Agronomic performance and seed quality of a new source of yellow seeded *Brassica oleracea*

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Abstract

Brassica oleracea var acephala is one of the viewing plants in China, the leaf of the wild materials is floweriness but the agronomic characteristics are very poor. In 1990, some seedlings of *B. oleracea var acephala* were planted in the farm of Southwest University, the pedigree selecting had been done in later years. In 1994, some yellow-seeded plants in one of the wild materials were found. After more than ten generations of pedigree selecting and selfing by peeling bud, 35 yellow-seeded inbred lines with different characteristics have been bred, some of the lines have shorter growth period(<230 d), light seed color(100% yellow seed rate and 80% yellow-seeded degree), higher oil content(about 40%), better agronomic characteristics and yield. Some of the lines have lower glucosinolate (68.66—87.96μmol/g cake), and the components of glucosinolate are much different than that of *B. napus L.*, especially indole-glucosinolate is lower than canola(5.26—5.37μmol/g cake). The seedcoat rate of the yellow-seeded *B. oleracea var acephala* was 15.76%-19.79%, thicker than that of yellow-seeded B.napus.

Embryo rescue and double chromosome technique were applied to obtain interspecific hybrids between *B. rapa* and *B. oleracea var. aceaphala*, the seed color in first generation of artificial synthesized *B.napus* was brown, there were some yellow-seeded plants found in second or third generation. The seed color in F1 between the yellow-seeded lines of artificial synthesized *B.napus* and other yellow-seeded lines (*B.napus*) was brown too, which means that the yellow-seeded genes in *B. oleracea var. aceaphala* were different from that of *B. napus.* Very strong heterosis of the yield were found in F1 between the lines of artificial synthesized *B.napus* and other *B.napus* lines.

Key words: *Brassica oleracea var acephala,* resynthesized *B.napus*, yellow-seeded lines, intersubgenomic heterosis

Introduction

The yellow-seeded *Brassica. napus* L. have been one of the most important objects in rapeseed breeding because the yellow-seeded *B. napus L.* has a series of advantages. However, it is quite difficult to breed a perfect yellow-seeded *Brassica. napus* L. (AACC) material as a result of infrequent yellow-seeded genes, especially in C genome. Some researchers wanted to transfer the yellow-seeded genes in C genome from *B. carinata* (BBCC) to *B.napus* L. (Rashid A. 1994), however the agronomy characteristics of the resynthesized yellow-seeded *B. napus* were always very poor in primal generations. Chen et al. (1998) crossed light brown-seeded *B. alboglabra* with yellow-seeded *B. rapa* for the creation of yellow-seeded *B. napus*, but the seed color of resynthesized *B. napus* plants was light brown seed.

Brassica oleracea var acephala (2n=18) is one of the ornamentals in China, the leaf of the wild materials is floweriness but the agronomic characteristics are very poor. In 1990, some seedlings of *B. oleracea var acephala* were planted in the farm of Southwest University, the pedigree selecting had been done in later years. In 1994, some yellow-seeded plants in one of the wild materials were found, from then on some work about the improving and research of *B. oleracea var acephala* had been done in Southwest University, Chongqing, China.

Materials and methods

35 yellow-seeded inbred lines with different characteristics had been bred after more than ten generations of pedigree selecting and selfing by peeling bud, the main agronomic and qualitative traits of some yellow- and black-seeded inbred lines of *B. oleracea* var. *acephala*, with the wild type of *B. oleracea* var. *acephala* and *B. napus L.* cultivar *Zhongyou 821* as check, were observed in field experiments in 1999~2000 and 2000~2001.

Embryo rescue and double chromosome technique were applied to obtain interspecific hybrids between yellow-seeded *B. rapa* (A^rA^r) and yellow-seeded *B. oleracea var. aceaphala* (C^oC^o), the resynthesized yellow-seeded *B.napus* lines ($A^rA^rC^oC^o$) with yellow-seeded genes both in A^rA^r and C^oC^o had been gotten. The seed color in the generations of the artificial synthesized yellow-seeded *B.napus* and the heterosis of the hybrids ($A^rA^nC^oC^n$) with other yellow-seeded *B.napus* lines ($A^nA^nC^nC^n$) were observed in past five years.

Results

1. the inbred lines of B. oleracea var. aceaphala

All wild materials of *B. oleracea var. aceaphala* were strong winter types for keeping the ornamental period as long as possible, usually sow the seeds in August and blossom in April nest year, the whole generation was more than 250 days.

After more than ten generations of pedigree selecting and selfing by peeling bud, the agronomic characteristics and yield had been improved remarkably (see Table 1). The inbred lines of *B. oleracea var. aceaphala* had lower plant height with shorter main anthotaxy, but more branch number and seeds/pod than that of *B.napus*, the yield per plant was same or higher than that of Check *Zhongyou 821*.

Table 1 Agronomic performance of *B. oleracea* var. *aceaphala* inbred lines(2000)

lines	Plant height (cm)	Primary branch number	Pods in main raceme	Seeds/pod	1000-seed weight (g)	Seed weight/ plant (g)	Growth period (d)
C104	137	16	41	15.35	3.2	25.80	235
C105	145	18	77	20.45	3.2	31.60	231
C106	144	15	72	19.30	3.2	18.20	224
C107	127	19	48	19.20	3.2	22.20	225
C108	127	16	59	16.10	2.8	16.40	220
C109	153	19	71	17.90	3.0	23.00	229
C119	115	16	40	25.30	3.6	33.90	234
Average	135.4	17	58.29	19.09	3.17	24.44	228
Zhongyou821 (*B.napus* CK)	207	12	103	16.90	3.10	20.80	219

In 1994, some yellow-seeded plants with yellow-brown seed colour trait in one of the wild materials of *B. oleracea var. aceaphala* were found. By the pedigree selection, the seed color of some yellow-seeded inbred lines became bright yellow and some kept yellow-brown, the heredity of the yellow seed trait in yellow-seeded *B. oleracea var. aceaphala* could be stable and the behavior was just as same as in yellow-seeded *B. napus L.*. The qualitative characteristics of some yellow- and black-seeded *B. oleracea* var. *aceaphala* were analyzed in 2001(Table 2 and Table 3).

Table 2 qualitative characteristics of yellow- and black-seeded *B. oleracea* var. *aceaphala* (2001) (%)

lines	yellow seed rate	yellow-seeded degree**	oil content in seeds	testa content	oil content in embryo	protein content in embryo
C102 (y*)	100	65	44.24	19.79	48.02	44.18
C103 (y)	98	70	37.69	18.63	44.08	44.96
C108 (y)	100	80	40.24	15.76	47.87	41.07
C112 (y)	100	60	36.91	17.76	46.31	45.96
Average			39.77	17.98	46.57	44.04
C105(b)			38.77	16.39	45.23	43.31
C108(b)			36.37	16.92	42.07	47.77
C119(b)			37.18	15.36	44.47	50.84
Average			37.44	16.22	43.93	47.31
ZhongYou821 (*B.napus* CK)			37.75	14.36	44.90	40.04

Note: *y-yellow-seeded line, b-black-seeded line; ** the yellow-seeded degree of *B.rapa* with bright yellow seed was confirmed as 100%.

Table 3 The contents of glucosinolates components in *B. oleracea* var. *aceaphala* and *B. napus L*(μmol/g meal)

components	*B. oleracea* var. *aceaphala**		*B. napus L*** (Li P.W. et al,2005)	
	03k08	03k15	Middle level	Low level
Desulfoprogoitrin	17.44	23.13	12.36	3.8
Desulfogluconapin	4.67	0.42	8.80	3.60
Desulfogluconapoleiferin	0.06	0.06	0.72	0.45
Desulfoglucobrassicanapin	0.06	0.07	1.45	0.71
Desulfo-4-hydroxyglucobrassicin	5.22	5.08	7.42	7.36
Desulfoglucobrassicin	0.01	0.01	0.40	0.43
Desulfo-4-methoxyglucobrassicin	0.13	0.16	0.18	0.16
Desulfo-1-methoxyglucobrassicin	0.01	0.01	0.15	0.16
3-methylsulfoxide-propyl- glucosinolate	15.55	27.57	0	0
Propenyl-glucosinolate	41.24	0	0	0
Desulfoglucotropaeol	3.31	11.72	1.12	1.20
Desulfoglucoalyssin	0.06	0.13	0.51	0.33
Desulfoglucoraphanin	0.04	0.15	0.37	0.21
Desulfogluconasturtin	0.16	0.15	4.03	4.38
total	87.96	68.66	37.51	22.79

Note:* the data was analyzed by Oil Crops Research Institute of Chinese Academy of agricultural Science in 2003; **the data was the average of 499 lines *B. napus*.

2. the resynthesized yellow-seeded B. napus with yellow-seeded genes in AA and CC genomes

The seed color of the first generation of the resynthesized *B.napus* lines ($A^rA^rC^oC^o$) with yellow-seeded genes both in A^rA^r and C^oC^o was brown, some yellow-seeded plants were found in the second or third generation and the yellow-seeded inbred lines with bright yellow seeds and normal yield were bred in 2000 (Table 4).

3. the heterosis of F1 and BC1 between the yellow-seeded resynthesized B.napus *($A^rA^rC^oC^o$)and other yellow-seeded* B.napus *lines ($A^nA^nC^nC^n$).*

In past five years, more than 100 crosses between the yellow-seeded lines of resynthesized *B.napus* and other *B. napus* lines had been observed, most of the hybrids with $A^nA^rC^nC^o$ genomes showed stronger heterosis than hybrids with $A^nA^nC^nC^n$ genomes (Table 4), which was an example of intersubgenomic heterosis. However, the seed color in F1 between the yellow-seeded lines of artificial synthesized *B.napus* and other yellow- seeded lines (*B.napus*) (even some yellow-seeded lines had yellow-seeded genes from *B. carinata*) was brown too.

Table 4 Heterosis of some agronomic characters in (ArACrC) hybrids(2003)

line	Plant height (cm)	Branch position (cm)	Main raceme length (cm)	Primary branch number	Pods of main raceme	Total pods/ plant	Seeds/pod	Yield/ Plant (g)
Check	167.4	46	57.6	10.4	83.4	554.9	21.6	40.1
K116	183.6	54.4	53.4	13	90	589.8	20.0	41.3
A	222.6	91.2	72.6	9	88.4	564	29.2	57.4
B	213.4	77.6	66.6	10.4	73	666.8	21.8	50.9
C	209.8	84.2	60.4	8.2	73.2	536.4	29.1	54.7
K166	242.2	98.4	69	11.2	101.8	830	22.0	64.0
K168	232.6	77.4	77	11.2	110	821.2	23.3	67.0
K170	220.4	63.6	74.8	11.8	117.4	989.4	27.8	96.2
Crosses	202.3	60.2	60.6	10.9	95.6	653.4	22.4	50.2

Note: 1) the data is the average value of 10 plants; 2) Check was inbred line of *Zhongyou 821* with $A^nA^nC^nC^n$; K116 was a line with $A^rA^rC^oC^o$; 3) A, B, C were hybrids with $A^rA^nC^oC^n$; 4) K166, K168, K170 were hybrids of $A^rA^nC^oC^n \times A^nA^nC^nC^n$; 5) Crosses was the average of ten F1 with $A^nA^nC^nC^n$ genomes.

Conclusions

1) improved yellow-seeded *B. oleracea* var. *aceaphala* inbred lines have quite perfect agronomic characteristics and the relative yield traits of the resynthesized yellow-seeded *B. napus* from them are as same as normal *B. napus* ($A^nA^nC^nC^n$), the yellow seed rate, yellow seed degree and qualities of yellow-seeded *B. oleracea* var. *aceaphala* are quite good, so it is the best provider of the yellow-seeded genes from C genomes.

2) the seed color in the first generation of the resynthesized *B.napus* lines with yellow-seeded genes both in A^rA^r and C^oC^o and in F1 between the yellow-seeded lines of resynthesized *B.napus* and other yellow-seeded lines (*B.napus*) was brown too, which means that the yellow-seeded genes in *B. oleracea var. aceaphala* were different from that of *B. rapa* and *B. carinata.*

3) the testa content of yellow-seeded *B. oleracea* is thicker than that of black-seeded *B. oleracea* and *B. napus;* which is much different than that in *B. napus*.

4) the contents of glucosinolates components in *B. oleracea* are much different from low glucosinolate *B. napus*, maybe *B. oleracea* var. *aceaphala* is a new provider of low glucosinolate genes.

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