

CORRELATION AND PATH COEFFICIENT ANALYSIS ON SEED YIELD IN SUNFLOWER

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Abstract

The research was conducted to investigate the correlations among agronomic and yield-related characters of sunflower and to verify their direct and indirect effects which will be used for the selection for seed yield. Twelve candidate synthetic varieties and 4 check synthetic varieties were evaluated at Suranaree University of Technology experimental farm, Nakhon Ratchasima, Thailand, in November, 2006 using a randomized complete block design with 4 replications. Eight characters were collected and analyzed for correlations and path coefficients. The results showed that the seed yield was strongly correlated with head diameter and plant height. Furthermore, seed yield was also positively correlated with percent seed set and 100-seed weight. A highly negative correlation coefficient was found between days to flower and oil content. Significantly positive correlations were found between percent seed set and number of seeds per head, head diameter and 100-seed weight and between number of seeds per head and oil content. The head diameter showed the highest positive direct effect on seed yield followed by plant height. In addition, the indirect effects of most characters were high through head diameter. Therefore, head diameter and plant height should be used in the selection for yield in sunflower. The results obtained from correlation and path analyses showed that the efficiency in the selection for seed yield in sunflower should increased through the selection of head diameter and plant height.

Keywords : Sunflower, correlation coefficient, path-coefficient analysis, agronomic characters

Introduction

Sunflower (*Helianthus annuus* L.) has become an important oil crop in the world with annual production of 20 to 25 million hectares worldwide in the present decade. It is a relatively new crop in Thailand where about 40,000 ha are grown annually. However, the production is not sufficient for domestic consumption in the form of oil and meal (Office of Agricultural Economics, 2007).

Sunflower breeders in Thailand are attempting to develop synthetic varieties to replace expensive imported hybrid seeds (Laosuwan, 2000). Synthetic varieties are naturally variable in yield and certain agronomic characters. The selection imposed on these varieties can directionally improve characters such as seed yield and agronomic characters. However, selection for yield

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directly is difficult due to low heritability of the character. Indirect selection using yield components may increase seed yield of synthetic varieties of sunflower. Fick *et al.* (1974) found the relationship between seed yield and many characters, including yield components, of sunflower. Furthermore, among yield components, seed size was the most important yield-related character (Miller and Fick, 1997; Hladni *et al.*, 2006). Therefore, selection based on yield components may increase seed yield of sunflower. Moreover, path coefficient analysis may be used to partition the correlation coefficients into direct and indirect effects to clarify the relationship between different characters with the seed yield.

The objectives of this research were to investigate the relationships among some agronomic and yield characters and to verify the direct and indirect effects of certain characters on seed yield of sunflower.

Materials and Methods

This study was conducted on the Suranaree University of Technology experimental farm (SUT Farm), Nakhon Ratchasima, in the North-eastern region of Thailand (lat. 16° N) during 2006. Twelve candidate synthetic varieties and 4 checks developed for high oil content by Suranaree University of Technology (Laosuan, 2000) were evaluated. These varieties were S471-SE, S471-TE, S471-TL, S473-TL, HOC-SE, HOC-SL, HOC-TE, HOC-TL, MOC-SE, MOC-SL, MOC-TE, MOC-TL, and the checks were S471, S473, HOC, and MOC. The experiment was conducted in November, 2006 and a randomized complete block design with 4 replications was used. Each plot consisted of four 6-m rows with spacings 75 cm between rows and 25 cm between hills. Each hill was planted with 3-4 seeds and thinned to one seedling per hill 12 days after germination. Fertilizer formula 15-15-15 (N, P₂O₅, and K₂O₅) was applied at the rate of 40 kg rai⁻¹ at planting and 25 days after germination. Weed control was done manually at 25 days after germination to give a free weed condition. Diseases and insects were controlled by regular applications of fungicides and insecticides. Overhead sprinkler

irrigation was applied once a week as there was no rain in the planting season.

Eight characters were collected from the two central rows. They were days to flower, percent seed set, number of seeds per head, head diameter, plant height, 100-seed weight, oil content and seed yield. Days to flower was recorded as the number of days from planting to the opening of 50% of flower in each plot. Ten heads per plot were selected at random from the interior portion of the two central rows for determination of percent seed set and number of seeds per head. Head diameter and plant height were measured as the average of all plants from the central rows of each plot at the stage of physiological maturity. The weight of 100 seeds was recorded as the average of three 100-seed samples. Oil content was reported as the average of 3 samples per plot. Two central rows were harvested for measuring seed yield. Phenotypic correlations were computed following the method shown by Weber and Moorthy (1952). Direct and indirect effects of the agronomic characters on yield were determined by the path-coefficient analysis after the method outlined by Wright (1921) and applied by Dewey and Lu (1959).

Results and Discussion

Correlations

The data for mean seed yield and other characters of 16 entries of sunflower are presented in Table 1. The means for plant height, number of seeds per head, days to flower and oil content were significantly different, whereas means for yield, percent seed set, head diameter and 100-seed weight were not significantly different. Although the differences in means for seed yield were not significant, certain varieties tended to give a higher seed yield than others, especially HOC-SL, MOC and MOC-SL. Further tests are required to determine the potential of these varieties. Most varieties were high in oil percentage and many varieties gave a similar level to S471, the high oil check variety. Phenotypic correlations among all characters are presented in Table 2. The correlation coefficients between seed yield with head diameter and plant height were 0.641 and 0.551, respectively, and

both were highly significant. Positive correlations were also found between seed yield and percent seed set (0.341*) and between seed yield and 100-seed weight (0.342*). These associations were supported by the results of many authors (Ahmad *et al.*, 1991; Marinkovic, 1992; Chikkadevaiah *et al.*, 2002; Satjawattana, 2005; Hladni *et al.*, 2006; Srimuenwai, 2006; Kaya *et al.*, 2007). Significant positive correlations were also found between percent seed set and number of seeds per head (0.429*), between head diameter and 100-seed weight (0.359*) and between number of seeds per head and oil content (0.393*). These results are in agreement with those reported by Ahmad *et al.* (1991) and Marinkovic (1992) who found strong positive correlation between 100-seed weight and head

diameter. However, a significantly negative correlation was found between days to flower and number of seeds per head (-0.511**). In addition, days to flower gave negative correlations with oil content and 100-seed weight (-0.342* and -0.309, respectively). The correlations of all characters with 100-seed weight were positive except days to flower. On the other hand, the correlations of most characters with days to flower were negative except head diameter and plant height. This experiment, which were also supported by many researchers, suggested that to ease the selection for seed yield of sunflower, especially synthetic varieties, it showed be made through the selection for head diameter and plant height.

Table 1. Means for yield and other characters of 16 synthetic varieties of sunflower

Entry	Yield (kg/rai ³)	PSS ¹ (%)	HD (cm)	PH ² (cm)	NS/H (no.)	100-SW (g)	DF (no.)	OC (%)
S471	347	70.2	15.6	153 bc	844 cd	6.24	59 d	43.1 a
S473	319	69.5	16.2	130 d	969 bcd	6.56	61 c	39.5 bcd
HOC	325	69.9	16.8	147 bc	1,122 bcd	6.36	62 bc	37.4 cd
MOC	354	70.9	16.5	171 a	884 bcd	6.52	61 c	35.6 d
S471-SE	305	68.8	15.8	148 bc	1,258 bc	6.02	59 d	41.8 ab
S471-TE	318	72.5	15.7	147 bc	1,670 a	6.92	60 cd	43.6 a
S471-TL	320	71.0	16.3	145 bc	1,048 bcd	6.75	60 cd	43.6 a
S473-TL	304	68.9	15.5	154 b	929 bcd	5.81	62 bc	38.8 bcd
HOC-SE	335	71.4	16.3	147 bc	1,154 bcd	5.67	62 bc	42.1 ab
HOC-SL	363	74.2	16.7	152 bc	1,330 ab	6.42	62 bc	40.9 abc
HOC-TE	285	69.8	15.3	139 cd	1,019 bcd	6.01	63 b	39.0 bcd
HOC-TL	331	69.2	16.2	143 bcd	1,161 bcd	6.29	62 bc	40.5 abc
MOC-SE	326	72.5	16.3	143 bcd	923 bcd	6.55	60 cd	40.2 abc
MOC-SL	351	66.9	16.4	154 b	999 bcd	6.67	62 bc	42.4 ab
MOC-TE	302	68.4	15.6	139 cd	970 bcd	6.11	61 c	41.5 ab
MOC-TL	320	69.5	16.6	154 b	764 d	6.23	65 a	39.6 bcd

¹ PSS = percent seed set, HD = head diameter, PH = plant height, NS/H = number of seeds per head, 100-SW = 100-seed weight, DF = days to flower, OC = oil content.

² Means within a column followed by the same letters are not significantly different at $P < 0.05$ according to DMRT.

³ 1 rai = 0.16 ha.

Path Analysis

Path coefficient analysis was used to partition the correlations between yield and characters related to yield into direct and indirect effects as shown in Table 3. Positive direct effects of head diameter and plant height on seed yield were high (0.603 and 0.450, respectively). Many researchers also reported the positive direct effect of head diameter and plant height on seed yield of sunflower (Ahmad *et al.*, 1991; Hladni *et al.*, 2006; Kaya *et al.*, 2007). However, various literature data (Alba *et al.*, 1979; Marinkovic, 1992) found that the direct effect of head diameter on seed yield was negative. This

contradictory evidence might be due to the environmental effect or difference in population used in the study. The direct effect of other characters on seed yield such as percent seed set, number of seeds per head, and oil content were all positive but quite low (0.099, 0.034, and 0.220, respectively). These were reflexed by low correlations of these characters with seed yield (Table 2). Among the above mentioned characters, noindirect effects were found to be important, even though some were positive. On the other hand, the direct effect on seed yield of 100-seed weight and number of days to flower were negative (-0.010 and -0.167, respectively). These results did not agree with the report by

Table 2. Phenotypic correlations among eight characters including seed yield for 16 synthetic varieties of sunflowers

Character	HD	PH	NS/H	100-SW	DF	OC	Yield
PSS ¹	0.245	0.080	0.429*	0.250	-0.198	0.059	0.341*
HD		0.285	-0.054	0.359*	0.282	-0.285	0.641**
PH			-0.165	0.024	0.063	-0.287	0.551**
NS/H				0.266	-0.342*	0.393*	0.110
100-SW					-0.309	0.177	0.342*
DF						-0.511**	-0.109
OC							0.021

¹PSS = percent seed set, HD = head diameter, PH = plant height, NS/H = number of seeds per head, 100-SW = 100-seed weight, DF = days to flower, OC = oil content.

Table 3. Direct and indirect effects of seven characters on seed yield of sunflower

	PSS ¹	HD	PH	NS/H	100-SW	DF	OC	Correlation
PSS	0.099	0.148	0.036	0.014	-0.002	0.033	0.013	0.341
HD	0.024	0.603	0.128	-0.002	-0.004	-0.047	-0.063	0.641
PH	0.008	0.172	0.450	-0.006	0.000	-0.011	-0.063	0.551
NS/H	0.042	-0.033	-0.074	0.034	-0.003	0.057	0.086	0.110
100-SW	0.025	0.217	0.011	0.009	-0.010	0.052	0.039	0.342
DF	-0.012	0.170	0.028	-0.011	0.003	-0.167	-0.112	-0.109
OC	0.006	-0.172	-0.129	0.013	-0.002	0.086	0.220	0.021

¹PSS = percent seed set, HD = head diameter, PH = plant height, NS/H = number of seeds per head, 100-SW = 100-seed weight, DF = days to flower, OC = oil content.

Marinkovic (1992) who found that high and positive direct effect of 100-seed weight and days to flower on seed yield of sunflower. However, in this study, seed size might express its influence on seed yield indirectly through head diameter, as it was found to be relatively high (0.217).

In this study, significant associations were found between seed yield with percent seed set, head diameter, plant height and 100-seed weight of sunflower but with head diameter and plant height were more important than others. The partitioning of these correlations showed that head diameter and plant height exhibited high direct effects on seed yield. Therefore, beside selection for yield *per se* which are practicing in breeding program of most crops, this study showed that selection for yield in sunflower may be done through these characters. However, seed size and percent seed set are also good indicator for seed yield. The results of this experiment should be implemented for improving synthetic varieties of sunflower.

Conclusions

From the above results, the head diameter and plant height have shown considerable direct positive effects on seed yield. Positive direct effect of head diameter and plant height associated with highly significant and positive correlation with seed yield. It is concluded that these characters may be good selection criteria to improve the seed yield of sunflower. Therefore, selection for seed yield of sunflower, especially synthetic varieties showed be made through the selection for head diameter and plant height

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