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Performance of Heritabilities, Genetic Correlations and Path Coefficients of Some Agronomic Traits at Different Cultural Environment in Sesame

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ABSTRACT: This study was conducted to analyze the responses of some agronomic traits to the different cultural environments and relations among the agronomic traits for selecting sesame varieties with higher cultural stabilities. The indexes for stability parameters measured were coefficient of variability, heritabilities, genetic correlations and path coefficients of agronomic traits according to locations and years in Korea. The heritabilities of agronomic traits showed different by locations and years. Number of seeds per capsule and 1000 seeds weight showed higher heritabilities, but stem length and seed weight per plant showed relatively lower heritabilities. Average heritabilities of some agronomic traits in 1998 were comparatively higher than those of 1999. Of six areas, Jinju area showed biggest coefficient of yield variability in 1998~1999. Iksan and Taegu areas showed higher heritabilities in 1998, but Iksan and Jinju areas showed lower heritabilities in 1999. Genetic correlations were slightly higher than corresponding phenotypic correlations. Stem length showed positive genetic correlation with the number of capsules per plant, and seed weight per plant and the number of capsule per plant showed positive genetic correlation with seed weight per plant. On the analysis of path coefficients, stem length and number of capsules effected highly on grain yield. Great regional variations were observed on the effects of agronomic traits on grain yield. Higher direct effects of stem length on grain yield were observed at Suwon, Chungwon, Taegu, Jinju and Naju areas, but in Iksan area was observed higher direct effect of the number of capsules per plant on grain yield in 1998. In 1999, higher direct effect of stem length on grain yield was observed at Chungwon and Suwon areas. Iksan and Taegu areas were also observed higher direct effect of the number of capsule per plant on grain yield.

Keywords **:** sesame, agronomic, traits, variation, heritability, genetic correlation, path coefficient.

Sesame (*Sesamum indicum*) is very sensitive to the changes of cultural environments compared to other crops and average grain yields of sesame in Korea varied according to cultural environments such as locations and years. Therefore the main targets of sesame researches were usually focused on breeding new varieties with more stabilities to the cultural environments and diseases.

The first experiment on the genetic analysis of some agronomic traits in sesame was conducted by Lee in 1959 and later, several reports concerning the genetic analysis of agronomic traits in sesame were reported in Korea. On the analysis of heritabilities among the agronomic traits in sesame, maturing date and number of seeds per capsule showed higher heritability, but 1000 seeds weight and seed weight per plant showed lower heritability. On the analysis of path coefficient, number of capsules per plant, 1000 seeds weight and number of seeds per capsule showed higher direct effect on grain yields (Lee *et al.*, 1986).

Min *et al.*, reported that more important agronomic traits determining grain yield of rape (*Brassica napus*) on the analysis of phenotypic, genetic and environmental correlations were stem length, number of capsules per plant and 1000 seeds weight in early maturing varieties and stem length, number of primary branches, number of secondary branches and number of capsules per plant in late maturing varieties. This experiment was conducted to analyze genetic relationships among the agronomic traits and responses of those traits to the different cultural environments for determining adequate parameters needed to select sesame varieties with higher stabilities under the different cultural conditions.

MATERIALS AND METHODS

General culture methods

This experiment was conducted at Suwon, Iksan, Taegu, Chungwon, Jinju and Naju areas in 1998~1999. Nine varieties and selected lines were used : Yangbaek, Ansan, Suwon 158, Suwon 162, Suwon 168, Suwon 169, Iksan 12, Iksan 14, Iksan 15. Experimental area was about 12 and black polyethylene film with holes of 30×10 cm interface was mulched and thinned to grow one plant per hole. Fertilizer (N-P_2O_5-K_2O=8-4-9) was applied as basal fertilizer. Soil

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Table 1. Genetic, phenotypic, environmental variance and heritability estimate at six locations and two years of 1998~1999.

Location	Statistics value	Stem length		No. of capsules per plant		No. of seeds per capsule		1000 seed weight		Seed weight per plant	
		1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
Suwon	Vg	17.6351	5.8767	22.1148	9.7787	18.7447	5.2460	0.0259	0.0043	0.0904	0.1739
	Ve	35.1141	4.4798	15.4678	13.7383	2.1658	1.4804	0.0142	0.0028	0.1851	0.2431
	Vph	52.7492	10.3565	37.5826	23.5170	20.9135	6.7264	0.0401	0.0071	0.3755	0.4170
	h^2	0.3299	0.5674	0.5884	0.4158	0.8963	0.7799	0.6463	0.6067	0.3280	0.4169
Iksan	Vg	98.9232	25.7082	79.9450	9.4165	15.9214	5.1445	0.0170	0.0180	2.1641	0.1554
	Ve	34.6391	245.2177	22.2860	44.2506	1.1487	4.5895	0.0085	0.0101	0.0566	0.1626
	Vph	133.5623	270.9259	102.2310	53.6671	17.0363	9.7340	0.0255	0.0281	2.2207	0.3180
	h^2	0.7407	0.09489	0.7820	0.1755	0.9327	0.5285	0.6675	0.6411	0.9254	0.3936
Chungwon	Vg	52.7540	39.8002	32.4546	44.1850	8.1211	0.8474	0.0175	0.0648	0.1196	0.2544
	Ve	85.6530	45.1905	40.6786	58.6946	34.5097	15.4397	0.0052	0.0044	0.0737	0.1794
	Vph	138.4070	84.9907	73.1332	102.8796	42.6308	16.2871	0.0227	0.0692	0.1933	0.4338
	h^2	0.3812	0.4683	0.4438	0.4295	0.1905	0.0520	0.7695	0.8108	0.5695	0.5864
Taegu	Vg	9.5224	9.4701	27.95	17.8228	16.6106	5.4174	0.0163	0.0179	0.1855	0.0259
	Ve	15.8701	21.3370	8.2982	22.9395	1.3947	2.6657	0.0032	0.0027	0.0246	0.0869
	Vph	25.3925	30.8071	36.2482	40.7623	18.0053	8.0831	0.0195	0.0206	0.2101	0.1118
	h^2	0.3750	0.3074	0.7711	0.4372	0.9225	0.6702	0.8353	0.8701	0.8829	0.2293
Jinju	Vg	55.3768	30.3926	136.8147	24.6805	13.5028	6.0001	0.0289	0.0098	0.3473	0.0185
	Ve	60.7991	31.0241	66.3706	102.5417	0.5724	0.5969	0.0122	0.0028	0.4029	0.0784
	Vph	116.1759	61.4167	203.1853	127.2222	14.0752	6.5970	0.0411	0.0126	0.7502	0.0969
	h^2	0.4767	0.4949	0.6733	0.1940	0.9593	0.9095	0.7029	0.7798	0.4603	0.1910
Naju	Vg	48.3619	1.5595	46.6989	13.7083	10.9087	4.5225	0.0041	0.0029	0.1120	0.0299
	Ve	45.9807	51.9034	13.9863	26.9583	0.6130	0.4508	0.0036	0.0013	0.1485	0.0532
	Vph	94.3426	53.4629	60.6852	40.6666	11.5217	4.9733	0.0077	0.0042	0.2605	0.0831
	h^2	0.5126	0.02917	0.7695	0.3371	0.9468	0.9094	0.5351	0.6965	0.4299	0.3602

characteristic at six locations in 1998~1999 were analyzed. PH value ranged 5.5~7.1, O.M. (%) ranged 0.30~0.87, Av. P_2O_5 ranged 20.3~130.0. Among the ex. cations K ranged 0.14~1.86, Ca ranged 2.70~5.90 and Mg ranged 0.87~3.23. C.E.C (mg/100 g) ranged 4.73~10.90. The experiment plot was arrayed by randomized block design with 3 replications. Flowering date was measured at the time of 50% flowering stage and maturing date was measured at the time of changing two or three lower leaves yellowish, stem length was measured from the ground level to the tip of main stem, number of capsules per plant was counted capsules containing normal seeds, number of seed per capsule was counted normal seed in capsule, 1000 seeds weight was weighed 1000 seeds and seed weight per plant was weighed all the seeds in plant.

Heritability, genetic correlation and path coefficient

Heritability in broad sense was estimated by $h^2=\sigma^2G/(^2G+^2E)$ where σ^2G means genetic variance and σ^2E means environmental variance respectively. Dewy & Lu's methods to estimate path coefficient were used and Robinson's methods to estimate phenotypic, genetic and environmental correlations were calculated by the following equntions;

Genetic correlation : $rG = Cov \cdot XYG/(\sigma^2XG \cdot \sigma^2YG)$
Phenotypic correlation : $rPh = Cov \cdot XY/(\sigma^2X \cdot \sigma^2Y)$
Environmental correlation : $rE = Cov \cdot XYE/(\sigma^2XE \cdot \sigma^2YE)$

RESULT AND DISCUSSION

Comparison of heritability among the agronomic traits of sesame selected lines

Heritabilities of agronomic traits in sesame selected lines were different according to years and locations. In 1999, heritabilities of agronomic traits showed lower than those of corresponding in 1998 (Table 1).

Heritability of stem length, number of capsules per plant and 1000 seeds weight ranged 0.17~0.65, 0.12~0.94 and 0.57~0.86 respectively. Generally, number of seeds per capsule and 1000 seeds weight showed relatively higher heritability than those of the other traits.

Comparison of correlations among agronomic traits of sesame selected lines

Much different response of correlations among the agronomic traits showed by years and locations (Table 2).

Table 2. Genotypic correlations estimated among some agronomic traits at six locations and two years of 1998~1999.

Characters	Locations	No. of capsules per plant		No. of seeds per capsule		1000 seeds weight		Seed weight per plant	
		1998	1999	1998	1999	1998	1999	1998	1999
Stem length	Suwon	0.5847*	0.6867*	0.5965*	0.5189	0.3773	0.0566	0.7881**	0.7585**
	Iksan	0.7829**	0.1193	0.0173	0.3549	0.7179*	0.3203	0.8340**	0.1517
	Chungwon	0.4123	0.4315	0.9209**	0.0920	0.6170*	0.3759	0.9664**	0.1286
	Taegu	0.5605	0.9424**	0.3966	0.1186	0.7870**	0.3464	0.7720**	0.6932*
	Jinju	0.4108	0.6070*	0.1172	0.9720**	0.2238	0.1912	0.5854	0.5555
	Naju	0.7610**	0.9612**	0.0789	0.9979**	0.2784	0.9469**	0.7300**	0.6750*
No. of capsules per plant	Suwon			0.4760	0.2402	0.0640	0.2735	0.1054	0.8082**
	Iksan			-0.2111	0.1485	0.7660**	0.2031	0.9574**	0.8591**
	Chungwon			-0.6236*	0.5100	-0.0459	0.3667	0.5071	0.0443
	Taegu			-0.1243	0.2032	0.5981*	-0.1855	0.5779	0.9351**
	Jinju			-0.5981	0.4037	-0.7787**	-0.6574*	0.5648	-0.1931
	Naju			-0.4152	0.4578	0.1056	0.7992**	0.6710*	0.8022**
No. of seeds per capsule	Suwon					0.1134	0.4381	-0.4288	0.1360
	Iksan					0.2910	0.3749	-0.0478	0.2416
	Chungwon					0.2371	0.5928*	0.6029*	0.0459
	Taegu					0.1515	0.1169	0.2825	0.4979
	Jinju					-0.3800	0.1787	-0.2560	0.8926**
	Naju					-0.4930	0.5665	-0.4930	0.8720**
1000 seeds weight	Suwon							-0.5053	-0.0952
	Iksan							0.8904**	0.8036**
	Chungwon							0.3519	-0.2499
	Taegu							0.7369**	-0.5666
	Jinju							0.1889	-0.0223
	Naju							0.2783	0.0047

Table 3. Phenotypic correlations estimated among some agronomic traits at six locations and two years of 1998~1999.

Characters	Locations	No. of capsules per plant		No. of seeds per capsule		1000 seeds weight		Seed weight per plant	
		1998	1999	1998	1999	1998	1999	1998	1999
Stem length	Suwon	0.5555	0.3793	0.3115	0.2496	0.0728	0.3174	0.1110	0.5656
	Iksan	0.7072**	0.2550	0.0365	0.0825	0.5287	-0.0485	0.7727**	0.1842
	Chungwon	0.6014*	0.2814	0.3104	0.2084	0.3658	0.3787	0.8089**	0.2202
	Taegu	0.5921*	0.8249**	0.4218	-0.1186	0.2942	0.1665	0.5445	0.5540
	Jinju	0.5176	0.2234	0.0096	0.5499	0.1357	-0.0216	0.3505	0.2382
	Naju	0.5982*	0.7393*	0.1198	0.2793	0.3415	0.6169*	0.6998*	0.6310*
No. of capsules per plant	Suwon			0.2995	0.3232	0.0634	0.1276	0.0946	0.4917
	Iksan			-0.1765	0.0206	0.4356	-0.1357	0.8965**	0.7944**
	Chungwon			0.1022	0.0034	0.1094	0.2006	0.7078*	0.4031
	Taegu			-0.0462	-0.0365	0.3094	-0.1197	0.6116*	0.7583*
	Jinju			-0.3936	0.1046	0.1589	-0.2440	0.5327	0.2940
	Naju			-0.3316	0.2693	0.0724	0.7035*	0.6484*	0.7537*
No. of seeds per capsule	Suwon					-0.0474	0.2623	- 0.7808**	0.0944
	Iksan					0.2852	0.1670	-0.0172	0.2689
	Chungwon					-0.0113	0.4337	0.4753	-0.0187
	Taegu					0.0886	0.0810	0.2692	-0.1357
	Jinju					-0.0738	0.1318	-0.0737	0.0461
	Naju					0.1346	0.4998	0.1124	0.5535
1000 seed weight	Suwon							-0.5053	0.0468
	Iksan							0.7115*	0.3841
	Chungwon							0.3846	-0.1961
	Taegu							0.4839	-0.1375
	Jinju							0.6699*	-0.0216
	Naju							0.0625	0.7869*

In 1998, stem length in Iksan and Naju areas showed positive correlation to the number of capsules per plant and, in Chungwon area, stem length showed highly positive correlation to the number of seeds per plant and 1000 seeds weight. In 1999, stem length in Taegu and Naju areas showed highly positive correlation to the number of capsules per plant. In Suwon area, stem length showed positive correlation to seed weight per plant. Number of capsules per plant showed negative correlation to the number of seeds per capsule and 1000 seeds weight in all cultural areas, but showed positive correlation to seed weight per plant. Number of seeds per capsule generally showed negative correlation to 1000 seeds weight, seed weight per plant in the cultural areas. 1000 seeds weight showed positive correlation to seed weight per plant. Genetic correlations were slightly higher than corresponding phenotypic correlations (Table 3).

Generally, phenotypic correlations showed similar trends to those of genetic correlations.

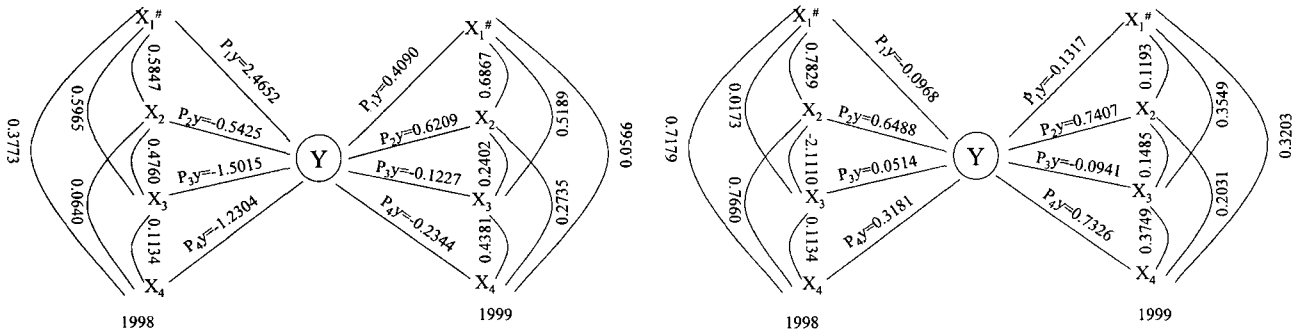

Fig. 1. Path diagram and coefficients of some agronomic traits effecting seed weight in two years of 1998~1999 (Left : Suwon, Right : Iksan). # X_1 : Stem length, X_2 : No. of capsules per plant, X_3 : No. of seeds per capsule, X_4 : 1000 seeds weight, Y : Seed weight per plant.

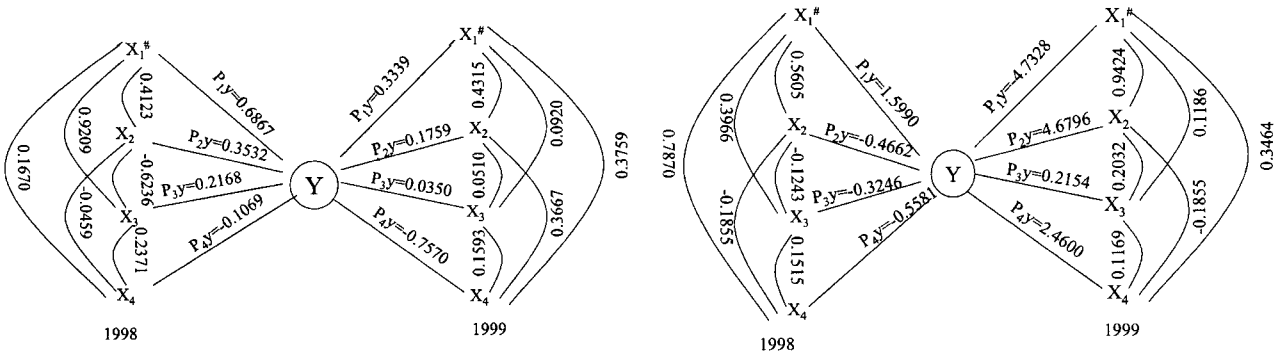

Fig. 2. Path diagram and coefficients of some agronomic traits effecting seed weight in two years of 1998~1999 (Left : Chungwon, Right : Taegu).

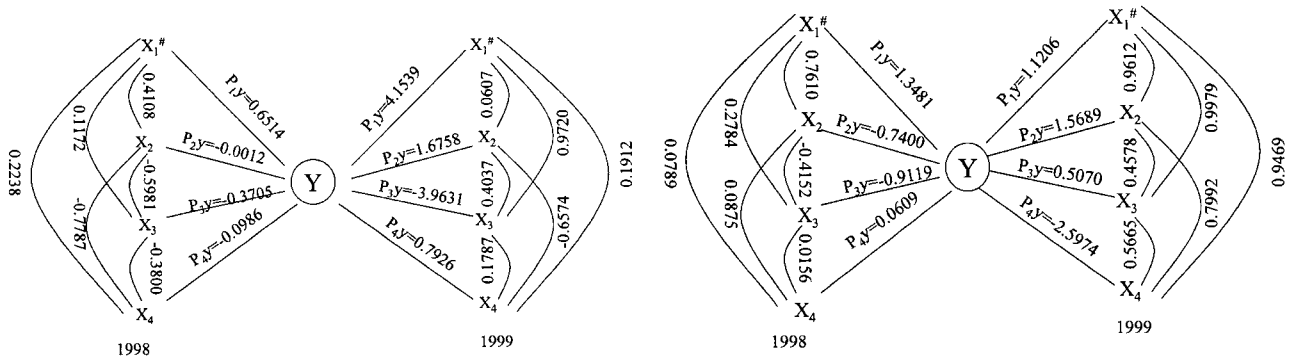

Fig. 3. Path diagram and coefficients of some agronomic traits effecting seed weight in two years of 1998~1999 (Left : Jinju, Right : Naju).

Comparison of path coefficient of some agronomic traits of sesame breeding lines at different locations

The important agronomic traits determining grain yield at the path coefficient analysis were stem length and the number of capsules per plant (Fig. 1, 2, 3).

Otherwise, the number of seeds per capsule and 1000 seeds weight were also showed important traits in several locations where environmental correlations showed relatively higher than those of the other locations. In 1998, direct effects on grain yield according to locations were as follows : stem length (P_1y=2.4552), the number of seeds per capsule (P_3y=-0.5425) in Suwon area ; the number of seeds per capsule (P_2y=0.6488), 1000 seeds weight (P_4y=0.3181) in Iksan area; stem length (P_1y=0.6867), the number of capsules per plant (P_3y=0.3532) in Chungwon area; stem length (P_1y=1.5990), the number of seeds per capsule (P_2y=-0.3246) in Taegu area; stem length (P_1y=0.6514), the number of capsule per plant (P_2y=-0.0012) in Jinju area; stem length (P_1y=1.3481), 1000 seeds weight (P_4y=0.0609) in Iksan area. In 1999, the path coefficient showed different results as those of previous year.

The number of seeds per capsule (P_3y=0.6209), stem length (P_1y=0.4090) in Suwon area; the number of seeds per capsule (P_2y=0.7407), 1000 seeds weight (P_4y=0.7326) in Iksan area; stem length (P_1y=0.3339), the number of capsules per plant (P_3y=0.1759) in Chungwon area; the number of seeds per capsule (P_2y=4.6796), 1000 seeds weight (P_4y=2.4000) in Taegu area; the number of capsule per plant (P_2y=4.6796), stem length (P_1y=2.4600) in Jinju area; the number of seeds per capsule (P_3y=1.5986), stem length (P_1y=1.1206) in Iksan area.

In summaries of this experiment, the number of seeds per capsule and 1000 seeds weight showed relatively higher heritability. Stem length were showed positive correlation to the number of capsules per plant and seed weight per plant. Stem length and the number of capsules per plant were showed largest direct effects on grain yield in sesame. Those results would be important factors to determine indexes for selecting sesame varieties with higher environmental stabilities.

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