

INFLUENCE OF PLANTING DATE AND PLANT SPACING ON YIELD AND OTHER CHARACTERS OF SOYBEAN

Paisan Laosuwan*

ABSTRACT :- Soybean [*Glycine max* (L) Merrill] was planted in two to six plant spacings at six planting dates at Hat Yai, Songkhla, to formulate production technology of this crop at the location. Soybean grown at high plant density (670,000 plants/ha) by using a close spacing of 30 x 5 cm between and within rows gave the highest yield at most dates observed. The rainfall distribution was not wide enough to cover all six planting dates spaced at intervals of one month or more. Two planting dates were identified as suitable for soybean production at the location, one during mid and late June and the other in early October. The former, however, required an artificial drying of the seed.

No serious diseases or insect pests were observed across the planting dates with the exception of bacterial blight and bacterial pustule which were found at all dates.

INTROCUCTION

Soybean [*Glycine max* (L) Merrill] is among the most important field crops agrown in Thailand. It has been grown in Northern, Northeastern and Central Thailand. The current increase in demand for this crop in the country has stimulated soybean

*Associate Professor, Department of Plant Science,
Prince of Songkla University, Songkhla.

workers to explore and formulate the production technology necessary to increase the yield of soybean. In recent years, many new varieties of soybean were released by the Department of Agriculture. Besides this effort, the expansion of the area of production into new environments has been another attempt to increase the production of this crop.

In 1978, the area planted to soybean in the country was approximately 160,000 hectares and the total production was 150,000 tons. The South, however, shared a very insignificant part of this acreage (1). The production of soybean in this region cannot be underestimated since it may fit into certain agricultural systems of the region, such as as a multiple crop in the rice-based agriculture of the eastern plain of the region, or as an intercrop in the rubber replanting program.

Basic information relating to soybean production in the South has not been thoroughly investigated. The first intensive investigation was made by Wongsukon et al. (5). They observed the performance of eight varieties of soybean at four different Rubber Stations in the South. The mean for all stations (excluding Hat Yai) was 1,288 kg/ha, ranging from 1,188 to 1,450 kg/ha, and a local variety SJ-2 was the highest yielder averaged across stations. In 1978, Niamsrichand et al. (4) conducted an experiment to determine planting date and to survey problems relating to soybean production at Songkhla. They found that, among the three planting dates they tried, the October planting date gave the highest seed yield.

Plant population or plant density was reported to affect yield of soybeans (3). Laosuwan et al. (2) reported from their experiments made for three years at Khon Kaen that plant density of 400,000 plants per hectare, obtained by varying either between-row or within-row spacing, outyielded the standard plant density

(200,000 plants per hectare obtained from 50 x 10 cm spacing) by 15 to 40 %. They recommended the use of narrow between-row spacing of 30 cm for soybean production at Khon Kaen.

Objectives of this research were to determine the date of planting of soybean at Songkhla and to survey problems that may be encountered during the production of this crop.

MATERIALS AND METHODS

This experiment was conducted in June, 1980 through January, 1981, at Prince of Songkla University, Songkhla. The experimental field is located at 6°59'N latitude and 100° 29'E longitude. The elevation at the experimental site is about 25 m above the sea level. The soil is loamy sand in texture with the average pH of 4.7, and soil organic matter of 1.43 %. The available P and K are 4 and 44 ppm, respectively. The 14-year average rainfall recorded at the Kohong Agrometeorology Station, 500 m from the experimental site, during 1967-1980 was 2084.9 mm. The total rainfall in 1980 was 2085.3 mm.

Generally, the rainy season in the South starts as early as April and lasts until December. Quite often the first rain came in March and the last rain occurred in January of the subsequent year. In this experiment, six planting dates were spaced from mid June through mid December. Irregular rain observed during March through June was the only result to leave out the portion of the season. The planting dates for this study are presented in Table 1.

Soybean variety SJ-4 released by the Department of Agriculture in 1975 was used in this experiment. Prior to planting, the plots were limed with 625 kg/ha CaO. The seed was planted in two to six plant spacings on each date by using a randomized complete-block design with six replications across planting dates

(Table 1). Most plots for all dates consisted of four 5-m rows. An additional row was added to the 50 x 5 cm spacing of all dates from which ten plants were sampled for recording certain characters. Without exception, yield determination and other data were collected from two middle rows.

All plots were over-planted and thinned in eight to ten days leaving only one plant per hill. After thinning, fertilizers 93.8 kg N/ha, 40.2 kg P/ha and 75 kg K/ha were applied.

Data was recorded for seed yield, days to first flowering, height at flowering, days to maturity, height at maturity, lodging score, shattering score, 100-seed weight, seeds per plant and other characters. The following measuring or rating techniques were used for certain characters :

1. *Lodging* : Lodging was visually rated from 1 to 5 (1 = most plants erect, 5 = 80 % or more of plants lodged).
2. *Shattering* : Shattering was rated from 1 to 5 (1 = all seeds remained in the pods, 5 = 50 % or more of pods shattered).
3. *Seed yield* : Seed yield was measured after the seed was dried and then adjusted to a uniform moisture content of 12 %. Seed dryer was used to supplement sun-drying in the wet period.

Ten plants were sampled randomly from one middle row of the 50 x 5 cm spacing of each date. They were tagged and used for measuring certain characters such as leaves per plant, nodes per plant, pods and types of pod per plant, etc.

RESULTS

Among the six planting dates tried in this experiment, only D_1 , D_4 and D_5 had all the plant spacings (Table 1). The last planting date, D_6 , was not so favorable due to the high rainfall

at the planting time and the lack of adequate moisture at flowering and seed filling stages, thus resulting in very poor seed yield. The data for this date was excluded from the experiment.

Table 1. Treatments (plant spacings), planting dates and designations for soybean experiment at Prince of Songkla University, 1980.

Plant spacing (cm)	Plant density (plants/ha)	Planting date ^{1a}					
30 x 5	670,000	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆
30 x 10	340,000	D ₁			D ₄	D ₅	
30 x 15	220,000	D ₁			D ₄	D ₅	
50 x 5	404,000	D ₁	D ₂	D ₃	D ₄	D ₅	D ₆
50 x 10	204,000	D ₁			D ₄	D ₅	
50 x 15	134,000	D ₁			D ₄	D ₅	

^{1a} D₁ = June 17, D₂ = July 22, D₃ = August 28, D₄ = October 1, D₅ = November 1, D₆ = December 11.

The total rainfall of 1980 was equivalent to that of the 14-year average. However, the 1980 rainfall distribution was quite uneven and created three heavy peaks throughout the season (Figure 1). The approximated amounts of rainfall for all planting dates, except D₆, and their distribution based on 10 day total are presented in Figure 2. These amounts were in general higher than those required for normal growth and development of soybean. The distribution patterns of rainfall for D₁ through D₃ demonstrated the increased rain towards the end of the growing period. This certainly affected the normal maturity, harvesting, and drying of the seed.

Analysis of variance of the data for seed yield of D₁,



D_4 and D_5 showed that the variances due to plant spacing and due to planting date were both highly significant. This indicates the sizable effects of plant spacing and planting date on yield of soybean. Mean seed yield for these dates is shown for all plant spacings in Table 2. There was some linear increase in yield as the plant population increased. The highest yield for each date was obtained from the respective highest plant density. The orthogonal breakdown of the mean squares for plant spacing did not

Table 2. Means for seed yield of soybean variety SJ-4 grown in different plant spacings.

Plant spacing	Plant density	Yield			Mean ^{1a}
		Jun.17(D_1)	Oct.1(D_4)	Nov.1(D_5)	
(cm)	(plants/ha)	(kg/ha)	(kg/ha)	(kg/ha)	(kg/ha)
30 x 5	670,000	2,647	2,707	1,400	2,251
30 x 10	340,000	1,941	2,467	1,090	1,833
30 x 15	220,000	1,533	1,667	1,010	1,403
50 x 5	404,000	1,886	2,300	1,220	1,802
50 x 10	204,000	2,421	2,020	1,040	1,827
50 x 15	134,000	1,615	1,600	520	1,245
Mean ^{1b}		2,007	2,126	1,047	

CV(%) = 12.85 ; ^{1a}LSD(.05) = 365 kg/ha, LSD (.01) = 526 kg/ha ;
^{1b}LSD (.05) = 283 kg/ha, LSD (.01) = 407 kg/ha.

show significant difference between 30 and 50 cm between row spacings. This gave an indication that high plant density would increase yield regardless of how the plants within each row were spaced.

Only two sets of plant spacings, namely 30 x 5 and 50 x 5 cm, were tested at all planting dates, the means for seed yield and other agronomic characters of which are presented in Table 3. The average yields for D₁ and D₄ were high and were 2,257 and 2,533 kg/ha, respectively. Days to flowering of soybean was not

Table 3. Means for seed yield and other characters of soybean variety SJ-4 grown in two selected plant spacings.^[a]

Planting date	Plant spacing	Yield	DF	HF	DM	HM	LDG	SH	HSW
	(cm)	(kg/ha)	(no)	(cm)	(no)	(cm)	(score)	(score)	(g)
D ₁	30 x 5	2647	34	33	106	58	2	1	1
	50 x 5	1886	34	31	106	48	1	1	1
D ₂	30 x 5	1167	33	33	116	59	3	1	1
	50 x 5	1140	33	30	116	57	2	1	1
D ₃	30 x 5	1330	30	32	109	54	4	1	1
	50 x 5	1460	31	28	109	45	3	1	1
D ₄	30 x 5	2300	32	32	110	78	2	1	1
	50 x 5	2300	32	28	110	78	2	1	1
D ₅	30 x 5	1400	35	29	103	45	1	1	1
	50 x 5	1220	35	28	103	43	1	1	1

^[a] Designation : DF = days to flowering, HF = height at flowering, DM = days to maturity, HM = height at maturity, LDG = lodging score, SH = shattering score, HSW = 100-seed weight.

affected by plant spacing, but by planting date. This demonstrates some response to either day length or daily bright sunshine during these planting dates. Days to maturity of certain dates was unreliable due to excessive rainfall which occurred as the crop approached maturity.

Height of soybean at flowering and also at maturity was obviously affected by plant spacing. Plants grown at high plant density were always taller than those at low plant density. This response to plant population seemed to associate with high lodging score. Lodging scores were high at D_2 through D_4 , but most plants were quite erect at D_1 and D_5 .

Insect pests and diseases were not found to cause much damage to the crop at all planting dates. Leaf roller (*Lamprosema* spp.) and leaf minor (*Stomopteryx subsecivella* Zeller) were found to attack soybean at most dates but were controlled by applying insecticides. Bacterial blight caused by *Pseudomonas glycinea* Coeper, and bacterial pustule caused by *Xanthomonas phaseoli* var *sojensis* (Hedges) Starr & Bush were observed throughout the experiment.

Means for certain characters of soybean variety SJ-4 taken from ten plants sampled randomly from the 50 x 5 cm spacing are presented for D_1 through D_5 in Table 4. Most characters manifested some variation, with the exception of nodes per plant which were similar to each other for all dates. All the pods observed in this study had 1, 2 or 3 seeds but there were no pods without seeds.

DISCUSSION AND CONCLUSION

The results of this study reveal that suitable planting dates for soybean at Songkhla are either in late June or early October. This conclusion may include other nearby provinces. Upon observing the pattern of rainfall average for 14 years (Figure 1), June planting may encounter insufficient moisture somewhere along the growing season since the total rainfall for the period is less than that usually required by soybean. However, the result of this study does not conform to such a conclusion due to sufficient rainfall which occurred in the respective period in 1980. The early

Table 4. Means for certain characters of soybean variety SJ-4 obtained from standard spacing of 50 x 5 cm.

Characters	Planting date					Mean
	D ₁	D ₂	D ₃	D ₄	D ₅	
	----- (no.) -----					
Leaves/plant	26	19	18	31	22	23.2
Branches/plant	6	3	3	4	3	3.8
One-seeded pods/plant	11	12	3	5	3	6.8
Two-seeded pods/plant	31	19	20	29	17	23.2
Three-seeded pods/plant	3	2	2	9	2	3.6
Nodes/plant	13	12	12	15	14	13.2
Seeds/plant	81	48	43	87	36	59.0
Plant dry weight (g)	5	6	3	6	6	5.2

October planting is more recommendable in terms of soybean yield and available moisture for soybean growth and development. Niam-srichand *et al.* (4) also gave the same conclusion. Excessive rainfall at planting may prevent good seedbed preparation, but the monsoon rains subside and end at early January resulting in good condition for crop maturing, harvesting and for drying of the seed.

The choice of spacing depends more or less on growing conditions. This study showed that the yield of 30 x 5 cm spacing was higher than that of 50 x 5 cm spacing. Between-row spacings narrower than 50 cm should be used in the growing condition where the soil is low in fertility or moderately fertile. Laosuan *et al.* (2) also gave the same conclusion for Khon Kaen growing conditions. Many workers in other countries also discern the advantage of high plant population obtained by close spacings between and within rows (3).

REFERENCES

1. Division of Agricultural Economics. 1979. Agricultural statistics of Thailand, crop year 1978/79. Ministry of Agriculture and Co-operatives.
2. Laosuan, Paisan; Pensak Sornkulpakdee, Tavatchai Teekachoonhathien, and Sumrith Panichbutr. 1981. Soybean breeding. KKU-IDRC Semi-arid Crop Project Summary Report, p. 79-94.
3. Minor, H. C. 1976. Planting date and plant spacing in soybean production. In Proceeding of A Conference for Asia and Oceania. Expanding the Use of Soybeans (R. M. Goodman ed.) p. 56-61.
4. Niamsrichand, Nati; Quanchit Sasipreeyachan, and Wallop Santi-pracha. 1979. Influences of planting times on growth performance and seed yield of soybean grown in the South Thailand. Faculty of Natural Resources Research Report (1979).
5. Wongsukon, Pravit; Anan Kongton, Kanda Katikarn, and J. K. Templeton. 1971. Soybean variety trials in Southern Thailand. Rubber Research Center of Thailand Technical Report No. 26.

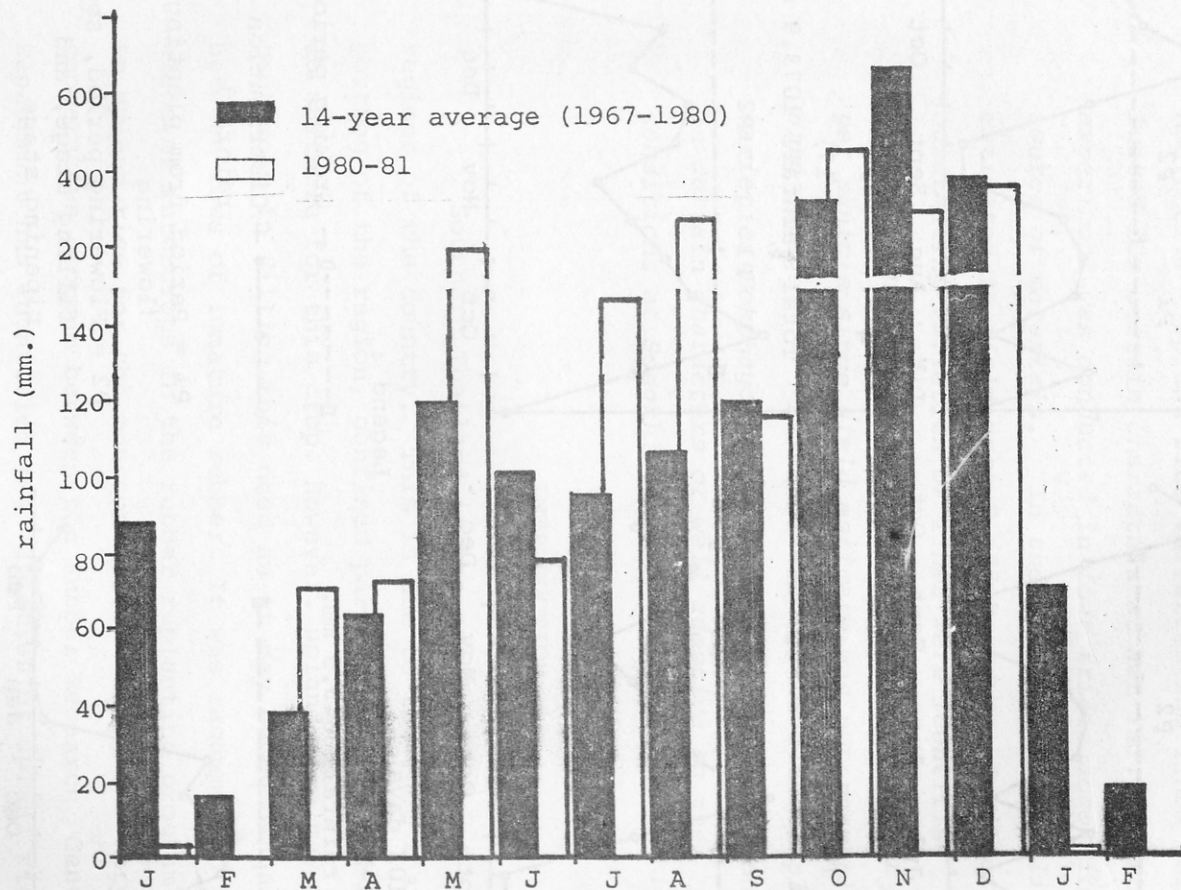


Fig. 1 Monthly rainfall at Hat Yai for the period of 1967-1980(81) and 1980-81.

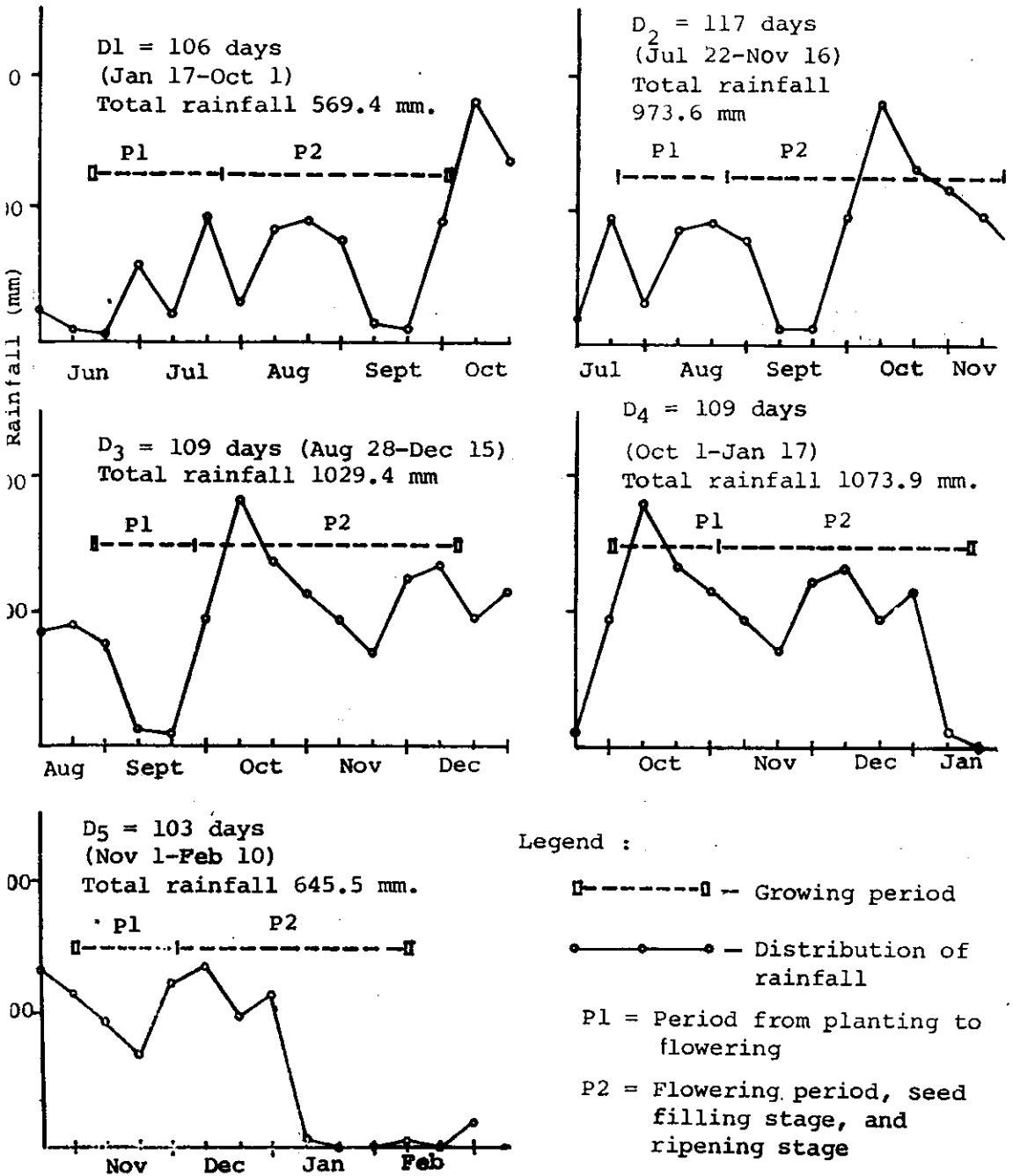


Fig.2 Total rainfall at every 10-day interval for each planting date of soybean, 1980-81.