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Interpretation of Relationship Between Sesame Yield and It's components under Early Sowing Cropping Condition

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ABSTRCAT : Multiple linear regression analysis was conducted to interpretate the relationship between sesame grain yield and its components under early sowing cropping condition. The *t* test showed that stem length, number of capsules per plant, 1000 seeds weight and seed weight per plant gave significant contribution to sesame grain yield, therefore those variables were assumed to mostly influenced components to grain yield of sesame. In the stepwise regression analysis, the predicted equation for sesame grain yield per square meter (Y) was Y = -7.900 + 0.150X1 + 0.461X5 + 15.553X6 + 8.543X7. Meanwhile, *F* value showed that stem length, number of capsules per plant and seed weight per plant gave significant contribution to sesame grain yield, while 1000 seeds weight did not significantly show. Based on the results, it is reasonable to assume that high yield potential of sesame under early sowing cropping condition would be obtained by selecting breeding lines with long stem length, number of capsules per plant, and seed weight per plant, which was different result at the late sowing cropping condition in which days to flowering and maturity were assumed to be more affected factors to the sesame grain yield.

Keywords: sesame, multiple linear regression, stepwise regression, early sowing cropping system

Developing high yielding sesame varieties under early sowing cropping condition in Korea is an important objective of breeding program. In general, sesame has been cultivated under late sowing cropping condition in terms of succeeding crop of wheat and barley, while, nowadays, it was changed to early sowing cropping condition in which enough growing period was guaranteed to give higher grain yield of sesame. Sowing date under early sowing cropping condition is in early May which is one month earlier than that of late sowing and harvest period is in early August. Nevertheless, sesame breeding program has not been effectively conducted under early sowing cropping condition. Sesame (*Sesamum indicum* L.) with indeterminate inflorescence habit accelerates flowering and maturity period under 10~12 hours of short day length condition. Most plants responded differently to the different sowing dates due to the changed day length, temperature and their interaction (Boote, 1980; Lee *et al.*, 1982). Byth (1968) reported that meteorological factors, such as temperature and day length, determined yield components of soybean under different sowing dates. Yingzhong *et al.* (2002) reported that number of capsules per plant and plant height had significantly positive correlations and direct path coefficients on seed yield per plant. In path coefficient analysis, the number of capsules per plant, 1000 seeds weight and numbers of seed per plant were shown to have higher direct effect on grain yield (Lee *et al.*, 1986). Shim (2000) reported that days from flowering to maturity and days to maturity were highly correlated to the grain yield of sesame by which maturity period could be the most important selection index for sesame breeding under late sowing cropping condition. This study was conducted to interpretate the relationship between sesame grain yield and its components to establish effective selection criteria under early sowing cropping condition.

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MATERIALS AND METHODS

Plant materials and cultivation methods

Twenty sesame varieties were taken for the study and cultivated during the year of 2004 and 2005 at the Yeongnam Agricultural Research Institute, Miryang. A randomized complete block design with three replications was used for this experiment. Spacing between plants was 10cm and row spacing was 30cm in a 70cm wide black polyethylene film mulching bed. Sowing was done on 10th May, and late sowing was also done on 10th June to analyze the variance of sesame variables on during the first and second year respectively.

Observation on plant height, days to flowering, days to maturity, days from flowering to maturity, number of capsules per plant, plant height, 1000 seeds weight and seed yield per plant were recorded individually in each replication.

Average temperature and rainfall condition in 2004 were favorable rather than that of the next year for sesame cultivation, especially, rainfall in 2004 was recorded properly dur-

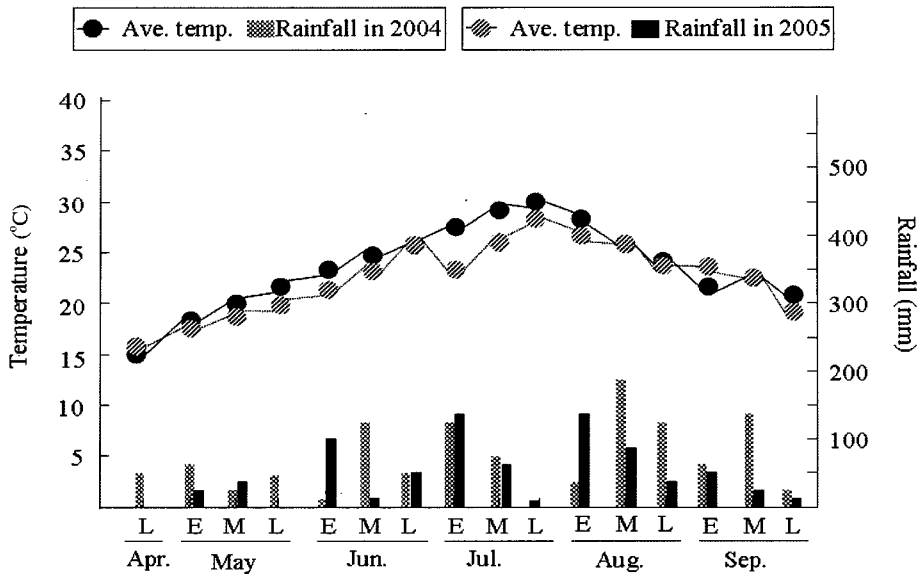

Fig. 1. Rainfall and temperature conditions during the year of 2004 and 2005.

ing the whole period of sesame cultivation.

Statistical analysis

A matrix of simple correlation coefficients between grain yield and its components were calculated by the ways of Cochran *et al.,* (1981). Multiple linear regression and partial coefficient of determination (R^2) was calculated for each component to estimate the relative contribution and to establish the prediction model for sesame grain yield (Y) by the formular of $Y = a + b_1X_1 + b_2X_2 + c_3X_3 + c_4X_4 + \ldots + b_nX_n$ (Cochran *et al.,* 1981). Stepwise multiple linear regression was used to determine the variable accounting for the majority of total yield variability (Smith *et al.,* 1966). This procedure calculated a series of multiple linear regression in a stepwise manner. One variable was added to the regression equation step by step. Added variable was the one that induced the greatest reduction in the error sum of squares. It was also the one that had the highest partial correlation with the dependent variable for fixed values of those variables already added.

RESULTS AND DISCUSSION

Basic statistics and simple correlation analysis

Mean values, standard deviation and F values for all estimated variables of sesame are showed in Table 1. All components except 1000 seeds weight and seed weight per plant showed significantly different. Days to flowering and 1000 seeds weight showed higher coefficient of variance.

Table 2 shows the analysis of variance for stem length,

Table 1. Basic statistics for the estimated variables of sesame

	PH†(cm)	DTF	DTM	DFM	NCP	TSW (g)	SWP (g)	GY (g)
Mean	111.25	51.50	118.08	66.58	56.78	2.60	6.22	128.48
Maximum	157.00	59.00	144.50	87.50	79.00	3.00	8.45	169.00
Minimum	73.50	44.00	93.00	49.00	47.50	2.33	4.90	102.00
Range	83.50	15.00	51.50	38.50	31.50	0.68	3.55	67.00
S. D.	23.59	3.69	11.40	9.17	9.12	0.21	1.01	19.22
C. V.	4.72	13.96	10.36	7.26	6.22	12.55	6.16	6.68
F value	11.04**	1.73*	5.33**	4.29**	4.27**	0.10^{ns}	0.47*	9.00**

†PH : Plant height, DTF : Days to flowering, DTM : Days to maturity, DFM : Days from flowering to maturity, NCP : Number of capsules per plant, TSW : 1000 seeds weight, SWP : Seed weight per plant. GY : Grain yield per square meter *, ** : Significant at the 5%, 1% level respectively

Table 2. Analysis of variance for stem length, days to flowering, days to maturity, number of capsule per plant, 1000 seeds weight, and seed weight per plant of twenty sesame lines.

Sources	Mean Square					
	PH†	DTF	DTM	NCP	TCW	SWP
Year (Y)	2502.60**	176.82**	700.42**	924.34**	0.26**	3.46**
Sowing date (S)	9163.70**	6976.82**	8784.60**	9563.44**	1.36**	146.95**
Genotype (G)	5837.56**	88.89**	1408.99**	724.44**	0.22**	8.97**
Interaction (G ×Y)	64.34**	10.53**	92.96**	53.93**	0.01**	0.37**
Interaction (G × S)	49.55**	33.14**	56.55**	38.27**	0.04**	1.08**

†PH : Plant height, DTF : Days to flowering, DTM : Days to maturity, DFM : Days from flowering to maturity, NCP : Number of capsule per plant, TSW : 1000 seeds weight, SWP : Seed weight per plant
**: Significant at the 1% level

Table 3. A matrix of simple correlation coefficients for the estimated variables and seed weight of sesame.

Variables	X1	X2	X3	X4	X5	X6	X7
Plant height (X1)	1.000						
Days to flowering (X2)	0.101^{ns}	1.000					
Days to maturity (X3)	-0.305^{ns}	0.701**	1.000				
Days from flowering to maturity (X4)	-0.425^{ns}	0.473*	0.959**	1.000			
Number of capsules per plant (X5)	0.888**	-0.077^{ns}	-0.314^{ns}	-0.362^{ns}	1.000		
1000 seeds weight (X6)	0.903**	0.130^{ns}	-0.455*	-0.513*	0.919**	1.000	
Seed weight per plant (X7)	0.942**	-0.058^{ns}	-0.370^{ns}	-0.441*	0.932**	0.943**	1.000
Grain yield (Y)	0.952**	-0.042^{ns}	-0.353^{ns}	-0.425^{ns}	0.954**	0.958**	0.983**

*, **Significant at the 5%, 1% level respectively. ns : Not significant

days to flowering, days to maturity, number of capsule per plant, 1000 seeds weight, and seed weight per plant of twenty sesame lines. Most of variables showd significantly different by year, sowing date, genotype and interaction. Sowing date was affected mostly to express the variables, meanwhile, interactions of genotype by year and genotype by sowing date showed smaller factors to express the variables compared to that of genotype. Therefore, environmental factors such as meteorological or soil condition didn't affect to interpret sesame yield and its components under early sowing cropping condition.

Table 3 shows simple correlation coefficients of estimated variables each other. All components had positive correlation with grain yield, except days to flowering, days to maturity and days from flowering to maturity. Grain yield was positively correlated with plant height (0.95), number of capsules per plant (0.94), 1000 seeds weight (0.96) and seed weight per plant (0.98). Plant height was negatively correlated with days to maturity (0.31) and days from flowering to maturity (0.43) respectively. Number of capsules per plant was negatively correlated with days to flowering (-0.08), days to maturity (-0.31) and days from flowering and maturity (-0.36). Seed weight per plant was positively correlated with plant height (0.94), number of capsules per plant (0.93) and 1000 seeds weight (0.94), but days to maturity (-0.37) and days from flowering and maturity (-0.44) were negatively correlated with seed weight per plant. Days to flowering did not show significant correlation with seed weight per plant. Similar results were also observed by Yingzhong. Z. *et al.* (2002), Uzo (1985) and Singh *et al.* (1997).

Regression coefficient and the probability of the variables in predicting sesame grain yield are estimated in Table 4. The predicted equation for sesame grain yield per square meter (Y) is estimated as follows: $Y = -9.460 + 0.185X1 + 0.979X2 - 1.078X3 + 1.150X4 + 0.401X5 + 16.169X6 + 8.501X7$. The formula explained about 99% of the total variation within the sesame grain yield components, and the remaining 1% might be residual effects. The *t* test showed that stem length, number of capsules per plant, 1000 seeds weight and seed weight per plant gave significant contribution to sesame grain yield, while others did not. These results are in accordance with that of Yingzhong *et al.,* (2002). Therefore, those four variables are important selection criteria for sesame breeding program under early sowing cropping condition in Korea.

Table 5 shows that partial, cumulative R^2 and probability for the selected four variables in predicting sesame grain yield. Seed weight per plant showed most larger relative

Table 4. Regression coefficient (*b*), standard error (SE) and *t* value of the estimated variables for sesame grain yield by multiple linear regression analysis.

Variables	DF	Coefficient regression (*b*)	Standard error (SE)	*t* value	Prob>|T|
Plant height (X1)	1	0.184	0.114	1.62	0.130*
Days to flowering (X2)	1	0.979	2.456	0.40	0.697^{NS}
Days to maturity (X3)	1	-1.078	2.534	-0.43	0.678^{NS}
Days from flowering to maturity (X4)	1	1.150	2.554	0.45	0.661^{NS}
Number of capsules per plant (X5)	1	0.401	0.230	1.75	0.106*
1000 seeds weight (X6)	1	16.169	12.033	1.34	0.204*
Seed weight per plant (X7)	1	8.5001	2.792	3.05	0.010**

*and **mean that *b* is significant at 5%, 1% level of probability. NS: not significant. Y intercept (*a*) = -9.460, SE = 23.399, R^2 = 0.985, Adj. R^2 = 0.978, Root SE = 2.869.

Table 5. Prediction of relative contribution to sesame grain yield by partial R^2, model R^2 and *F* value using stepwise procedure analysis.

Step	Variables	Partial R^2	Model R^2	*F* value
1	Seed weight per plant (X7)	0.967	0.967	530.73**
2	Number of capsules per plant (X5)	0.011	0.978	8.24**
3	Plant height (X1)	0.005	0.983	4.19*
4	1000 seeds weight (X6)	0.003	0.985	2.74*

*and **mean that R^2 is significant at 5%, 1% level of probability.

Table 6. Regression coefficient (b), standard error (SE) and F value of the accepted variables for the prediction of sesame grain yield by the stepwise procedure.

Variables	Coefficient regression (*b*)	Standard error (SE)	*F* value
Plant height (X1)	0.150	0.076	3.84*
Number of capsules per plant (X5)	0.461	0.195	5.58**
1000 seeds weight (X6)	15.552	9.403	2.74^{NS}
Seed weight per plant (X7)	8.5431	2.497	11.71**

*and **mean that *b* is significant at 5%, 1% level of probability. NS: not significant. Y intercept (*a*) = -7.900, SE = 13.809.

contribution as 97%. Number of capsules per plant, plant height and 1000 seeds weight showed 1.1%, 0.5%, 0.3% respectively. According to the results, about 98.6% of the total variation in sesame grain yield could be attributed to those above four variables. The other variables were not contributed so much due to their low relative contribution values.

Table 6 shows that regression coefficient and the probability of the accepted variables in estimating sesame grain yield by the stepwise procedure. The predicted equation for sesame grain yield per square meter (Y) was Y = -7.900 + 0.150X1 + 0.461X5 + 15.553X6 + 8.543X7. Meanwhile, F value showed that stem length, number of capsules per plant and seed weight per plant had significantly contribution to sesame grain yield, while 1000 seeds weight did not significantly show.

The multiple statistical analysis in this study showed that plant height, number of capsules per plant and seed weight per plant were the most important yield variables to be considered for the sesame breeding program to select high yield potential under early sowing cropping condition in Korea. The results in this study different from the report that days from flowering to maturity and days to maturity were highly correlated to the grain yield of sesame by which maturity period was the most important selection index for sesame breeding under late sowing cropping condition (Shim, 2000). Therefore, it is need to establish different selection criteria for sesame breeding according to differnt cropping conditions in Korea.

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