PERFORMANCE OF SYNTHETIC VARIETIES OF SUNFLOWER

Satjawattana, K.[1] and Laosuwan, P.[1*]

Abstract

Synthetic varieties of sunfower may be suitable for the present crop production system in Thailand. Ten synthetic varieties developed from 13 high oil lines and two check entries including DOA synthetics and Pacific 33, were evaluated for yield and other characters in two seasons in 1998 - 2000 using a randomized complete block design with four replications. The results showed that synthetic varieties flowered earlier and were shorter than Pacific 33, the check variety. However, the synthetics showed a longer range of flowering period and were more variable in height than the check. The score for head quality showed that most synthetics gave similar score to the check and DOA synthetics. Seed size of synthetic varieties ranged from 5.31 - 6.17 grams/100 seeds, whereas that of Pacific 33 was 5.41 grams/ 100 seeds. Seed yield of synthetic variety Low Oil (OP) was as high as 2.28 t/ha, whereas that of Pacific 33 was 1.91 t/ha. The results from the two seasons showed that most synthetics gave similar oil content to Pacific 33. This experiment showed the potential of these synthetics and that further yield trials are required before they can be released to farmers.

Key words: sunflower breeding, synthetic varieties, oil content.

Introduction

Sunflower (*Helianthus annuus* L.) is an important oil crop of the world. It is grown mainly in Europe, USA and Canada. The seed of this crop is rich in high quality oil which is suitable for human consumption. Sunflower is a relatively new crop in Thailand and was first grown as an oil crop in about 120 ha in 1989 but increased to about 112,000 ha in 2000 (Saengphrathum, personal communication). This rapid expansion of the production requires a lot of seed for planting which resulted in the increase of the import of hybrid seed. Sunflower breeding in Thailand is still in initial stage and the development of synthetic variety to be used as a stop gap variety is most suitable.

Hayes and Garber (1919) recommended that synthetic varieties of corn can be used for production in a commercial scale. This procedure can be applied to other open-pollinated crop like sunflower. In Thailand, attempts were made independently by investigators at the Department of Agriculture (DOA) and Kasetsart University beginning in 1986 to develop synthetic or composite varieties. Sunflower lines were developed by DOA, testcrossed with Hysun 33 and eight lines were identified for their superiority to combine into synthetic varieties (Kaewmeechai *et al.*, 1992). At Kasetsart University, 36 bulks were selected from open-crosses among 67 varieties of sunflower and were recombined for

[1] *School of Crop Production Technology Suranaree University of Technology, Muang, Nakhon Ratchasima 30000.*

[*] *Corresponding Author*

five generations to form a composite varieties (Yothasiri, 1992). However, such a breeding program has to be given a higher priority over a longer time span before the success can be achieved. This program at some institutes was discontinued due to the short of support (Laosuwan, 1997). The objective of this study was to evaluate the performance of synthetic varieties of sunflower developed at Suranaree University of Technology.

Materials and Methods

Plant materials

Plant materials used in this study was developed at Suranaree University of Technology as of 1994 as follows:

1. Dry season - 1994. Yield trial of 17 hybrid varieties was conducted using Pacific 33 as the check.

2. Late wet season - 1994. Equal amount of F2 seed was taken from each variety, mixed thoroughly and planted for open pollination.

3. Dry season - 1995. Seeds harvested from the previous season were planted for open pollination. At harvest, 400 heads were selected for medium height, strong neck, good head shape, seed color and harvested separately.

4. Late wet season - 1995. Seeds harvested in the previous season were planted head-to-row. Good rows were selected, selfed and 100 rows was selected at harvest. Each head was harvested separately.

5. Dry season - 1996. Seeds harvested in the previous season were planted head-to-row, selfed and 30 rows, one head per row, were harvested.

6. Late wet season - 1996. Seeds ware divided into two parts. The first part was analyzed for oil percentage. The second part was planted for selfing and bulkñpollen crossing to test for general combining ability (gca).

7. Dry season - 1997. Yield trial of bulk-pollen cross hybrid. Thirteen lines were selected based on oil percentage and gca, using selfed seed in step 6.

Breeding Procedures

In the late wet season - 1997, the thirteen lines of sunflower were separated into three groups according to oil parentage and were named High Oil, Medium Oil, and Low Oil and planted in isolation to produce synthetic varieties by using two procedures as follows:

(1) *Bulk pollination methods* : Pollens were collected from all lines within groups and were dusked upon flowers of each lines in the morning of each day until the receptive period of each head completed.

(2) *Open pollination methods* : Open pollination of each group was allowed.

Yield Trial

All synthetics produced by the above procedures together with Synthetic DOA a commercial hybrid variety Pacific 33 were tested in yield trials for two seasons in 1998 at Suranaree University of Technology Experimental Farm, Nakhon Ratchasima, NE Thailand using a randomized complete block design with four replications. Five row plots were used with row width of 70 cm and plants within row were spaced 25 cm apart. Fertilizer formula 15-15-15 NPK was applied at 187.5 kg/ha at planting. The following observations were taken:

1. *Flowering periods* : Differences between days to first flowering and days to 100 percent flowering.

2. *Height (cm)* : Height of stem was measured at flowering on ten random plants from three central rows of each plot.

3. *Head quality* : Recorded as 1-5 scores to compare with Pacific 33 as follows:

Score 1 : Highly deformed head and the rate of pollination was less than 50 percent of disc flower.

Score 2 : Rather deformed head and had a rate of pollination about 50 percent of disc flower.

Score 3 : Good quality with none deformed head and had a rate of pollination about 70 percent of disc flower.

Score 4 : Good quality head and had a rate of pollination more than 70 percent of disc flower.

Score 5 : Best quality head and had a rate of pollination about 100 percent of disc flower.

4 *Seed size (gram)* : Recorded as 100 seed weight.

5 *Seed yield (t/ha)* : Seed yield per ha calculated as :

$$\text{Seed yield (t/ha)} = \frac{\text{Yield per plots (gram)}}{1{,}000{,}000 \text{ grams}} \times \frac{10{,}000 \text{ m}^2}{\text{Harvested area (m}^2\text{)}} \times \frac{100-12}{100-X}$$

Table 1. Combined analysis of yield trials of synthetic varieties of sunflower grown in 1998 - 2000.

Sources of Variation	df	MS				
		Seed yield	Plant height	Head score	Seed size	Range of flowering
Seasons (S)	1	4328.55	459.33	0.30	0.76	1650.04
Rep/Season	6	7021.93	162.49	0.93	0.97	7.98
Varieties (V)	11	16910.14**	1753.58**	0.94**	0.66	22.29**
S x V	11	2863.68	371.79*	0.14	0.39	22.34**
Pooled error	66	1932.52	158.09	0.14	0.69	5.80
CV(%)		14.10	7.70	11.60	14.5	28.30

* = *significant at 0.05 level.*

** = *significant at 0.01 level.*

Table 2. Seed yield, oil content and 100 seed weight of synthetic varieties of sunflower.

Variety	Seed yield[a, b] (t/ha)	Oil[c] (%)	Weight of 100 seed (g)
1. High Oil 1 (Cross)	2.09 bc	38.16	5.66
2. High Oil 1 (OP)	1.74 d	40.53	5.83
3. High Oil 2 (Cross)	2.05 bcd	37.82	5.51
4. High Oil 2 (OP)	2.11 bc	35.37	5.57
5. Medium Oil 1 (Cross)	1.85 cd	36.82	5.94
6. Medium Oil 1 (OP)	1.83 cd	38.44	6.03
7. Medium Oil 2 (Cross)	1.87 cd	40.73	5.29
8. Medium Oil 2 (OP)	1.37 e	38.84	5.22
9. Low Oil (Cross)	1.82 cd	40.22	5.89
10. Low Oil (OP)	2.28 ab	39.85	5.85
11. Pacific 33	1.91 cd	41.54	5.75
12. Synthetic DOA	2.51 a	32.25	6.16
F-test	**	ns	ns

[a] *Means of two seasons.*

[b] *Means followed by different letters are significantly different at P = 0.05 level by DMRT.*

[c] *ns = not significant.*

Results and Discussion

Significant differences were found for seed yield, plant height, head quality and ranges of flowering of sunflower (Table 1). The interactions between varieties and seasons were not significant for all characters except plant height and ranges of flowering. This indicates that these characters except plant height and ranges of flowering were in the same order of importance in both seasons.

Seed Yield

In this study, Pacific 33, the check, yielded 1.91 t/ha. DOA synthetic, a synthetic variety developed by the Department of Agriculture, Thailand, gave the highest seed yield of 2.51 t/ha which was higher than the check, Pacific 33. Many synthetic varieties developed in this study tended to give a higher yield than the check. These synthetics were Low Oil(OP), High Oil 2(OP), High Oil 1(Cross) and High Oil 2(Cross) (Table 2). This study showed that the yield of synthetic varieties was at least similar to the check. The use of synthetic varieties of crops has been recommended where the growing conditions is unadequate or high level of input cannot be employed (Allard, 1960, Briggs and Knowles, 1967). Thus, these synthetic varieties, after being thoroughly selected and refined, can be used in many areas where the farmers cannot employ the optimum inputs.

Oil Content

The highest oil content (41.54%) was found in Pacific 33, the check (Table 2). The second importance were Medium Oil (Cross) (40.73%) and High Oil (OP) (40.53%). The lowest oil content was found in Synthetic DOA (32.25%). Other synthetic varieties developed in this program gave acceptable levels oil content. We found in this study and other reports that oil content of sunflower varies according to seasons.

Seed Size

Weight of 100 seeds of all entries was not significantly different. The range of seed size was from 5.22 to 6.16 grams per 100 seeds. However, variation in seed size of sunflower both within and among varieties was found in many experiments depending on seasons and stresses (Khunnual *et al.*, 2001 ; Laosuwan *et al.*, 2001).

Disc Quality

The quality of the disc of many synthetic varie-

Table 3. Score for head quality, ranges of flowering period and plant height.

Variety[a]	Head score[b] (score)	Range of flowering (day)	Plant height (cm)
1. High Oil 1 (Cross)	3.47 b	10 a	162 cd
2. High Oil 1 (OP)	3.20 bcd	8 ab	145 d
3. High Oil 2 (Cross)	3.13 bcd	9 a	166 bcd
4. High Oil 2 (OP)	3.13 bcd	7 ab	163 bcd
5. Medium Oil 1 (Cross)	3.96 a	6 b	156 cd
6. Medium Oil 1 (OP)	3.28 bc	9 a	166 bcd
7. Medium Oil 2 (Cross)	3.46 b	8 ab	162 cd
8. Medium Oil 2 (OP)	2.66 e	11 a	142 d
9. Low Oil (Cross)	2.97 cde	10 a	162 bcd
10. Low Oil (OP)	2.82 de	10 a	168 bc
11. Pacific 33	3.13 bcd	6 b	198 a
12. Synthetic DOA	2.93 cde	10 a	181 b
F-test	**	**	**

[a]*Cross = control pollination, OP = open pollination*
[b]*Quality score : 1 = highy deformed head, 5 = best quality head with about 100% pollination*

ties developed in the project was comparable to the check (Table 3). Medium Oil 1(Cross) gave the highest quality of 3.96, whereas Low Oil (OP) gave the lowest quality of 2.82. This character of the synthetic varieties will be improved further in future selections.

Days to Flowering

Generally, synthetic varieties of crop plant are not as uniform as hybrids for most characters as they are the mixture of many genotypes. However, these characters should be within the acceptable ranges. The range of flowering period of synthetic varieties developed in this program was higher than the check, Pacific 33, for one to five days. This is acceptable (Table 3).

Plant Height

Although the height of individual plants of the synthetic varieties were not as uniform as the check, Pacific 33, but the average height of each synthetic varieties was lower. The height of 11 synthetic varieties was significantly shorter than Pacific 33, the check (Table 3). Among synthetic varieties, Medium Oil (OP) was the shortest (141 cm) and Low Oil(OP) was the tallest (168 cm). Pacific 33 and Synthetic DOA gave respective height of 198 cm and 181 cm. However, plant height of sunflower was found to vary according to seasons, spacing and stresses (Khunnual *et al.*, 2001; Laosuwan *et al.*, 2001).

Conclusion

This report provides preliminary tested results for synthetic varieties of sunflower developed in our breeding program. The results show a good possibility in obtaining varieties that can be released to farmers. We concentrated on oil content rather than yield performance since the farmers are not ready to utilize the optimum or high input. In this situation, the best yielder would be of no value. The synthetic varieties developed gave good yield and high oil percentage similar to the check, Pacific 33.

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