

# Breeding of apetalous and dwarfish line APL03(*Brassica napus*)

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## Abstract

APL03 (*Brassica napus* L.), an apetalous and dwarfish rapeseed line was developed from a cross of a petalous canola line ZH004 and an apetalous line APL01. Results from observation showed that 100% of plants performed apetalous in APL03 population, and over 90% of flowers gave apetalous on each of individual plants. APL03 showed 130-140cm in plant height, set 400 pods per plant and gave a seed oil content of 43%-47%. APL03 was also characterized with lodging resistance and stem rot disease tolerance. It can be used as parental line in a breeding program to develop a variety with a particular agronomic traits required for mechanization management of rapeseed production.

**Key words:** *Brassica napus*, Apetalous, Short plant height, variety, breeding

## Introduction

Transferring the apetalous character to high yield rapeseed variety is recruiting high attention in rapeseed breeding owing to its advantages of higher solar energy utilization efficiency, low disease incidence, strong root assimilation effect, and high yield potential (Buzza 1983; Medhan et al., 1991; Fu et al., 1990, 2001). The apetalous hybrid variety "Hylite200TT" was registered in Australia (Pacific Seeds 1999). The author takes the apetalous character as ideotype breeding, after the apetalous germplasm APL01 was bred in 1980's (Fu et al 1995). In this program, APL01 was used as parent, the traditional breeding method was combined with molecular marker assisted selection in order to breed the new varieties, which combine the apetalous character with superior quality, high yield, high oil content and disease resistance (Fu et al 1996; Zhang et al 1998). The process of breeding of apetalous line APL03 with short plant height and its potential in rapeseed breeding were reported in this paper.

## Material and method

The normal petalous variety ZH004 with canola character and apetalous line APL01, which provided by Institute of Industrial Crops, Jiangsu Academy of Agricultural Sciences, were used as two parents in apetalous rapeseed breeding. The contrast Zhongshuang 9 was provided by Institute of Oil Crops, National Academy of Agricultural Sciences.

The normal petalous variety ZH004 was crossed with apetalous line APL01, plants with 0-3 petals were selected from generation F<sub>2</sub>-F<sub>3</sub>, the segregation in plant height was found in the population of generation F<sub>4</sub>. The plants with apetalous and short plant height character were selected for several generations, the apetalous and short height character was stabilized (Table 1).

The agronomic traits, the organization of stem, the disease resistance and lodge resistance were tested in traditional method. The oil content in seed was tested using Buchi B-811 oil content analyzer according to the method of GB/T5512. The fatty acid composition in oil was tested using Agilent 6890N gas chromatogram analyzer according to the method of GB10219-1988. The design of lines comparison test was 3 replicates, the plot was 4m×1.6m. The agronomic traits were the mean of 10 plants.

**Table 1 Breeding procedure of APL03**

Year	Generations	Traits selected	Treatments
1995	F <sub>0</sub>		Cross
1996	F <sub>1</sub>	Normal petalous	Inbreed
1997-1998	F <sub>2</sub> -F <sub>3</sub>	Apetalous	Inbreed
1999	F <sub>4</sub>	Apetalous and short plant height	Inbreed
2000-2002	F <sub>5</sub> -F <sub>7</sub>	Apetalous and short plant height	Inbreed
2003-2005	F <sub>8</sub> -F <sub>10</sub>	Agronomic and resistances	Inbreed in isolated plot

## Results

**Occurrence of apetalous and dwarf plants in segregation population** It was reported that the F<sub>1</sub> and RF<sub>1</sub> in the crosses between normal and apetalous lines were with normal petalous. The number of petals segregated in F<sub>2</sub>, and the inheritance of petal number was controlled by 2-4 pairs genes (Buzza 1983; Fu et al 1995, 2001). So we planted one large population in (ZH004/APL01) F<sub>2</sub>. Among 562 F<sub>2</sub> population plants, two plants with 0-3 petal were obtained, and the others were all with normal petalous plants. The lodge resistance of these two plants was significantly higher than APL01. In F<sub>3</sub> generation, plant height was used for selection except apetalous trait. In the four selected lines 98A51, 98A52, 98A53 and 98A54, the plant

height of 98A54 was segregated significantly, the range of plant height was 87.5-174.6cm. After evaluating the plant from plant-type and economic traits, plants with the height between 131-145cm was selected. Owing to the height of two parents were about 160cm, the appearance of the plant with the height of 131-145cm should be the overparent inheritance.

The plants in stable APL03 population were all apetalous, and over 90% flowers were apetalous on each individual plants. The pistil, stamen and nectar were all normal except the loss of petal in flower organ. The plant height of APL03 was 130-140cm in maturity (Fig 1).



Fig. 1 Flower and plant of APL03

**The performance of main traits of APL03** The plants with 130cm height in 98A54 were selected after selfing and compared for several generations. The line with stabilized apetalous and short plant height traits in F<sub>6</sub> generation was named APL03.

In 2003-2005, the agronomic traits of APL03 were compared with the lodge resistant, high yield canola Zhongshuang 9. Table 2 showed that, in comparison with Zhongshuang 9, APL03 was characterized with shorter plant height, lower branch height, more branch and silique and larger seed. Among the three factors related to seed yield, APL03 had more silique, larger seed weight, fewer seeds per silique, which led to higher yield per plant.

**Table 2 Comparison of agronomic traits between APL03 and Zhongshuang 9**

Variety	Plant height (cm)	Branch height (cm)	No. of branches		Silique per plant	Silique length (cm)	Seeds per Silique	1000 seed weight (g)	Yield per plant(g)
			Primary	Secondary					
APL03	135.3	26.6	10.3	4.5	418.0	5.9	23.6	4.05	39.9
Zhongshuang 9	153.9	45.8	8.3	4.6	386.2	5.7	24.3	3.75	35.2

The main stem of rapeseed was composed by short stem, stretch stem, bole stem and main rachis. Different variety had different combination of these four stems, which related with yield and lodge resistance (Fu et al 1983). In order to obtain high yield, the length of these four stems should be increased one after another (Fu et al 1983). Compared with Zhongshuang 9, the short stems of APL03 were not different, the stretch stem was decreased by 57.8%, but the bole stem and main rachis was increased by 28.1% and 21.5%, respectively. The decrease of stretch stem in APL03 led to the short plant height, low branch height, and strong lodge resistance, while the increase of bole stem and main rachis led to high yield potential (Table 3).

**Table 3 Comparison of stem composition between APL03 and Zhongshuang9**

Variety	Short stem(cm)	Stretch stem(cm)	Bole stem(cm)	Main rachis(cm)
APL03	3.4	24.2	52.4	62.2
Zhongshuang 9	4.2	57.3	40.9	51.2

Both parents, APL01 and ZH004, were low erucic acid lines, and the offspring generations were all selfed, which led to the fatty acid composition of APL03 similar as that of two parents. After selected for several generations, the lines with more than 65% oleic acid and less than 8% linoleic acid was obtained, such as APL03-2. The oil content of APL03 was higher than its parents and reached more than 45%, which should be related to seed-color. The seed of APL03 was plumped, shining and brown-yellow.

**Table 4 Fatty acid composition and oil content of APL03**

Lines	Fatty acid composition (%)							Oil content (%)
	16:0	18:0	18:1	18:2	18:3	20:1	22:1	
APL03	4.04	1.85	61.80	18.27	10.34	1.18	0.00	46.68
APL03-2*	4.10	2.05	65.14	17.37	7.09	1.37	0.55	45.55
APL01	3.96	2.07	61.93	18.51	11.22	1.51	0.20	41.78
ZH004	4.18	2.08	63.26	20.41	7.50	1.91	0.35	43.69

\*APL03-2: High oleic acid line in APL03

Like its male parent APL01, APL03 was characterized with apetalous trait, which led to the avoidance of *sclerotinia*. In 2005, the disease incidence and disease index of stem rot in APL03 were 5.55% and 4.55%, while that of Zhongshuang 9 were 10.23% and 7.29%, respectively. APL03 was strongly resistant to lodge in the period from the end of flowering to maturity. In addition, the plants in APL03 population matured at the same time.

## Discussion

The results of rapeseed plant structure and ideotype research showed that apetalous had important effect in rapeseed ideotype construction (Fu et al 1996,2001; Zhang et al 1998). APL03, which was bred from the cross of high yield variety and apetalous line, had several advantages. Firstly, owing to the disease avoidance, the incidence of *sclerotinia* in APL03 was lower than other variety. Secondly, in plant structure, the length of short stem was shorter than stretch stem, bole stem and main rachis. Especially, the stretch stem was significantly shorter than usual variety, which led to short plant height, strong lodge resistance, thick pod layer, more silique and large seed. Thirdly, the harvest index of APL03 was 0.286, which significantly higher than that of normal variety--about 0.252 (Zhang FC et al 1996). In a word, APL03 had the main characters required for mechanization management of rapeseed production. The inheritance of short stem and lodge resistance in APL03 will be studied in the future.

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