OIL CROPS: BRASSICA SUBNETWORK

PROCEEDINGS OF THE THIRD WORKSHOP, QUALITY TRAINING, AND CHINESE PROJECT REPORTS, HELD IN SHANGHAI, PEOPLE'S REPUBLIC OF CHINA, 21–24 APRIL 1990

ABBAS OMRAN



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July 1993

Oil Crops: Brassica Subnetwork

Proceedings of the Third Workshop, Quality Training, and Chinese Project Reports, held in Shanghai, People's Republic of China, 21–24 April 1990

> Edited by Abbas Omran Technical Advisor, Oilcrops Network

Organized by Ministry of Agriculture, Beijing, China and International Development Research Centre, Ottawa, Canada

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE Ottawa • Cairo • Dakar • Johannesburg • Montevideo • Nairobi • New Delhi • Singapore

12100 VIII 1993 16

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ISBN 0-88936-670-5



Printed on recycled paper

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2. INSTITUTE OF OILCROPS CHINESE ACADEMY OF AGRICULTURAL SCIENCES, WUHAN, CHINA

Chengqing Liu

GENERAL OBJECTIVES

1. Selecting and identifying rapeseed varieties:

To select and breed low erucic acid varieties and low erucic acid-low glucosinolate varieties which are adaptable to the upper and middle reaches of Yangtze River in China.

2. Improving breeding techniques:

To investigate methods of shortening breeding time and identifying *Sclerotinia sclerotiorum* resistance or tolerance in rapeseed varieties.

3. Investigating suitable methods for the analysis of erucic acid and glucosinolates.

ACHIEVEMENTS AND RESULTS

1. <u>Selection of low erucic acid and</u> <u>double-low varieties</u>

During the first and second periods of the project, three single-low varieties and three double-low varieties (*B. napus*) were bred up. Among these, 5 have been licensed by the provincial government. Their names and origins are described as follows:

Zhongdi* No. 1 (81002), by systematic selection from Ganyou 5. Zhongdi* No. 2 (81007), from the cross of Ganyou 5 x Expander. Zhongdi* No. 3 (81008), from the cross Oro x Shanghai 2413. Zhongshuang** No. 1 (84001), from (84008 x Ganyou 5) x PB52. Zhongshuang** No. 2 (84004), from Start x Ganyou 5. Zhongshuang** No. 3 (84039), from Ru3 x Ganyou 5.

Note: *Zhongdi means single low

(erucic acid), and ** Zhongshuang means double-low (erucic acid and glucosinolates).

A. <u>Quality</u>:

The qualities of the six varieties are in accordance with the requirements of quality determinants. Results of several years' testings showed that contents of erucic acid and glucosinolates of those six varieties were less than 1% and 25 μ mole/g respectively, oil contents varied from 41% to 43%, all of which were higher than the oil contents of the double high varieties cultivated widely in our country, Table 1.

B. <u>Yields</u>:

Yields of the improved varieties were equal to or higher than those of the check local commercial cultivated varieties.

Single-low varieties: Zhongdi No. 2 and Zhongdi No. 3 were approved with high yields in regional tests. The yield of Zhongdi No. 2 was almost equal to that of the check Ganyou 5 while the yield of Zhongdi No. 3 was even higher than that of check, Table 2.

> The three varieties have been popularized and put into production in upper and middle reaches of Yangtze River as well as in Henan and Anhui provinces. According to statistics, accumulative cultivated areas of Zhongdi No. 1, Zhongdi No. 2 and Zhongdi No. 3 have achieved 600,000 mu (40,000 ha), 900,000 mu (60,000 ha) and 1,846,800 mu (123,100 ha) individually. It was proven by productional activities both in Hubei and Yunnan that Zhongdi No. 2 and Zhongdi No. 3 possessed good production potentials, exceeding

		Components of fatty acid (%)							
Varieties	C16:0	C18:0	C18:1	C18:2	C18:3	C20:1	C22:1	(unnol/g)	Content (%)
Ganvou 5(CK)	3.57		15.15	13.95	9.49	10.78	47.06		39.43
8 2 1 (CK)	3.51		12.25	13.74	9.87	40.96	47.52		41.00
Zhongdi No.1	3.42	1.75	63.72	22.14	9.81	1.02	0.21		42.00
Znongdi No.2	3.58	1.19	63.24	22.12	9.09	0.79	0.00		42.60
Zhongdi No.3	3.25	1.51	64.94	20.58	8.66	1.08	0.00		41.00
Zhongshuang 1	3.26	1.19	64.01	22.13	9.01	0.61	0.23	14-23.79	42.00
Zhonoshuang 2	3.27	1.21	64.18	22.05	8.97	0.68	0.05	13-22.10	43.00
Zhongshuang 3	3.29	0.31	63.76	21.98	9.10	0.72	0.16	14-25.13	42.00

Table 1. Quality characters of 5 improved varieties

Table 2. Yields of 3 single-low varieties in regional tests during 1982.

	Impro	ved variety	Check variety		
Place	Name	Yield (kg/mu)	+/-over Check _(5)	Name	Yield (kg/mu)
National Trials					
Middle Reaches of Yangtze River Middle Reaches of Yangtze River Upper Reaches of Yangtze River Provinancial Trials	Zhongdi No. 1 Zhongdi No. 2 Zhongdi No. 3	92.9 97.6 130.0	-13.0 -8.6 +4.4	Ganyo 5 Ganyo 5 Xinan 302	106.8 106.8 124.2
Hubei Province Hubei Province Sichvan Province Yunnan Province Guizhou Province	Zhongdi No. 1 Zhongdi No. 2 Zhongdi No. 3 Zhongdi No. 3 Zhongdi No. 3	111.2 121.2 134.0 185.8 133.4	-15.4 -7.8 +19.1 +4.6 +2.2	Ganyo 5 Ganyo 5 Yungyou 31 Qianyou 9	131.5 131.5 112.5 177.7 130.5

* 1 ha = 15 mu

the yields of the check varieties by 12-15% with a total area of 671,800 mu in Yunnan.

b. <u>Double-low varieties</u>: Results of regional tests conducted in the upper region along Yangtze River and in Yunnan province during 1986 to 1988 indicated that Zhongshuang No. 1 (84001) yielded as much as, or more than the check varieties. However, yields of Zhongshuang No. 2 (84004) and Zhongshuang No. 3 (84039) were significantly lower than that of the check Zhongyou 821, according to results of regional tests in the middle region along Yangtze River and during 1986 to 1989. Hubei Nevertheless, there were still 3 -4 test spots where those two low varieties yielded double significantly more than the check, Table 3.

Productional experiment is an essential and important process in

our country in complement to regional adaptation test. Its sample area is usually 0.5 - 1 mu multiplied 2 - 3 times. Results of productional experi-ments in various provinces showed that those three double-low varieties yielded much more than checks did in all cases, Table 4.

those three double-low When varieties were put into regional and productional tests, they were also cultivated widely at suitable places for demonstration. Although influenced by extremely low temperature and heavy infection of insects and diseases, those three varieties still increased in yield compared to check varieties, Table 5.

The cultivated area of Zhongshuang No. 1 reached 62,000 mu (4,133 ha) in three provinces of Southwest China, that of Zhongshuang No. 2

Table 5. Tretus of 5 doub	te-tow varieties	in regionat criat	s, 1700-00.		
Regions	Varieties (lines)	Sample yield (kg)	Yield kg/mu)	+/- over Check (%)	Comparison (5% <u>)</u>
Upper reaches of Yangtze	Zhongshuang 1 CK(Xinan302)	4.5936 4.4976	153.21	+2.19	not signifi.
Middle reaches of Yangtze	Zhongshuang 2 Zhongshuang 3 CK(Ganyou 5)	2.8130 2.8951 3.1501	93.77 96.50 105.01	-10.71 -8.51	significant not signif.

Table 3. Yields of 3 double-low varieties in regional trials, 1986-88.

Table 4. Yields of 3 double-low varieties in productional experiments.

Place	Year	Varieties (lines)	Yield (kg/mu)	+/- over Check (%)	Comparison
Yunnan province	1986-89	Zhongshuang 1	230.00	+16.0	Significant
Sichuan province	1988-89	Zhongshuang 2 CK(Xinan 302)	153.70	+30.9	High signif.
Guchen of Hubei province	1986-87	Zhongshuang 2 CK (821)	192.75	+25.44	Significant
Dayong of Henan province		Zhongshuang 2 CK(Xiangyou 11)	157.10 128.01	+18.52	High signif.
Runan of Henan province	1987-88	Zhongshuang 2 CK (Yuyou 1)	244.54 183.83	+33.03	Significant
Qicun of Hubei province	1987-88	Zhongshuang 3 CK (Ganyou 5)	125.60 106.01	+15.60	Significant
Jian of Jiangxi province	1987-88	Zhongshuang 3 CK (Xinan 302)	101.20 87.22	+14.80	Significant

Table 5.	Yield of	3 double-low va	rieties in l	arge scale	cultivations at	various p	olaces,	1987-90.
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Place	Varieties	Year	Area (mu)	Yield (kg/mu)	+/- over Check	Area (mu)	Yield (kg/mu)
Yunnan province	Zhonashuana 2	1987	34, 18	231.62		0.33	325.75
	Zhongshuang 2	1989	11000.00	190.20	+23.80	1.27	442.23
	Zhongshuang 2	1990	44930.00				
Gucheng of Hubei province	Zhongshuang 2	1987	378.10	153.20	+24.00	935.00	
· ·	Zhongshuang 2	1988	9000.00	90.00	+15.70	2.10	154.00
	Zhongshuang 2	1989	28000.00	108.00			243.80
	Zhongshuang 2	1990	38000.00				
Qichun of Hubei province	Zhongshuang 3	1987	36.20	113.50		1.20	
-	Zhongshuang 3	1988	375.00	113.80		3.20	136.10
	Zhongshuang 3	1989	869.50	127.40			156.30
	Zhongshuang 3	1990	5500.00				
Jian of Jiangxi	Zhongshuang 3	1989	5000.00	66.00	3.2-14.2		
Wanzai ofJiangxi	Zhongshuang 3	1989	200.00	125.20	15.27		
-	Zhongshuang 3	199 0	4000.00				

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accumulated about 400,000 mu (26,000 ha) in four provinces of Central China, that of Zhongshuang No. 3 got more than 25,000 mu (1,666 ha) in Hubei and Henan. It is expected for them to get a great development in production this year.

C. <u>Adaptability</u>:

All six varietie possessed. Relatively high adaptability. Among them Zhongdi No. 3, Zhongshuang no.1 and Zhongshuang No 3 matured early and were best adapted to upper and middle reaches of Yangtze River where 3 seasons of crops were harvested, Table 6. Zhongdi No. 1, Zhongdi No. 2 and Zhongshuang No. 2 best adapted to middle and lower reaches where only 2 seasons of crops were harvested.

D. <u>Resistance</u>:

- a. <u>Cold hardiness</u>: After several years' tests, especially after the happening of the serious cold in and long rains, low 1987 temperature, and rains, low temperature, and rare light during the spring of that year, it could be seen that, excluding Zhongdi No. 1 and Zhongshuang No. 3, the cold hardness of the other forur varieties were significantly stronger than that of the check For varieties. example, Zhongshuang No. 1 was successfully cultivated for the first time at Beisa village of Lijian county, Yunnan province, where rapessed had not been suitableto grow originally because of high altitude (1,800 - 2,400) m and low temperature. Owing to its strong cold hardiness, Zhongshuang No. 1 yielded the highest in history at that village with the yield of 200 kg/mu. During the Winter of 1987, the temperature at Hubei province decreased rapidly from 22°C to about - 7°C, and continued over a few days. In the Spring of 1988 there was a great snow fall when rape was flowering in Hubei. Tests of cold hardiness in these two seasons indicated that Zhongshuang No. 2 was much stronger than the check in Hubei, Table 7.
- b. <u>Resistance or tolerance to</u> <u>diseages</u>: Diseases identified by natural inoculation in large area tests and by artificially

inoculating in the laboratory had been made for years. Among the six single- and double-low varieties, the tolerance to S. sclerotiorum of "Zhongshuang No. 2" and "Zhongdi No. 2" can reach or surpass double-high "Zhongyou 821" which is considered as the best tolerant variety in China, and "Zhongshuang No. 2" also resists virus disease, Tables 8 & 9. The two varieties have the best resistance to S. sclerotiorum among the same kind of varieties in China.

2. <u>Research on improving breeding</u> <u>techniques</u>

A. <u>Simple technique of vernalization</u> to double generations in Wuhan region:

In Wuhan region rapeseed is harvested in Summer. The seeds are taken to sprout. The sprouts are put under 2°C - 5°C condition for 25 - 30 days Then they are to be vernalized. transferred to grenhouses. Next January, the second generation can be harvested. Having been artificially vernalyzed again, the third generation can mature late June. This method can keep the full and half winter hardiness of varieties and avoid that these varieties can flower normally by not the traditional method where the seeds are planted in high mountain areas and are vernalized by natural low temperature. It is also cheaper.

B. <u>Breeding for Sclerotinia</u> <u>resistance</u>:

been It has confirmed that differences of tolerance to Sclerotinia between varieties really exist. Heritability of tolerance is High to low tolerance is high. partially dominant. The crossing effects is high x high > high x low > low x low. There are no significant difference between the directions of reciprocal crossing. Back - crossing effects are obvious, Tables 9,10 &11.

3. <u>Research on assay methods of erucic</u> <u>acid and glucosinolates</u>

Under the support of Canadian experts, by cooperation of scientists from Shanghai, Jiangsu Agricultural Sciences Academy and Huazhong Agriculture University, the achievements were made as follows:

- a) The standardization of determination of erucic acid contents of rapeseed has been finalized. Now it has been adopted in breeding.
- b) The standardization of determination of glucosinolates is being established.
- c) There are a number of rapid methods for determination of erucic acid and glucosinolates, which are further being compared.

4. The cooperation experiment of identifying tolerance to S. sclerotiorum between Manitoba University and China

The cooperative experiment was decided in October, 1989. Becuase the seeds were not received on time, sowing was late. In flowering time, identification was made by inoculating on ex-leaves. The results showed that 2 - 3 varieties are with higher tolerance.

Table 6. Growth duration and adaptable regions of the six varieties.

Variety	Growth duration	Maturing date	Maturing compared	date to CK	Regions best suited
Zhongdi 1	220-225	17-18 May	3-4 days l	later	Middle & lower reaches of Yangtze River, Henanand Anhui provinces
Zhongdi 2 Zhongdi 3 Zhongshuang 1 Zhongshuang 2 Zhongshuang 3	220-225 205-210 206-210 220-227 210-215	18-20 May 4-6 May 4-6 May 18-20 May 4-6 May	3-4 days l 0 3-4 days l 2-3 days e	later later earlier	Same as Zhongdi 1 Upper reaches of Yangtze River Same as Zhongdi 3 Same as Zhongdi 1 Same as Zhongdi 1

Table 7. Resistance to freezing of Zhongshuang 2 in regional trials and large area test.

	Regional trials		Large area tests		
	1*	2*	3*	4*	5*
CK (821) Zhongshuang 2	72.90 68.80	40.10 36.80	57.70 16.00	36.30 10.00	57.30 3.20

Frigid damage plant propor, 2. Index of frigid damage, 3. Frigid damage plants propor. in seedling time,
 Broken plants propor. in flowering time, 5. Broken branches propor. in flowering time.

Table 8.	Naturally	/ identifying	results of	resistance	to Sclerotinia	of Z	hongdi 2	and Zhongshuang	, 2.
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Regional			<u>Sclerotinia (%)</u>		<u>Virus disease</u>	
trials	Varieties	Years	Disease rates	Disease index	Disease rates	Disease index
Hubei provinance	Zhongdi 2	1982-85	29.59	15.17		
	CK (Ganyou 5)		40.37	19.58		
	Zhongshuang 2	1987-89	13,10	4.90	14.33	5.32
	CK (821)		19.10	6.50	22.22	8.26
The middle reaches of Yangtze River	Zhongdi 2	1982-85	12.86	6.87	1.12	1.16
	CK (Ganyou 5)		20.67	11.44	1.82	1.79
	Zhongshuang 2	1986-88	13.57	6.87	11 .8 0	4.53
	CK (Ganyou 5)		26.85	15.24	14.30	5.32
The lower reaches of Yangtze River	Zhongdi 5	1982-85	21.79	11.24	10.57	7.43
	CK (Ningyou 7)		30.71	19.47	8.78	6.16
The reaches of Huang and Huai Rivers	-	1988-89	5.70	3.56	4.17	2.45
······································	Zhongshuang 3 CK (Qinyou 3)		41.01	37.15	9.13	7.51
Large area test in gucheng of Hubei		1987-88	8.83	6.20		
······································	Zhongshuang 2 CK (Ganyou 5)		28.40	8.16		

Varieties ^{**}	Size of disease spots (cm²)	Comparison	
039	17.86	a	
381	15.79	ab	
Ganyou 5	14.02	ab	
Zhongdi 2	13.12	bc	
081	13.00	bc	
821	9.05	cd	
Zhongshuang 2	8.43	d	

Table 9. Artificially inoculating in lab, results of resistance to to <u>sclerotinia</u>.

* Ex-leaves inoculating given by Builey D.T. was adopted ** 039 is double-low line. 381 and 081 are double-high lines

Table 10. Hertibility of tolerance to Sclerotinia.

Inoculation time	Materials	Average lengths of disease spots	Variance	Broad-sense hertibility	
Seedling period	84039 821x84039 84039x821 821 Rul 8400xRul Rulx84004 84004	4.00 3.40 3.26 2.94 3.85 2.74 2.94 2.70	0.25 0.50 0.56 0.18 0.54 1.20 1.32 0.73	56.0 60.9 47.0 52.0	
Flowering period	84039 821x84039 84039x821 821	5.45 3.68 2.73	1.15 2.13 2.13 0.35	64.8 59.5	

Table 11. Back-cross effects on the tolerance from back-cross parents.

	(821x8439)F2	[(821x8439)x8439]82	[(821x8439)F1x821]B1
Average lengths of disease spots (cm)	3.67	4.30	3.36
Ranges of Varieties	1.6-5.4	3.1-5.6	1-5.0

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