

PERFORMANCE OF HYBRID AND SYNTHETIC VARIETIES OF SUNFLOWER GROWN UNDER DIFFERENT LEVELS OF INPUT

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Abstract

Sunflower (*Helianthus annuus* L.) is an important oil crop grown in the central part of Thailand for oil and its field can be a tourist attraction. This experiment was aimed to evaluate the potential of hybrid and synthetic varieties of sunflower under different levels of input. Two hybrid varieties (Pac22 and Pac77) and four synthetic varieties (CM1, S471, S473 and LOC) were evaluated under four levels of input (Control, Low, Medium and High) by using a strip-plot design at Suranaree University of Technology Experimental Farm during August, 2009 and August, 2010. The results, averaged over all input levels, showed that hybrid varieties outyielded synthetic varieties by 6.62%. Pac77 yielded the highest at 2,000 kg ha⁻¹. Among synthetic varieties, LOC gave the highest yield at 1,894 kg ha⁻¹. The highest oil content was obtained from hybrid variety Pac77 (39.60%), while S471 gave the highest oil content for synthetic variety (35.47%). All characters of the sunflower were found to respond to increased levels of input. The yield and yield supporting characters including seed size, head size and shelling percentage responded in a quadratic manner.

Keywords: Sunflower, hybrid variety, synthetic variety, input level

Introduction

Sunflower (*Helianthus annuus* L.) has been grown in certain provinces in the central part of Thailand for oil and its field can serve as a tourist attraction. Popular varieties for farmers are hybrids which have to be imported from foreign countries. They are expensive for subsistent farmers and sometimes not available when needed. Recently, many synthetic varieties have been developed for temporary uses before the establishment of hybrid seed

production business in the country (Laosuwan *et al.*, 2001; Tungsagul *et al.*, 2001).

The term “crop production input package” was first coined by Laosuwan and Macartney in 1992 (Laosuwan and Macartney, 1992) for evaluation of crop varieties suitable with different planting conditions. The levels of input in each package were obtained from the combination of levels of fertilizer application, weed control, irrigation and other

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managements. It was found in peanut that the medium input level gave similar yield with the high input level, but the cost of package was lower while the net income was higher (Laosuwan and Juntaraniyom, 1990).

The objective of this study was to evaluate the performance of hybrid and synthetic varieties of sunflower grown under different levels of input.

Materials and Methods

Six varieties of sunflower were compared under different input levels at Suranaree University of Technology Experiment Farm, Nakhon Ratchasima, during August, 2009 and August, 2010. The sunflower varieties were two hybrids including Pacific 22 (Pac22) and Pacific 77 (Pac77) and four synthetic varieties including Chiangmai 1 (CM1), Suranaree 471 (S471), Suranaree 473 (S473) and Low Oil Cross (LOC). Levels of input derived from the combination of different rates or numbers of irrigation, fertilizer applications and weed control (Table 1).

The experiment was conducted in a strip-plot design with 3 replications. The horizontal treatments were 6 varieties of sunflower, while the vertical ones were 4 levels of input. Each plot consisted of 6 rows of 6 m in length with spacings 75 cm between rows and 25 cm between hills. Three to four seeds were planted in each hill and were thinned to one plant per hill 10-12 days after emergence.

The measurements of characters were conducted as follows:

Seed yield: Three central rows were harvested to estimate yield. Before harvest, the end plants at both ends of each row were trimmed to eliminate the bias of estimation. The yield was recorded at 12% moisture content in kg per hectare.

Seed size: The seed size of each plot was recorded in grams per 100 seeds by using the mean of 3 samples of 100 seeds, each of which was taken from the seed of each plot.

Head size: The head size of each plot was the average in centimeter of 10 randomly selected heads measured before harvest.

Shelling percentage: The shelling percentage was calculated from the proportion of weight of seed to the weight of head before threshing. Ten randomly selected heads were used for each plot.

Days to flowering: Days to flowering were the number of days from planting to the mean of number of days which 10 plants flowered.

Plant height: The average of stem length in centimeter of 10 randomly selected plants in each plot measured from the ground level to the top of the plant just beneath the disk flower.

Oil content: Three samples of seed from each varieties were analyzed in laboratory by using AOAC method. The mean of 3 samples was used as the representative of oil content of each varieties.

Table 1. Input levels used for evaluation of sunflowers

Input Levels	Irrigation (A) ⁽¹⁾	Fertilizer (B) ⁽²⁾	Weeding (C) ⁽³⁾	Treatment
Control	1	1	1	A ₁ B ₁ C ₁
Low input	2	2	2	A ₂ B ₂ C ₂
Medium input	3	3	2	A ₃ B ₃ C ₂
High input	4	3	3	A ₄ B ₃ C ₃

⁽¹⁾ Irrigation: 1 = sustainable rate; 2, 3 and 4 = irrigated every 15, 10 and 5 days, respectively.

⁽²⁾ Fertilizer: 1 = no fertilizers applied, 2 = 15-15-15 NPK fertilizer applied 125 kg ha⁻¹, 3 = 15-15-15 NPK fertilizer applied 125 kg ha⁻¹ twice.

⁽³⁾ Weeding: 1 = no weed control except hilling up, 2 = weed control once plus hilling up, 3 = continuous weeding to give weed free condition.

Results and Discussion

Varieties, input levels and their interactions were highly significant ($P < 0.01$) for all characters indicating the different potentials of these sunflower varieties and their responses to levels of input (Table 2). Mean values for all characters measured on sunflower varieties are shown in Table 3. The highest yield was given by Pac77 (2000 kg ha⁻¹) followed by Pac22 (1994 kg ha⁻¹), both were hybrid varieties. Among synthetic varieties, the highest yield was obtained from LOC (1894 kg ha⁻¹).

The mean for seed yield of two hybrid varieties was 6.62% higher than that of the four synthetic varieties, indicating the high yield potential of hybrids over synthetic varieties. Other reports showed that hybrids gave a better yield than synthetic varieties (Piasai and Laosuwan, 2009; Sutjawattana and Laosuwan, 2002). The two hybrid varieties and two synthetic varieties (CM1 and S471) gave similar seed size (5.86-5.90 g/100 seeds). Small seed sizes were found in S473 (5.07 g/100 seeds) and LOC (5.13 g/100 seeds). Head size of all varieties ranged from

Table 2. Results from analysis of variance of 7 traits of 6 varieties of sunflower grown under different levels of input of Nakhon Ratchasima

Sources	df	Yield	Seed size	Head size	Shelling	Day to flowering	Height	Oil content
Replications	2	ns	ns	ns	ns	ns	ns	ns
Varieties (V)	5	**	**	**	**	ns	**	**
Inputs (I)	3	**	**	**	**	**	**	**
V × I	15	**	**	**	**	**	**	**

**, ns = statistically significant at $P < 0.01$ and not significant, respectively.

Table 3. Mean values of seed yield and other characters of 6 varieties of sunflower

Variety	Seed yield ⁽¹⁾	Seed size	Head size	Shelling	Days to flowering	Height	Oil content
	(kg ha ⁻¹)	(g/HS) ⁽²⁾	(cm)	(%)	(no.)	(cm)	(%)
Pac22	1,994 ^a	5.90 ^a	15.27 ^a	64.70 ^a	65	167.94 ^b	35.92 ^b
Pac77	2,000 ^a	5.86 ^a	15.20 ^a	64.78 ^a	65	165.23 ^b	39.60 ^a
CM1	1,888 ^b	5.89 ^a	14.90 ^b	63.28 ^b	63	172.02 ^a	33.99 ^d
S471	1,869 ^b	5.89 ^a	14.38 ^c	63.07 ^b	63	166.18 ^b	35.47 ^c
S473	1,837 ^c	5.07 ^b	14.77 ^b	62.08 ^c	62	166.38 ^b	33.78 ^c
LOC	1,894 ^b	5.13 ^b	14.74 ^b	62.48 ^c	62	168.22 ^b	35.33 ^c

⁽¹⁾ Mean values followed by different letters are significantly different at $P = 0.01$ by DMRT.

⁽²⁾ HS = One hundred seeds

14.38 to 15.27 cm and the biggest head of 15.27 was obtained from Pac22. The range of 62.08% to 64.78% was obtained for shelling percentage. The highest shelling percentage (64.78%) came from Pac77. The number of days to flowering ranged from 62 to 65 days and hybrid varieties tended to flower late. CM1 exhibited the tallest plant height (172.02 cm), whereas the highest oil content was given by Pac77 (39.60%). Among the synthetic varieties, S471 gave the highest oil content of 35.47%.

The responses of sunflower to input levels were positive for all characters (Table 4). The lowest mean yield of all varieties of 1179 kg ha⁻¹ was obtained from the lowest level of input or control, A₁B₁C₁, whereas the highest mean yield of 2291 kg ha⁻¹ was gained from the highest level, A₄B₃C₃. However, this was not significantly different from the mean yield given by the medium input level, A₃B₃C₂, at 2267 kg ha⁻¹. Similar responses were also found for other characters. The lowest mean values for seed size, head size, shelling percentage, days to flowering, plant height and oil content were found at the control level (A₁B₁C₁), increased to the low input level (A₂B₂C₂) and to the medium input level (A₃B₃C₂), but tended to stagnate at the high input level (A₄B₃C₃), indicating that these were the maximum responses for these

characters. It was evident that the increase of seed yield associated with the increase of yield supporting characters, i.e. seed size, head size and shelling percentage. When these characters were stagnated, seed yield did not increase further. Similar findings were found in peanut applied with lime and fertilizers that when yield components stagnated, seed yield did not increase (Laosuwan and Juntaraniyom, 1990).

The responses of the 6 varieties of sunflower to input levels are shown for all characters in Table 5. Seed yield and other characters of all varieties increased with the increase of input levels. The increases of yield and yield supporting characters due to increased levels of input for 6 varieties are shown in Figure 1. Hybrid varieties, Pac22 and Pac77, outyielded synthetic varieties only at low input levels but the yields of all varieties were similar at the high input levels. This may suggest that synthetic varieties perform well at the high input levels. The increase of seed size of S473 and LOC stagnated at the low level (A₂B₂C₂) but that of others went on further and seemed to decrease at the highest level (A₄B₃C₃). The increase of head size took the same trend for all varieties, but hybrid varieties tended to give larger seed at all levels except at the highest level at which the seed size of all varieties became

Table 4. Mean values of seed yield and other characters of 6 varieties of sunflower obtained different levels of input

Variety	Seed yield ⁽¹⁾	Seed size	Head size	Shelling	Days to flowering	Height	Oil content
	(kg ha ⁻¹)	(g/HS ⁽²⁾)	(cm)	(%)	(no.)	(cm)	(%)
A ₁ B ₁ C ₁	1179 ^c	4.77 ^d	10.65 ^c	50.73 ^c	55 ^c	168.98 ^c	32.68 ^c
A ₂ B ₂ C ₂	1908 ^b	5.67 ^c	15.86 ^b	63.94 ^b	59 ^b	169.87 ^b	35.14 ^b
A ₃ B ₃ C ₂	2267 ^a	6.10 ^a	16.54 ^a	69.54 ^a	60 ^a	176.10 ^a	37.43 ^a
A ₄ B ₃ C ₃	2291 ^a	5.96 ^b	16.46 ^a	69.54 ^a	60 ^a	175.69 ^a	37.48 ^a

⁽¹⁾ Mean values followed by different letters are significantly different at $P = 0.01$ by DMRT.

Table 5. Mean values for seed yield and other characters of 6 varieties of sunflower obtained from different levels of input

Variety	Variety Input	Seed yield ⁽¹⁾	Seed size	Head size	Shelling	Days to flowering	Height	Oil content
		(kg ha ⁻¹)	(g/HS ⁽²⁾)	(cm)	(%)	(no.)	(cm)	(%)
Pac22	A ₁ B ₁ C ₁	1255 ^c	5.11 ^c	10.93 ^b	51.40 ^c	55 ^c	151.60 ^b	31.90 ^c
	A ₂ B ₂ C ₂	2075 ^b	5.93 ^b	16.23 ^a	66.03 ^b	59 ^b	169.13 ^a	36.47 ^b
	A ₃ B ₃ C ₂	2314 ^a	6.43 ^a	17.00 ^a	71.30 ^a	60 ^b	175.57 ^a	37.50 ^a
	A ₄ B ₃ C ₃	2313 ^a	6.13 ^b	16.57 ^a	70.07 ^a	62 ^a	175.48 ^a	37.80 ^a
Pac77	A ₁ B ₁ C ₁	1248 ^c	5.12 ^c	11.03 ^b	51.63 ^c	54 ^c	149.23 ^b	36.57 ^c
	A ₂ B ₂ C ₂	2074 ^b	5.88 ^b	16.50 ^a	66.80 ^b	58 ^b	164.97 ^a	38.43 ^b
	A ₃ B ₃ C ₂	2339 ^a	6.30 ^a	16.83 ^a	70.07 ^a	59 ^b	172.80 ^a	41.73 ^a
	A ₄ B ₃ C ₃	2326 ^a	6.18 ^a	16.43 ^a	70.63 ^a	61 ^a	173.90 ^a	41.70 ^a
CM1	A ₁ B ₁ C ₁	1163 ^c	5.15 ^c	10.60 ^c	51.50 ^c	55d	152.70 ^c	29.33 ^d
	A ₂ B ₂ C ₂	1862 ^b	5.56 ^b	15.73 ^b	62.77 ^b	58 ^c	169.40 ^b	33.47 ^c
	A ₃ B ₃ C ₂	2219 ^a	6.52 ^a	16.67 ^a	69.57 ^a	60 ^a	181.97 ^a	36.23 ^b
	A ₄ B ₃ C ₃	2265 ^a	6.33 ^a	16.63 ^a	69.27 ^a	59 ^b	184.00 ^a	36.90 ^a
S471	A ₁ B ₁ C ₁	1125 ^c	4.68c	10.27 ^b	50.07 ^c	54.30 ^b	147.63 ^b	33.97 ^b
	A ₂ B ₂ C ₂	1874 ^b	5.81 ^b	15.43 ^a	64.67 ^b	60.10 ^a	171.90 ^a	33.77 ^b
	A ₃ B ₃ C ₂	2267 ^a	6.53 ^a	15.90 ^a	68.60 ^a	60.47 ^a	174.23 ^a	37.27 ^a
	A ₄ B ₃ C ₃	2275 ^a	6.52 ^a	15.93 ^a	68.93 ^a	59.63 ^a	170.93 ^a	36.87 ^a
S473	A ₁ B ₁ C ₁	1121 ^d	4.21 ^c	10.73 ^c	49.37 ^c	54.63 ^b	145.40 ^b	30.07 ^c
	A ₂ B ₂ C ₂	1776 ^c	5.50 ^b	15.80 ^b	62.33 ^b	60.30 ^a	171.63 ^a	34.50 ^b
	A ₃ B ₃ C ₂	2195 ^b	5.33 ^{ab}	15.97 ^b	68.37 ^a	59.50 ^a	174.30 ^a	35.47 ^a
	A ₄ B ₃ C ₃	2266 ^a	5.23b	16.60 ^a	68.27 ^a	59.93 ^a	174.20 ^a	35.10 ^a
LOC	A ₁ B ₁ C ₁	1137 ^c	4.36 ^b	10.30 ^d	50.40 ^c	54.83 ^b	147.33 ^b	34.27 ^b
	A ₂ B ₂ C ₂	1789 ^b	5.35 ^a	15.50 ^c	61.03 ^b	59.10 ^a	172.17 ^a	34.13 ^b
	A ₃ B ₃ C ₂	2318 ^a	5.44 ^a	16.93 ^a	69.33 ^a	59.57 ^a	177.73 ^a	36.37 ^a
	A ₄ B ₃ C ₃	2305 ^a	5.36 ^a	16.27 ^b	69.17 ^a	59.97 ^a	175.63 ^a	36.53 ^a

⁽¹⁾ Mean values followed by different letters are significantly different at $P = 0.01$ by DMRT.

comparable. The increase of shelling percentage was similar to that of seed yield. The highest percentage for all varieties was obtained at medium input level ($A_3B_3C_2$). Oil contents of all varieties also were found to increase in response to increased levels of input, but the rates were slow (Figure 2). The oil content of hybrid varieties was higher than those of synthetic varieties at all levels of input.

Conclusions

In this experiment, both hybrid and synthetic varieties were evaluated for their responses to input levels. It was not unexpected that seed yield and many characters of hybrids were higher than those of synthetic varieties. This was due to their genetic background as the hybrids were developed from crossing

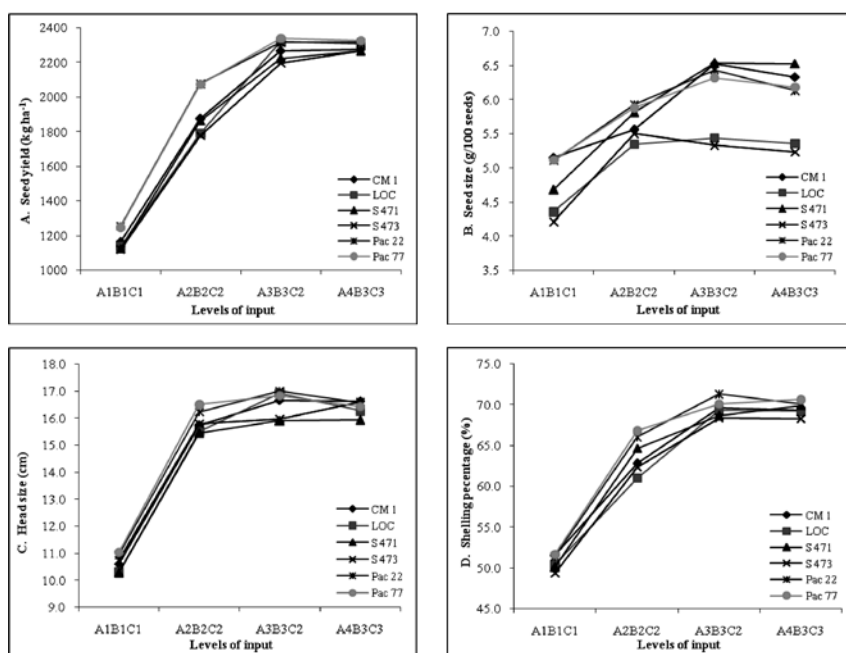


Figure 1. Yield and yield components of 6 varieties of sunflower receiving 4 input levels (A = Seed yield, B = Seed size, C = Head size, D = Shelling percentage)

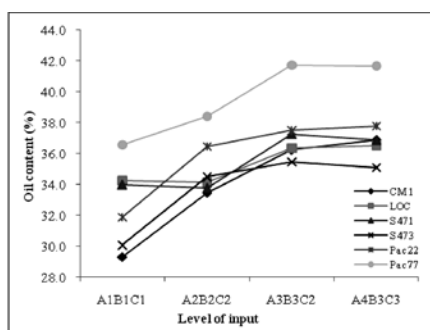


Figure 2. Oil content of 6 varieties of sunflower receiving 4 input levels

between elite inbred lines but synthetic varieties were selected from the composition of lines or open-pollinated varieties. This study showed that the yield, head size, shelling percentage and oil contents of hybrid were significantly higher than those of synthetic varieties. Among the hybrids, Pac77 should be more favourable than Pac22 as it gave higher yield and oil content, but both gave similar seed size, head size, shelling percentage, days to flowering and plant height. Among the four synthetic varieties,

S471 and LOC should be more acceptable than others due to their favourable seed yield and oil contents.

The responses of the six varieties of sunflower to increased levels of input were found for all characters. The increase of seed yield, seed size, head size and shelling percentage seemed to follow quadratic trend and all become stagnated at medium input level ($A_3B_3C_2$) indicating that further increase of input did not contribute to these characters, particularly to seed yield. This recommends that the medium input level should be applied to sunflower.

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