Techniques of high yielding seed production of hybrid rice

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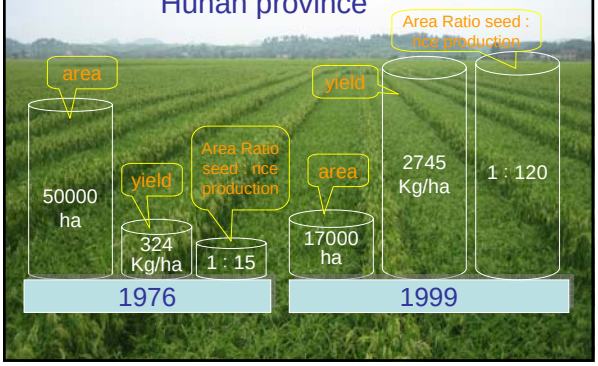
The area and yield of seed production in Hunan province



Area and yield of seed production in China

1990-2007

Seed area/year 80000～100000 ha

Seed yield ⩾2550kg/ha

Hybrid rice planting area/year 15 million ha

The four stages of research and application of hybrid rice seed production technology in China

1 **The technical exploration stage** （1973-1978）

Seed yield：90kg/ha ⟹ 450kg/ha

Main technical achievements：

- Methods to determine seeding interval：time (days)、leaf number、EAT。
- Facts influence flowering and outcrossing：temperature、sunshine、RH。
- Adjusting heading date：irrigation、fertilizer、and chemicals。
- Improving outcrossing posture：cutting leaf、striping flag leaf sheath、lower dosage of GA3.。
- Maintaining purity：isolation、roguing。

The four stages of research and application of hybrid rice seed production technology in China

2、**The technical development stage** （1979-1983）

Seed yield：450kg/ha ⟹ 1500kg/ha

Main technical achievements：

- Concentrated study on GA3 application，increasing the outcrossing seed set。
- Study on techniques of cultivating high yielding population with compatible composing between male and female lines。
- Directionally cultivating high yielding population、GA3 applied with proper dosage and time, no need cutting canopy leaves and tripping the flag leaf sheath neither.
- Selecting favorable location and season as seed base and for seed production: Seed base concentrated to the hilly and mountain rice area. Spring and Summer as the main production season.

The four stages of research and application of hybrid rice seed production technology in China

3、**The technical maturation stage** （1984-1990）

Seed yield：1500kg/ha ⟹ 2700kg/ha

Main technical achievements： increasing outcrossing seed set。

- Change the sowing model of male line from 3-phase to 2-phase or 1-phase to increase the pollen density in unit area.
- The cultivation techniques of increase the female capacity in unit area.
- The techniques of improving outcross traits of female line: Raising the stigma exsertion rate, increase vitality of stigma, adjust the blooming time of female line within the day

The four stages of research and application of hybrid rice seed production technology in China

4.Two-line hybrid rice seed production technology research stage (1989-1995）

- **Challenge**：Fertility express of photo/thermo genic male sterile rice (PTGMS) was response to environmental conditions genetic drift of the critical temperature for fertility reversing

- **Technical key for ensure the safety of two line hybrid seed production**：

Breeding and using PTGMS line with lower critical temperature

Using procedure of producing core and foundation seed of PTGMS line

The four stages of research and application of hybrid rice seed production technology in China

4.Two-line hybrid rice seed production technology research stage (1989-1995）

Main technical points for two line hybrid rice seed production：

- Based on the high-yield with high-quality seed production technology of three-line hybrid rice 。
- Safety index to select seed base and determine the period of sensitive stage
- Cultivation techniques to ensure the sterility express entirely.
- Techniques of monitoring the fertility express in the fields and seed purity judgment before harvesting.

The characteristics of cultivation technology of hybrid rice seed production in China

1. Outcrossing cultivation of rice

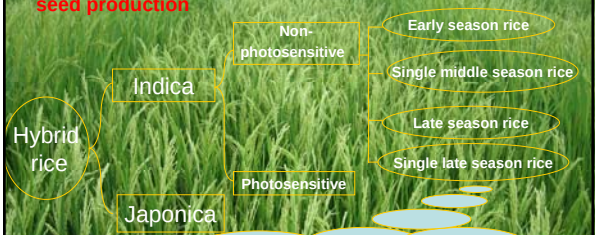
- Two parental lines cultivated alternating with each other symbiotically and them must flower at the same time
- A and R lines Planted with certain sowing interval，must flowering At the same time；
- Sterile line can seeds through accepting pollen from the restore line by supplementary pollination。

Differences compare with rice cultivation：

- A and R lines flowering simultaneously----Synchronization；
- Compatible proportion of parental population；
- Establishing a ideal posture for outcrossing；
- Pollination and harvesting under favorable weather condition；
- Secure male sterility expression of two-line hybrid rice seed production。

The characteristics of cultivation technology of hybrid rice seed production in China

2、Large number of hybrid combinations put in seed production



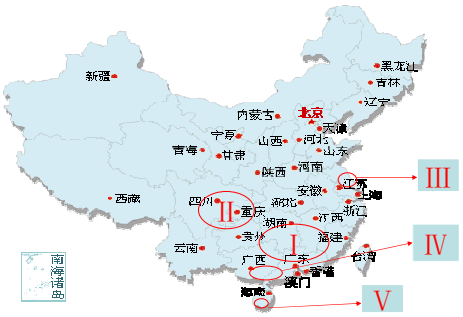
Sowing interval between parents varied a lot with different types of hybrid rice. for seed production, for instance, the sowing interval for Xianglianyou68 was -11 days while the Xinxiangyou63 was about 60 days.

The characteristics of cultivation technology of hybrid rice seed production in China

3.Seed production covers four seasons, with a wide range of seed base

5 Seed production districts located from N17° to N33°	Production season
I South and southwest part of Hunan、Middle part of Jiangxi. North parts of Guangdong and Guangxi. west part of Fujian.	Spring, Summer and Autumn
II Plain and hilly single rice area of Sichuan and Chongqing	Summer
III Coastal rice area of Yancheng, Jiangsu	Late Summer
IV South China rice area	Early Spring +Autumn
V South part rice area of Hainan	Winter season

Distribution of main hybrid seed base in China



The characteristics of cultivation technology of hybrid rice seed production in China

4、Technique based on labor-intensive

Techniques with many steps and higher technical requirement；

Labor-intensive with high-intensity；

Fine field management, all technical steps carry out timely.

The current status of cultivation techniques on hybrid rice seed production in China

1、Quantitative composing of parental population

Quantitative composing of parental population determined by

- Row ratio
- Transplanting density

Guideline of composing of high-yielding parental population

- Land ratio (R:A)：1：3～4
- Spikelets ratio (R:A)：1：2.5～3
- Outcrossing rate≥50%

Adopt different method to cultivate R and A

The current status of cultivation techniques on hybrid rice seed production in China

1 Quantitative composing of parental population

Outcrossing seed set

The current status of cultivation techniques on hybrid rice seed production in China

2.Cultivate the R line

Raising seedlings

- Wet bed in paddy — Seedlings transplanted with 5～7 leaves Adoptable to all types R line
- Wet bed with two phases in paddy — Seedling transplanted with 8 ～9 leaves Suitable to R line with longer growth Duration, sowing interval≥20days
- Floppy-pad in paddy
- Floppy-pad on dry land

Seedlings transplanted with 2.3 ～3.5 Leaves Adoptable to the R line with shorter growth duration and closely sowing interval or even inverse

The current status of cultivation techniques on hybrid rice seed production in China

2.Cultivate the R line

Fertilizer

- Based on the same quantity of fertilizer Used to A line
- Plus 2～3 times with deep-dressing

The time and times of deep-dressing fertilizer to R line determined by the growth duration of the R line, the sowing interval and the time of A line transplanting

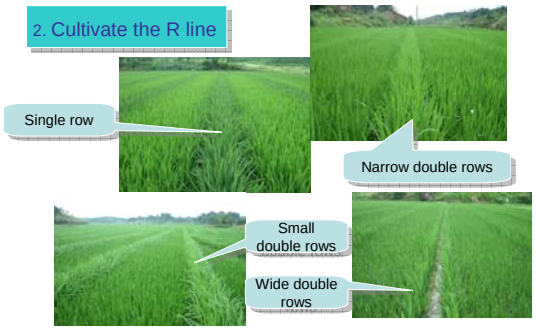
The current status of cultivation techniques on hybrid rice seed production in China

2.Cultivate the R line

Planting model of R line	Suitable for R line type	Row ratio
Single row	R line with longer growth duration and heavier pollen load	1：10～12
Narrow double rows	R line with shorter growth duration, closer sowing interval or inversion	2：10～12
Small double rows	R line with longer growth duration and heavier pollen load	2：12～14
Wide double rows	R line with longer growth duration and heavier pollen load	2：16～18

The current status of cultivation techniques on hybrid rice seed production in China

2. Cultivate the R line



The current status of cultivation techniques on hybrid rice seed production in China

3 Cultivate the A line

- Seeding and transplanting
  - Transplanting Seedling
    - Wet-bed in paddy, hand transplanting
    - Floppy-bed in paddy, parachuting planting
    - Floppy-bed on dry land, small seedling with hand transplanting
  - Direct seeding Germinated seed
    - Manual broadcasting
    - Direct seeding by drill machine

The current status of cultivation techniques on hybrid rice seed production in China

3 Cultivate the A line

The current status of cultivation techniques on hybrid rice seed production in China

3. Cultivate the A line

The current status of cultivation techniques on hybrid rice seed production in China

3 Cultivate the A line

- Fertilize
  - Heavier basal fertilizer: 70-80% of N、100% 0f P and 40% of K applied before transplanting
  - Light top-dressing: 20-30% 0f N、20% 0f K top-dressed 5-7days after A line transplanting
  - Applying K and microelements Fertilize at later stage: 30% of K and little amount of P and other microelements fertilize applied at stage V of panicle differentiation and initial heading（liquid on leaf）

The quantity of fertilize demand varied a lot by different A line

The current status of cultivation techniques on hybrid rice seed production in China

3 Cultivate the A line

- Irrigation
  - Keep the field sun-cured during The period from the end of tillering to the stage III of panicle differentiation
    - To control the late tiller for getting A uniform population and to control the length of canopy leaves for raising the resistibility to lodging and reducing the obstacle of pollination
  - Keep deep standing water In the fields during booting stage and pollination period
    - To maintain the stigma vitality of A and pollen vitality of R，to raise the simultaneity of blooming between A and R
  - irrigate intermittently with shallow water all other times

The current status of cultivation techniques on hybrid rice seed production in China

4.Techniques for raising the rate of outcrossing seed-setting of A line

Choice of appropriate season and location for seed production

Selected seed base with concentrated land, relatively flat topography, sufficient sunshine, fertile soil, perfect irrigation and drainage system.
The environmental condition had appropriate temperature, humidity and sunshine during the flowering and pollination period.

Techniques for getting synchronization

Determining sowing interval correctly（leaf number difference, time difference).
Adopting one-phase, two-phases or three-phases planting model of R line.
Adopting technical rules for A and R lines cultivation.
Forecasting and regulating synchronization.

The current status of cultivation techniques on hybrid rice seed production in China

4.Techniques for raising the rate of outcrossing seed-setting of A line

Techniques for improving outcrossing posture

Techniques of spraying GA3 and cutting leaves

Panicle layer of male parents was 10～20cm higher than female.
The height of male parent was about 90～100cm.
The exserted length of panicle necks was about -2～10㎝.
The grain exposed rate was more than 95%.
Full panicle exposed rate was more than 90%.
The panicle was above the flag leaves.
The distance between the top of panicles and flag leaves was more than 5cm

The current status of cultivation techniques on hybrid rice seed production in China

4.Techniques for raising the rate of outcrossing seed-setting of A line

Pictures of the best outcrossing posture

The current status of cultivation techniques on hybrid rice seed production in China

4.Techniques for raising the rate of outcrossing seed-setting of A line

Supplementary pollination

Pushing single pole

Sweeping single pole

Pulling rope

Pushing double poles

Development tendency of cultivation technology of hybrid rice seed production in China

1、challenges

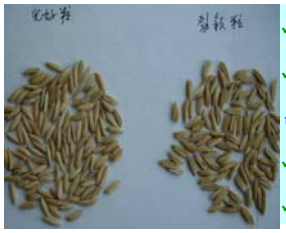
1）Agricultural-labor transfer to city become the main problem of hybrid rice seed production in China today

- Many families involved, scattered with small scale, increase the difficulty of isolation and more difficult to organize production.
- more labor-input and labor-intensive, low level of mechanization, increase the production cost.
- weak ability to withstand a bad harvest induced by abnormal climate, with unstable seed yield and quality.

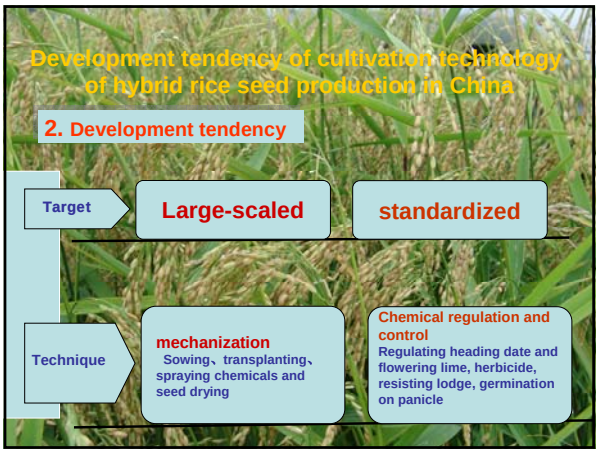
Development tendency of cultivation technology of hybrid rice seed production in China

1、challenge

2）New developed parental lines with complicated genetic background, come with some new technical problems



- ✓Thermo sensitivity of TGMS
- ✓Higher outcrossing ability easy to be contaminated by other pollen
- ✓F1 seed with dissilient glumes
- ✓F1 seed with unstable germination


Development tendency of cultivation technology of hybrid rice seed production in China
2. Development tendency
Target
Large-scaled
standardized
Technique
mechanization
Sowing、transplanting、spraying chemicals and seed drying
Chemical regulation and control
Regulating heading date and flowering lime, herbicide, resisting lodge, germination on panicle


Thanks