Progress and Research Direction of Sunflower Breeding in China

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翻译：张希吏

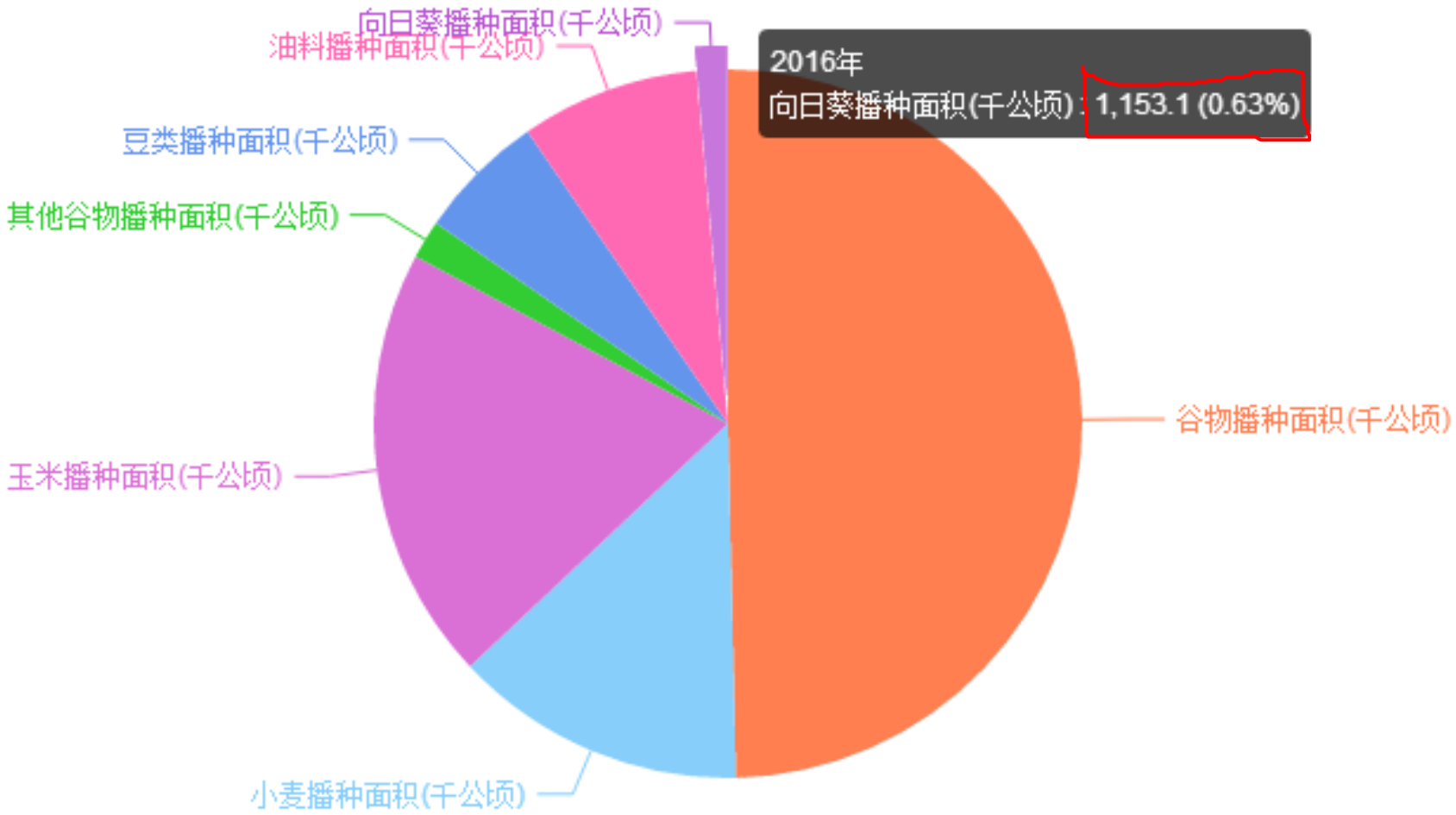
Abstract

In this paper, the development process and progress of Sunflower Breeding in China are summarized, the future development direction of Sunflower Breeding is prospected, and the problem of solving the theory of sunflower genetic breeding is solved; ideal plant type research, resistant breeding, quality breeding and mechanized harvesting are the direction of breeding, and a large number of introduction is introduced. Germplasm resources, the application of biotechnology and the technology of distant hybridization, multidisciplinary combined with various techniques and means, in order to help improve the breeding level of sunflower in China, and make our sunflower industry get more development.

Summary

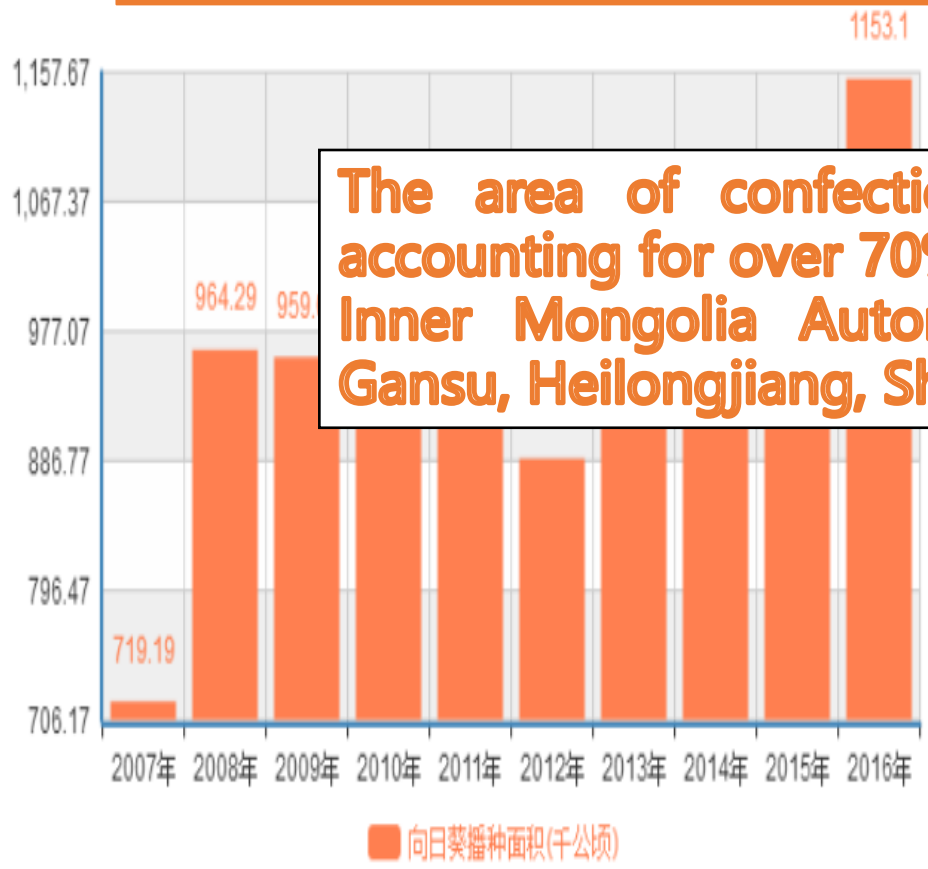
Sunflower (*Helianthus.annuus L.*) is a dicotyledonous plant of the genus Helianthus (*Helianthus*) of family chrysanthemum (Compositae). It originates in southwestern North America. Sunflower is divided into oil sunflower and confectionary sunflower. The number of chromosomes is 17 and the cultivated species are two. Sunflowers were introduced to China in the late sixteenth Century and early seventeenth Century. In 1950s, the introduction and breeding of sunflower in China were studied, including introduction experiments, systematic breeding, heterosis utilization and so on.

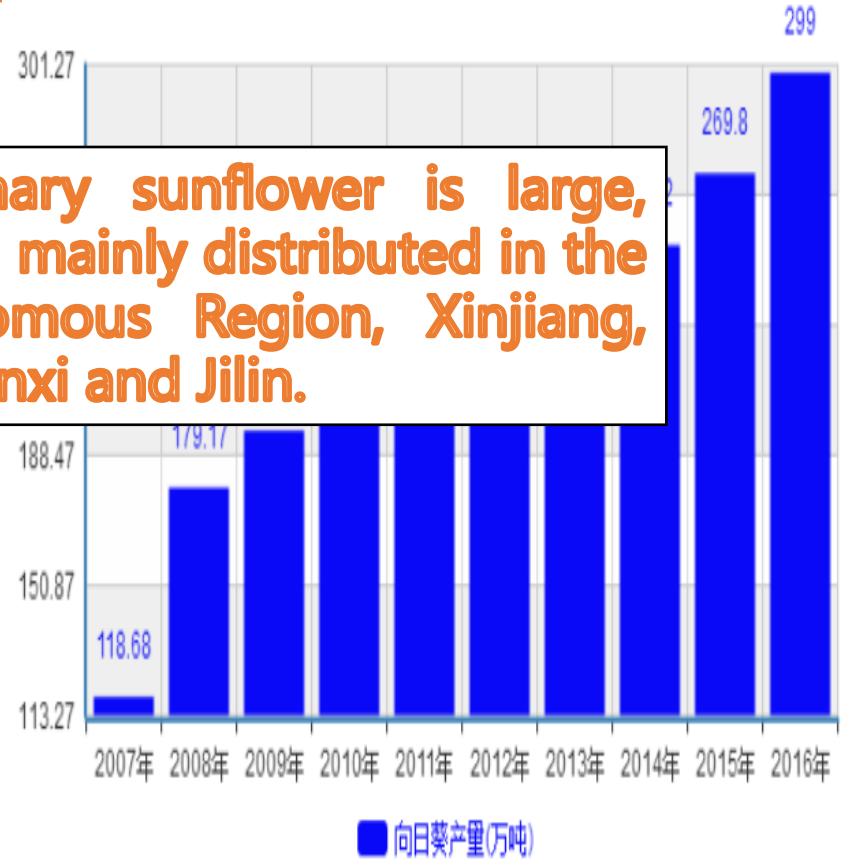
Since 1970s, sunflower has developed rapidly in China, and its planting area has increased year by year. As a kind of dried crop, sunflower is more fragrant, easy to shelling, high content of unsaturated fatty acid and good for health. It has become a favorite leisure food and is all over the dry nuts market all over the world. Since the beginning of this century, the area of confectionary sunflowers has increased rapidly in China.


向日葵播种面积(千公顷)
油料播种面积(千公顷)
豆类播种面积(千公顷)
其他谷物播种面积(千公顷)
玉米播种面积(千公顷)
小麦播种面积(千公顷)
谷物播种面积(千公顷)
2016年
向日葵播种面积(千公顷): 1,153.1 (0.63%)

With the statistics of the National Bureau of statistics, the growing area of sunflower in China has increased from 719,190Hm^2 to 1036,300hm^2 from 2007 to 2015, with a total output of 1 million 950 thousand tons to 2 million 500 thousand tons.

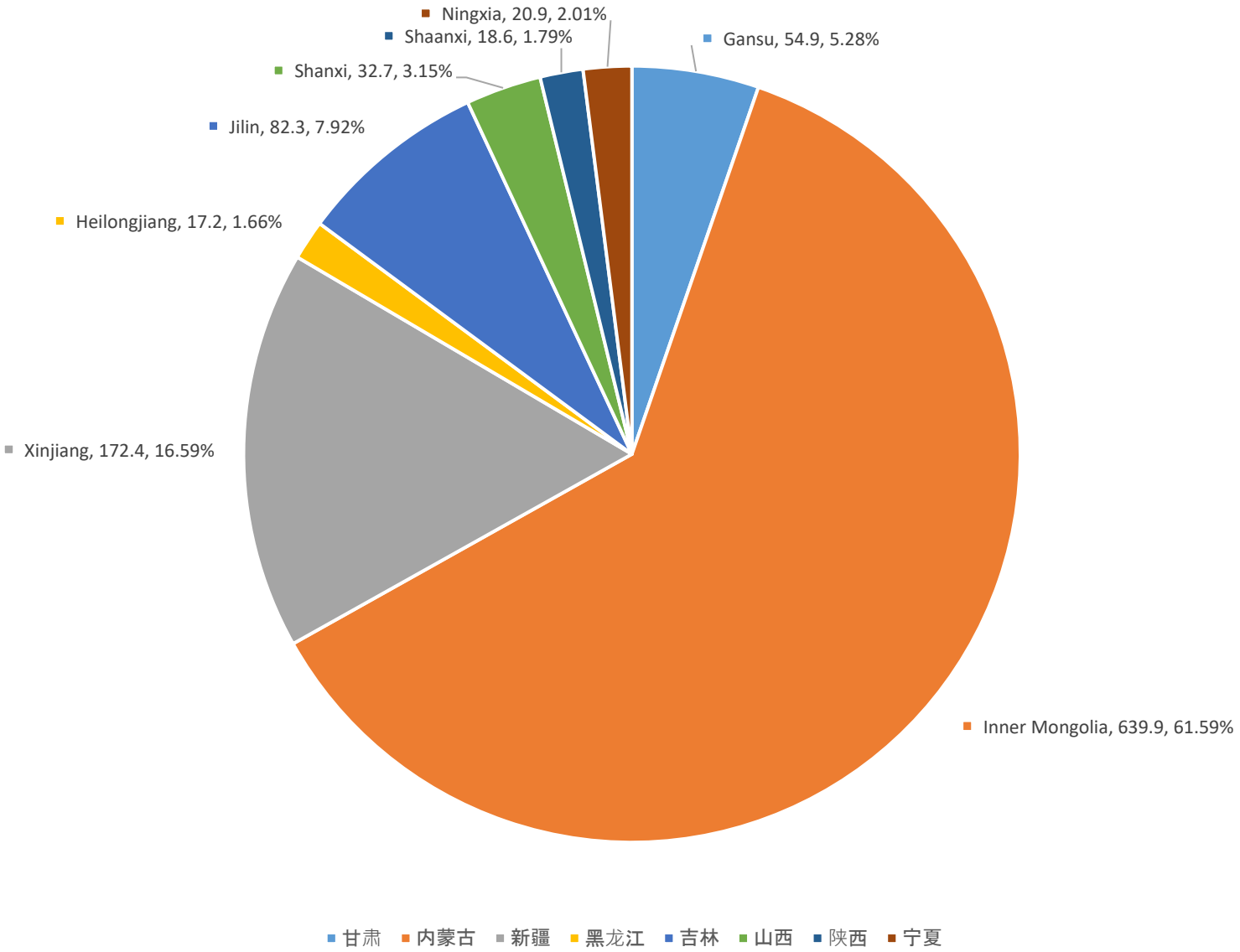
Planting area and yield of sunflower in China from 2007 to 2016





The area of confectionary sunflower is large, accounting for over 70%, mainly distributed in the Inner Mongolia Autonomous Region, Xinjiang, Gansu, Heilongjiang, Shanxi and Jilin.

The main planting area of sunflower in 2016(1000ha)



Sunflower is the main economy crop of these provinces, which has important significance for increasing farmers' income and agricultural gains.

Sanrui
三瑞农科

Content of the report

Part I: The Course of Sunflower Breeding in China

Part II： Progress in Sunflower Breeding in China

part Ⅲ: The research direction of sunflower in China

Part one

The study of Sunflower Breeding in China

Sunflower Breeding in China has experienced two stages: introduction and systematic breeding.

1、Introduce a new plant

As early as 1955, the Jilin Academy of Agricultural Sciences introduced a number of oil sunflower germplasm resources, such as Hungary 1, USSR 3. On this basis, the Baicheng Academy of Agricultural Sciences in Jilin began to use the system selection method in 1962 to select the No. 3 white sunflower with Hungary 1 as the base material, and the North China Agriculture Department, Hungary 4, was bred in addition to the No. 5 of the North sunflower.

The first stage

In 1969, cytoplasmic male sterile lines were selected from French hybrids in Le Craig's hybrid progenies of wild and cultivated sunflowers. In 1970, Kimman L M discovered the gene of fertility restoration, and the utilization of sunflower heterosis reached a new stage. Since then, Europe and the United States have invested a lot of manpower and resources to lead the cultivation of sunflower hybrids. From the end of last century to the beginning of this world, our country introduced a large number of oil sunflowers and confectionary sunflower hybrids with enterprise's behavior.

The second stage

The course of research on Sunflower Breeding in China

Sanrui 三瑞农科 新三瑞 新起点 新征程

introduced variety

1、Introduced variety

Beijing Yongtai Feng(Beijing) Agriculture Technology Co., Ltd. (Sanrui predecessor of ruinong branch) introduced hybrids of RH316, DC6009, 909, 1122 and so on from the United States.

Kai Fu Rui Agriculture Technology Co., Ltd. introduced LD5009, 135.

In addition, DK119, 3638C, 3939 and other Australians and Israeli confectionary sunflower varieties were introduced.

At the same time, the hybrid seed of oil sunflower was introduced, such as DK101 and so on.

1.2 Heterosis

The utilization of sunflower heterosis in China began in 1970s, which is divided into four stages.

一

It began in 1973 and successfully completed three line matching of sunflower in 1980. Chinese Academy of Agricultural Sciences introduced cytoplasmic male sterile line "1366A" and its homotypic maintainer line "1366B". A sterile line '74102-4A' and a homotypic maintainer line '74102-4B' were bred in Baicheng Research Institute of Jilin in 1977.

二

From 1981 to 1989. The hybrids selected at this stagewere characterized by high oil content and high yield. A breakthrough has been made in production, which has brought a new height to Sunflower Breeding in China.

三

From 1989 to 2012, breeders have made breakthroughs in the field of breeding. They have been fully integrated in biotechnology breeding and traditional breeding, and have been gradually adopted by breeders.

四

From 2012 to the present, China's sunflower breeding has made breakthroughs, and a group of high yield and high quality, good commodity and sweet taste varieties have been selected successfully. Breakthrough has been made in germplasm innovation. The target of eating and breeding has changed from short grain type to long grain type. The comprehensive characteristics of the resistant varieties such as Lei Dan and Breton are more outstanding.

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新三瑞 新起点 新征程

Independent research and development varieties

The confectionary sunflower varieties cultivated in China are introduced to foreign countries, such as SH383, SH7108, and so on, which are cultivated in Sanrui branch in Argentina.

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新三瑞 新起点 新征程

The second part

Progress in the research of Sunflower Breeding in China

二、Progress in the research of Sunflower Breeding in China

2.1 • 育种基础理论研究

2.2 • 抗病虫育种研究

2.3 • 抗列当育种研究

2.4 • 产量品质育种研究

2.5 • 生物技术育种研究

2.1 Research on the basic theory of breeding

Sunflower researchers in China learn from foreign advanced technologies and theories, and do a lot of detailed research on the following theories.

The correlation between the yield and main characters of confetionary sunflower, single disc number, plant height, flower disc, seed setting rate, seed kernel rate, 100 grain weight and yield were studied.

The relationship between the morphological characteristics of sunflower and the yield of oil, the oil content and vitamin E content, the relationship between the variation coefficient of the main characters, the study of genetic variability, stability and correlation of the economic characters, the main economic characters such as plant height, the diameter of the flower plate, the stem diameter, the shell rate, the number of leaves and the heredity of the yield.

The salt and alkali resistance of sunflower was also studied. Wang Qingyu and others studied the inheritance of the shell rate of sunflower. Zhang Wenyi and other studied the young stem color, leaf shape, leaf shape, leaf handle angle, leaf vein color, corolla color, stigma color, shape of the glossy flower, fruit shape, skin color, pigment heredity, branching, and the growth period. Plant height, petiole length, leaf length, and leaf width heritage characteristics.

Qiao Chungui Studied the inheritance of white pollen in natural maintainer line of the male cytoplasmic and male sterile line in France. At the same time, some studies have been made on the innovation of sunflower germplasm, such as selection of new cytoplasmic male sterile lines and resistant materials by use of wild sunflower, and Wang Pengdong and other reports on the application of Jerusalem artichoke in Sunflower Breeding.

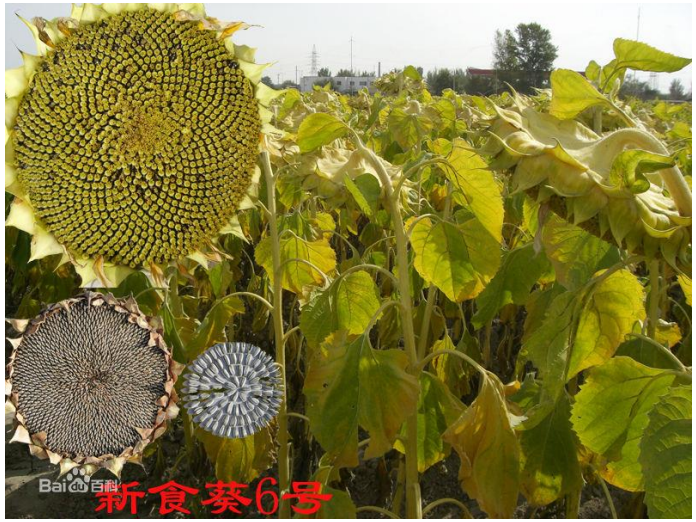
2.2 Study on disease resistance breeding

Sunflower disease, downy mildew, Verticillium wilt, rust, black spot and brown spot disease of sunflower began to increase in 1980s. The resistance breeding of sunflower has been strengthened step by step, and has achieved good results.

The resistance identification method has made great progress. The identification of the resistance to Sclerotinia Sclerotinia, the inoculation of the nuclear mycelium and field root inoculation in root of sunflower, the black spot and the brown spot are mainly identified by the inoculation resistance level under the condition of field isolation, rust and Verticillium wilt are mainly in the field conditions.

The genetic mechanism of Sunflower Sclerotinia sclerotiorum and the heritability and combining ability of Sclerotinia sclerotiorum resistance were studied.

A number of new varieties and inbred lines resistant to Sclerotinia sclerotiorum, downy mildew, Verticillium Wilt and rust were selected. New varieties such as: new sunflower No. 6, dragon confectionary sunflower 1, 2, 3, new sunflower 14, etc.



2.3 Study on broomrape breeding

Sunflower broomrape is a worldwide problem in sunflower production. Zhang Yi studied the genetic rule of sunflower, and proposed a modified method for the hybrids and inbred lines, and he studied new germplasm resources and new methods of sunflower.

In 2015,SanRui agritec researchers identified the minor species in the main producing areas of the sunflower in China, and the areas of Jilin, which was released in 1996, upgraded from race A to F.

In recent years, a number of materials have been introduced from abroad.

In recent years, remarkable achievements have been made in resistance breeding confectionary sunflower, and selection resistant varieties SanRui 3, 1601E, 1648E, 7105, Tonghui 15, Tonghui 31, green crown 3316 and so on.

2.4 Study on Breeding of yield and quality

Increasing yield and improving quality have always been the main breeding targets for sunflower breeders. Oil sunflower of inbred lines adapted to different natural conditions in China, with stable traits, high yield and high oil, has become a valuable resource for oil sunflower in China. A group of oil sunflower hybrids, such as BA kuiza 4 and Jinkui 5, were produced with higher yield and higher oil content.

Sunflower is a big proportion of sunflower production and consumption in China, but research of confectionary Sunflower Breeding is lagging behind oil sunflower. Inner Mongolia Academy of Agricultural Sciences, Jilin agricultural academy and other units have selected Inner Mongolia Food Sunflower 1, Liaoning Food Sunflower 1, Jinkui 3 and so on.Only the Liaoning Academy of agriculture selected a Liao, kowtow No. 1. Before 2008, it was also bred in Liaoning.

In 2011, Beijing SanRui agricultureTechnology Co., Ltd. had selected selected breeding out of SH363 in2012. Anhui Huaxia agricultural science and Technology Co., Ltd. breed JK601, and in 2010 Beijing sunflower science and Technology Co., Ltd. was selected to have a successful selection of TY0409, Beijing SanRui agricultural science and technology company selected first Rui 10.


SH363商品长度与宽度
DOUBLE WAY
SHOCK-PROOF


SH361


JK601


6号

The promotion of these varieties greatly reduced the planting area of American confectionary sunflower varieties in China. Since then, enterprise breeding has become a powerful force for Sunflower Breeding in China. The breeding of sunflower in China has reached a new height. In recent years, new progress has been made in the breeding of confectionary sunflower in China. A series of varieties such as kaoyang 1, No. 3 and No. 7 have been selected, and San Rui 7, 6, 8, and No. 1 of sunflower. In 2014 , 15 sunflower varieties were certified in the Inner Mongolia Autonomous Region. In 2015, 18 varieties were approved and 15 varieties were approved in 2016.

Registered varieties in 2017

序号	登记编号	作物名称	品种名称	状态	登记年份	申请者	生产经营许F	品种权	品种推广
1	GPD向日葵(2017)110001	向日葵	关尔一号	完成	2017	北京关尔科技发展有限公司	暂无	暂无	暂无
2	GPD向日葵(2017)110002	向日葵	NH2202	完成	2017	北京关尔科技发展有限公司	暂无	暂无	暂无
3	GPD向日葵(2017)110003	向日葵	GY9191	完成	2017	北京关尔科技发展有限公司	详情	暂无	暂无
4	GPD向日葵(2017)110069	向日葵	TK9102	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	暂无
5	GPD向日葵(2017)110070	向日葵	TK503	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	详情
6	GPD向日葵(2017)110071	向日葵	KF3099	完成	2017	北京凯福瑞科技股份有限公司	详情	暂无	暂无
7	GPD向日葵(2017)110072	向日葵	天葵206	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	暂无
8	GPD向日葵(2017)110073	向日葵	TYOR13A	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	暂无
9	GPD向日葵(2017)110074	向日葵	TY0409	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	详情
10	GPD向日葵(2017)110075	向日葵	TK311	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	暂无
11	GPD向日葵(2017)110076	向日葵	TK601	完成	2017	北京天葵立德种子科技有限公司	详情	暂无	详情
12	GPD向日葵(2017)110117	向日葵	T562	完成	2017	北京凯福瑞科技股份有限公司	详情	暂无	详情
13	GPD向日葵(2017)110122	向日葵	凯福瑞一号	完成	2017	北京凯福瑞科技股份有限公司	暂无	暂无	暂无
14	GPD向日葵(2017)110123	向日葵	凯福瑞二号	完成	2017	北京凯福瑞科技股份有限公司	暂无	暂无	暂无
15	GPD向日葵(2017)110139	向日葵	TK14013	完成	2017	北京天葵立德种子科技有限公司	暂无	暂无	暂无

Registered varieties in 2017

序号	登记编号	作物名称	品种名称	状态	登记年份	申请者	生产经营许F	品种权	品种推广
31	GPD向日葵(2017)140236	向日葵	YS809	完成	2017	山西农业科学院棉花研究所	详情	暂无	详情
32	GPD向日葵(2017)140237	向日葵	H7108	完成	2017	山西农业科学院棉花研究所	详情	暂无	暂无
33	GPD向日葵(2017)150006	向日葵	SH363	完成	2017	三瑞农业科技股份有限公司	详情	暂无	详情
34	GPD向日葵(2017)150007	向日葵	三瑞6号	完成	2017	三瑞农业科技股份有限公司	详情	暂无	暂无
35	GPD向日葵(2017)150008	向日葵	SH338	完成	2017	三瑞农业科技股份有限公司	详情	暂无	详情
36	GPD向日葵(2017)150009	向日葵	SH361	完成	2017	三瑞农业科技股份有限公司	详情	暂无	详情
37	GPD向日葵(2017)150062	向日葵	SZL2812	完成	2017	包头市三主粮种业有限公司	详情	暂无	暂无
38	GPD向日葵(2017)150111	向日葵	GL601	完成	2017	巴彦淖尔市关尔农业发展有限责任公司	暂无	暂无	暂无
39	GPD向日葵(2017)150112	向日葵	A803	完成	2017	巴彦淖尔市关尔农业发展有限责任公司	暂无	暂无	暂无
40	GPD向日葵(2017)150113	向日葵	新启源5号	完成	2017	内蒙古五原县丰收向日葵种业有限责任公司	详情	暂无	详情
41	GPD向日葵(2017)150114	向日葵	FS7333	完成	2017	内蒙古五原县丰收向日葵种业有限责任公司	详情	暂无	暂无
42	GPD向日葵(2017)150124	向日葵	三瑞5号	完成	2017	三瑞农业科技股份有限公司	暂无	暂无	暂无
43	GPD向日葵(2017)150125	向日葵	三瑞7号	完成	2017	三瑞农业科技股份有限公司	暂无	暂无	暂无
44	GPD向日葵(2017)150126	向日葵	蒙昌12号	完成	2017	刘慧	暂无	暂无	暂无
45	GPD向日葵(2017)150127	向日葵	蒙昌13号	完成	2017	刘慧	暂无	暂无	暂无

Extension area of main varieties

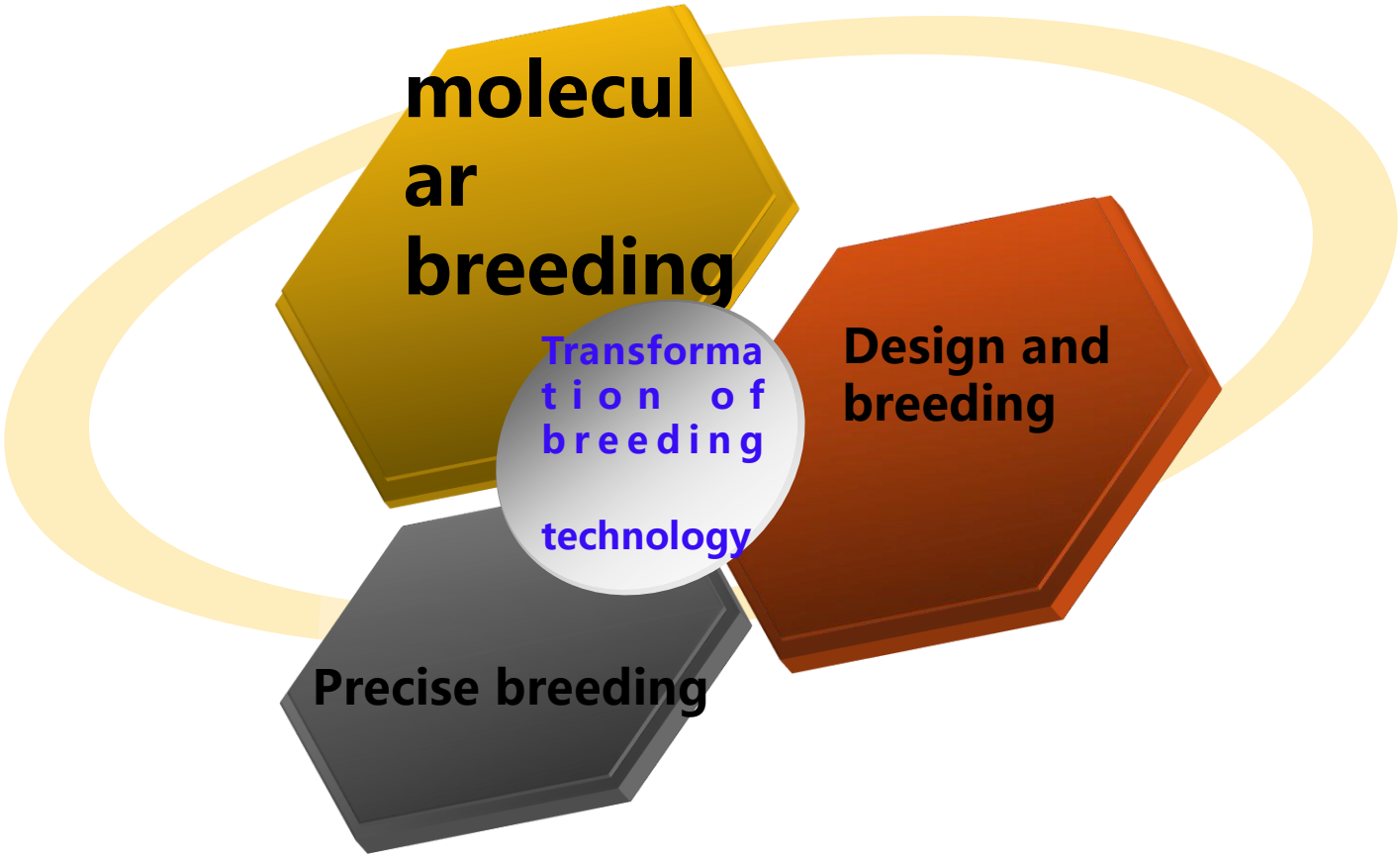
Variety species	Variety name	Loaction	Year	Area / (10000 mu)
Sunflower	SH363	Gansu Province	2015	7
Sunflower	SH363	Jilin Province	2015	31
Sunflower	SH363	Inner Mongolia Autonomous Region	2015	65
Sunflower	SH363	Xinjiang Uygur Autonomous Region	2015	4
Sunflower	SH363	Gansu Province	2014	1
Sunflower	SH363	Jilin Province	2014	8
Sunflower	SH363	Inner Mongolia Autonomous Region	2014	43
Sunflower	SH363	Gansu Province	2013	1
Sunflower	SH363	Jilin Province	2013	6
Sunflower	SH363	Inner Mongolia Autonomous Region	2013	13
Sunflower	SH363	Gansu Province	2012	1

2.5 Research on Biotechnology Breeding

With the development of biotechnology, sunflower biotechnology breeding has been carried out one after another。

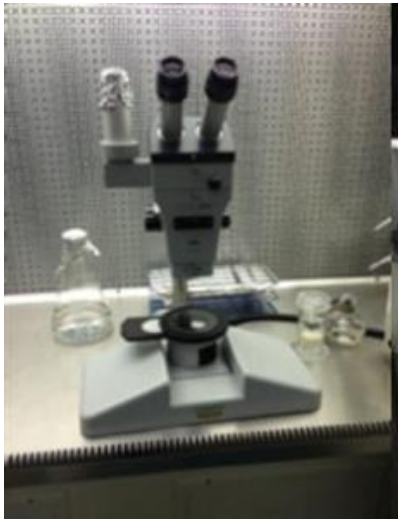
Liu Haixue and other isozyme techniques were used to analyze the genetic diversity, origin, evolution and phylogenetic relationship of sunflower. Liu Jie and other methods used RAPD and AFlP to study the genetic variation of sunflower germplasm resources, and constructed the fingerprint related materials, which provided a theoretical basis for effective utilization and protection sunflower germplasm resources sunflower. Liu Haixue successfully established different explant culture regeneration system and obtained sunflower plant. Genetic transformation and mutant screening have laid the foundation. Hua Lin studied the regeneration of Plantlets from unfertilized ovules of sunflower, providing a technique for haploid breeding and cell engineering of sunflower. Zhang Shanmei and other researchers have successfully developed new sunflower materials using exogenous DNA technology, and opened up a useful way for sunflower to transfer beneficial foreign genes. In breeding program, Zhang Yi and other techniques used for improvement of wild species and culture of immature embryo nutrient soil, overcame developmental obstacle distant hybrid embryo and accelerated speed of material transfer. Wang Xingde made use of Wild Germplasm to construct male sterile source of sunflower. Huang Xianqun made QTL analysis and marker assisted selection of sunflower somatic cells. Tan Meilian made SSR analysis of sunflower germplasm. Sun Li has reported progress of genetic engineering of sunflower in the world. These studies are of great significance for the rapid transfer of good genes.

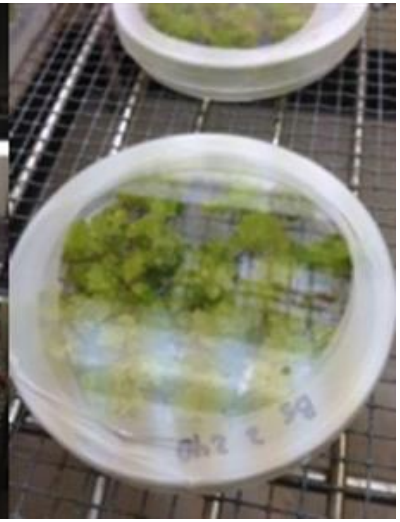
Transformation of breeding technology



Molecular genetic breeding

tissue culture





The third part

The direction of sunflower research in China

3.1 Research on the basic theory of sunflower

3.2 Quality breeding of sunflower

3.3 Breeding of multi resistant sunflower varieties

3.4 Sunflower Breeding suitable for mechanized harvesting

3.5 Study on ideal plant type and economic coefficient

3.1 Research on the basic theory of sunflower

The genetic mechanism of sunflower characters was further studied, and the relationship between environment and sunflower performance was also studied.

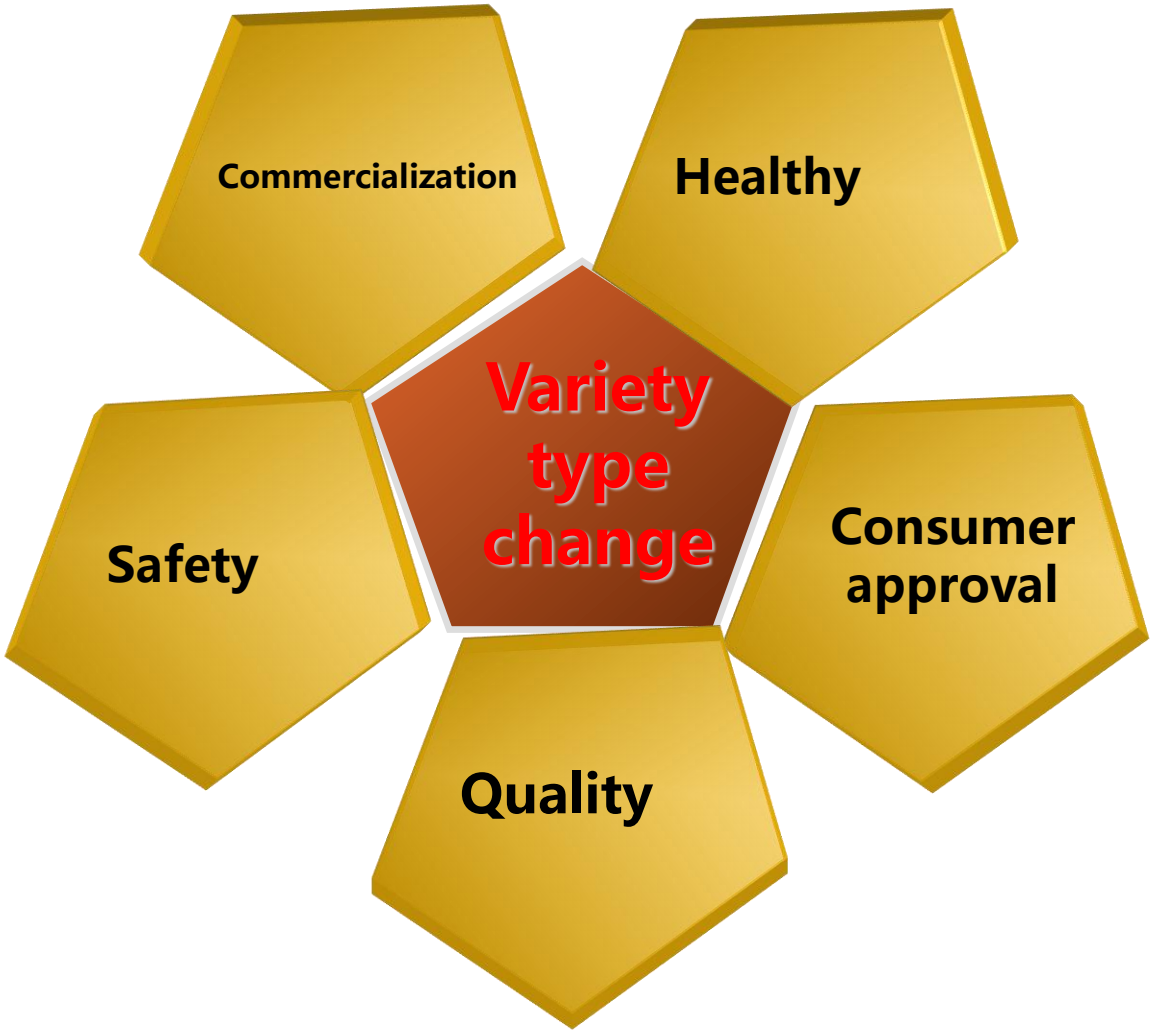
New germplasm resources are created by combining wild resources, conventional species and farm families with foreign sunflower resources. Genome wide genetic map of sunflower was constructed by molecular biotechnology. Using biotechnology, gene editing technology, molecular markers and other means to accelerate the selection of new breeding materials. Efforts should be made to increase collection, introduction, sorting and research of germplasm resources. The genetic mechanism of sunflower character was further studied. To study the genetic mechanism of sunflower diseases and find antigens of Sclerotinia sclerotiorum and black spot. The distribution, occurrence mechanism and genetic mechanism of the herb were studied.

3.2 Quality breeding of sunflower

Oil sunflower is mainly bred high oleic acid, high linoleic acid, rich in vitamin E, high lysine oil sunflower varieties. Sunflower oil is a high quality oil, but because of our people's consumption habits, the planting area of sunflower is decreasing in recent years, and the area of sunflower is increasing steadily. As people pay more attention to health, oil sunflower will usher in the time of big grain development.

To eat sunflower, it is necessary to accelerate the selection of appearance and commodity, the grain length x width is 25mm x 10mm, seed weight is more than 190g, seed kernel rate is high (seed kernel rate is >50%), seed rate is high (75%), taste is sweet, kernel is crisp, resistance to disease and adaptability is strong, resistance to middle and late mature (105 to 125d) and high yield (3750/hm^2) of confectionary sunflower varieties .

Variety type change




SH363

3.3 Breeding of multi resistant sunflower varieties

3.3.1 Sunflower Breeding for disease resistant insects

3.3.2 Breeding of sunflower broomrape

3.3.3 Selection of herbicide resistant sunflower

3.3.1 Sunflower Breeding for disease resistant insects

At present, sunflower breeders are mainly resistant to disease breeding, but Sclerotinia sclerotiorum and black spot disease have not been found. We should pay attention to the search for excellent antigen from wild sunflower. Through biological technology, all kinds of disease resistant and insect resistant genes are transferred into sunflower, and new sunflower varieties with high yield, high quality, high resistance and multi resistance are cultivated.

3.3.2 Breeding of sunflower broomrape

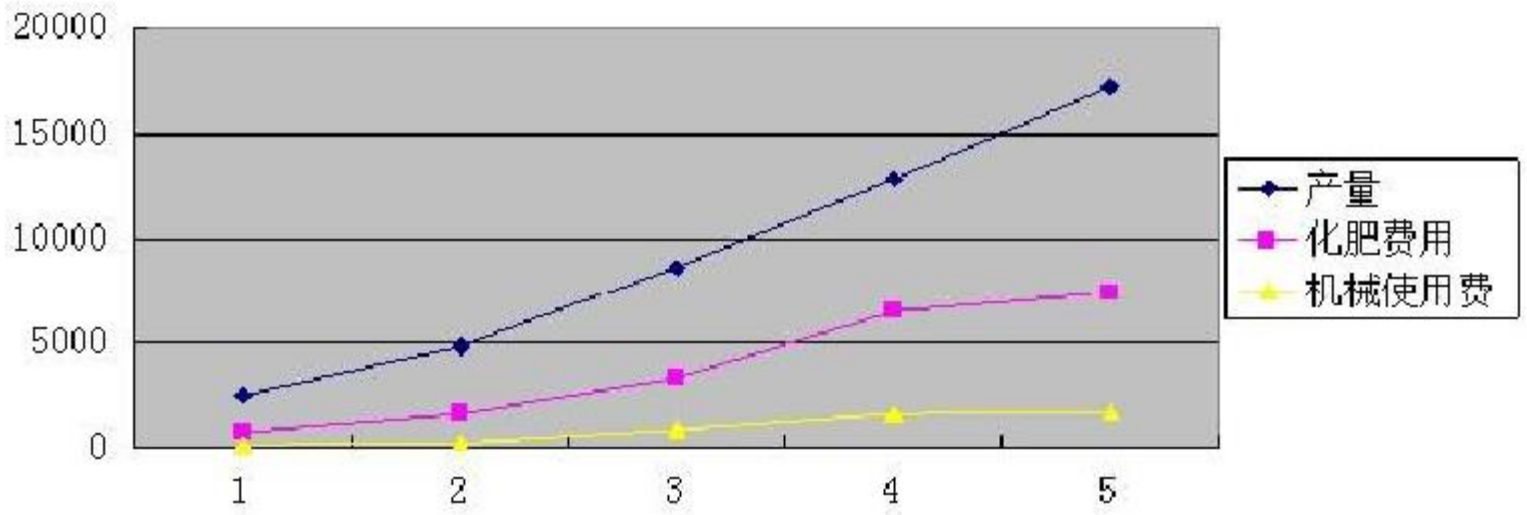
In recent years, it has spread rapidly in the main producing areas of sunflower in China, and it has caused great loss to production and caused great loss to production. Therefore, we have also intensified breeding of sunflower varieties with excellent resistance to synthetic varieties.

3.3.3 Selection of herbicide resistant sunflower

Because of the use of chemical weeding machine in field crops such as wheat and corn, the following crop was planted to the sunflower, and there was no suitable herbicide in sunflower production, which affected the sunflower production. Foreign varieties of sunflower with anti IMI, SU and other herbicides have been bred. It is still in this field in China. If a herbicide resistant variety is bred, even in the land of broad-spectrum herbicide, it can reduce labor intensity, save investment cost , and increase the capacity of the unit area. Sunflower production provides a broader space for development.

3.4 Sunflower Breeding suitable for mechanized harvesting

With the development of China's economy, the improvement of the people's living standards, increasing labor cost, traditional harvest method of sunflower, a large amount of manpower and material resources, increase of harvest cost, and selection of sunflower varieties suitable for mechanized harvesting can reduce harvest cost, improve benefit and promote development of sunflower planting.



The relationship between yield of sunflower and cost of chemical fertilizer and machinery

The increase of mechanical cost increases gradually with the output, but the increase trend gradually tends to be stable. It can be seen that with the increase of production, the cost use of marginal machinery gradually decreases.

3.5 Study on ideal plant type and economic coefficient

E.Zaffaroni(1989)thought When leaf area index of sunflower is in 3.4~3.7, the maximum amount of light interception can be obtained. The high leaf area index can only cause shade, reduce the photosynthetic efficiency and influence the accumulation of dry matter. Therefore, the selection of plant type should be emphasized while the leaf area index is raised. The plant type and tower shape on the leaf are more reasonable. The utility model is suitable for reasonable planting, and can reasonably increase photosynthetic efficiency and achieve high yield.

Due to the difference of economic coefficient, two varieties with similar biological output will cause great disparity in economic output. A reasonable coordination source - sink flow relationship and maintaining a reasonable organ balance is more important for improving the economic coefficient and grain yield of sunflower.

Improving sunflower yield is the most basic goal of sunflower genetic improvement. With the continuous improvement of people's daily life, sunflower quality is also higher. Therefore, strengthening research on genetic improvement of sunflower and constantly improving breeding technology, theory and breeding level are the long-term tasks for Sunflower Breeding Research. The technological content of new varieties depends on innovation of germplasm resources and research directions. Ideal plant type research, resistance breeding, quality breeding and suitable breeding for mechanized harvesting are the directions. The introduction of a large number of germplasm resources, application of biotechnology and technology of distant hybridization, multidisciplinary combined techniques and means to solve the problems in theory of sunflower genetics and breeding, and promote more fruit of Sunflower Breeding.

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新三瑞 新起点 新征程

Sanrui
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谢谢大家！