Analysis of self-compatibility in *Sinapis alba* (L.) Boiss

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Abstract

Self-compatibility of 8 cultivars or lines of *S. alba* (L.) Boiss from different ecological origin were tested by applying the self-compatibility index method. The results showed that self-compatibility of *S. alba* varied among the cultivars, and the average self-compatibility indexes of all the cultivars ranged from 0.01~4.10. The differences of self-compatibility were detected among the cultivars and the individual of the population of the same cultivars. Of the eight cultivars in this study, three cultivars had the self-compatibility index ⩽1, and the average self-compatibility index ranged from 0.01~0.37. Five cultivars had the self-compatibility index >1, they are Minlehongshuijiema, 04white mustard(X), Wuweimaojiao, Minlehuangjiema and Lintaobaijie, with average self-compatibility indexes range of 1.23~4.10. Plants with self-compatibility index⩽1 was not found in these cultivars and the self-compatibility index of Minlehongshuijiema-12 reached 6.36. According to their self-compatibility indexes, the cultivars in this study could be divided into three groups, the high self-compatible group with the self-compatibility index >4.00, the self-compatible group with the self-compatibility index 1.00~3.99, and the self-incompatible group with the self-compatibility index ⩽1.00. The results showed that it is possible to select pure cultivars/lines with self-compatibility in *S.alba*.

Key words: *S. alba* (L.) Boiss, cultivar, self-compatibility, self-compatibility index

Introduction

Sinapis alba L. (white mustard, 2n=2x=24) is one of the self-incompatible cruciferous oilseed crops. In apiculture, *S. alba* is recommended as a good melliferous plant. It has strong resistance to drought and pod shatter, considerable promising as an alternative oilseed crop because it performs better than oilseed rape (*B. napus*) in areas with short-dry growing seasons and requires only minimal inputs (Rakow et al. 2000).*S. alba* is also an important breeding genetic resource, with seeds being important condiment. *S. alba* is strongly pest-resistant (Grishechkina,1998; Mvehlchen,1990). Recently, studies on *S. alba* are mainly concentrated on three aspects: (1) Resistance to insect and plant disease, drought (Long, 2003;Tang, 1999); (2) Cytological analysis of chromosome number (Lian, 1989); (3) Somatic crossing between *S. alba* and oilseed rape (Wang,1999). However, there are few reports on self-compatibility in *S. alba*. It is very difficult for people to obtain, retain pure lines of *S. alba* because of self-incompatibility. So new cultivars easily lose valuable biological traits. Thus studies on self-compatibility, breeding and selection of self-compatible lines are of great importance in research and agricultural production. Eight *S. alba* materials selected from different regions were studied on their self-compatibility, in order to know their strong or weak self-compatibility. These results provide a theoretical basis and technical approach for breeding and selection of self-compatible cultivars or lines and further breeding by other means.

Material and methods

04 (X), 04(Y), Lintao, Minlehongshui, Linxia, Albazuo, Wuwei and Minlehuang, eighty materials were obtained from Department of Agriculture of Gansu Agricultural University. Experiment was performed in the teaching base of Gansu Agricultural University. Experiment was arranged in order, with 4 raw blocks of 1.5m long, and 20 cm raw space containing 60 seedings. At flowering stage, 7-15 plants were chosen in each material and 10-15 buds bagged on each plant and marked. After 20 days (until all petals shed off for 6-7 days), paper bags was taken away, at mature period, pods were harvested in bags. To determine related traits, the number of flowers, pod, seed in bags were recorded. The data were analyszed by DPS, then calculate the self-compatibility index according to following formula: the self-compatibility index=the number of self-pollination seeds/the number of bagged buds; relative self-compatibility index = the number of self-pollination seeds/the number of open-pollination seeds ×100%. At last, judge the strong or weak self-compatibility (Liu et al.,1981; Fang et al., 1983; Liu,1985; Liu,1999).Classification was performed according to methods established by Taoguohua (Tao et al., 1982), Fangzhiyuan, Liuhouli. If the self-compatibility index is less than 1, the cultivar is classified as self-incompatible; If the self-compatibility index is more than 1, the cultivar is classified as self-compatible (Sun et al., 2006; Meng,1995).

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Results

1. Difference of self-compatibility index among cultivars

The results showed that there are great differences on the self-compatibility among different cultivars in *S. alba*. The self-compatibility index ranged within 0.01-4.10 (table 1). Square analysis indicated that there was very significant difference in self-compatibility index among 8 cultivars. According to the evaluation standard, 8 materials fall into two categories: (1) self-compatible type (including 5 cultivars); (2)self-incompatible type (including 3 cultivars). Regardless the self-compatibility type or self-incompatibility type, there are obvious difference among each cultivars in the same type. For example, there are 4 cultivars with self-compatibility indexes of 1-4, belonging to medium self-compatibility, 1 cultivars with self-compatibility index of 4, belonging to high self-compatibility. According to self-compatibility index, the cultivars in this study could be divided into three groups: (1) The highly self-compatible group with self-compatibility index >4.00, Minlehuang; (2) The self-compatible group with the self-compatibility index from 1.00~3.99, 04(X) etc; (3) The self-incompatibility group with the self-compatibility index ⩽1.00, Linxia, Albazuo (Table 3).

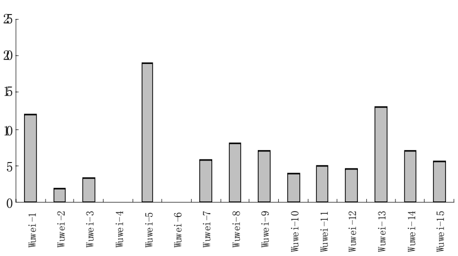
2. Difference of relative self-compatibility index among cultivars

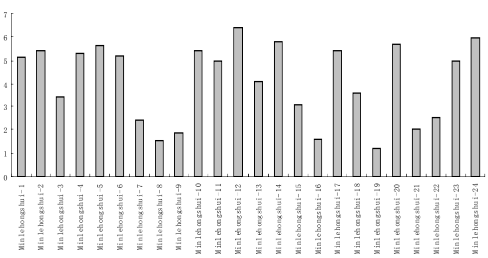
There is great difference in the rate of set seed by open-pollination among different *S. alba*. As to the same cultivars, the rate of set seed by open-pollination is obviously higher than that by artificial selfing. Self-incompatibility of *S. alba* is controlled by the sporophytic type, its self-incompatible response occurred in the stigmatic papillae of the pistil, pollination by self-compatible pollen (which come from different plants or flower) mixed with self-incompatible pollen (which come from the same plants or flower) can increase the rate of set seed to some degree. So, when the genotype is the same, the rate of set seed by allogamy-pollination is higher than that by artificial selfing. Cultivars with high self-compatibility indexes also have high relative self-compatibility indexes and the indexes are different among different cultivars. The results showed whether strong or weak self-compatibility is indirectly judged by relative self-compatibility index.

3. The difference of self-compatibility between ecotypes, cultivars and landraces

Self-compatibility of materials from different regions are significantly different. When it comes to the self-compatibility, materials from west regions in Gansu are high, but those from east regions in Gansu are low, the average self-compatibility indexes are 2.99, 0.62 respectively. The order of percentage of self-compatible cultivars in population is: western, eastern, foreign and the percentage of self-compatible plants in each population is 100.00%, 50.00%, 33.33%. Because *S. alba* is easily grown in cool regions, especially if the weather condition was adapted to *S. alba* reproductive growth from bud stage to mature stage, its rate of set seed can be increased greatly. In this study, the self-compatibility index of cultivars is higher than that of landraces. The self-compatibility index of 04 white mustard (X) is as high as 3.45, but the percentage of self-compatible plants in cultivars is lower than that in landrace. Perhaps because the number of cultivars is too small, the statistical results is lack of accurateness. Regardless the self-compatibility index or the percentage of self-compatible plants, materials abroad are lower than domestic ones. So it is feasible to obtain cultivars with high self-compatibility by artificial breeding methods.

4. Difference of individual from the same cultivars





Variation of self-compatible degree in *S. alba* not only exist among cultivars, but also in individuals of the same cultivar. Self-compatible plants were also found in cultivars with low self-compatibility. At the same time, there are variation of self-compatibility index among cultivars with high self-compatibility. The average self-compatibility index of 04 (Y)(SI) is 0.37, but the self-compatibility index of 04 (Y)-13 is as high as 3.09. Minlehongshui belongs to high self-compatible type, all plants in the population are self-compatible, the self-compatibility indexes of some plants reached 6.36 (Figure 1). Thus, if the cultivars has higher self-compatibility, there are more self-compatible individuals. So it is easier to select high self-compatible genotypes in high self-compatible materials. The self-compatibility index of Wuwei (SC) is 3.26, but plants with self-compatibility index of 5.2 were found in this cultivars and all plants are self-compatible (Figure 2). Minlehongshui belongs to high self-compatible type, the highest self-compatibility index of in this population is as high as 6.36 (Figure 1).

Discussion

The results suggested that there are extensive variation on self-compatibility, great difference in the self-compatibility index, the rate of seed set in *S. alba*. Of all 8 materials, the self-compatibility index of Linxia is the lowest, which is 0.01. The highest one is 4.10 (Minlehongshu). Three cultivars are self-incompatible, their self-compatibility index is less than 1. Five cultivars are self-compatible, their average self-compatibility indexes are more than 1, with an average of 2.73. Materials with self-compatibility index>3 are Minlehongshui, 04(X), Wuwei, respectively and Minlehongshui is the highest. Based on this result, materials can be divided into three categories:(1) high self-compatible type with the self-compatibility index >4.00; (2) self-compatible type with the self-compatibility index 1.00~3.99; (3) self-incompatible type with the self-compatibility index ⩽1.00. When the rate of bagged set seed is higher, the relative self-compatibility index is also higher. Obvious difference can be found among cultivars. The self-compatibility index is virtually correlated to the number of seed in each pod, and the relative index is percentage of all seeds in ovule. It is thus clear that relative self-compatibility index also can be used more accurately to judge the degree of self-compatibility.

Conclusions

In this research, self-compatibility variation exists not only among cultivars, but also among plants from the same cultivar. There are high self-compatible plants in self-incompatible cultivars. Also, self-incompatible plants can be found in self-compatible cultivars. With regards to cultivars from west and east regions, the self-compatibility from west is higher than that from east. Firstly, it may be related to the infiltration of self-compatible gene from other self-compatible species into *S. alba*. Secondly, *S. alba* is easily grown in cool west region, especially when weather condition can satisfy the reproductive growth during the growth period from bud to mature, its rate of set seed can be increased greatly. The self-compatibility index of cultivars is higher than that of local cultivars. For example, the self-compatibility index of 04 (X) reached 3.45. To summarize, it is feasible to increase the self-compatibility of self-incompatible crops or cultivars by selection and inheritable improvement.

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