tect crops from high soil temperature and drought.

Mulching with a layer of napier grass (*Pennisetum purpureum*), 10 cm in thickness, was found very effective in protecting soils from high temperature, although napier grass mulch of 3 cm in thickness was less effective.

Effect of napier grass mulch in preventing soil temperature rising in the daytime was striking as shown in Fig. 4, which gives data obtained in a fine day. Without the mulch, soil temperature rose higher than 35°C in the soil layer at least down to 20 cm in depth.

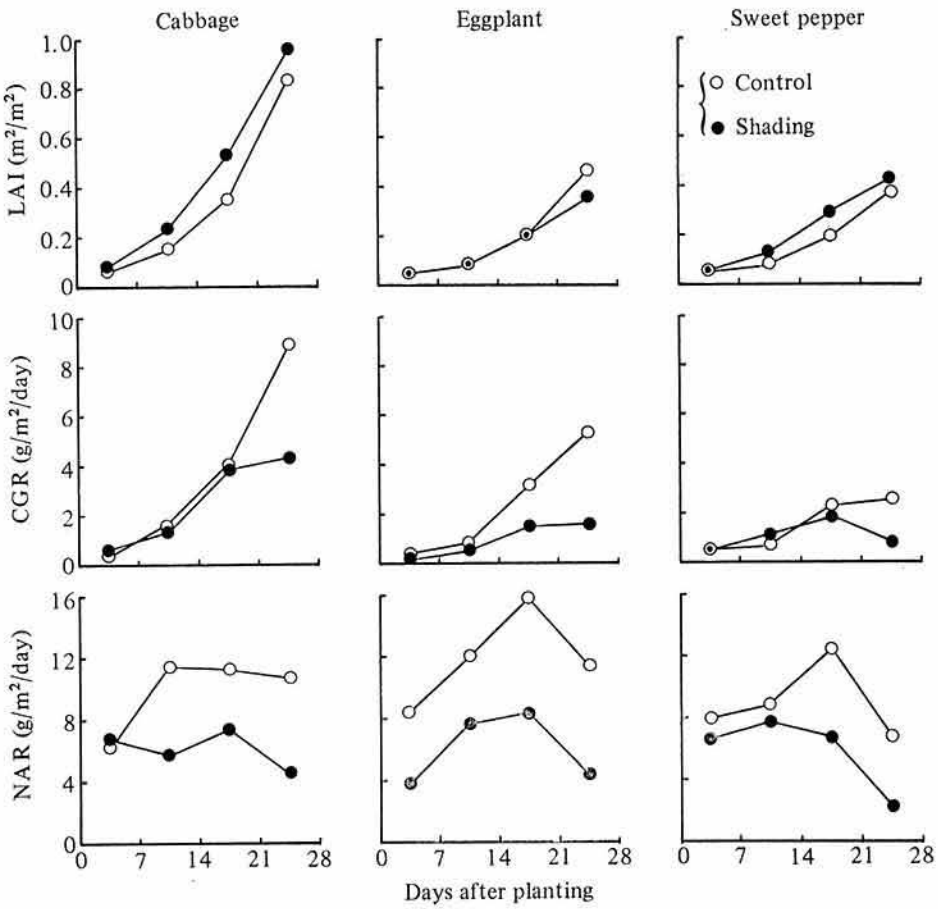

Fig. 3. Effect of shading on growth parameters of vegetable crops

Table 2. Effect of covering materials on environmental conditions[a)]

Covering material	Light transmission	Air temperature		Leaf temperature		Soil temp. (1 cm depth)		Soil temp. (10 cm depth)	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
	%	°C							
Control	100	35.4	25.1	38.3	24.4	48.6	26.8	37.8	29.1
Cheesecloth[b)] (white)	69.5	40.4	24.4	37.9	24.6	41.3	26.6	34.6	28.7
Material A[b)] ("tafuberu")	53.5	41.3	24.5	39.3	23.9	38.2	26.4	32.7	28.4
Material B[c)] ("WYS-50")	11.6	—	—	—	—	31.4	26.2	29.4	27.4

a) Measured on August 5~6, 1982.
b) Closely covered on the rows.
c) Spread at the height of about 40 cm above crop rows.

Table 3. Yields[a] of vegetable crops

Vegetable	Covering materials and harvest dates								
	Cheesecloth (white)			Material A ("tafuberu")			Material B ("WYS-50")		
	Jul. 27	Aug. 6	Aug. 14	Jul. 27	Aug. 6	Aug. 14	Jul. 27	Aug. 6	Aug. 14
	g								
Chinese mustard	—	111	—	—	160	—	—	—	—
Pak-choi (A)	—	124	—	—	183	—	—	—	—
Pak-choi (B)	—	337	—	—	338	—	—	90	—
Chinese kale	—	—	164	—	—	108	—	—	—
Edible amaranthus	417	—	275[b]	463	—	213[b]	86	—	—
Leaf mustard	—	73	—	—	120	—	—	—	—
Chinese cabbage (santousai)	483	—	—	340	—	—	102	—	—

a) Top fresh weight per 1 m length of row. No yield in the control.
b) Regrowth after harvest of July 27.

Table 4. Air temperature under coverings[a]

Air temperature	Control (outdoor)	Plot a (PVC-film tunnel)	Plot b (PVC-film greenhouse)	Plot c (PVC-film greenhouse + cheesecloth)
	°C			
Maximum	19.8	25.9	28.9	30.2
Mean	16.8	17.8	19.4	19.9
Minimum	14.5	14.3	15.8	15.9

a) Measured on February 15~18.

Soil temperature higher than 35°C is known to inhibit growth of fruit vegetables.[1]

Napier grass mulch is also known to be effective in maintaining or even increasing soil productivity under subtropical climate of Ishigaki Island.[2]

In winter, three different treatments aiming at raising air temperature were given to seedlings of lettuce (GL 366), eggplant (F_1 Kisshin), and sweet pepper (Suigyoku No. 2). The treatments were culture in PVC-film tunnel (plot a), culture in PVC-film greenhouse (plot b), and culture in PVC-film greenhouse covered with black cheesecloth (plot c). In each plot, the seedlings were transplanted on Feb. 3, 1983 onto ridges and on flat rows. Leaf area and dry weight of the seedlings were measured 4 weeks after transplanting.

As shown in Table 4, maximum and mean temperatures were highest in plot c, followed by plot b, plot a, and the control (outdoor) in that order, but no appreciable difference was found with minimum temperature. Leaf area and top dry weight were greater in any treatmental plot than the control (Fig. 5). Particularly, the greatest values were found in plot a for lettuce, and in plot b for other crops. As to the type of rows, the flat rows tended to give slightly better growth than ridges, probably due to more humid soil, but the difference is not clear.

Another experiment was done to examine

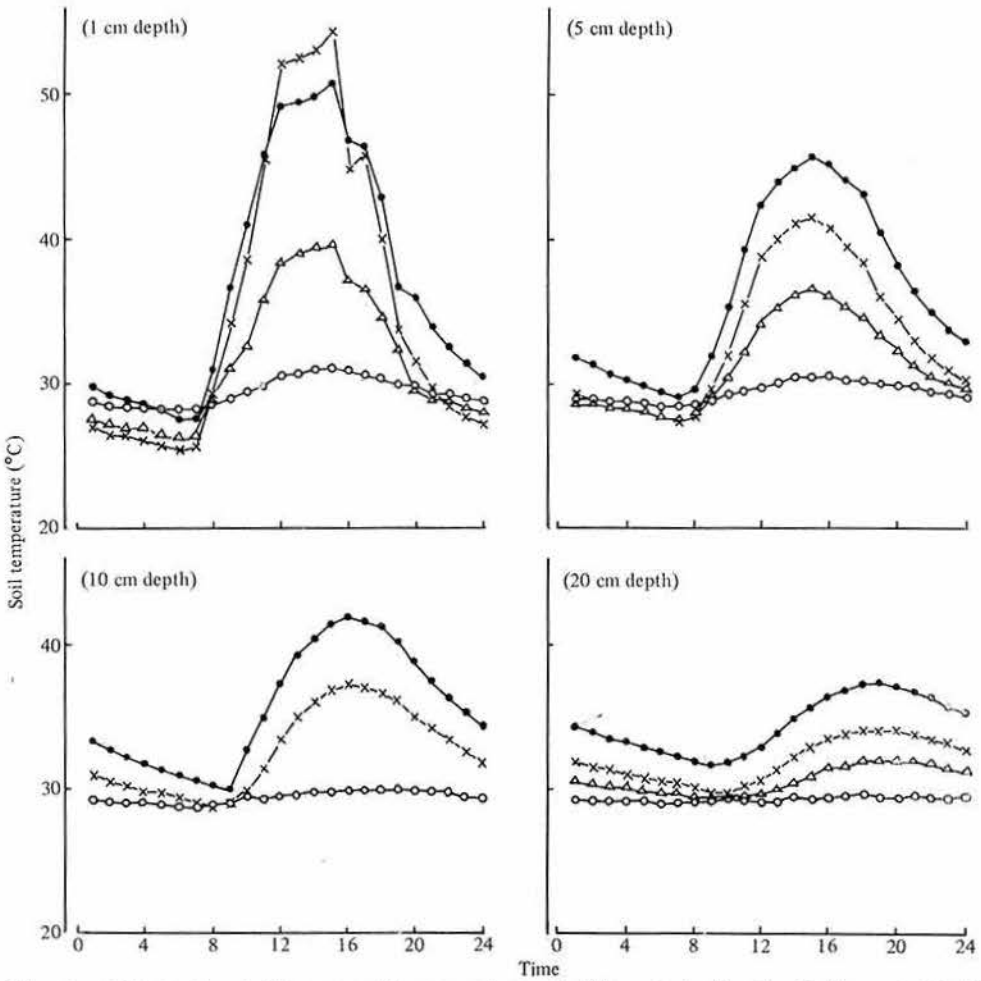

Fig. 4. Effect of mulching on soil temperature at different depth of soil (August 22, 1982)

Remarks × : Control (bare soil)
△ : Napier grass (3 cm thickness)
○ : Naapier grass (10 cm thickness)
● : Polyethylene film (black)

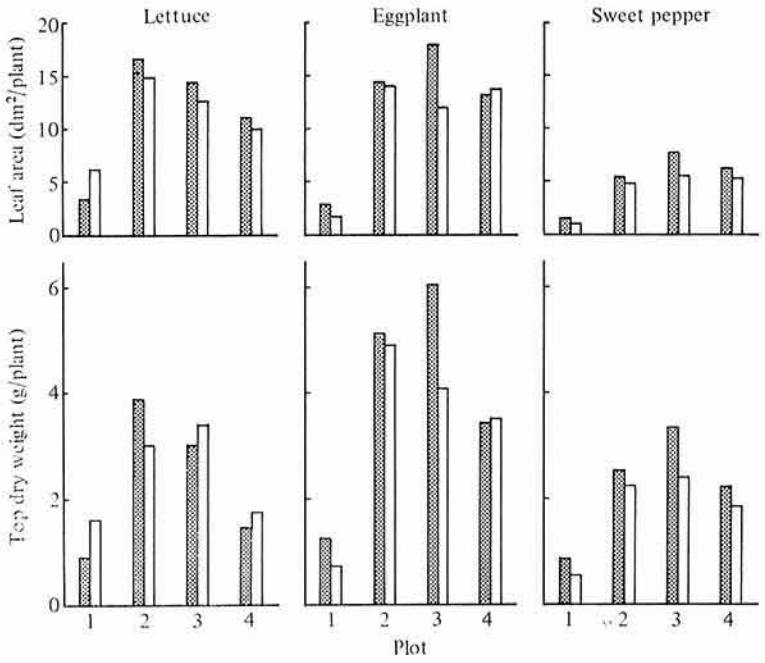

Fig. 5. Effect of coverings on growth of vegetables at an early stage

Remarks Plots 1 : Control
2 : Plot a (PVC-film tunnel)
3 : Plot b (PVC-film greenhouse)
4 : Plot c (PVC-film greenhouse + cheesecloth)
Type of row Left : Flat row
Right : Ridge

effects of different covering materials and size of covering facilities on air temperature under the covering. From the result shown in Fig. 6, it is known that (1) big size tends to give more temperature rise than small size, and (2) as already known[4,5] some kinds of plastic film promote radiational cooling in the night, showing lower temperature under the covering than outdoor. Water melon grown under the covering indicates that an effective covering is desirable in winter in Ishigaki, where minimum temperature falls to near 12°C.

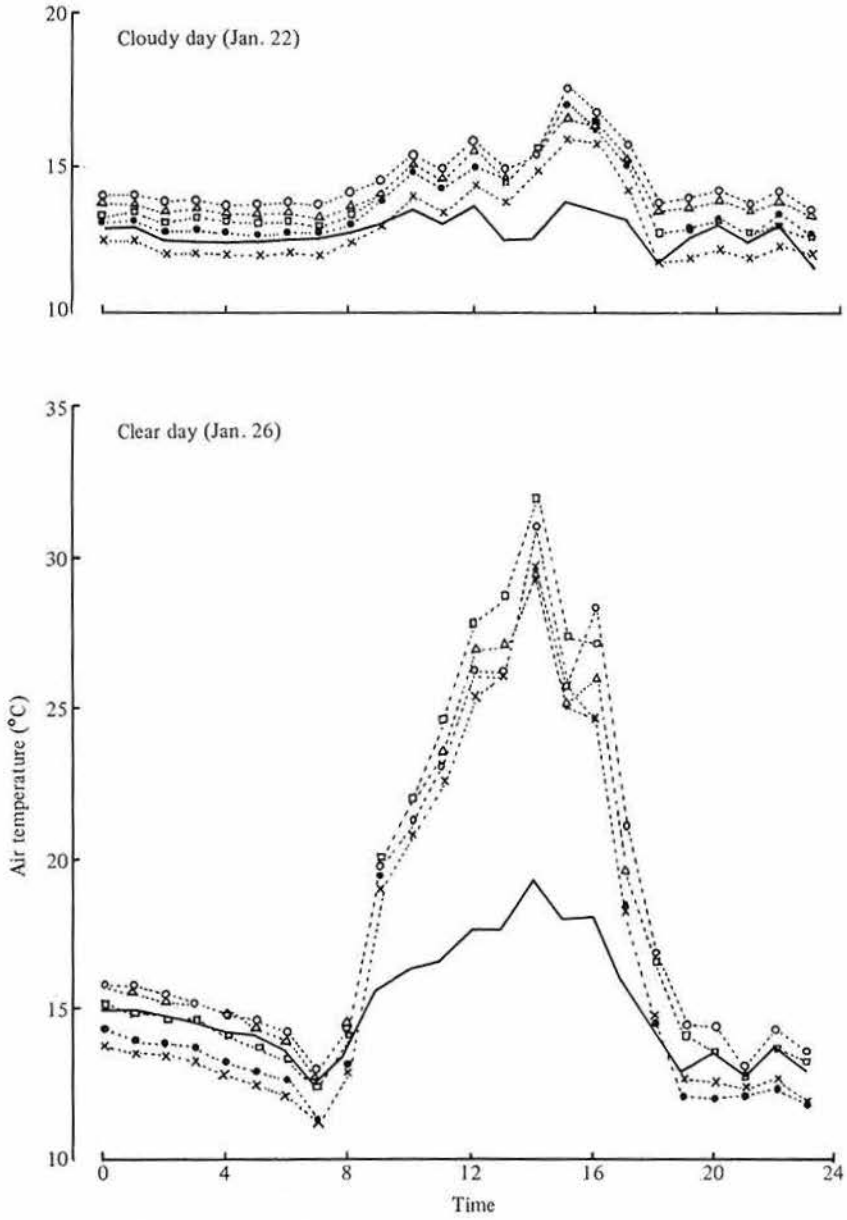

Fig. 6. Diurnal change of air temperature under plastic film covering

Remarks
- ○ : Greenhouse frame covered with PVC-film A (bouteki)
- □ : Large tunnel of PVC-film A (bouteki)
- △ : Large tunnel of PVC-film B (nobi ace)
- × : Large tunnel of ethylenevinyl acetate copolymer film
- ● : Middle sized tunnel of polyethylene film
- — : Outdoor

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