Kasetsart J. (Nat. Sci.) Vol. 24 : 224 - 229 (1990)

The Study on Climatic Adaptation of Soybeans at Kamphaeng Saen, a Representative of Central Plain of Thailand

Aphiphan Pookpakdi and Harisadee Patharadilok [1]

ABSTRACT

Twenty soybean genotypes of diverse origin and maturity were grown at Kamphaeng Saen Campus of Kasetsart University in the Central Plain region of Thailand. The purpose of this study was to obtain basic informations on the relative effect of sowing dates and cultivars on the performance of this crop. Soybeans were sown at monthly interval between June 1986 until May 1987. Measurements included phenology, total plant weight and yield. It was found that days to flower of soybeans were affected by daylength and temperature. Cultivars least affected by photoperiod were most affected by temperature particularly during the cooler months. Days to maturity was dependent upon days to flowering. Total plant weight and grain yield were strongly affected by phenology. Cultivars which flowered and matured properly would produced considerable amount of plant dry matter and grain yield.

INTRODUCTION

Soybeans *(Glycine max* (L.) Merrill) is one of the key economic crops in Thailand. Because of its extensive use in various cropping systems, the seasons and locations when and where the crops are grown represent a wide range of environments. Consequently, environmental effects on phenology, growth and yield are large, different genotypes react differently to various environments (Lawn and Byth, 1974). The aim of plant improvement is to develop cultivars which are better adapted, given the prevailing conditions at a location ; also to diverse agronomic strategies which minimise the particular constraints imposed by the environment at a given location (Lawn, 1989).

The objective of the experiment was to generate informations on growth and development of soybeans when grown at Kamphaeng Saen Campus of Kasetsart University in twelve sowing dates. Kamphaeng Saen represent the lowland central plain region of Thailand which is the area where the production of soybean after rice will be extended.

MATERIALS AND METHODS

The experiment was conducted at Kamphaeng Saen Campus of Kasetsart University in the Central Plains region of Thailand. 12 sowings at regular monthly intervals was made, one at the same time each month, commencing June 11, 1986 and ending May 11, 1987. Twenty genotypes of soybean were chosen for the study (Table 1). Split plots design was used in this study, main plots consisted of 12 sowing dates and sub plots were twenty soybean genotypes. Two replicated plots were sown at each sowing dates. Seed were planted into a finely cultivated and ridged seed bed. Individual genotypes were sown into 2 m.

[1] Dept. of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.

Table 1 Soybean genotypes grown in year-round sowing at Kamphaeng Saen Campus in Thailand.

No.	Genotypes	No.	Genotypes
1	Nakornsawan 1*	11	CNS 68
2	S.J. 2*	12	Davis
3	S.J. 4*	13	DB 1593
4	Khunpae 1*	14	Durack
5	Chiangmai 60*	15	Farrer
6	Line 7608*	16	G 2120
7	Fiskeby V	17	Jupiter
8	BM	18	P 44
9	Buchanon	19	R 114
10	Canapolis	20	Valder

* No. 1-6 are Thai cultivars and elite line

long rows spaced at 1 m. and using a hill spacing of 10 cm. within rows. The number of seedlings was thinned to one per hill after emergence. Fertilizer as an N:P:K: mixed was applied at the rate of 18:54:36 kg. ha^{-1} before each sowing.

Daylengths for Kamphaeng Saen Campus was calculated by computer (Goodspeed, 1975). Daily maximum, minimum temperatures and rainfall were obtained from station meteorological facilities. They were presented in Figure 1. Date of sowing, flowering (50% of plants with flowers (f)) and maturity (m) were record. At harvesting, plants were cut from the center 1 m. (10 plants) of each 2 m. row; pod threshed and all materials dried, counted and weighed, total plant weight (Tw) and seed yield (y) were recorded.

RESULTS AND DISCUSSION

I. Phenology :

a. Days to flowering (f)

Days to flowering of 20 soybean genotypes were shown in Table 2. Variation in days to flowering at different sowing dates was due to environmental factors such as daylength and temperature. Most soybean genotypes are quantitative short-day plants and various phenological sequences such as time to flowering and maturity are greatly affected by daylength (Hartwig, 1970). However, photoperiodic responses are further modulated by temperature (Summerfield *et al,* 1983). Among 20 soybean genotypes used, three cultivars, Fiskeby V, S.J.4, and Durack can be classified as early, medium and late genotypes respectively according to f. In Durack, f decreased as photoperiod decreased from June to December and increased afterward when photoperiod gradually increased from January to June. Meanwhile, reduction in f were not consistent as sowing dates progress in S.J.2 as well as the average of 20 soybean genotypes and 6 Thai genotypes indicated that temperature modulated the plant response. In Fiskeby V which is completely insensitive to photoperiod (Summerfield, *et al* 1983), f was influenced by air temperature and plants flowered sooner in the warmer months and later in the cooler months similar to those reported by Summerfield, *et al* (1983).

Table 2 Phenology, plant dry weight and seed yield of 20 soybean genotypes grown at 12 sowing dates at Kamphaeng Saen Campus between June 1988 - May 1989.

Sowing dates and years	Days to flower (days)	Days to maturity (days)	Total plant weight (g. plant^{-1})	Seed yield (g. plant^{-1})	Harvest index (%)
June	36.2	96.7	36.6	10.6	0.3
July	37.1	97.1	24.8	8.7	0.3
August	35.0	93.3	15.5	4.9	0.2
September	39.0	96.2	9.9	5.1	0.5
October	31.6	82.3	12.2	5.9	0.5
November	40.6	93.0	17.9	8.7	0.5
December	34.3	86.8	14.2	6.8	0.5
January	37.2	95.1	25.3	12.8	0.5
February	33.7	101.7	30.4	11.6	0.4
March	37.9	114.1	37.0	9.8	0.3
April	37.2	109.3	62.7	22.8	0.4
May	44.4	112.9	54.1	20.4	0.4
Mean	37.3	98.2	28.4	10.7	0.4
$LSD_{0.05}$	3.51	12.16	19.38	10.23	0.1

When compared between the average f of 20 genotyped with the means of f in six adapted Thai cultivars. For the total 20 genotyped used, of the total variance in f, 63.7% was due to cultivar, 12.4% was due to sowing date with the remainder of 25.5% due to genotype × environment interaction (Table 4 a.). However, for the adapted Thai genotypes, variance due to cultivar was reduced to 40% and variance due to sowing date increased to 37%. This result revealed that variation in f among the adapted varieties in a given environment will be much less, therefore, plant performance and yield potential will be much dependable to the sowing dates and planting seasons.

b. Days to maturity (m)

Days to maturity of 20 genotypes responsed to environmental variation similar to f. (Table 2). We also obtained significant linear regression relationship with r value = 0.5003 indicating that m and f varied accordingly. Variation of 20 soybean genotypes in m was mainly due to cultivar than the sowing date effects. However, among 6 Thai genotypes, variance due to cultivar was reduced to 37% and the increase of variance due to sowing date of 45% was obtained.

II. Growth and yield as related to phenology :

The result of this study revealed that total plant weight (Tw) seed yield (y) and harvest index (HI.) of 20 soybean genotypes varied accordingly with f and m (Table 2). Plant performance was relatively poor between September to December when daylength were shorter and

Table 3 The average number of days to flower of 6 adapted Thai genotypes, days to flower of cultivar Fiskeby V (early), S.J.4 (medium) and Durack (late) when planted at monthly interval between June 1986 - May 1987.

Cultivars / Sowing dates and years	Days to flower (days)			
	Means of 6 Thai genotypes	Fiskeby V	S.J.4	Durack
June	35.3	22.0	37.0	61.0
July	37.0	25.0	40.0	56.0
August	34.7	26.0	37.0	49.0
September	40.0	27.0	42.0	52.0
October	31.7	23.0	33.0	38.0
November	36.6	36.0	38.0	47.0
December	33.8	36.0	36.0	37.0
January	36.3	29.0	38.0	43.0
February	31.6	31.0	34.0	51.0
March	35.6	26.0	37.0	67.0
April	34.6	21.0	36.0	70.0
May	39.8	31.0	42.0	102.0
Means	38.5	27.7	37.5	56.1
$LSD_{0.05}$	3.0	3.13	3.13	3.13

Table 4 Percentage of sum of the square partition of soybean genotypes planted at monthly interval at Kamphaeng Saen Campus between June 1986 - May 1987.

a. Total soybean genotypes

Phenology	% Sum of square		
	Sowing dates	Cultivars	Sowing dates × cultivars
Days to flowering	12.36	67.76	25.54
Days to maturity	26.36	48.36	24.07

b. Six adapted Thai soybean genotypes

Days to flowering	37.62	40.56	17.27
Days to maturity	45.38	37.10	12.76

temperature was reduced (Figure 1 and Table 2). HI. increased between September 1988 - January 1989, during this particular period plant sizes were greatly reduced due to shorter daylength and lower temperature.

The relationship between phenology, growth and yield was shown in Table 5. Since f and m were strongly affected by daylength and temperature, then m was positively related to Tw. but negatively with HI. Meanwhile, Y was positively related to Tw. In this case, it can be elaborated that if soybean cultivar response to favorable environments and days to flower occur properly. Proper vegetative and reproductive growth which is well balanced by flowering will enhanced the plant to accumulate better dry matter and subsequently produced high yield.

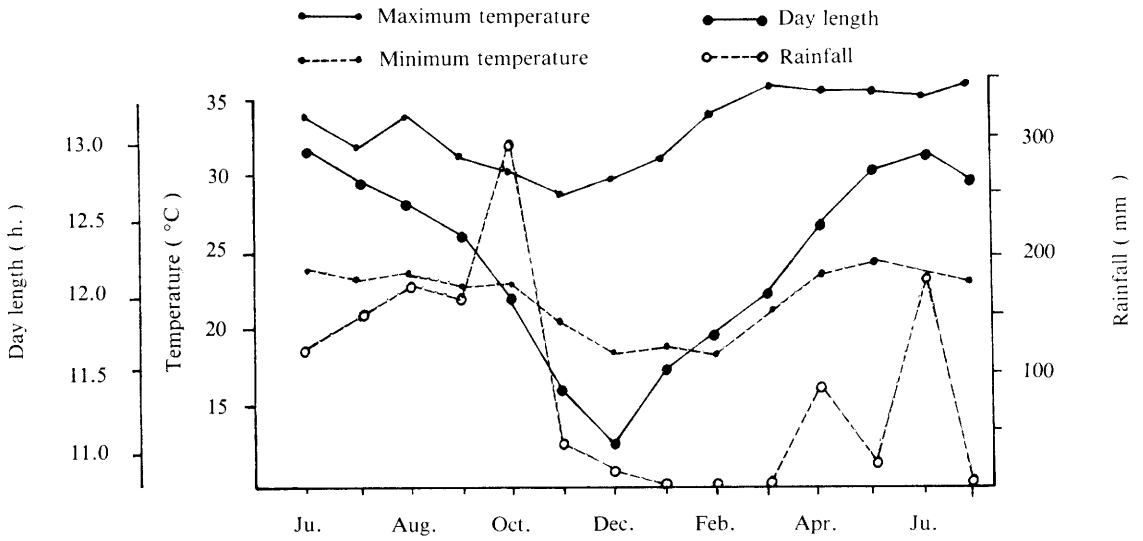

Figure 1. Daylength, rainfall, maximum and minimum temperature at Kamphaeng Saen Campus, June 1986 - July 1987.

Table 5 Linear regression equations and correlation coefficients of different characteristics of 20 soybean genotypes grown at Kamphaeng Saen Campus at monthly interval between June 1986 - May 1987.

Characteristics	Equations	Correlation coefficient (r)
f vs. m.	$Y = 51.0881 + 1.2191\ f^{**}$	0.5003
Tw vs. m.	$Y = -21.0911 + 0.5171\ m^{**}$	0.4895
HI vs. m.	$Y = 0.7906 + 0.00382\ m^{**}$	−0.7719
y vs. Tw	$Y = 3.39614 + 0.2472\ Tw^{**}$	0.7258

** = significant at 0.01 level of probability

LITERATURE CITED

Goodspeed, M.J. 1975. Computer routines for solar position, daylength and related quantities. CSIRO Div. Land Use Res. Tech. Mem. 75/11.

Hartwig. E.E. 1970. Growth and reproductive characteristics of soybeans (*Glycine max* (L.) Merrill) grown under short day conditions. Trop Sci. 12 : 47-53.

Lawn, R.J., 1989. Agronomic and physiological constraints to the productivity of Tropical grain legumes and prospects for improvement. Expl. Agric. 25 : 509 - 528.

Lawn, R.J. and D.E. Byth, 1974. Response of soybeans to planting date in south - eastern Queensland II. Vegetative and reproductive development. Aust. J. Agric. Res. 25 : 723-727.

Summerfield, R.J.,S. Shanmugassundaram, E.H. Roberts. and P. Hardley. 1983. Soybean adaptation to photo-thermal environments and implications for screening germplasm. *In* Soybean in tropical and subtropical cropping systems : Proceedings of a Symposium, Tsukuba, Japan, 26 Sept. - 1 Oct., 1983.