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The Relationship between Growth Duration and Yield in Soybean in the Sub-tropics

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亜熱帶 地域의 콩生育期間과 收量과의 關係

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ABSTRACT

Seasonal variations influence the growth duration and yield of soybeans in the tropics and subtropics. Results of different yield trials were used to determine the relationship between yield with days to R_1 and R_8 in different seasons. Similarly relationship for 100 seed weight was examined. Multiple regression equations suggest that increase in yield can be obtained by increasing the days to R_8 regardless of seasons. However, increasing the days to R_1 invariably reduced the yield. The longer the time from R_1 to R_8, the higher the 100 seed weight. Since the population examined was heterogeneous for photoperiod sensitivity, the need to examine photoperiod sensitive and insensitive selections separately is discussed.

Introduction

Environment, production practices and genetic differences are known to influence the number of days between development stages of soybean (*Glycine max* (L.) Merr.), but the extent to which different durations for specific development stages affect soybean yields is poorly understood.

Crop scientists[1,3,10] have recently examined the growth duration and the rate of seed growth in order to determine how the two components relate to yield. Studies with soybean have demonstrated a strong correlation between the duration of the linear seed-filling phase and final seed yield.[2,4,8].

The period from R_4 to R_7 was shown to be strongly associated with the yield of soybean.[2,6,9,12]. However, Gbikpi *et al*[7] reported that meaningful relationships do not exist between soybean seed growth rate, duration of seed growth phases and seed size. They found the most critical stages for defoliation with indeterminate and determinate soybean strains varied with strain, but was either R_5 or $R_{5.5}$.

This study was conducted with the following two objectives: 1. To determine the relationships of final seed yield and 100-seed weight with the number of days to R_1 and R_8. 2. To investigate the seasonal variation in number of days to R_1 and R_8 and its influence on soybean grain yields.

Materials and Methods

Four uniform yield trials were conducted at the Asian Vegetable Research and Development Center (AVRDC) during three crop seasons in 1981.

A total of 482 selections (consisting of 15 selections for Advanced Yield Trials (AYT), 63 for

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Intermediate Yield Trials (IYT), 237 for Preliminary Yield Trials (PYT) and 167 for AVRDC *Glycine* Selections (AGS)) were planted together with two or three check cultivars in each trial.

During the spring season, plantings were done from February 15 to 27, during the summer season from July 1 to 7, and in the autumn season from September 16 to 29. Plant population density was 400,000 plants/ha in all trials and seasons.

Each experimental plot had 6 rows for AYT selections and 4 rows for IYT, PYT and AGS selections. Entries were planted on 5m x 1m raised beds. Each bed comprised two rows spaced 40cm apart. The harvest plot size was $10m^2$ in all cases.

All trials were arranged in a randomized complete block design with four replications for AYT selections and two replications for the IYT, PYT and AGS selections.

Grain yield was expressed on a 13% moisture basis. Seed size was determined by weighing 100 randomly selected seeds from each sample collected for yield determination.

Data was collected on days to flowering (DF), R_1 stage, and days to maturity (DM), R_8 stage. AVRDC suggested cultural practices were followed.[11]

Simple correlation coefficients between some of the variables recorded from the four trials were calculated. Multiple regression equations were calculated for yield and X_1 = DF and X_2 = DM independent variables using SAS GLM procedures and an IBM Model 2780 computer.

Results and Discussion

Grain yield varied significantly with season (Table 1, Fig. 2). Average yield was highest in the spring season and lowest in the summer season. The

Table 1. Means and ranges (maximum, minimum and difference) of grain yield of all selections from soybean uniform trials in three cropping seasons, 1981.

Season	Number of entries 1/	Mean ± S.E.	Ranges		
			Maximum	Minimum	Difference
		kg/ha	kg/ha	kg/ha	kg/ha
Spring	482	3,042 ± 20	4,491	1,257	3,234
Summer	482	2,152 ± 21	3,917	483	3,434
Autumn	482	2,369 ± 18	3,292	1,560	1,732
LSD (5%)		69			
CV (%)		21.6			

1/ Consists of 15, 63, 237 and 167 selections from AYT, IYT, PYT and AGS, respectively.

yield variance during autumn season was relatively narrow compared to those of the spring and summer seasons. Generally in Taiwan, soybean yields are highest in the spring, followed by the summer and autumn seasons (Shanmugasundaram, 1980). However, the low yield in the summer trial was due to excessive rains and flooding (Fig. 1).

The number of days from R_1 to R_8, DM minus DF, was positively correlated with seed yield in all seasons. DM was also similarly correlated with seed yield as DM minus DF. The results suggest that a greater number of days from R_1 to R_8 produces higher seed yields regardless of season. However,

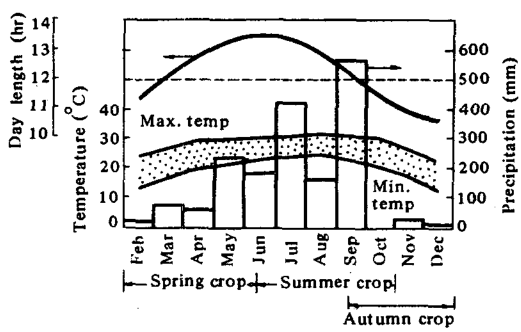

Fig. 1. Seasonal fluctuations of daylength, temperature (max. and min.) and precipitation at AVRDC (23°07'N) in 1981 (Source: AVRDC weather station)

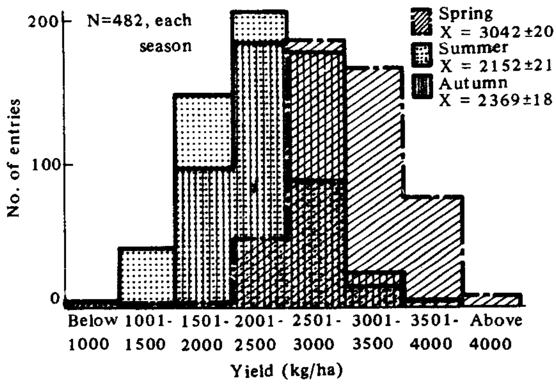

Fig. 2. Frequency distribution of yield of soybean selections from AYT, IYT, PYT and AGS at the AVRDC during three seasons.

for selections yielding 3 t/ha or more, DM was not significantly correlated with yield.

The 100-seed weight was significantly negatively correlated with DF (R_1). A longer DF is likely to result in an increased number of pods and thus smaller seed size. During the summer and autumn seasons, when the number of days from R_1 to R_8 is greatest, the 100-seed weight was also greatest, suggesting that increasing the seed filling period will increase 100-seed weight (Table 2). Further analysis of the data showed that the number of days to R_1 and R_8 was significantly positively correlated with pod number regardless of season. However, there was a highly significant negative correlation between number of pods and 100-seed weight.

Table 2. Correlation coefficients between yield or 100-seed weight and days to flowering (DF), days to maturity (DM) and DM minus DF (DM-DF) for all selections, and for selections yielding more than 3 t/ha in each of the three cropping seasons.

Variables		Spring		Summer		Autumn	
		All selections	Above 3 t/ha	All selections	Above 3 t/ha	All selections	Above 3 t/ha
Yield vs	DF	-0.128**	-0.172**	0.194***	-0.184	-0.069	-0.113
	DM	0.079	-0.011	0.292***	0.085	0.263***	0.366
	DM-DF	0.261***	0.230***	0.149**	0.294	0.339***	0.434*
100 seed wt. vs	DF	-0.271***	-0.284***	-0.285***	-0.671**	-0.247***	-0.015
	DM	-0.211***	-0.216***	0.169***	0.098	-0.068	-0.340
	DM-DF	0.049	0.074	0.422***	0.866***	0.118**	-0.358
	N[1/]	482	247	482	17	482	24

*, **, *** Significant at the 5%, 1%, 0.1% level, respectively.

1/ Number of selections involved.

In the spring and autumn seasons, an increase in the number of days to R_1 corresponded with a yield decrease, whereas in the summer, yield increased with increasing number of days to R_1. An increase in the number of days to R_8 corresponded with a yield increase in all seasons. The yield increase per additional day increase in the days to maturity was 47.6 kg/ha in autumn, 23.5 kg/ha in summer and 21.5 kg/ha in spring. These results agree with previous findings that seed yield was more a function of the length of the seed development period than the vegetative period.[2,8,13]

The multiple regression equation for the pooled data suggested that an increase in days to both R_1

Table 3. Regression equations for yield, both as independent variables for each season and for all season spooled.

Season	Multiple regression equations
Spring	$Y = 1988.9 - 25.5 X_1 + 21.5 X_2$
Summer	$Y = -540.9 + 8.3 X_1 + 23.5 X_2$
Autumn	$Y = -430.9 - 43.0 X_1 + 47.6 X_2$
Pooled	$Y = 1146.2 + 31.3 X_1 + 1.5 X_2$

X_1 = Days to flowering (DF)
X_2 = Days to maturity (DM)

and R_8 positively increased the yield. From the pooled results, it would appear that when selections are made for adaptability to diverse environments it is better to select for longer days to both R_1 and R_8. But the populations were heterogeneous with selections having different degrees of photoperiod sensitivity. Therefore, in future research to obtain a clear picture it is better to evaluate photoperiod sensitive and insensitive splections separately.

摘　　要

亞熱帶 地域에서의 콩生育期間과 收量과의 關係를 究明하고자 1981年 대만 所在 亞細亞 菜蔬研究開發센타(AVRDC)에서 選拔한 콩 482系統을 봄, 여름, 가을 作期에 同一材料를 供試 生産力試驗을 實施하여 얻은 結果를 要約하면 다음과 같다.

1. 作期別 平均收量 및 最高收量은 봄作期에서 높았고 가을, 여름 順으로, 낮았으며 가을 作期에서 系統間의 收量差가 제일 적었다.

2. 콩 收量은 作期에 關係없이 生育日數가 增加됨에 따라 增加되었으나 開花日數가 길어짐에 따라 收量은 減少되었다.

3. 100粒重은 作期에 關係없이 結實期間이 길수록 무거운 傾向을 보였으며 여름과 가을 作期에서 그 關係가 有意的이었다.

4. 多重回歸分析 結果 봄, 여름, 가을 어느 作期에서나 開花日數는 짧고 結實期間이 相對的으로 긴 系統이 高位生産力을 보이는 系統으로 考慮되었다.

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