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# The selection and application of TuMV resistant germplasm of Chinese cabbage

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**Summary** "8407" is a disease resistant germplasm of Chinese cabbage which is highly resistant to turnip mosaic virus(TuMV),selected by the Vegetable Institute,Hebei Academy of Agricultural and Forestry Sciences. In 1985 and 1989,it was approved and accepted as one of the national disease resistant germplasm of Chinese cabbage by the National Expert Group. The identification in 1989 showed that "8407" was highly resistant or immune to 19 TuMV strains from 10 provinces/cities across the country. Therefore ,it was regarded as the best germplasm both vertically and horizontally resistant to TuMV of Chinese cabbage. This germplasm was selected from Chang Paodan(Inner Mongolia)of Qingmaye system after 6 generations of successive self cross. Using the disease resistant germplasm of "8407",we developed new multi-resistant varieties of "8361"and"8612"in 1983 and 1986 respectively,which was highly resistant to TuMV and downy mildew and soft rot. These varieties have been extended to an areas of over 20000 ha.

**Key words** Chinese cabbage,disease resistant germplasm,turnip mosaic virus

## Introduction

For many years,several diseases severely affected the yield and quality of Chinese cabbage (*Brassica campestris* L. ssp *pekinensis* Rupr). Especially the three major diseases of virosis,downy mildew and soft rot are the major difficulty which the plant protection scientists and breeders expect to resolve. Since 1980s,disease resistant breeding of vegetable has been widely conducted,and the selection of disease resistant germplasm have become the breeder's major target. This research activity started in 1976 and finished in 1983. By means of natural inducement,manual inoculation and recurrent selection,we successfully developed disease resistant germplasm of Chinese cabbage of "8407",which has been successfully utilized in vegetable breeding program. Two new varieties,"8612"and"8361"were released,which are characterized with mid/late maturity,high and stable yield,multi-disease resistance and cylinder form. In 1986,1988 and 1992,the three most severe disease years,the variety of 8361 showed high yield and disease resistance. The average yield of 8361 is higher than that of control variety of Yuqing by 54.84% in 8 years running. The variety has been extended to an area of over 20000 ha.

## Materials and methods

From 1976 to 1978,we widely collected various genetic germplasm with different ecological type and observed and selected in the field. Since 1978 we started self crossing using Chang Paodan (Inner Mongolia) of Qingmaye system, Yuqing, Fudong No. 1 and artificially crossed multi-relationship materials as the parent materials. According to breeding goal we selected the expected material by pedigree single plant method. After successive 5 generations of self cross,the index of incompatibility was tested in 1982. Combining ability was tested in 1983. From 1984 to 1985,susceptible varieties were planted in the field to induce

natural occurance of disease, and field selection and identification was conducted. Meanwhile, TuMV strains were inoculated in the climatic laboratory. Selections and identifications were conducted both indoors and in the field.

*Indoor selection and identification in the climatic laboratory*

The materials were soaked in 50 C water for 3—4 hours and then pregerminated for 24 hours in incubator at 25 C. After germination seeds were planted in the plastic tray in the way of hole distance of 5cm × 5 cm. The temperature was controlled at 18—25 C during daytime, and at 16—18 C at night. When 3 or 4 leaves came out, the TuMV was inoculated by frictional methods. The seedlings inoculated with the virus were kept at 17—18 C under dark condition for 24 hrs, then the light treatment was conducted at 15 klux for 6 days and nights. After that the light was given during daytime and stopped at night. Survey was made based on the standards of 9 grade commonly used in the world 20 days later.

*Field selection and identification*

Each material was planted in 2 rows, and 16 plants each row. One susceptible row was established for every 4 materials. Field investigations were made 3 times during the growing period to calculate the incidence rate of disease and the disease index.

## Results

"8407" was developed from 3562 single plants which were the progeny of Chang Paodan (Inner Momgolia) of Qingmaye system through self-crossing for 6 generations (see Figure 1). All horticultural characters of 7th plant (code number is 8407) met the breeding objectives, and its compatibility index was between 0. 1—0. 6. The 5th generation became basically stable in these characters. In addition the excellent characters of Qingmaye such as thin outside leaves, good taste and compact head, strong disease resistance remained unchanged (see Table 1). The field observation showed that the resistance to virosis was basically stable since 1983. In addition it was highly resistant to downy mildew and soft rot.

**Table 1.** The performance of "8407" self-cross incompatibility line for successive several years

| Year | Generation | Index of virosis | Index of compa. | Variation of population | Head character |
|---|---|---|---|---|---|
| 1980 | F3 | 12. 3 | 4. 5 | Segregation | Compact |
| 1981 | F4 | 1. 8 | 0. 7 | Light segreg. | Medium |
| 1982 | F5 | 0 | 0. 6 | Basic. stab. | Medium |
| 1983 | F6 | 0 | 0. 6 | Stable | Medium |
| 1984 | F7 | 0 | 0. 1 | Stable | Medium |

Laboratory identification showed that disease index of 8407 inoculated with Hebei TuMV 6 times was 0, indicating that it was immune to TuMV. In Aug. 1985, when it raced up to the national identification, it showed that it was not only highly resistant to Hebei local virus, but also highly resistant to the viruses from Beijing and Heilongjiang. In 1989, the tests were carried out in a lot of provinces of our country. The result showed that "8407" was highly resistant or immune to 19 TuMV strains from 10 provinces or cities across the country. Therefore, in the national vegetable disease-resistance breeding annual conference, it was generally acknowledged as the best germplasm both vertically and horizontally resistant to Chinese cabbage diseases (see Table 2). Among the 6 disease-resistant germplasms selected into the national disease-resistant gene bank, "8407" ranked second in

disease-resistance. The materials ranking first, second and third in disease-resistance were all developed by the Vegetable Institute of Hebei Academy of Agricultural and Forestry Sciences (see Figure 1). The new varieties of "8361" and "8612", developed from the disease-resistant germplasm of "8407", showed excellent disease-resistance in 2 severe disease years of 1986 and 1988. The yield was 75. 5% higher than that of control variety of Yuqing. From 1984 to 1992, the planting area amounted to 21720 ha. The average yield was 133500kg/ha and 54. 84% up on that before then.

**Table 2.** Results of the national identification of Chinese cabbage germplasm resistant to TuMV in 1989

| TuMV strains | | Test materials and disease index | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Code No. | Strain | Bp016 | Bp007 | Bp058 | Bp031 | Bp051 | Bp079 | Bp197 | Bp112 | Erniuxin(ck) |
| Qin 1 | Tu 1 | 0* | 0. 37 | 0. 74 | 0. 93 | 2. 04 | 1. 11 | 4. 07 | 2. 22 | 42. 6 |
| Ning 1 | Tu 2 | 0* | 0* | 0. 19 | 0. 56 | 1. 85 | 1. 11 | 1. 67 | 3. 15 | 25. 9 |
| Ning 2 | Tu 3 | 0* | 0* | 0 | 0. 93 | 0. 19 | 0. 93 | 1. 11 | 1. 30 | 33. 3 |
| Hu 1 | Tu 2 | 0* | 0. 19 | 0* | 0. 56 | 0. 37 | 1. 11 | 1. 67 | 2. 22 | 35. 2 |
| Hei 2 | Tu 3 | 0* | 0. 19 | 0 | 0. 93 | 0. 93 | 0. 74 | 4. 44 | 8. 33 | 40. 7 |
| Liao 1 | Tu 3 | 0* | 0. 18 | 0. 56 | 4. 44 | 0* | 4. 07 | 3. 33 | 5. 00 | 38. 9 |
| Ji 2 | Tu 3 | 0. 93 | 0. 19 | 2. 41 | 0. 93 | 0. 19 | 1. 85 | 4. 07 | 3. 15 | 33. 3 |
| Lu 1 | Tu 3 | 0. 19 | 0. 19 | 0. 74 | 0. 93 | 0* | 4. 81 | 2. 04 | 3. 33 | 55. 6 |
| Hu 2 | Tu 7 | 0* | 0* | 0* | 0. 19 | 0. 37 | 0. 37 | 1. 11 | 1. 11 | 42. 6 |
| Jing 1 | Tu 7 | 0* | 0. 37 | 0. 56 | 1. 11 | 0. 93 | 3. 33 | 3. 81 | 4. 07 | 33. 3 |
| Jing 2 | Tu 7 | 0* | 0. 37 | 0 | 1. 48 | 0 | 1. 11 | 2. 22 | 4. 81 | 33. 3 |
| Jing 3 | Tu 7 | 0* | 0* | 0 | 0* | 0* | 1. 11 | 2. 04 | 2. 04 | 42. 6 |
| Hei 1 | Tu 4 | 0. 37 | 0. 19 | 0. 19 | 1. 85 | 0. 93 | 3. 33 | 8. 33 | 4. 63 | 51. 9 |
| Yue 1 | Tu 4 | 0. 19 | 0. 22 | 0. 56 | 1. 11 | 0* | 2. 59 | 3. 70 | 4. 07 | 44. 4 |
| Lu 2 | Tu 3 | 0. 56 | 0. 39 | 0. 63 | 3. 83 | 0. 19 | 2. 59 | 2. 22 | 1. 83 | 55. 6 |
| Chuan 1 | Tu 5 | 0. 19 | 0. 74 | 0. 93 | 0. 74 | 0. 93 | 3. 33 | 2. 22 | 3. 89 | 55. 6 |
| Ji 1 | Tu 5 | 0* | 0. 37 | 2. 59 | 4. 26 | 1. 30 | 4. 81 | 5. 19 | 5. 74 | 53. 7 |
| Hei 3 | Tu 6 | 0* | 0. 19 | 0* | 1. 85 | 0. 37 | 2. 59 | 2. 59 | 0. 74 | 59. 3 |
| Ji 3 | Tu 6 | 0 | 0* | 0* | 0. 19 | 0* | 1. 11 | 2. 78 | 0. 93 | 66. 7 |
| Average | | 0. 41 | 0. 45 | 0. 90 | 1. 46 | 1. 47 | 2. 21 | 3. 15 | 3. 29 | 44. 5 |
| Ranked place | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |

**Note**: 0* — Immune materials; 0 — virus-bearing materials without symptoms

## Discussion and conclusion

*Establishing natural disease seedling garden to increase the effect of selection*

The experimental plot was the severely infected land on which the Chinese cabbage was continually planted for over 30 years. It was used for seed production in spring and for Chinese cabbage experiment in fall to increase disease incidence of the materials. The experimental plot was similar to the natural disease garden. Virus sample collected from this field was a strong virulent strain. This was an important condition to successfully develop the disease-resistant germplasm.

*Combining the laboratory and field selecting to identify the disease-resistant materials*

This method expressed a good effect. Laboratory inoculation provided an equal opportunity of infection for all materials, and created favourable conditions for invasion of the disease, so that vast number of susceptible materials could be eliminated. It can be replicated for

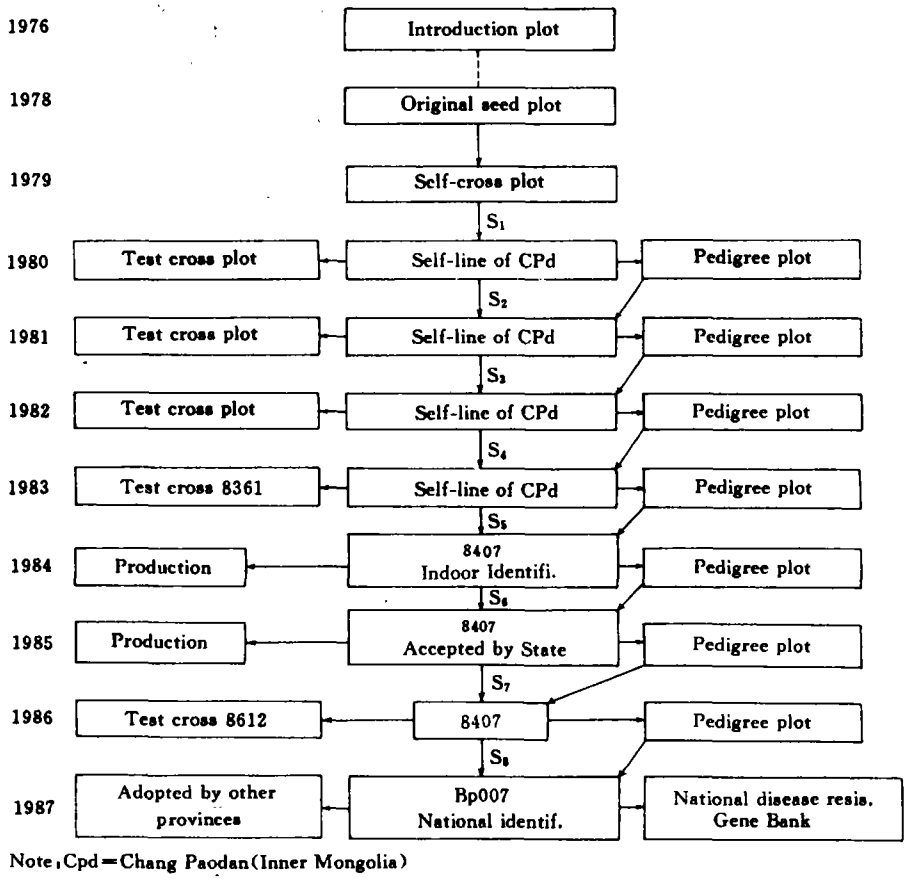


**Fig. 1.** A sketch scheme for the selection of Bp007

many times in one year. Therefore, field labour intensity is greatly reduced. It is characterized by quickness and accuracy. On the other hand, the field selection is carried out in natural condition. The pathogens are diversified and complicated in field. The experimental materials not only suffer from the various pathogens' infection, but also are greatly affected by various factors such as climate, soil, farming practice, etc. The materials selected under this environment not only have strong disease resistance, but also have good horticultural characters. So the purpose of fast and efficient breeding can be reached.

*The progeny population of each self crossing*

Our experience expressed that the progeny population of each self crossing should be kept at least 10 plants, otherwise the ideal material which met the requirement was difficult to select. However the population should not exceed 20 plants. If not the workload was too heavy. Generally the population could be between 10—20 plants. This is in accordance with Professor Tan Qimeng's results(1980).

*A question concerning self-cross degeneration*

Self-cross degeneration and vigour fall are common phenomena. However, after certain

generations of self crossing, slowlly degenerating and basically stable materials are greatly formed, and endogamy does not exert harmful influence any more. Through directed selection these materials do not degrade the vigour in the process of artificial purification, either. Even a few materials, controlled by additive gene, show a tendency of increasing the vigour generation by generation, and they not only strengthen their resistance to diseases, but also increase some good quantitative characters.

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