

Experimental Results

I. Water Consumption and Irrigation

1. Water Consumption of Upland Crops

Water consumption of cultivated field consists of transpiration of plant, evaporation from soil surface, percolation and surface run off of water. Among these factors, transpiration is most closely related to plant growth, while percolation and surface run off are affected by field conditions such as soil texture and inclination of field. For irrigation planning, it is important to estimate transpiration of plant and evaporation from soil surface. The experiments were carried out in 1976 and 1977 to measure evapotranspiration of maize, soybean, mungbean and peanut.

1) *Water consumption of maize and soybean (1976)*

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Materials and method

1. Variety: Maize: Suwan No. 1
Soybean: SJ 2
2. Test field: 1/20 m² Wagner's pots were used. In order to eliminate the effect of microclimatic condition possibly caused by pot culture, those pots were buried in the field which ensured the ordinary plant community of the crops, by keeping the soil surface of the pots at the same level as ground surface. Thus, 20 pots were placed in the central part of the field, 15 m wide (20 ridges) and 40 m long for each crop.
3. Water management: While furrow irrigation was applied in the field to maintain the plant community, water was supplied to the pots by means of sub-surface irrigation using automatic irrigators. As shown in Fig.1-1, two suction tubes made of porcelain were placed in the soil of each pot 5 cm above the bottom. Water was kept in the tanks which were installed at a certain depth in the field. Each pot was supplied with water through PVC flexible tube connecting the suction tubes and the tank.
4. Soil moisture treatment: soil moisture tension in the pot varied with the elevation difference (water head) between the water level in the tank and the suction tube in the pot (Fig.1-1). soil moisture content in the pots were controlled to keep low (in L plot) and moderate (in M plot) levels respectively, by changing the depth in which the tank was installed in the field. Thus, the soil moisture tension was maintained at 2.7—2.9 in planted pot of L plot and 1.0—2.6 in that of M plot.
5. Fertilizer application

	Maize	Soybean
N	2.8*g/pot (150 Kg/ha)	0.19 g/pot (10 Kg/ha)
P ₂ O ₅	1.4 g/pot (75 Kg/ha)	0.93 g/pot (50 Kg/ha)
K ₂ O	0.93 g/pot (50 Kg/ha)	0.93 g/pot (50 Kg/ha)

* A half of the amount was applied as basal dressing and the rest was as top dressing.

6. Seeding: January 28, 1976. Three holes were made in one pot and four seeds of maize or five seeds of soybean were sown in one hole.
7. Thinning: carried out three times (Feb. 9, 16 and 23).
8. Spacing:
 - Maize: 75 cm × 25 cm, 1 plant/hill.
 - Soybean: 75 cm × 20 cm, 2 plant/hill.

The pots were buried in the central part of the field in such positions that the plant(s) in each pot constitute one hill of the field. Besides those planted pots, some non-planted pots were buried between plant hills on ridges to estimate the evaporation from surface soil.
9. Harvesting: April 26, 1976.
10. Measurement of water consumption: Weight of the water tank or water level in the tank was checked once a week to measure the amount of water consumed by the evapotranspiration.

Results

1. Plant growth

The growth of both the crops was vigorous in M plot, but was depressed in L plot. The difference of the growth between both the plots was especially big in case of maize as shown in Fig.1-2. It suggested the difference of the response to soil moisture stress between the crops.

2. Water consumption

(1) The rate of evapotranspiration increased as the plant grew, from 1 mm to 2 mm/day at the initial growth stage up to the maximum, about 7.5 mm/day of maize and nearly 7 mm/day of soybean, at the growth stages after silking of maize and after podding of soybean respectively. Both the stages were 9 weeks after seeding (Table 1-1, Fig.1-3). The total evapotranspiration during the growth period was 370 mm in maize and 300 mm in soybean (Table 1-1). Twenty-five % of the total was consumed during 6 weeks of vegetative growth stage and the rest 75% during another 6 weeks of reproductive growth stage in case of M plot of both the crops (Fig.1-4). The ratio of evapotranspiration to pan evaporation is shown in Fig. 1-5. The highest was 1.0 of maize and 0.9 of soybean, both in M plot.

(2) The amount of transpiration was estimated by subtracting 'evaporation from soil surface' from 'evapotranspiration'. The total amount transpired during the growth period was 315 mm in maize and 246 mm in soybean, both in M plot (Table 1-1).

3. Water requirement

Water requirement is defined as the amount of water absorbed by plant to

produce 1g of dry matter. In this experiment, the amount of transpiration calculated as mentioned above was used for the absorbed amount of water to estimate the water requirement. The data are in Table 1-2.

Table 1-1. Amount of water consumed

Period	Et kg/pot		Et mm/day		Es (L)		T mm/day		Ep	No. of plants per pot	
	L	M	L	M	kg/pot mm/day	mm/day	L	M	mm/day		
(Maize)											
Feb. 2-9	}	*1.64	2.19	*1.0	1.2	*0.50	0.5	*0.5	0.7	4.6	12
9-16										3.9	9
16-23										1.30	1.76
23-Mar. 1		1.53	2.06	1.6	2.0	0.20	0.6	1.0	1.4	5.0	1
Mar. 1-8		1.65	3.63	1.9	3.4	*0.30	0.9	1.0	2.5	6.1	:
8-15		2.22	5.48	2.3	4.7			1.5	3.9	6.0	:
15-22		2.00	5.86	2.1	5.0	0.82	0.8	1.3	4.2	6.9	:
22-29		1.78	9.32	1.9	7.7			1.1	6.9	7.6	:
29-Apr. 5		1.41	8.14	1.5	6.6	0.21	0.6	0.9	6.0	7.7	:
Apr. 5-12		1.03	9.18	1.2	7.4	0.20	0.6	0.6	6.8	9.3	:
12-19		0.84	8.73	1.0	7.0	0.15	0.4	0.6	6.6	10.6	:
19-26		0.47	5.59	0.7	4.6	0.18	0.5	0.2	4.1	8.0	1
Total		15.87	61.94	(122.5)	(367.5)	2.56	(52.5)	(70.0)	(315.0)	(555)	
(Soybean)											
Feb. 2-9	}	*1.03	1.15	0.8*	0.9	0.48*	0.5	0.3*	0.4	4.6	20
9-16										3.9	15
16-23										0.72	1.12
23-Mar. 1		1.04	1.23	1.5	1.6	0.25	0.7	0.8	0.9	5.0	2 (1 hill)
Mar. 1-8		1.25	2.40	1.6	2.7	*0.22	0.6	1.0	2.1	6.1	:
8-15		1.82	3.67	2.2	4.0			1.4	3.2	6.0	:
15-22		1.62	4.29	2.1	4.6	0.79	0.8	1.3	3.8	6.9	:
22-29		1.79	6.65	2.2	6.8			1.4	6.0	7.6	:
29-Apr. 5		1.54	6.65	1.8	6.6	0.16	0.5	1.3	6.1	7.7	:
Apr. 5-12		1.17	6.27	1.5	6.3	0.18	0.5	1.0	5.8	9.3	:
12-19		0.53	4.20	0.8	4.3	0.13	0.4	0.4	3.9	10.6	:
19-26		—	1.75	—	2.0	0.13	0.4	—	1.6	8.0	2
Total		12.51	39.38	(114.1)	(294.7)	2.34	(49.0)	(67.9)	(245.7)	(555)	

- Remarks: 1) Et, Es, T and Ep represent evapotranspiration, evaporation from soil, transpiration by plants and evaporation from free water surface in a pan (20 cm in diameter), respectively.
- 2) Et (kg/pot), Es (kg/pot) and Ep were actually measured. Other items were calculated as follows:

$$\text{Et mm/day} = \text{T mm/day} + \text{Es mm/day}$$

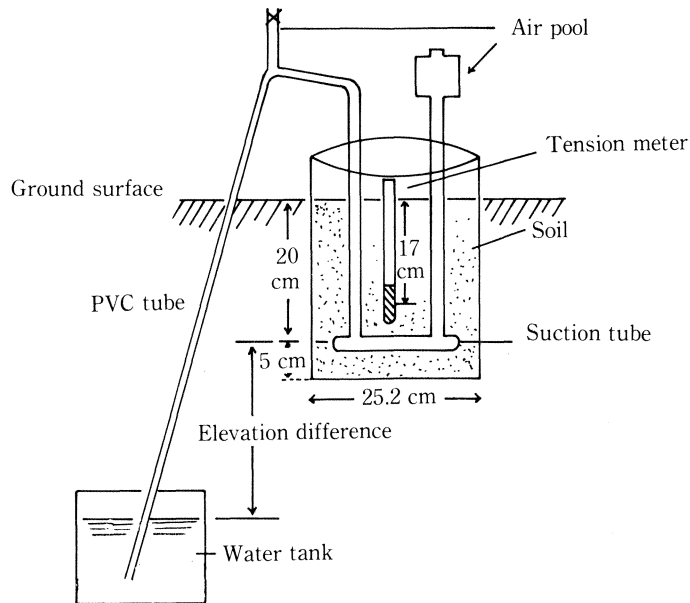
$$\text{T mm/day} = (\text{Et kg/pot} - \text{Es kg/pot}) \times \begin{cases} 5.33 \text{ (maize)} \\ 6.67 \text{ (soybean)} \end{cases} \div 7 \text{ days}$$

$$\text{Es mm/day} = \text{Es kg/pot} \times 20 \div 7 \text{ days}$$
- 3) Non-planted pots of L plot were used to estimate Es of planted pots of both L and M plots, because soil pH in non-planted pots of M plot was too low to estimate Es of planted pots of the plot.
- 4) *: Since the data were disturbed by rainfall, weekly observation was not available.

Table 1-2. Estimation of water requirement

Crop	Soil moisture	Amount of transpiration	Dry matter production (g/pot) ¹⁾			Estimated water requirement		
			whole plant	top part	grain	for whole	for top	for grain
		Kg/pot						
Maize	L	13.31	80.0	73.8	9.1	166	180	1,463
	M	59.38	282.7	258.3	95.4	210	230	622
Soybean	L	10.30	39.5	37.2	18.6	261	277	554
	M	37.04	81.3	78.5	35.6	456	472	1,040

Remarks: 1) Dry matter of thinned plant was included.

**Fig. 1-1. Apparatus for measurement of water consumption**

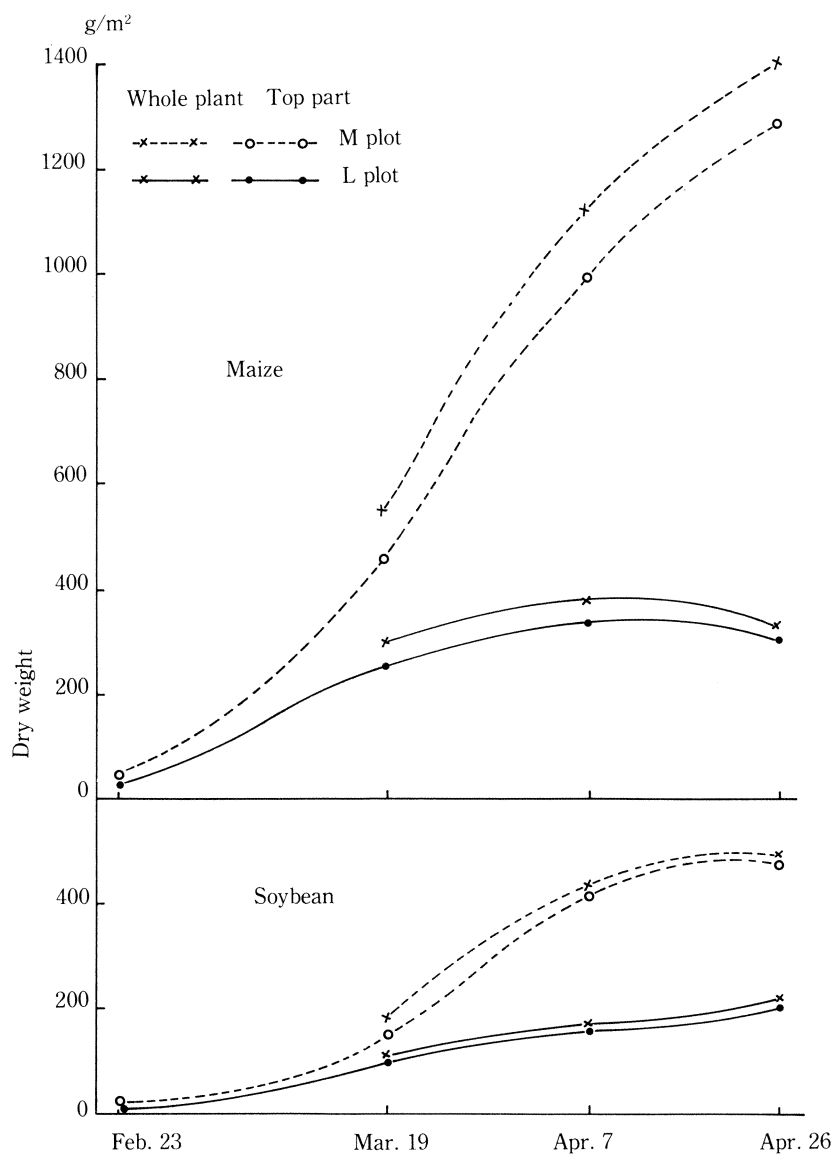


Fig. 1-2. Dry weight of plant

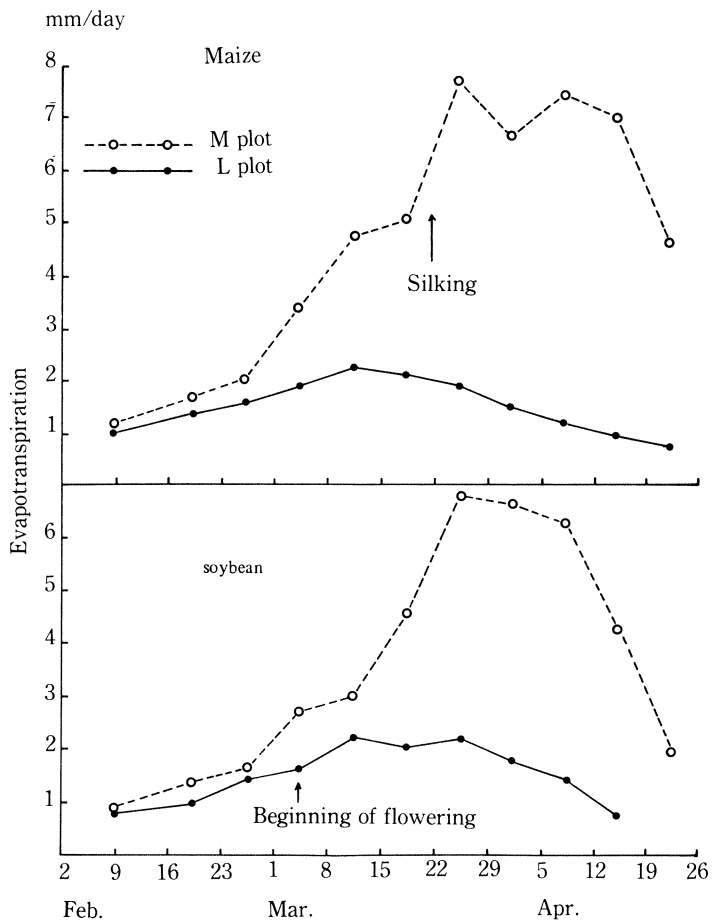


Fig. 1-3. Daily evapotranspiration (7 day average)

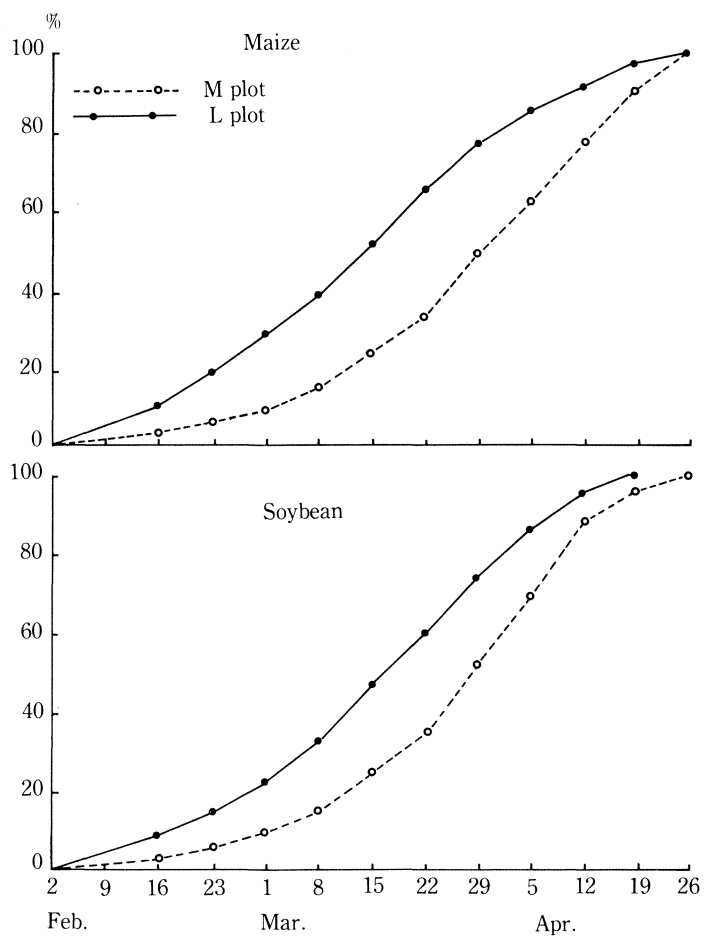


Fig. 1-4. Weekly accumulation of the ratio of consumed water by evapotranspiration

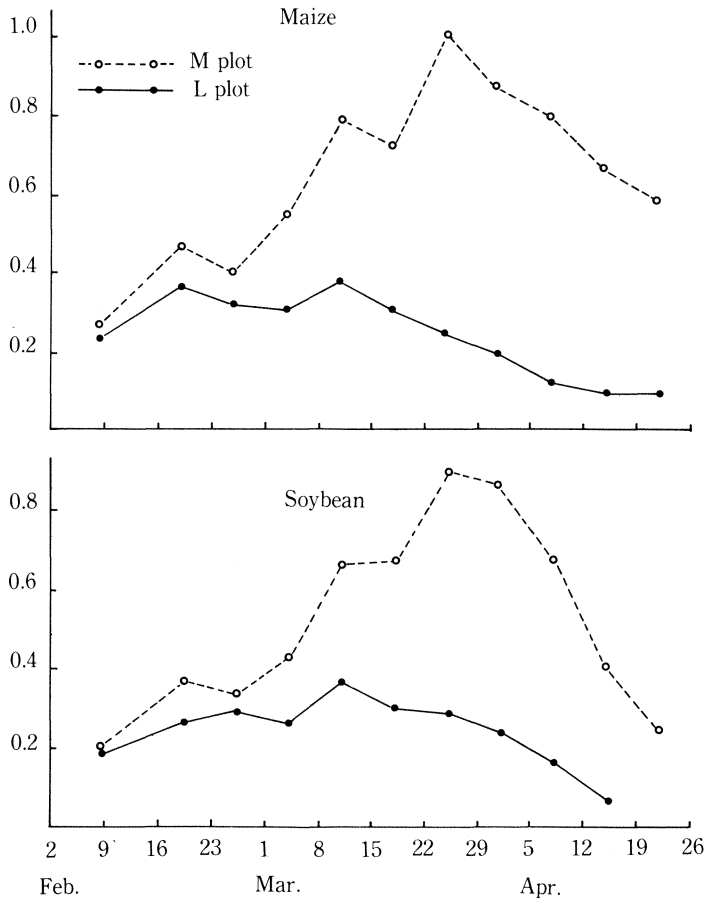


Fig. 1-5. Ratio of evapotranspiration to pan evaporation