IV. Cropping System

1. Growth of Upland Crops in Paddy Field with regard to the Seeding Time and Fertilizer Application (1974—1975)

Hitoshi TAKAHASHI
Vichien SASIPRAPA
Supachai BANGLIANG

Growth performance of several upland crops was examined with reference to seeding time and fertilizer application to obtain fundamental information required for selection of crops for dry season culture and development of cropping systems in paddy field.

Materials and method

1. Test crops and varieties
   - Maize (T_1: Suwan No.1, T_2: PB5, T_3: Thai DMR No.6) ..... S_1
   - Sorghum (Early Hegari) ..... S_2
   - Rice (RD 1) ..... S_3
   - Soybean (SJ 2) ..... S_4
   - Peanut (Tainan No. 6) ..... S_5
   - Mungbean (SPR 1) ..... S_6
   - Cotton (B.T.K. 12 × ST. 213) ..... S_7
   - Sunflower (Saratovskij) ..... S_8
   - Sesbania (Indica sp.) ..... S_9
2. Seeding time
   - Early (19, Dec. 1974) ..... T_1
   - Medium (11, Feb. 1975) ..... T_2
   - Late (17, Mar. 1975) ..... T_3
3. Fertilizer application
   - Low ..... F_1
   - High (only nitrogen application was doubled as compared with F_1) .... F_2

Amount of fertilizer application to F_1 plot (Kg/ha)

	Leguminous crops	Non-leguminous crops
N	20	75
P_2O_5	75	75
K_2O	37.5	37.5

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

4. Spacing

Maize	75 cm	× 25 cm (1 plant/hill)
Sorghum	"	× 20 cm (2 plants/hill)
Rice	"	× drill
Soybean	"	× 20 cm (3 plants/hill)
Peanut	"	× " (2 plants/hill)
Mungbean	"	× " (")
Cotton	"	× 25 cm (1 plant/hill)
Sunflower	"	× 20 cm (")
Sesbania	"	× drill

5. Size of sub-plot
   5.25 m (7 ridges of 75 cm in width) × 8 m = 42 m^2
6. Design
   Split plot design with 3 replications.
7. Irrigation
   Furrow irrigation was made when necessary.

Results

1. The climatic conditions during the growth period of the crops for each seeding time are shown in Fig. 1-1. The growth of all the crops tested was generally inferior under the low temperature condition (T_1 plot) as compared with T_2 and T_3 plot where crops were grown in higher temperature conditions. Between T_2 and T_3 plots, the growth was similar or the latter was superior. In case of maize (S_1), however, such trends were not observed because a different type of variety was used in each seeding time. Fertilizer response was generally remarkable in non-leguminous crops and less in leguminous crops (Table 1-1 and 2).
2. Relative growth rate (RGR) during the period from 6 week to 9 week after seeding showed a tendency of $T_1>T_2>T_3$ in general. However, this tendency seems dependent upon the common fact that RGR is high with light dry weight of plants and low with heavy dry weight of plants. When RGR was compared among crops with reference to the dry weight of plants of each crop, it was high in sesbania (S_9), sunflower (S_8), peanut (S_5) and low in rice (S_3), mungbean (S_6), cotton (S_7) (Fig. 1-2).
3. Net assimilation rate (NAR) was lower as leaf area index (LAI) was higher. When NAR was compared among crops in relation to LAI, it was high in sesbania (S_9), sorghum (S_2), sunflower (S_8) and low in rice (S_3), soybean (S_4), mungbean (S_6), cotton (S_7) (Fig. 1-3).
4. Pattern of dry matter production with reference to seeding time and fertilizer application varied according to crops. Among the crops, sesbania (S_9) was highest and mungbean (S_6) was lowest in dry matter production (Fig. 1-4).
5. The yields and yield components are summarized in Fig. 1-5 and Table 1-3. The yields of the crops were generally low, but soybean and peanut yielded higher than the national average reported in the "Statistics of Agriculture in Thailand"
6. Judging from the yield components in Table 1-3, the growth of plants was generally insufficient to raise high yields.
7. The crops could be classified into three groups as follows according to their performance under different seeding time:
   1) Favorable to later seeding.
      Sorghum and sesbania

2) Most favorable to seeding in February followed by seeding in March.
   Soybean, peanut, mungbean, cotton and sunflower
3) Little difference among each seeding.
   Maize and rice

Discussion

Paddy soils consisting of heavy clay are not suited for growing upland crops because of their poor areation and water holding capacity as well as low fertility.

In this experiment, yields of the test crops were generally low but soybean and peanut seemed promissing for introduction into paddy fields as dry season crops.

Table 1-1. Index number of growth response to seeding time

Crops \ Weeks after seeding / Items		Plant height				LAI		Dry matter		Dry matter
		3	6	9	12	6	9	6	9	increase
S_1	T_1	60	64	84	96	67	121	63	80	92
	T_2	139	131	144	139	121	161	154	183	203
S_2	T_1	64	93	70	63	24	19	25	31	33
	T_2	84	119	100	97	112	83	89	118	129
S_3	T_1	80	109	84	80	36	50	58	68	74
	T_2	98	114	96	101	75	78	76	87	94
S_4	T_1	67	63	67	71	24	36	21	32	35
	T_2	107	99	100	96	85	62	77	79	80
S_5	T_1	62	56	46	63	4	16	3	13	20
	T_2	99	104	94	86	96	89	78	105	121
S_6	T_1	61	41	45	48	11	14	8	11	13
	T_2	108	78	82	83	75	63	55	63	67
S_7	T_1	60	83	62	66	21	22	18	20	20
	T_2	84	98	94	93	125	103	81	97	104
S_8	T_1	37	44	44	70	13	33	8	24	30
	T_2	108	123	106	109	119	78	106	99	96
S_9	T_1	—	9	14	37	—	9	—	4	—
	T_2	66	68	79	80	45	99	53	81	94

Remarks: The growth of plants in T_1 and T_2 plots was compared with that in T_3 plot (in average of fertilizer treatment).

Table 1-2. Index number of fertilizer response in plant growth

Items / Weeks after seeding / Crops	Plant height				LAI		Dry matter		Dry matter
	3	6	9	12	6	9	6	9	increase
S_1	107	120	114	115	141	143	141	136	135
S_2	103	119	109	104	157	148	158	156	156
S_3	103	111	115	115	140	151	134	138	140
S_4	103	105	106	104	112	105	118	106	104
S_5	100	103	102	101	142	103	137	103	95
S_6	104	105	101	102	111	110	120	112	108
S_7	94	105	113	115	140	141	119	135	144
S_8	101	105	107	103	144	162	118	128	129
S_9	117	115	114	112	105	118	126	131	102

Remarks: The growth of plants in F_2 plot was compared with that in F_1 plot (in average of 3 seeding times).

Table 1-3. Yield and yield components

S_1 (maize) 13% moisture content

Treatment		Grain weight	No. of plants	No. of ears	No. of grains	Weight of 100 grains	Actual * grain yield
		t/ha	/m²	/m²	/ear	g	t/ha
T_1	F_1	1.29	4.5	2.4	287	20.8	1.05
	F_2	2.59	4.5	3.8	336	22.6	1.95
T_2	F_1	0.95	5.6	4.0	108	22.3	
	F_2	1.92	5.4	4.1	216	22.1	
T_3	F_1	0.67	5.4	3.6	116	16.3	
	F_2	1.63	5.6	4.3	216	17.6	

* reduced by rat damage

S_2 (sorghum) 13% m.c.

Treatment		Grain weight	No. of stems	No. of heads	No. of grains	Weight of 1,000 grains	Actual * grain yield
		t/ha	/m²	/m²	/head	g	t/ha
T_1	F_1	1.22	27.2	15.9	404	18.0	0.17
	F_2	1.56	29.7	18.4	508	16.9	0.25
T_2	F_1	1.13	12.4	9.6	809	14.3	0.54
	F_2	2.01	13.8	12.7	1,174	13.4	1.43
T_3	F_1	1.85	11.5	10.8	861	22.2	
	F_2	2.89	10.7	11.9	1,091	22.3	

* reduced by rat and bird damages

S_3 (rice) 14% m.c.

Treatment		Weight of full grain	No. of panicles	No. of spikelets	Ripenning percent	Weight of 1,000 full grains
		t/ha	m^2	/panicle	%	g
T_1	F_1	— *	—	—	—	—
	F_2	— *	—	—	—	—
T_2	F_1	1.84	161.7	76.8	59.7	24.9
	F_2	2.21	158.5	88.1	62.1	25.4
T_3	F_1	1.37	131.4	69.3	60.9	24.7
	F_2	1.55	137.0	75.6	60.4	24.7

* damaged by insects (mainly stem borer)

S_4 (soybean) 13% m.c.

Treatment		Grain weight	No. of plants	No. of pods	No. of grains	Weight of 100 grains	Actual * grain yield
		t/ha	/m^2	/plant	/m^2	g	t/ha
T_1	F_1	1.42	19.2	39.9	876	16.25	1.30
	F_2	1.42	16.5	40.0	922	15.45	1.33
T_2	F_1	3.56	17.3	65.3	2,295	15.52	1.72
	F_2	3.69	17.9	64.3	2,340	15.79	1.87
T_3	F_1	2.67	12.7	85.0	2,069	12.88	1.23
	F_2	2.61	14.3	76.9	2,166	12.10	0.96

* reduced by rat and bird damages

S_5 (peanut) 9% m.c.

Treatment		Grain weight	No. of hills	No. of pods	Percentage of effective pod	No. of grains	Weight of 100 grains
		t/ha	/m^2	/hill	%	/hill	g
T_1	F_1	1.34	5.28	35.3	92.8	53.9	46.3
	F_2	1.39	5.63	37.4	95.3	56.8	43.2
T_2	F_1	2.40	6.42	44.7	92.3	72.4	50.8
	F_2	2.18	6.47	39.2	93.2	65.0	52.2
T_3	F_1	1.48	6.32	33.5	94.8	51.3	45.7
	F_2	1.50	5.93	35.5	96.0	55.6	46.1

S_6 (mungbean) 13% m.c.

Treatment		Grain weight	No. of plants	No. of pods	No. of grains	Weight of 100 full grains
		t/ha	/m^2	/plant	/pod	g
T_1	F_1	— *	—	—	—	—
	F_2	— *	—	—	—	—
T_2	F_1	0.92	12.0	10.0	9.8	8.03
	F_2	0.90	13.1	8.7	10.4	7.96
T_3	F_1	0.87	12.5	11.0	8.7	7.17
	F_2	0.63	11.8	9.1	7.9	7.38

* damaged by rat

S_7 (cotton) 13% m.c.

Treatment		Weight of seed cotton	Weight of lint	Lint percent	No. of plants	No. of balls/plant	
						open	un-open
		kg/ha	kg/ha	%	/m²		
T_1	F_1	244	91	39.1	5.5	1.7	0.5
	F_2	487	104	38.9	6.5	3.4	0.8
T_2	F_1	96	38	39.2	5.3	1.1	3.2
	F_2	358	144	39.3	5.0	2.3	4.6
T_3	F_1	217	89	41.3	5.6	1.6	3.4
	F_2	411	171	41.4	5.8	1.8	4.9

S_8 (sunflower) 9% m.c.

Treatment		Weight of fully ripened seed	No. of plants	No. of flowers	No. of seeds	Ripenning percent	Weight of 100 seeds	Actual* seed yield
		t/ha	/m²	/m²	/flower	%	g	t/ha
T_1	F_1	0.62	5.8	5.6	314	77.6	4.27	0.54
	F_2	0.73	5.7	6.3	393	66.9	4.63	0.67
T_2	F_1	1.48	6.9	7.2	516	81.2	4.88	
	F_2	1.97	6.7	6.8	691	70.7	5.90	
T_3	F_1	1.27	6.6	6.2	562	61.8	5.81	
	F_2	1.30	6.4	6.0	575	57.3	6.54	

* reduced by rat damage

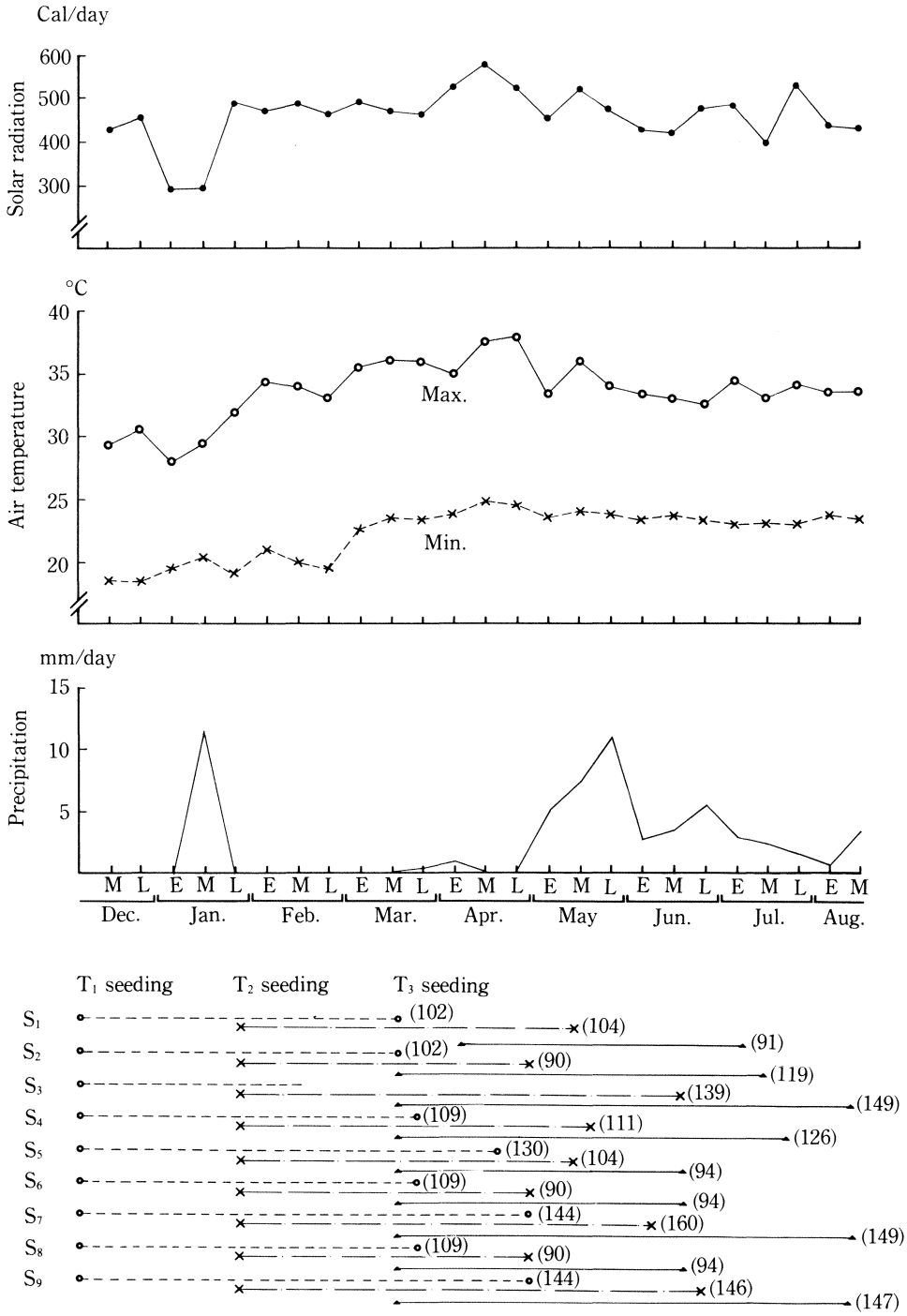

Figure in parenthesis shows number of days of growth.

Fig. 1-1. Weather condition and growth duration of each crop

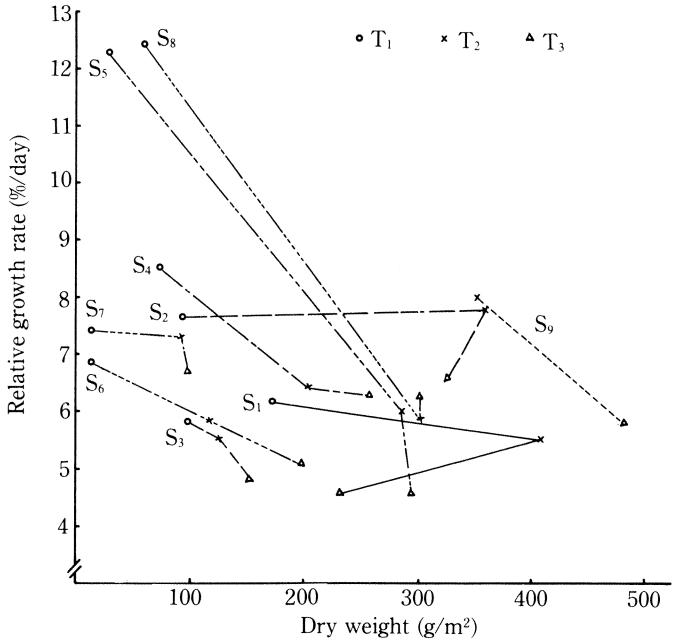

Fig. 1-2. Relation between relative growth rate and dry weight (average of 2 levels of fertilizer application)

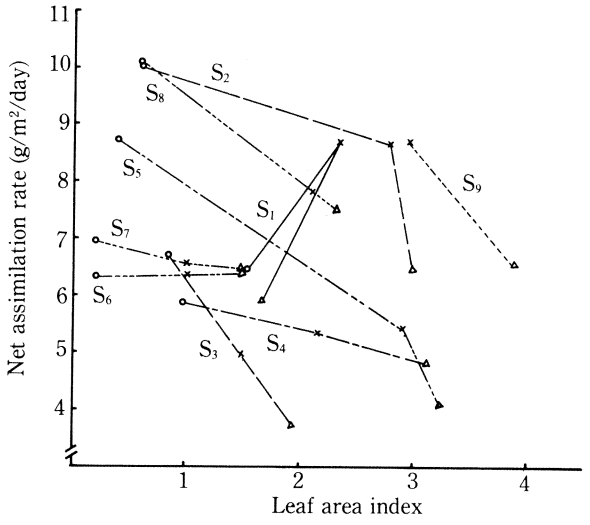

Fig. 1-3. Relation between net assimilation rate and leaf area index (average of 2 levels of fertilizer application)

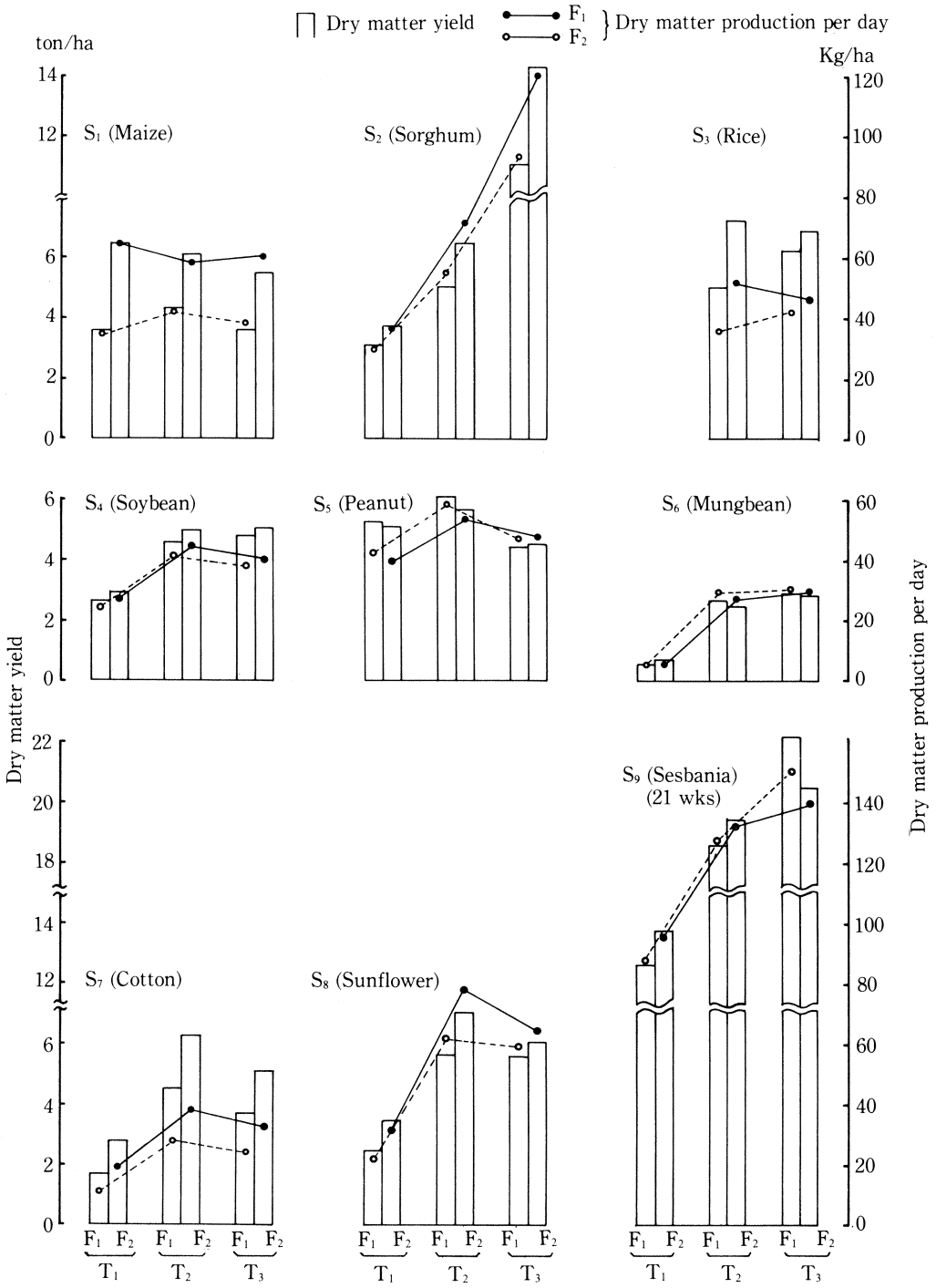

Fig. 1-4. Daily production and yield of dry matter

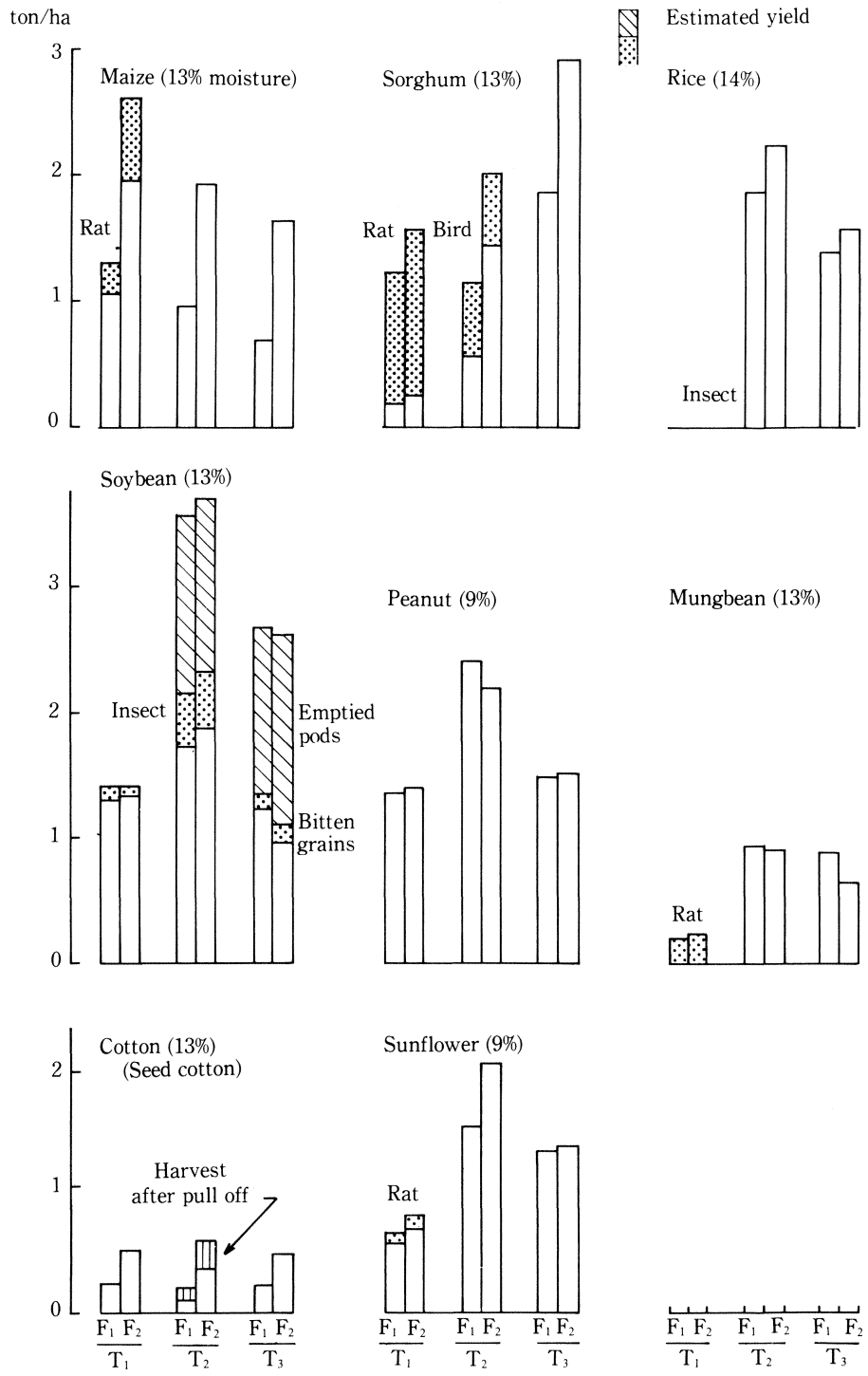

Fig. 1-5. Yield of each crop

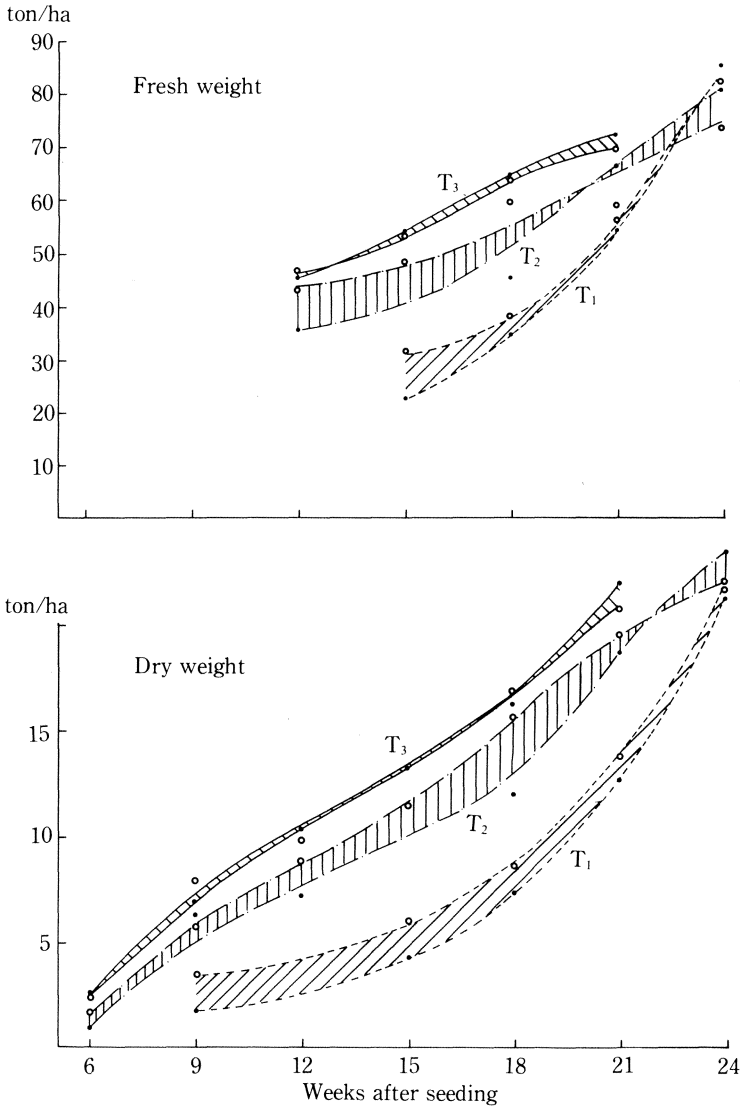

Fig. 1-6. Periodical changes in fresh and dry weight of Sesbania