



# Research Progress in Genetic Breeding and Production Application of *Cynodon Dactylon*

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**Abstract.** Lawn grass is closely related to the ecological environment and people's happy lives. With the rapid development of China's economy and the promotion of urbanization and industrialization, the annual output value of China's lawn has exceeded 10 billion yuan in recent years. As one of the grass species with high value in the global warm season lawn grass, *Cynodon dactylon* was only widely used in the sports field lawn, but also used as ecological grass for solid soil protection and slope protection and excellent forage grass. However, the data show that more than 90% of the lawn grass seeds for greening in China rely on foreign imports. On the whole, China's lawn industry has problems such as an incomplete industrial chain, few excellent varieties, low industrialization degree of seed and turf production, and low maintenance and management level, which restrict the development of China's lawn industry. In this paper, the distribution of *Cynodon dactylon* germplasm resources, genetic breeding research progress, stress research, and production utilization development, analysis of the utilization of *Cynodon dactylon* germplasm resources in China, and further study and rational exploitation and utilization have been reviewed.

**Keywords:** *Cynodon dactylon*; genetic breeding; production application; research progress

## 1 Introduction: Distribution and Origin of *Cynodon dactylons*

*Cynodon dactylon*, also known as Bermuda grass, wire grass, salted grass, climbing grass, and stumbling grass, is a type C4 perennial herb in the subfamily. *Cynodon dactylons* mainly grow in warm and humid tropical, subtropical, and warm temperate areas. From the horizontal distribution, *Cynodon dactylons* cover almost all continents and islands in the range of 45 N-45 S. In terms of vertical distribution, it is distributed as high as Nepal, Kashmir, and the Himalayas, and as low as below sea level, such as southern Xinjiang in China, Jordan, and California in America<sup>[1]</sup>.

Among them, ordinary *Cynodon dactylons* are distributed throughout the vast area south of the Yellow River basin, and wild *Cynodon dactylons* are mainly distributed in the hills and mountains of China. The *Cynodon dactylon* is mainly distributed in Taiwan, islands of the South China Sea, Hainan, and other places. Some of the floodplain

is also distributed in bands or clumps, and even in wild *Cynodon dactylon* in arid deserts.

## 2 Development History of *Cynodon dactylon* Breeding at Home and Abroad

At the end of the 19th century, the United States began a systematic survey of grassland plant resources. In the middle of the 20th century, scholars from European and American countries successfully completed the inventory of biological resources of various countries. *Cynodon dactylon* breeding began in the United States in the 1940s, and in 1936, the first *Cynodon dactylon* breed was bred as Tiflawn. Twenty years later, the triploid hybrid *Cynodon dactylon* was bred and named Tifgreen. Tifgreen has soft leaves, and a good texture, suitable for golf green grass. In 1960, Tifway triploid hybrid *Cynodon dactylon* was bred. Compared with Tifgreen, Tifway was darker, more dense, with stronger disease resistance, freezing resistance, insect resistance, and wear resistance, and is widely used in golf lanes<sup>[2]</sup>.

*Cynodon dactylon* breeding in China started late. In recent years, many scientific researchers have developed and utilized the root resources of wild *Cynodon dactylon* in China. At present, there are only 8 kinds of independently breeding *Cynodon dactylon* breeds in China, according to the breeding period, which are: *Cynodon dactylon* No.1, Yangjiang, Xinnong No.1, Xinnong 2, southern Sichuan *Cynodon dactylon*, Handan, Baoding *Cynodon dactylon*, and Edong No.3. Among them, Xinnong No.2 *Cynodon dactylon*, Handan *Cynodon dactylon* and Baoding *Cynodon dactylons* have strong disease resistance and cold resistance; Yangjiang *Cynodon dactylon* and southern Sichuan *Cynodon dactylons* have good texture and long green stage; Eyin No.3 *Cynodon dactylon* have strong heat resistance.

## 3 Research Progress of *Cynodon dactylon* in China

*Cynodon dactylon* including *Cynodon dactylon* (*C.dactylon*), curved ear *Cynodon dactylon* (*C.arquatus*), and double flower *Cynodon dactylon* (*C.dactylon* var.*biflora*), in our country, *Cynodon dactylon* is mainly distributed in the yellow river basin and the central of china. Mainly scattered distributed in hills, mountain, and roadside growth environments, a small part is distributed in part of the beach grassland and meadow area. *Cynodon dactylon* is the most widely used grass in the warm season lawn grass, not only has tenacious vitality, but also very rapid reproduction, fine texture, good color and density, and trampling resistance, and is the first choice for lawn laying plants, is often used as green lawn, playground lawn, golf course lawn, slope protection lawn, etc.

In addition to being a widely used lawn grass seed, *Cynodon dactylonis* also a high-quality forage grass, which is favored by cattle, sheep, and rabbit herbivores because of its soft grass quality, rich leaves, and good palatability. More than 90 *Cynodon dactylon* germplasm resources had been studied for the nutrient composition, including

crude protein, dry matter, crude fiber, nitrogen extract, coarse ash, calcium, and phosphorus content of eight indicators, crude protein content is an important indicator of forage grass nutritional value, the determination results show that the *Cynodon dactylon* crude protein content is the least 9.2 g / kg, the maximum can reach 152.2 g / kg. Among the 91 *Cynodon dactylon* germplasm resources, only three had crude protein content below 32 g / kg, and the results of the remaining indicators showed that the nutritional value of *Cynodon dactylon* was high<sup>[3]</sup>.

## 4 Progress in Genetic Breeding of Root Resistance in *Cynodon dactylon*

*Cynodon dactylon* is a long-lived perennial grass suitable for the growth of warm, humid and warm and semi-arid areas of the world. It is extremely heat and drought-resistant, with strong trampling tolerance, but relatively poor cold resistance, shade tolerance, and salt tolerance.

### 4.1 Drought Tolerance Study in *Cynodon dactylons*

As drought stress increased, the leaf length, leaf width, leaf area, and average root diameter of root were significantly reduced, promoted root growth and development, increased the ABA content of leaf and root, reduced the content of IAA, GA3, ZR, Br, and IAA / ABA, GA3 / IAA, and leaf index, which showed that root and root chose the opposite survival strategies under drought stress, namely promoting the ground growth and inhibiting the shoot growth. Drought-resistant *Cynodon dactylons* maintain growth by having a more developed root system and higher ZR / ABA, GA3 / ABA, IAA / ABA, and Br / ABA under the same stress, while delaying senescence to better adapt to the drought-stress environment<sup>[4]</sup>.

### 4.2 Study on Trampled Tolerance of *Cynodon dactylons*

Different lawn grass has different trampled tolerance, Shanghai commonly used wisp of grass, *Zoysia*, *Paspalum*, and *Cynodon* three warm season lawn grass varieties for test material, set different traffic sizes of trampled intensity and trampled frequency, in the lawn growth peak 5-September distributed simulation trampled, from lawn grass wear resistance, soil firmness and resilience ability three aspects of multiple index membership function comprehensive evaluation. The results showed that *Cynodon dactylon* was more resistant to trampled than the other grass under mild moderate or severe trampled<sup>[5]</sup>.

### 4.3 Study on Cold Tolerance in *Cynodon dactylons*

As a warm-season grass, low temperature was the main reason to limit its growth. The optimal growth temperature of the root was between 25 and 30°C, below which the

growth will stop. When the temperature is lower than 10°C, the root begins to fade and gradually recover until above this temperature. *Cynodon dactylon* introduced to colder areas of the transitional climate zone was vulnerable to freezing damage and will die from low temperatures in 4-5 years, so caution is needed. The content of hormone ABA increased in *Cynodon dactylon*, while the content of IAA, GA3, and tZR all decreased, and the content of soluble sugar, fructose, and total nonstructured sugars in carbohydrates increased to varying degrees, and it was speculated that the accumulation or maintenance of high *Cynodon dactylon* hormone level and soluble sugar content under low-temperature stress may be the main reasons for improving cold resistance<sup>[6]</sup>.

The LT 50 (median lethal temperature) of *Cynodon dactylon* material in 28 regions was 8.70 ~ -0.70°C. The results show that the cold resistance of *Cynodon dactylon* and latitude and precipitation are correlated, and the material at higher and lower latitudes is stronger than that in the middle latitude. The materials from Xiantao City, Zhumadian City, Xuchang City, Zhengzhou City, Huixian City, and Cixian have the strongest comprehensive cold resistance and have good development potential of forage grass and lawn grass<sup>[7]</sup>.

The expression level of antioxidant enzyme activity and antioxidant enzyme genes in *Cynodon dactylon* leaves increased significantly with the decrease of treatment temperature, which was significant in "Motor Bermuda"; The expression of CBF 1, COR, and LEA genes in *Cynodon dactylon* increased significantly with decreasing temperature, especially in cold tolerant strains. The upregulation of antioxidant enzymes and cold tolerance genes enhanced the intracellular antioxidant defense, helped to maintain high photosynthesis and cell membrane stability, and delayed the senescence of leaves, thus improving the cold resistance of *Cynodon dactylon*<sup>[8]</sup>.

#### 4.4 Study on Shade Tolerance of *Cynodon dactylons*

The shade tolerance experiments used the Chinese penhazy grass, *Cynodon dactylon*, fake thrift, and bouquet four kinds of warm season lawn grass were carried, the result showed that fake thrift grass adapted to all degrees of shade, Chinese penhazy grass was moderate, bouquet four performed better at low shade intensity but failed to adapt to higher shade intensity, and *Cynodon dactylon* worst at low root shade intensity, but better at high shade intensity<sup>[9]</sup>. Tested and analyzed the response differences of 7 common *Cynodon dactylon* breeds (lines) in plant growth and lawn quality under different degrees of shade stress. The shade tolerance from strong to weak was: C792> "Su Zhi 2"> "Yangjiang"> "TifGrand"> "Guanzhong"> "Tifway"> "TifSport". It can be seen that C792 *Cynodon dactylon* has the strongest shade tolerance and is most suitable for low-light areas<sup>[10]</sup>.

#### 4.5 Study on Heavy Metals and Salinity Stress Tolerance in *Cynodon dactylons*

The study showed that *Cynodon dactylon* was tolerant to short-term, low-concentration lead stress, and when the lead concentration was too high, the plants will have abnormal reactions<sup>[11]</sup>. The other study showed that the aluminum stress treatment significantly

increased the aluminum content in the root plants and this stress treatment inhibited the *Cynodon dactylon*'s absorption of N, P, K, Ca. The absorption of N, P, K, and Ca by the root was reduced, decreasing by 28.69%, 14.58%, 26.28%, and 27.07%<sup>[12]</sup>. Using the hydroponmethod of critical aluminum concentration, it was found that low concentration of aluminum stress (250~1250  $\mu\text{mol/L}$ ) can promote the growth and development of dog root, and high concentration (1500~3500  $\mu\text{mol/L}$ ) of aluminum stress significantly inhibited the growth of dog root, with the increase of aluminum stress concentration and time, the inhibition degree is more serious. *Cynodon dactylon* was fully adapted to the stress conditions of low concentration of aluminum, and the low concentration of aluminum salt shows a slightly increased effect on its own growth. Under the condition of medium and high concentrations of aluminum, the poisoning degree of *Cynodon dactylon* increases with the higher concentration of aluminum salt and the longer stress time. The low concentration of sodium chloride had no significant effect on the *Cynodon dactylon*, and the chlorophyll content and relative water content of the *Cynodon dactylon* decreased significantly. There is a critical value for the tolerance of dog roots to copper, beyond which it is harmful<sup>[13]</sup>. In summary, *Cynodon dactylon*s can tolerate low concentrations of heavy metal stress and salt stress.

*Cynodon dactylon* was damaged by a small degree under NaCl stress, but nitrate nitrogen can alleviate *Cynodon dactylon* damage under NaCl stress, Adding MES can certainly promote *Cynodon dactylon* growth of NaCl stress, especially in the ammonium nitrogen treatment group. Therefore, the nitrate nitrogen or added MES are beneficial to improve *Cynodon dactylon* salt resistance, but when applying nitrogen fertilizer, one should consider all factors, to keep the rhizosphere neutral acid environment<sup>[14]</sup>.

## 5 *Cynodon dactylon* Production and Application Development

*Cynodon Dactylon* is not only widely used in the sports field lawn, but also used as an ecological grass for soil consolidation and slope protection and excellent forage grass.

### 5.1 Sports Field, Landscaping Lawn Use

*Cynodon Dactylon* is a perennial warm season lawn grass, with developed roots and stolons, the lawn of low, strong fertility, drought resistance, trampled resistance, fine texture, thick, good color, and has become a sports lawn, recreational lawn, and one of the ecological plants, was widely used lawn grass in south of the Yellow River and the Yangtze river area, used for residential, park, roads, slope protection, golf high grass area, fairway area and other sports lawn or green space. For example, during the Hangzhou Asian Games, the standard natural grass football field, which was 105 meters long and 68 meters wide, undertook 10 women's football matches. Hangzhou Asian Games football field lawn selection of *Cynodon dactylon* Tifsport, it has a strong rhizome, and a crawling stem can form a dense turf. The reason why using *Cynodon dactylon* was to consider that the football lawn was mainly planted in sand, especially in summer and

rainy seasons. The sandy soil has good permeability and is not easy to water, which can maintain the flatness of the lawn.

## 5.2 Protect Water and Consolidate Soil for Slope Protection

After being planted, the root system of *Cynodon dactylon* reproduces rapidly. *Cynodon dactylon* has a significant effect in retaining water and fixing earth masks and was often used in solid soil and slope protection greening projects on embankments, reservoirs, expressways, both sides of railways, and other places. For example, Guiyang Shengda Ecological Landscaping Co., LTD. Yukai Expressway slope protection project: starts from Yuqing Changqing Bay, and ends at Kaili Duck Pond, with a total length of 88 kilometers, Shibing connecting line 25.35km, a total of 109.423km, the highway will connect Shanghai-Kunming, Xiamen-Rong two national expressways. With the standard construction of four-lane highway, the design speed is 80 km/h, the subgrade width is 21.5 meters long, the Huangping section is 6.4 km long, the slope area is 58000 m<sup>2</sup>, moderate weathered stone slope, the project adopts the hanging hook net soil spraying construction, the ratio of grass shrubs choose *Cynodon dactylon* 20%, high sheep grass 30%, purple alfalfa 15%, locust 15%, wood bean 20% to protect the green.

## 5.3 Use Forage Grass

Due to the perennial, heat, and drought-resistant characteristics of *Cynodon dactylon*, it was widely used in ecological restoration projects. Its root has sweet roots, soft leaves, and rich nutrition. It is also one of cattle and sheep. It can not only be used as a green grazing landscape but also feed to livestock.

# 6 Conclusion: The Efficient Utilization and Conservation of Grass Germplasm Resources Need to Be Strengthened in China

*Cynodon dactylon* was one of the typical successful and efficient uses of grass seeds in China, but many excellent forage germplasm resources had not been efficiently used. China is rich in wild grass germplasm resources, which provides breeding materials for breeding new varieties and new strains of excellent lawn grass with specific traits (such as disease resistance, insect resistance, trample resistance, low resistance, low plant resistance, herbicide resistance, and stress resistance, etc.). There are 246 families, 21545 genera, and 6704 species of plant resources that can be used as lawn grass and grass in China. The National Forestry and Grassland Administration published the catalog of major grass species of the People's Republic of China (2021), with 12 branches and 120 species. Among them, there were 59 grass species, most of which can be used as lawn grass. The comprehensive development of grass breeding in China began in the 1980s. By 2022, a total of 674 new forage varieties in China had passed the approval, including 257 bred varieties and only 65 lawn grass varieties. Since the 12th Five-Year

Plan, with the support of central financial funds, China has successively established a number of sharing platforms, including one central database, one in-vitro database, two backup databases, and 17 resource beds, and formed a national grass germplasm resources conservation and utilization system<sup>[15]</sup>. Seeds are agricultural "chips". General Secretary Xi Jinping visited members of the agricultural sector, social welfare, and social security sectors who attended the fifth session of the 13th CPPCC National Committee. He said that provenance security is related to national security, and we must be determined to promote China's seed industry to achieve self-reliance, self-improvement, and independent provenance control.

China has carried out the investigation collection and preservation of grass germplasm resources for a long time, but with the change in environment and human interference, some rare germplasm resources are gradually disappearing. At present, the protection method for grass germplasm resources in China is mostly to establish germplasm resources nursery for remote protection. This protection environment is relatively simple, and the living space of protected germplasm resources is small, which is separated from the selection of the natural environment, leading to the genetic evolution of some germplasm resources staying in the collection stage. In addition, China's grass breeding development is relatively late, and the level is still different from foreign countries. At the same time, China's forage industry also started relatively late, the production and operation system is not yet perfect, the technical and equipment support capacity is not strong, and the supporting policy guarantee system is still lacking. Compared with developed countries, there is still a large gap in the level of scale, mechanization, and specialization. Huang Baoxue, director of the Animal Husbandry and Veterinary Bureau of the Ministry of Agriculture and Rural Affairs, proposed to strengthen the support of scientific and technological equipment, accelerate the cultivation of new varieties of forage with high yield, excellent feeding value, strong regional adaptability, and good disease resistance, improve the level of industrialization operation, and accelerate the improvement of facilities and conditions.

At present, nearly 90% of the grass seeds in China still rely on imports, lack of local independent research and development of grass seeds, there is a long way to go. Secondly, due to the lack of funds for grass breeding, the resource evaluation is not systematic, the genetic evaluation and resistance evaluation are not fully covered, and the genetic background of germplasm resources is not clear. Therefore, it is suggested that national and local governments should strengthen the efficient utilization and conservation of grass germplasm resources in China.

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