

Limiting Weather Factors on Yield and Their Interactions in Soybean

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Objectives

To find the critical limiting weather factors on soybean yield in three regions

Materials and Methods

- Soybean yield and related data from regional yield trial
 - Suwon : 30 years (1974~2003), 18 cultivars, seeded at the last 10 days of May
 - Miryang : 27 years (1977~2003), 16 cultivars, seeded at the second 10 days of June
 - Iksan : 16 years (1988~2003), 15 cultivars, seeded at the second 10 days of June
- Meteorological data
 - Weather data of Suwon and Miryang from Korea Meteorological Administration web site
 - Weather data of Iksan provided by Honam Agricultural Research Institute
- Statistical analysis by SAS (Ver. 8e)
 - Correlation analysis : PROC CORR
 - Model selection method for multiple linear regression : PROC STEPWISE
- Variables for statistical analysis
 - Variables related to yield and growth : ① "YIELD" for yield, ② "STEM" for stem height, ③ "LODGE" for lodging, ④ "SMV" for Soybean Mosaic Virus, ⑤ "POD" for pods per plant, ⑥ "WT" for 100-seed weight, ⑦ "V_DAYS" for days to flower, ⑧ "R_DAYS" for days from flowering to maturity, ⑨ "T_DAYS" for days from seeding to maturity
 - Variables related to weather factors are cumulative values and consist of two symbols. The former represents six periods such as "V" for seeding to flowering, R for flowering to maturity, "T" for seeding to maturity, "B" for seeding to 20days before flowering, "M" for 20days before flowering to 20days after flowering, and "A" for 20days after flowering to maturity, and the latter does weather factors such as "T" for daily mean temperature, "S" for sunshine hours, "G" for global solar radiation, "R" for rainfall, and "RC" for rainy days. For examples, "V_T" stands for cumulative daily mean temperature during seeding to flowering.

Results and Discussion

In Suwon, temperature and sunshine hours during reproductive stage of soybean showed highly positive correlation with yield ($r=0.51^{**}\sim 0.57^{**}$), but lodging of soybean did negative correlation with that ($r=-0.41^{**}$). In Miryang, rainfall, especially during reproductive stage showed highly negative correlation with yield ($r=-0.50^{**}\sim -0.63^{**}$), but temperature during

vegetative stage did positive correlation with that ($r=0.55^{**} \sim 0.59^{**}$). In Iksan, temperature, sunshine hours, and global solar radiation showed highly positive correlation with yield ($r=0.54^{**} \sim 0.71^{**}$), but rainfall did negative correlation with that ($r=-0.40^{**}$) (Table 1).

Therefore, the higher temperature and the more sunshine are expected to produce the more soybean yield in the middle (Suwon) and the south-western (Iksan) region of Korea. In the double cropping region (Miryang) of south-eastern Korea, rainfall, especially during reproductive stage, is considered to be the main limiting weather factor on soybean yield.

According to the multiple regression model, soybean yield is to be explained by 86% with 14 variables in Suwon, by 83% with 13 variables in Miryang, and by 89% with 11 variables in Iksan, respectively (Table 2).

Table 1. Correlation coefficient of different variables with soybean yield in three regions

Suwon		Miryang		Iksan			
Variables	Correlation coefficient	Variables	Correlation coefficient	Variables	Correlation coefficient	Variables	Correlation coefficient
R_T	0.57**	R_R	-0.63**	T_S	0.71**	V_DAYS	0.48**
R_S	0.53**	B_T	0.59**	R_S	0.69**	T_DAYS	0.47**
A_S	0.52**	T_R	-0.59**	B_S	0.64**	B_T	0.47**
A_T	0.51**	V_T	0.55**	A_S	0.63**	B_G	0.44**
T_T	0.46**	V_DAYS	0.53**	V_S	0.62**	V_T	0.42**
R_DAYS	0.45**	A_R	-0.52**	R_G	0.62**	M_RC	-0.40**
T_S	0.45**	M_R	-0.50**	T_G	0.60**	T_R	-0.40**
LODGE	-0.41**	LODGE	-0.48**	T_T	0.55**	R_T	0.39**
POD	0.35**	POD	0.42**	A_G	0.54**	V_G	0.39**
T_DAYS	0.30**	SMV	-0.41**	M_S	0.54**	R_R	-0.38**
		V_RC	-0.39**	POD	0.48**	M_R	-0.37**

Table 2. Summary of stepwise selection for three regions

Step	Suwon			Miryang			Iksan			
	Vars. entered	Partial R ²	Model R ²	Vars. entered	Partial R ²	Model R ²	Vars. entered	Vars. removed	Partial R ²	Model R ²
1	R_T	0.3292	0.3292	R_R	0.3935	0.3935	T_S		0.5019	0.5019
2	R_RC	0.1738	0.503	B_T	0.1376	0.5311	SMV		0.1326	0.6345
3	LODGE	0.1003	0.6033	POD	0.0682	0.5993	POD		0.0489	0.6834
4	STEM	0.0374	0.6407	STEM	0.0381	0.6375	WT		0.0407	0.724
5	M_S	0.0531	0.6937	LODGE	0.0601	0.6976	V_G		0.0504	0.7745
6	M_R	0.0359	0.7296	WT	0.0392	0.7368	LODGE		0.0365	0.811
7	A_T	0.0197	0.7494	A_S	0.0164	0.7531	BS		0.012	0.823
8	V_S	0.0247	0.7741	V_RC	0.0207	0.7738	BR		0.0082	0.8312
9	V_RC	0.0093	0.7834	SMV	0.0158	0.7896	BT		0.0187	0.8499
10	T_RC	0.0283	0.8117	V_T	0.0089	0.7985	T_T		0.0134	0.8632
11	V_R	0.015	0.8268	R_S	0.0186	0.8171	STEM		0.0131	0.8764
12	M_T	0.01	0.8368	B_R	0.0073	0.8244	BRC		0.0129	0.8892
13	A_RC	0.0058	0.8426	V_R	0.006	0.8304		BR	0.0017	0.8875
14	B_S	0.0144	0.857					LODGE	0.0011	0.8865
15								T_DAYS	0.0038	0.8902