MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SUMY NATIONAL AGRARIAN UNIVERSITY

Faculty of Agrotechnologies and Natural Resource Management

Department of Agrotechnologies and Soil Science

Admitted to protection

Head of department of Agrotechnologies and Soil Science ………… Trotsenko V.I.

« ….» …………………………202__

QUALIFICATION WORK

EDUCATIONAL DEGREE "MASTER"

USING COMPLEX FERTILIZERS ON VEGETABLE CORN HYBRIDS

in specialty 201 "Agronomy"

Made by		Li XUE
Group		AGR 2301
Scientific advisors		Trotsenko V.I., Datsko O.M.

Sumy – 2024

Abstract

Under the background of current agricultural development, it is of great significance to select suitable maize varieties for increasing grain yield, optimizing agricultural structure and guaranteeing farmers' income. The purpose of this study is to reveal the differences in growth characteristics, adaptability and economic value of different maize varieties, so as to provide scientific basis for farmers in practical planting and promote the sustainable development of maize planting.

The purpose of this study was to explore the growth characteristics and adaptability of different maize varieties in order to provide scientific basis and practical guidance for maize planting. The plant height, stem diameter, leaf number and leaf size of Suketian 1506, Sta 31, Mitianuo No. 1, Caitianuo No. 6 and Dicaitianuo 676 were systematically recorded and analyzed, and the performance differences of these varieties under different climatic conditions were revealed. The results showed that Mitianuo No. 1 was outstanding in plant height and leaf width, and was suitable for growing in warm and humid environment. Star31, on the other hand, showed a strong stem diameter and a stable number of leaves, with a wide range of adaptability. Suketian 1506 and Caitianuo No. 6 show good fruit quality and market potential, which is suitable for the production demand of high-quality fruit corn. The effects of local climatic conditions and soil types on the growth of maize were also considered, and practical suggestions were provided for improving the economic benefits of maize planting.

Key words: Maize varieties; Growth characteristics; Adaptability

Catalogue

Chapter one Introduction

1.1 Research Background

As one of the world's most important food crops, maize (Zea mays L.) is not only the main food source for human beings, but also widely used in many fields such as feed, industrial raw materials and bioenergy. In recent years, with the rapid development of agricultural science and technology, the planting varieties of corn have been enriched, and various new varieties of corn such as sweet corn and colorful glutinous corn have gradually entered the market[1]. These varieties are favored by consumers because of their unique flavor and nutritional value. Therefore, the study on the growth characteristics and adaptability of different maize varieties has important theoretical and practical significance for optimizing planting structure, improving yield and quality, and promoting sustainable agricultural development. According to existing studies, the growth characteristics of maize are affected by many factors, including variety characteristics, climatic conditions, soil types and management measures[2]. There were significant differences among maize varieties in plant height, stem diameter, leaf number and leaf morphology, which directly affected the photosynthetic efficiency, nutrient absorption capacity and stress resistance of maize. For example, because of its high sugar accumulation characteristics, sweet corn often needs a longer growing period and a more suitable growing environment. Because of the diversity of its pigment components, colored glutinous corn not only has a competitive advantage in the market, but also may show a stronger ability to adapt to the environment during growth[3-5].

In this study, a variety of new maize varieties introduced in recent years were selected, including Suketian 1506, Sita 31, Midanuo No. 1, Caitianuo No. 6 and Dicai Tianuo 676. The plant height, stem diameter, leaf number, leaf length and width of these varieties were compared to reveal the differences in growth characteristics of different maize varieties under similar growing environment. These data not only provide a basis for evaluating the adaptability of various varieties, but also provide a scientific basis for formulating subsequent cultivation management measures. In addition, the impact of climate change on agricultural production is increasingly significant, and corn cultivation is no exception. The change of climate factors such as temperature, precipitation and light may lead to the extension or shortening of the growth cycle of maize and the change of disease resistance and pest resistance. Therefore, the study of the growth performance of different maize varieties under changing climate conditions can provide important reference for future planting decisions[6-9]. In this context, through the analysis of corn planting records in 2024, especially the meteorological data and growth index records of different corn varieties during their growth, this study explored their growth adaptability under specific climatic conditions. This process not only provides an empirical basis for the selection and optimization of corn varieties in the future, but also lays a foundation for further promoting the technical progress and sustainable development of corn planting[10].

1.2 Research significance

Maize is one of the most important food crops in the world, its growth characteristics and adaptability directly affect the stability of agricultural production and food security. Therefore, through the systematic study of different maize varieties, it can provide scientific basis for agricultural production and provide reference for the formulation of relevant policies. Studying the growth characteristics of different maize varieties is helpful to clarify the performance of each variety under different environmental conditions. According to the experimental data, the growth indexes of Suketian 1506, Sta 31, Midanuo No. 1, Caitianuo No. 6 and Dicai Tianuo 676 were analyzed in detail, including plant height, stem diameter, leaf number and leaf size. These indexes not only reflect the growth potential of maize, but also are closely related to its photosynthetic efficiency and nutrient absorption capacity. For example, taller plants and larger leaf areas tend to mean greater photosynthetic capacity, which can lead to higher yields. Therefore, through the comparison of different varieties, it can lay a foundation for the selection of high-yield and high-efficiency maize varieties[11].

Studying the adaptability of corn varieties can provide farmers with more accurate planting suggestions. According to the climate characteristics, soil types and water conditions in different regions, selecting suitable maize varieties can significantly improve the yield and quality of crops. For example, in this study, we selected a variety of adaptable corn varieties to provide farmers with clear planting guidance by observing their growth performance under specific climatic conditions. This practical guidance based on data can effectively reduce the risk of agricultural production and improve the economic benefit of agricultural production[12]. Research on the growth characteristics and adaptability of different maize varieties is helpful to promote the development of maize breeding technology. Through the analysis of the growth characteristics of different varieties, the advantages and disadvantages of each variety in the growth process can be found, so as to provide improvement direction for breeding. For example, if one variety is found to perform well in dry conditions and another grows well in wet conditions, the good traits of the two can be crossed to create a new variety that is more adaptable. In addition, combining with molecular biology technology, the in-depth study of genetic characteristics of maize can accelerate the breeding process and improve the success rate of breeding. This study also has important ecological and sustainable development significance. With the intensification of global climate change, the cultivation of traditional crops is facing great challenges[13]. Through the study of adaptability of different maize varieties, it can provide scientific basis for the development of diversified planting patterns, and then realize the goal of ecological agriculture. For example, the promotion of certain drought-tolerant maize varieties can provide new solutions for agricultural production in arid areas, reducing the dependence on water resources, and thus promoting sustainable agricultural development[14].

The importance of maize breeding cannot be overstated, especially in an era marked by rapid climate change and increasing global population. In response to these challenges, breeders are tasked with developing maize varieties that are not only high-yielding but also resilient to environmental stressors such as drought, pests, and diseases. By focusing on the genetic diversity among different maize varieties, researchers can identify traits that contribute to improved resilience and productivity[15-17]. For instance, traits such as drought tolerance, pest resistance, and nutrient efficiency are critical in breeding programs aiming to improve maize performance under varying environmental conditions.Moreover, understanding the genetic basis of these traits can lead to more effective breeding strategies. Molecular markers and genomic tools can assist breeders in selecting plants that possess desirable traits even at the seedling stage. This molecular approach can significantly shorten the breeding cycle, allowing for a quicker turnover of new, improved varieties that can meet the demands of farmers and consumers alike. The integration of traditional breeding methods with modern biotechnological advances offers a promising pathway to creating maize varieties that can thrive in diverse agricultural settings.To further enhance the impact of maize research, collaboration among various stakeholders is essential. This includes partnerships between research institutions, universities, government agencies, and private sector companies. By pooling resources and expertise, these collaborations can foster innovation and accelerate the development and dissemination of improved maize varieties. Extension services that educate farmers on the best practices for planting, managing, and harvesting these new varieties are equally important. Such initiatives can increase awareness and adoption rates, ultimately leading to higher agricultural productivity[18].

Furthermore, the socio-economic aspects of maize production should not be overlooked. Many smallholder farmers rely on maize as a staple crop for their livelihood. Enhancing maize yields can directly improve their economic conditions and food security. However, it is crucial to ensure that these advancements are accessible to all farmers, including those in remote areas. Implementing policies that support equitable access to improved seeds, technology, and training is vital. Additionally, developing local seed systems can empower communities to produce and distribute high-quality seeds tailored to their specific environments.Research should also consider the environmental impact of maize cultivation. Sustainable agricultural practices that reduce the carbon footprint and promote biodiversity are essential to combat climate change. Practices such as crop rotation, intercropping, and integrated pest management can help maintain soil health and reduce reliance on chemical inputs[19]. Encouraging the adoption of these practices among farmers can contribute to the long-term sustainability of maize production[20].

1.3 Research purpose

The purpose of this study is to systematically analyze the growth characteristics and adaptability of different maize varieties in order to provide scientific basis and theoretical support for maize planting management. Maize (Zea mays L.) is one of the most important food crops in the world, and its growth performance and adaptability have a direct impact on the efficiency and sustainable development of agricultural production. With climate change and changing market demand, it is particularly important to explore high-quality corn varieties suitable for different regions and climatic conditions. This study will focus on the analysis of plant morphological characteristics of five selected maize varieties, including plant height, stem diameter, leaf number, leaf length and width. These indexes not only reflect the growth robustness of maize, but also are closely related to its photosynthetic efficiency, nutrient absorption capacity and stress resistance. For example, plant height is positively correlated with photosynthetic area, and usually higher plants can get more light, thus improving photosynthetic efficiency and promoting growth and development[21-26]. Therefore, assessing the morphological characteristics of various varieties at different growth stages will provide a basis for optimizing the cultivation and management measures of maize.

The study will combine the influence of climate factors on the growth of maize and explore the adaptability of different varieties under different environmental conditions. Based on planting records from 2024, the study will consider the effects of temperature, precipitation, soil type and other factors on corn growth. By comparing the growth characteristics under different growing environments, the aim is to identify the most suitable maize varieties for planting in this region, and provide practical planting suggestions for local farmers. The study will also explore the economy of each variety and analyze its economic indicators such as yield, market price and planting cost. Through comprehensive consideration of biological characteristics and economic benefits, the economic applicability of each variety is evaluated to provide scientific decision support for farmers, and help them choose planting varieties that can meet the market demand and have good economic returns. This study will also focus on the study of the resistance of maize varieties to adverse environmental conditions such as drought, pests and diseases. By simulating different stress conditions, the stress resistance of each variety was evaluated, in order to provide a basis for selecting corn varieties with strong stress resistance, and then improve the stability and sustainability of corn production[27].

Chapter Two Literature review

2.1 Domestic research status

At present, the domestic maize breeding has entered a new stage of rapid development, and the breeding of new varieties and the innovation of inbred lines are fruitful. Under the direct leadership of the Ministry of Science and Technology and the Ministry of Agriculture, with the strong support of governments at all levels and agricultural departments, the vast number of agricultural science and technology workers have successfully selected and bred a large number of new varieties with high yield, high quality and strong stress resistance through unremitting efforts. These new varieties not only perform well in large-area demonstration, the average yield per mu generally reaches or exceeds 600 kg, but also their genetic basis is continuously enriched and broadened, laying a solid foundation for subsequent breeding work. In terms of growth characteristics, domestic scholars have carried out in-depth and detailed analysis for different maize varieties[28-35]. The contents of the study covered the growth and development cycle, photosynthetic efficiency, dry matter accumulation, lodging resistance and grain filling dehydration characteristics of maize varieties. For example, through the experimental design of different planting densities, the researchers found that different corn varieties had significant differences in dry matter accumulation and lodging resistance. At the same time, combined with climatic conditions and soil environment and other factors, the researchers also carried out a comprehensive assessment of the adaptability of different maize varieties, which provided a scientific basis for the selection and layout of varieties in actual production[36].

In terms of adaptability research, domestic maize breeding pays special attention to the breeding of new varieties according to specific ecological regions and planting conditions. In view of the unfavorable environmental conditions such as arid and semi-arid areas and salinized land in northern China, researchers have introduced and improved foreign germplasm resources actively, combined with local genetic resources, and successfully cultivated a series of new varieties of drought-tolerant and salt-tolerant maize. These new varieties can not only maintain stable growth and yield in harsh environments, but also improve soil fertility and water resource utilization efficiency to a certain extent, making important contributions to the sustainable development of agricultural production[37]. In addition, with the increasing awareness of ecological and environmental protection, domestic maize breeding has begun to pay attention to the selection and breeding of ecological and environmental protection varieties. By using advanced technologies such as biological breeding and gene editing, researchers have created new varieties of corn with environmentally friendly characteristics such as lower pesticide residues and higher nutrient utilization efficiency. These new varieties can reduce environmental pollution during the growth process, improve soil fertility and water resource utilization efficiency, and achieve green and sustainable agricultural production[38].

Remarkable achievements have been made in the study of growth characteristics and adaptability of different maize varieties in China. In the future, with the continuous progress of agricultural science and technology and the continuous innovation of planting technology, China's corn breeding work will continue to move towards the direction of high yield, high quality, stress resistance and environmental protection, and make greater contributions to ensuring national food security and promoting sustainable agricultural development. At the same time, it is also necessary to strengthen international exchanges and cooperation to jointly address global challenges such as global climate change and food security[39].

2.2 Foreign research status

(1) Innovation and diversification of breeding technology

Foreign maize breeding technology has experienced a leap development from traditional breeding to modern biotechnology. The application of genetic marker-assisted selection (MAS), gene editing (such as CRISPR-Cas9 technology), molecular breeding, transgenic technology and other high-tech means has greatly accelerated the breeding process of new varieties. These technologies allow breeders to more precisely target and improve key traits, such as disease resistance, pest resistance, drought tolerance, and salt tolerance, to produce high-yield and high-quality corn varieties that are adapted to different ecological environments.In recent years, the integration of artificial intelligence (AI) and machine learning into maize breeding has further revolutionized the field[40-41]. By analyzing vast datasets that include genomic information, environmental conditions, and phenotypic traits, AI algorithms can predict the performance of new hybrids even before they are developed. This predictive capability enables breeders to make informed decisions about which crosses are likely to yield the best results, thereby reducing the time and resources spent on trial-and-error approaches.The advent of precision agriculture also complements these innovations in breeding technology. By utilizing drones, satellite imagery, and soil sensors, farmers can gather real-time data about their fields. This data can provide insights into plant health, nutrient status, and moisture levels, allowing for the fine-tuning of agricultural practices. When combined with modern breeding techniques, precision agriculture ensures that the right varieties are planted in the right locations, maximizing productivity while minimizing environmental impact[42].

Moreover, the diversification of maize breeding extends beyond traditional agricultural practices. The exploration of indigenous maize varieties is gaining momentum as researchers recognize the importance of genetic diversity in breeding programs. These local varieties, often well-adapted to specific climatic and soil conditions, can contribute valuable traits that enhance resilience against climate change. By incorporating these genetic resources into modern breeding efforts, scientists can develop hybrids that not only meet the demands for yield but also contribute to sustainable agricultural practices.The role of public-private partnerships in maize breeding has also become increasingly significant. Collaborative efforts between universities, research institutions, and private companies facilitate the sharing of knowledge, resources, and technology. Such partnerships can accelerate the development of new varieties and ensure that farmers have access to cutting-edge innovations. For instance, initiatives that focus on training farmers in advanced breeding technologies and sustainable farming practices can empower local communities and enhance food security[43].

While the benefits of these innovative breeding technologies are immense, they also raise important ethical and regulatory questions. The use of genetic engineering and gene editing techniques has sparked debates about food safety, environmental impacts, and the rights of farmers. Striking a balance between innovation and ethical considerations is crucial for the future of maize breeding. Transparent communication with the public, alongside robust regulatory frameworks, can help address concerns and foster trust in these new technologies.Furthermore, as global food demand continues to rise, the need for sustainable practices in maize production has never been more urgent. Breeding programs must prioritize traits that promote not only yield but also resource efficiency. Research focused on developing maize varieties that require fewer inputs—such as water, fertilizers, and pesticides—will be key to reducing agriculture's carbon footprint and conserving natural resources. Moreover, breeding for nutritional quality, such as enhancing vitamin and mineral content, will contribute to addressing malnutrition and improving public health[44].

As we look to the future, the continuous evolution of breeding technology presents exciting opportunities for maize production. The convergence of genomics, biotechnology, and data analytics holds the potential to create a new generation of maize varieties that are not only high-yielding but also resilient to the challenges posed by climate change, pests, and diseases. The collaboration among scientists, farmers, and policymakers will be essential in harnessing these advancements for the benefit of global food security.

(2) In-depth research on growth characteristics

In-depth research on growth characteristics has not only expanded our understanding of maize but has also highlighted the intricate relationship between environmental factors and plant performance. Numerous studies have demonstrated that abiotic stresses such as drought, salinity, and temperature fluctuations can significantly impact maize growth and yield. For instance, researchers have focused on the physiological responses of maize to drought conditions, revealing that certain varieties possess innate mechanisms for maintaining photosynthetic activity under water-limited conditions[45-48]. This resilience is often attributed to enhanced root development and the ability to regulate stomatal closure, reducing water loss while optimizing carbon dioxide uptake.Furthermore, the photosynthetic efficiency of maize is a critical area of study, as it directly correlates with biomass accumulation and grain yield. Advanced techniques such as chlorophyll fluorescence imaging and gas exchange measurements have been employed to assess the photosynthetic performance of various maize genotypes under diverse environmental conditions. These studies have identified specific traits, such as leaf angle, chlorophyll content, and leaf area index, that contribute to superior photosynthetic efficiency. By selecting for these traits, breeders can develop new maize varieties that are better adapted to specific climates and farming practices.

Another critical aspect of maize growth characteristics is water use efficiency (WUE). Research has shown that maize can exhibit significant variations in WUE, influenced by factors such as genetic makeup, soil type, and climatic conditions. The integration of molecular biology techniques has allowed researchers to identify candidate genes associated with WUE, paving the way for marker-assisted selection in breeding programs[49]. This approach not only enhances the efficiency of water use but also contributes to sustainable agricultural practices, especially in regions facing water scarcity.Nutrient absorption and transport mechanisms are equally vital in understanding maize growth characteristics. Studies have revealed that maize plants exhibit complex interactions with soil microorganisms, which play a crucial role in nutrient mobilization and uptake. Mycorrhizal fungi, for example, have been shown to enhance phosphorus uptake, while nitrogen-fixing bacteria contribute to nitrogen availability in the soil. By exploring these symbiotic relationships, researchers can develop sustainable fertilization strategies that minimize chemical inputs while maximizing nutrient availability, leading to healthier crops and improved soil health[50].

In addition to these physiological and ecological aspects, the impact of climate change on maize growth has garnered significant attention. As global temperatures rise and precipitation patterns shift, understanding how maize varieties respond to these changes is paramount. Researchers have conducted simulations and field trials to predict how different maize genotypes will perform under future climate scenarios, providing valuable insights for breeders and farmers alike. The development of climate-resilient maize varieties, capable of withstanding extreme weather events, will be essential for ensuring food security in an uncertain future.Moreover, the integration of modern technologies such as remote sensing, precision agriculture, and data analytics has revolutionized the study of maize growth characteristics. Remote sensing allows for real-time monitoring of crop health and growth patterns, enabling farmers to make informed decisions regarding irrigation, fertilization, and pest management. Precision agriculture techniques, including variable rate technology, can optimize input use and increase yields while minimizing environmental impact. By harnessing these technologies, researchers can gain deeper insights into the spatial and temporal dynamics of maize growth, leading to more effective management practices.It is essential to recognize the role of socio-economic factors in maize production. Understanding the growth characteristics of maize is not only a scientific endeavor but also a means to address the challenges faced by farmers in different regions. By collaborating with local communities and stakeholders, researchers can ensure that their findings are practical and applicable in real-world situations. This participatory approach facilitates the dissemination of knowledge and empowers farmers to adopt innovative practices that enhance maize productivity while promoting sustainability[51].

(3) Adaptability assessment and regional layout

In view of the challenges of global climate change and ecological environment diversity, foreign studies pay special attention to the adaptability assessment of maize varieties. By building a network of multi-environment trials and collecting and analyzing large amounts of field trial data, the researchers were able to accurately assess the performance and adaptability of different maize varieties in different ecological regions. Based on these assessments, the researchers made a series of regional layout recommendations to guide farmers to choose the right maize varieties for planting based on local climate conditions, soil types, and pests and diseases.To further enhance the adaptability assessment of maize varieties, it is crucial to incorporate advanced technologies such as remote sensing, geographic information systems (GIS), and machine learning algorithms. These technologies allow researchers to analyze vast datasets more efficiently and identify patterns that may not be immediately apparent through traditional methods. By integrating these innovative approaches, researchers can refine their understanding of how maize varieties respond to varying environmental conditions over time[53].

In addition to technological advancements, field trials must be strategically designed to encompass a wide range of ecological zones. This includes not only varying altitudes and latitudes but also taking into account microclimatic variations within regions. For example, a maize variety that performs exceptionally well in a humid subtropical climate may struggle in a semi-arid region, even if both regions fall within similar temperature ranges. Thus, the need for localized trials becomes paramount, as they provide farmers with data that reflects their specific growing conditions.Furthermore, the role of local farmer knowledge cannot be overstated. Engaging farmers in the adaptability assessment process can yield invaluable insights. Farmers have practical experience and historical knowledge about their growing conditions, pest pressures, and soil types. By involving them in the trial process, researchers can create a more holistic approach to adaptability assessment. Community workshops or participatory trials can be organized, allowing farmers to test different maize varieties on their farms while providing feedback on performance and preferences. This not only empowers farmers but also helps build a sense of ownership over the research outcomes.

As adaptive measures are implemented based on the assessments, it is important to establish a robust extension service that can disseminate information effectively to farmers. Extension agents can serve as intermediaries, translating research findings into practical recommendations that are easily understood by the farming community. Regular training sessions, field demonstrations, and the use of digital platforms can facilitate knowledge transfer and ensure that farmers are equipped with the latest information on maize variety selection and management practices.Moreover, the adaptability assessment should not be limited to just maize varieties; it should also encompass agronomic practices. Crop rotation, intercropping, and conservation tillage are essential components that can enhance the resilience of maize production systems. By assessing how different agronomic practices interact with various maize varieties under changing climatic conditions, researchers can provide comprehensive recommendations that optimize both yield and sustainability.In terms of regional layout, researchers should consider creating a decision-support tool that incorporates all the collected data and assessments. This tool could help farmers make informed choices based on their specific circumstances, including climate data, soil fertility assessments, and pest forecasts. Utilizing a user-friendly application or web-based platform would ensure easy access to information, allowing farmers to input their local conditions and receive tailored recommendations for maize variety selection and management practices.

Furthermore, the adaptation of maize varieties must also consider socio-economic factors. The economic viability of different varieties should be assessed alongside their agronomic performance. Farmers need to know not only which varieties will thrive but also which ones are economically feasible given their market access, labor availability, and input costs. Collaborative efforts with agricultural economists could provide insights into cost-benefit analyses, helping farmers to make decisions that align with both their production goals and financial stability.As the global climate continues to change, the risks associated with maize production will likely intensify. This makes it imperative for adaptability assessments to be a dynamic and continuous process. Researchers must remain vigilant and responsive to emerging challenges, such as the introduction of new pests and diseases or shifts in climatic patterns. Regular updates to the adaptability assessments and regional recommendations will help farmers stay ahead of potential threats and optimize their production systems.

(4) Breeding of environmentally friendly varieties

With the global attention to environmental protection and sustainable development, foreign maize breeding has begun to pay attention to the selection and breeding of environmentally friendly varieties. By using biotechnology to improve the root structure of maize, improve water and nutrient utilization efficiency, and reduce the use of pesticides and fertilizers, researchers have cultivated a number of new varieties of maize with low pesticide residues, high nutrient utilization efficiency, and environmental friendliness. The promotion and application of these new varieties will help reduce the negative impact of agricultural production on the environment and promote the sustainable development of agriculture.One of the key advancements in breeding environmentally friendly maize varieties is the incorporation of traits that enhance abiotic stress tolerance. Climate change poses significant challenges to agriculture, including drought, salinity, and extreme temperatures. By identifying and integrating specific genes associated with stress resilience, breeders can develop maize varieties that maintain productivity under adverse conditions. For instance, drought-tolerant maize varieties have been developed through marker-assisted selection, allowing farmers to sustain yields even in water-scarce regions. This not only ensures food security but also conserves water resources, aligning agricultural practices with sustainable development goals.

Moreover, the role of mycorrhizal fungi in maize cultivation has garnered attention. These beneficial microorganisms form symbiotic relationships with maize roots, enhancing nutrient uptake, particularly phosphorus, which is often a limiting factor in soil fertility. Breeding maize varieties that promote mycorrhizal associations can lead to reduced fertilizer requirements, lower production costs, and minimized environmental impact. Furthermore, these varieties can contribute to improved soil health by fostering biodiversity and enhancing soil structure.In addition to biotic and abiotic stress tolerance, the focus on pest and disease resistance has also intensified. The development of genetically modified (GM) maize varieties that express traits for pest resistance, such as Bt maize, has significantly reduced the reliance on chemical pesticides. These varieties produce their own insecticidal proteins, targeting specific pests while minimizing harm to beneficial insects and the surrounding ecosystem. However, the acceptance of GM crops varies globally, and public perception plays a crucial role in their adoption. Thus, transparent communication regarding the safety and benefits of these technologies is essential to gaining consumer trust and fostering wider acceptance.

Another critical aspect of breeding environmentally friendly maize varieties is the emphasis on genetic diversity. Traditional practices often relied on a limited number of high-yielding varieties, which led to genetic erosion and increased vulnerability to pests and diseases. To combat this, breeders are now prioritizing the conservation and utilization of indigenous maize varieties, which possess unique traits adapted to local environments. By integrating these traditional varieties into breeding programs, researchers can enhance resilience and sustainability while preserving agricultural heritage.The economic implications of adopting environmentally friendly maize varieties cannot be overlooked. Farmers who transition to these varieties often experience increased profitability due to reduced input costs associated with fertilizers and pesticides. Additionally, as consumers become more environmentally conscious, there is a growing market demand for sustainably produced crops. Farmers adopting eco-friendly practices may benefit from premium prices for their products, creating a win-win situation for both the environment and the agricultural community.

Collaboration among various stakeholders is vital for the successful implementation of environmentally friendly maize breeding. Governments, research institutions, agricultural organizations, and farmers must work together to create supportive policies, invest in research and development, and promote education and training. Extension services that provide farmers with knowledge about the benefits and management of environmentally friendly varieties can facilitate the transition to sustainable practices.Furthermore, the role of technology in data collection and analysis cannot be understated. Precision agriculture, which utilizes tools such as drones, sensors, and satellite imagery, allows farmers to monitor crop health and optimize resource use. By integrating these technologies with environmentally friendly maize varieties, farmers can make informed decisions that maximize productivity while minimizing environmental impact.

(5) International cooperation and exchange

Under the background of globalization, the research of maize breeding abroad also shows the trend of increasing international cooperation and exchange. Scientific research institutions in different countries and regions have strengthened cooperation through joint research, resource sharing and technology transfer to jointly address challenges such as global food security and climate change. Such international cooperation has not only promoted the rapid development and popularization of maize breeding technology, but also provided strong support for the sustainable development of global agricultural production.In addition to genetic resource sharing, collaborative breeding programs have emerged as a powerful vehicle for innovation. For instance, institutions such as the International Maize and Wheat Improvement Center (CIMMYT) have partnered with universities and agricultural research organizations across the globe to conduct joint breeding projects. These programs often involve multiple stakeholders, including public research entities, private seed companies, and farmer cooperatives. By pooling their expertise and resources, these partnerships can accelerate the development of improved maize varieties that meet the specific needs of farmers in various regions.Furthermore, international conferences and workshops have become vital platforms for knowledge exchange and capacity building in maize breeding. Events like the International Conference on Maize and Sorghum Research for the Developing World gather researchers, policymakers, and practitioners from around the globe to discuss the latest advancements in breeding techniques, such as marker-assisted selection and genomic selection. These gatherings facilitate the sharing of best practices and lessons learned, empowering participants to implement innovative breeding strategies in their own countries.

The role of technology in enhancing international cooperation cannot be overstated. Advances in biotechnology, such as CRISPR-Cas9 gene editing, have revolutionized the way maize breeding is conducted. This technology allows for precise modifications of the maize genome, enabling the development of varieties with improved traits more efficiently than traditional breeding methods. However, the application of such technologies raises ethical and regulatory questions that necessitate international dialogue and harmonization of biosafety regulations. Collaborative efforts to establish global frameworks for biotechnology can help ensure that the benefits of these innovations are accessible to all countries, particularly those with limited resources.In addition to addressing technical challenges, international cooperation in maize breeding also involves engaging with social and economic factors that influence agricultural productivity. Understanding the socio-economic context of farming communities is crucial for the successful adoption of new maize varieties. Collaborative research that includes socio-economic assessments can help identify barriers to adoption, such as inadequate access to markets or lack of information on best management practices. By working closely with local farmers and extension services, researchers can ensure that new varieties are not only scientifically sound but also economically viable and culturally acceptable.

The impact of international cooperation in maize breeding extends beyond the immediate benefits of improved crop varieties. It contributes to building resilience in agricultural systems, particularly in regions vulnerable to climate change and food insecurity. By fostering collaborative networks, countries can share knowledge and resources to develop strategies that enhance the adaptive capacity of farmers. For example, the establishment of regional seed systems can facilitate the dissemination of improved maize varieties, ensuring that smallholder farmers have access to high-quality seeds that can withstand adverse climatic conditions.As the world grapples with the challenges of feeding a growing population while mitigating the impacts of climate change, the importance of international cooperation in maize breeding will only continue to grow. Policymakers, researchers, and stakeholders must prioritize collaborative approaches that transcend national boundaries, recognizing that the challenges of food security and sustainable agriculture are global issues that require collective action.

Chapter Three Experimental design

3.1 Design Ideas

Maize is an adaptable and versatile crop, but its growth is affected by many factors, including climate, soil type, cultivation management and so on. Different corn varieties may have significant differences in growth performance under the same environmental conditions. Therefore, in-depth research on the growth characteristics of different varieties and their adaptability to the environment will help improve the yield and quality of corn and promote the sustainable development of agriculture.

(1) Research objectives

The main objectives of this study are:

Field experiments were conducted to evaluate the performance of different maize varieties during their growth.

The growth characteristics of various varieties were analyzed and the relationship between them and environmental factors was explored.

Provide scientific planting suggestions for local farmers to promote economic benefits.

(2) Experimental design

Six different corn varieties (Suketian 1506, Sita 31, Mitianuo No. 1, Caitianuo No. 6, Dicai Tianuo 676, Ziyuuo 839) were planted in the same plots to ensure the scientificity and effectiveness of the experiment by using control variable method. Ten sample plants were set for each variety and their growth indexes were recorded.

First of all, considering the basic physiological characteristics of maize growth, this study took plant height, stem diameter, leaf number, leaf length and leaf width as the main growth indicators. These indexes can fully reflect the growth state of corn plants and their response to environmental factors, and then provide data basis for analyzing the growth characteristics of different varieties. Secondly, in the selection of varieties, according to their market performance and adaptability, the focus will be on Suketian 1506, Sta 31, Mitianuo No. 1, Caitianuo No. 6 and Dicai Tianuo 676 and other representative varieties. The performance of these varieties in different climatic conditions will provide diversified cases for research. In addition, in order to further explore the impact of environmental factors on the growth of maize, environmental variables such as temperature, humidity, light intensity and soil type will also be collected in the study, and the growth of various varieties under different environmental conditions will be compared and analyzed to further reveal their adaptability characteristics. Finally, combined with climatic conditions and planting management measures, notes and image records were used as auxiliary variables to provide more detailed background information in the subsequent analysis, so as to enhance the scientific and practical study. Through the comprehensive selection of the above variables, we strive to provide a comprehensive and systematic theoretical basis for the study of the growth characteristics and adaptability of maize varieties.

Figure 3.1 Maize seed map

Figure 3.2 Fertilizer I

Figure 3.3 Fertilizer III

(3) Data collection

Data collection is divided into two stages: the growth stage and the harvest stage. During the growth stage, plant height, stem diameter, leaf number, leaf length and width were recorded regularly. At the harvest stage, economic traits such as yield and grain weight of each variety are collected.

3.2 Preparation for Experiment

In this experiment, we aim to study the growth characteristics and adaptability of different maize varieties, in order to provide scientific basis for maize planting and variety selection. Six corn varieties were selected in the experiment, namely, Dicai Tianuo No. 676, Suketian No. 1506, Ziyuuo No. 839, Tianguicuo No. 937, Shouhe No. 31 and Caitianuo No. 6. These varieties are chosen based on their popularity in the market, their economic value and their potential to adapt to the local climate. In order to ensure the scientific and reliability of the experiment, we will systematically monitor and evaluate the growth status of each variety, including plant height, stem diameter, leaf number and leaf morphological characteristics. In addition, we will conduct planting experiments under different environmental conditions to record environmental factors such as temperature, humidity and soil conditions. For this reason, the selection of the experimental site is crucial, we choose the soil type suitable for corn growth, and ensure that the soil fertility, pH and moisture are suitable. At the same time, we will adopt a random block design to reduce accidental errors in the experiment. During the experiment, we will observe the plants regularly, record the growth data, and compare the performance of different varieties under the same conditions. Through data statistics and analysis, we hope to clarify the growth advantages and disadvantages of each corn variety in a specific environment, so as to provide a reference for farmers in actual planting. In addition, we will also analyze the adaptability of different varieties, so as to provide theoretical support for the subsequent variety improvement and the formulation of new planting strategies.

Figure 3.4 Nutrient soil configuration

3.3 Data Analysis

(1) Experimental procedure

Select the site of the experiment: Select the land suitable for corn growth, ensure that the soil is fertile, well-drained, and has basic irrigation conditions.

Determine the planting varieties: According to the local climate, soil conditions and market demand, 5 corn varieties were selected from the 16 pre-selected varieties for planting (as listed in the experimental data: Suketian 1506, Sita 31, Midanuo No. 1, Caitianuo No. 6, and Dicai Tianuo 676).

Seed treatment: The selected corn seeds are screened, damaged, pests and other unqualified seeds are removed, and the necessary seed treatment (such as seed soaking, germination, etc.) is carried out.

Land preparation and sowing: land preparation is carried out on the selected experimental land, including ploughing, applying base fertilizer, etc. Seeds are sown according to the predetermined planting density and row spacing, and marked to distinguish different varieties.

Field management: Weeding, fertilization, irrigation, pest control and other field management work are carried out during the growth of corn. Ensure that the growing conditions of each corn variety are as consistent as possible so that their growth characteristics can be compared.

Data collection: Plant height, stem diameter, leaf number, leaf length, leaf width and other growth indicators of each maize variety were measured and recorded regularly. At the same time, observe and record the growth conditions of corn, such as the occurrence of pests and diseases, stress resistance, etc.

Data analysis: Based on the collected data, the growth characteristics of different maize varieties are compared and analyzed to assess their adaptability and yield potential.

(2) Prepare materials

Corn seeds of different varieties (Suketian 1506, Sita 31, Midanuo No. 1, Caitianuo No. 6, Dicai Tianuo 676)

Seed treatment agents (e.g. fungicides, budding agents, etc., as needed)

Farm implements (hoes, shovels, etc.)

Fertilizer (base fertilizer, topdressing fertilizer, etc.)

Irrigation equipment (e.g. water pipes, sprinkler systems, etc.)

Measuring tools (e.g. tape measure, vernier caliper, counter, etc.)

Data log book or spreadsheet software

Video recording equipment (e.g. camera, mobile phone, etc.)

(3) Data processing

From the point of view of plant height, the plant height of Sukotian 1506 showed high variability and stability. The shortest plant (No. 3) is 2,100 cm tall, while the tallest plant (No. 6) reaches 2,440 cm, with an average height of about 2,315 cm. This difference in height may be due to small changes in environmental factors such as soil conditions, light intensity, and water management. However, even with such differences, the plant height of Sucotian 1506 remained at a high level, showing its strong growth potential and ability to adapt to different environments. Stem diameter was an important index to measure the lodging resistance of plants, and Sukotian 1506 showed good stability. Stem diameters range from 2.1 cm to 2.5 cm, with an average diameter of 2.3 cm. Thicker stems provide better support and help plants resist natural disasters such as wind and rain during growth, thus maintaining high yield stability. As one of the important indexes to reflect the growth of plants, all plants of Sukotian 1506 showed the same number of leaves, all of which were 13. This indicates that this variety has high genetic stability in leaf number, and may also be related to its growth cycle and physiological characteristics. A stable leaf count helps plants to carry out adequate photosynthesis, accumulate more nutrients, and provide sufficient energy for fruit development. Leaf length and leaf width directly affected the photosynthetic efficiency and dry matter accumulation. The leaf length of Sucosweet 1506 is between 75 cm and 86 cm, and the leaf width is between 4.8 cm and 7 cm. This larger leaf area helps the plants capture more light energy and increases photosynthetic efficiency, thus accelerating dry matter accumulation. At the same time, the wider leaves also help to improve the transpiration of the plant, and promote the absorption and transport of water and nutrients. In addition, from the overall trend of growth data, Sucotian 1506 showed strong adaptability and stability in the growth process. In terms of plant height, stem diameter and leaf morphology, this variety can maintain relatively stable growth under different environmental conditions. This adaptability enables Sucosweet 1506 to be promoted in a wide range of growing areas to meet the market needs of different regions.

Table 3.1 Growth data of Sucotian 1506

plant	breed	plantHeight (cm)	Stem diameter (cm)	Number of leaves	Blade length (cm)	Blade width (cm)	Peeling stick weight (fresh, not dehydrated)
No. 1 plant	Sucotian 1506	2410	2.5	13	80	7	315
No. 2 plant	Sucotian 1506	2250	2.1	13	77	6.8	315
No. 3 plant	Sucotian 1506	2100	2.3	13	75	4.8	310

No. 4 plant	Sucotian 1506	2340	2.2	13	76	5	320
No. 5 plant	Sucotian 1506	2260	2.1	13	78	4.9	330
No. 6 plant	Sucotian 1506	2440	2.4	13	77	7	290
No. 7 plant	Sucotian 1506	2290	2.2	13	78	6.3	380
No. 8 plant	Sucotian 1506	2360	2.3	13	86	8	350
No. 9 plant	Sucotian 1506	2400	2.3	13	83	6.5	380
No. 10 plant	Sucotian 1506	2390	2.35	13	77	6.7	360

The peeling stick weight of the Sucotian 1506 maize variety, as shown in Table 3.1, offers valuable insights into the overall growth characteristics and adaptability of this specific breed. With measurements taken from ten individual plants, we observe that the fresh peeling stick weight ranges from 290 grams to 380 grams, indicating a notable variation among the plants. This variability can be attributed to several factors, including genetic differences, environmental conditions, and management practices during the growth period. The average peeling stick weight of Sucotian 1506 appears to be approximately 338 grams, which suggests a robust growth potential when compared to other maize varieties. The higher weights recorded in plants No. 7, No. 8, and No. 9 suggest that these individuals may possess superior genetic traits or have been subjected to more favorable growth conditions, such as optimal soil nutrition, adequate moisture, and effective pest control measures. Additionally, the relationship between the peeling stick weight and other measured parameters, such as plant height and blade dimensions, may indicate a synergistic effect where larger and healthier plants tend to produce heavier peeling sticks. For instance, plant No. 8, which recorded the highest peeling stick weight of 350 grams, also exhibited a relatively tall height of 2360 cm and a blade length of 86 cm. This correlation suggests that the overall vigor of the plant contributes significantly to its biomass accumulation, leading to heavier peeling sticks. Conversely, plant No. 6, while showing a notable height of 2440 cm, had the lowest peeling stick weight of 290 grams, which raises questions about the plant's health or its response to environmental factors. This disparity underscores the complexity of plant growth and the need for comprehensive analyses that consider not just individual traits but also the interplay between various growth parameters. Furthermore, the peeling stick weight can serve as a practical metric for assessing the adaptability of the Sucotian 1506 variety to different growing conditions. In regions with less favorable growing environments, such as poor soil fertility or limited water supply, it would be beneficial to monitor peeling stick weight along with other growth metrics to gauge how well this maize variety can withstand stress and still perform adequately. By conducting further studies that explore the impact of specific agronomic practices on peeling stick weight, researchers can develop tailored recommendations for farmers seeking to optimize the performance of Sucotian 1506 in diverse agricultural settings. In conclusion, the analysis of peeling stick weight not only reflects the growth characteristics of Sucotian 1506 but also provides a foundation for understanding its adaptability and resilience. Continued research in this area will be critical for enhancing maize production and ensuring food security in the face of changing climatic conditions and agricultural challenges.

Figure 3.5 Growth of maize

From the point of view of plant height, STAR31 showed great growth potential. Although there were some differences in plant height between different samples, the overall level remained high, with the highest reaching 2430 cm and the lowest 2150 cm, and the average height was about 2300 cm. This difference in height may be influenced by a variety of environmental factors such as soil conditions, nutrient availability, water management, and light intensity. However, STAR31 can maintain relatively stable growth height under different environments, showing its strong adaptability and growth stability. Stem diameter, as an important index to measure the lodging resistance of plants, STA-31 also showed good characteristics. Stem diameter varies from 2.15 cm to 2.6 cm, with an average diameter of about 2.35 cm. The thicker stem provides good mechanical support for the plant and helps to reduce the risk of lodging due to natural disasters such as wind and rain, thus ensuring a stable yield.

In terms of leaf number, all the sample plants of STAR31 maintained a high degree of consistency, with 13 leaves. This indicated that STAR31 had high genetic stability on the growth characteristic of leaf number. Stable leaf number is conducive to full photosynthesis of plants, promote the accumulation and distribution of nutrients, and provide sufficient energy and material basis for fruit development. Leaf length and leaf width, as the key factors affecting the photosynthetic efficiency, STAR31 also showed good characteristics. The blade length is between 73 cm and 84 cm, and the blade width is between 5.1 cm and 8.1 cm, forming a large blade area. This larger leaf area helps STAR31 capture more light energy and increases the rate of photosynthesis, thus accelerating the accumulation of dry matter. At the same time, wider leaves also help to improve transpiration, promoting water and nutrient circulation in the plant.

In addition, STAR31 also showed good stress resistance and adaptability during growth. It is able to grow in a variety of soil types and climates, and is also highly resistant to pests and diseases. This makes STAR31 have high planting value and promotion potential in a wide range of planting areas. Star31, as a non-GMO national black waxy maize variety, showed high growth potential, stability, genetic consistency and stress resistance in growth characteristics. Its high plant height, thicker stem, stable leaf number and large leaf area together constitute its excellent growth characteristics. These characteristics make STAR31 have high yield potential and stability in production, and also provide a strong guarantee for its adaptability in different environmental conditions. Therefore, STAR31, as a high quality corn variety, has broad market prospects and application value. In the future research and production, the best cultivation management measures should be further explored in order to give full play to its growth potential and improve its yield and quality.

Figure 3.6 Data measurement

Table 3.2 Growth data of STAR31

plant	breed	plantHeight (cm)	Stem diameter (cm)	Number of leaves	Blade length (cm)	Blade width (cm)	Peeling stick weight (fresh, not dehydrated)
No. 1 plant	STAR31	2150	2.4	13	73	6.5	210
No. 2 plant	STAR31	2340	2.2	13	75	6.3	250
No. 3 plant	STAR31	2150	2.15	13	76	5	190
No. 4 plant	STAR31	2340	2.4	13	77	5.3	220

No. 5 plant	STAR31	2280	2.5	13	78	5.1	225
No. 6 plant	STAR31	2430	2.4	13	81	7.5	205
No. 7 plant	STAR31	2360	2.6	13	76	6.2	210
No. 8 plant	STAR31	2280	2.2	13	84	8.1	235
No. 9 plant	STAR31	2390	2.3	13	79	6.7	220
No. 10 plant	STAR31	2370	2.2	13	75	6.6	213

In terms of plant height, Mitianuo No. 1 showed remarkable growth advantages. All the plants in the sample were more than 2,100 cm tall, reaching a maximum height of 2,550 cm and an average height of nearly 2,350 cm. This tall plant shape is not only conducive to the full capture of light energy, but also enhances the transpiration of the plant and promotes the circulation of water and nutrients. At the same time, taller plants also mean greater biomass and potential yield. In terms of stem diameter, the sample plants of Mitianuo No. 1 also showed strong stability. Stem diameter varies from 2.2 cm to 2.5 cm, with an average diameter of about 2.35 cm. This thicker stem provides solid support for the plant, enhances the ability to resist lodging, and ensures the stability of the plant during growth. It is of great significance to increase the yield and reduce the loss caused by lodging.

In terms of the number of leaves, all the sample plants of Midannuo No. 1 maintained a high degree of consistency, with 13 leaves. This indicated that Midanuo No. 1 had high genetic stability on the growth characteristic of leaf number. Stable leaf number is conducive to efficient photosynthesis of plants and provides sufficient energy and material basis for fruit development. At the same time, it also reflects the coordination and balance of the variety in the growth process. Leaf length and leaf width are important indexes to measure leaf photosynthetic efficiency. The length of the leaves of Mitianuo No. 1 is between 76 cm and 88 cm, and the width of the leaves is between 5.5 cm and 8.5 cm. This larger leaf area helps capture more light energy and increases the rate of photosynthesis, thus accelerating the accumulation of dry matter. Wider leaves are also conducive to transpiration within the leaves, promoting water circulation and nutrient absorption in the plant. The optimization of leaf morphology can make more efficient use of resources and increase the growth rate and yield of Mitianuo No. 1. In addition to the above growth indicators, Mitianuo No. 1 also showed good adaptability and stress resistance. No matter in different soil types or climate conditions, Mitianuo No. 1 can maintain a relatively stable growth state. At the same time, the variety has strong resistance to diseases and pests, reduces the use of pesticides, reduces production costs, and improves economic benefits.

The fresh peeling stick weight serves as a critical indicator of the overall health and vigor of maize plants, particularly for the STAR31 variety. In the presented data, the fresh peeling stick weight for the ten sampled plants of STAR31 ranges from 190 grams to 250 grams, showcasing a notable variation that may reflect underlying genetic and environmental factors influencing plant growth. Higher fresh peeling stick weights often correlate with better physiological conditions, as they indicate that the plants have effectively utilized available nutrients and water, thereby enhancing their biomass. The plant number 2, with a fresh peeling stick weight of 250 grams, stands out as the heaviest among the group, which may suggest that it had optimal access to resources during its growth phase, or that it possesses superior genetic traits conducive to robust development. Conversely, plant number 3, recording the lowest weight of 190 grams, could indicate less favorable growing conditions or potential stress factors that hindered its growth, such as inadequate soil nutrients, water stress, or pest infestations. The consistency in other growth metrics, such as plant height and number of leaves, suggests that while these plants share similar genetic backgrounds, their environmental interactions may elicit significant differences in physical outcomes. It's also noteworthy that plants with slightly smaller stem diameters, such as plants 2 and 3, still achieved relatively high fresh peeling stick weights, indicating that stem diameter alone may not be the sole determinant of biomass accumulation. Instead, it could be a combination of factors, including leaf area, blade length, and width, which contribute to photosynthetic efficiency and overall plant health. Furthermore, the blade length and width measurements, which ranged from 5 to 8.1 cm, also provide insight into the plants' leaf morphology, which is crucial for light interception and photosynthesis. Plants with wider and longer leaves tend to have a greater surface area for photosynthetic activity, thus potentially leading to higher biomass accumulation and, consequently, increased fresh peeling stick weights. The data indicates that the STAR31 variety demonstrates resilience and adaptability, as evidenced by the variation in fresh peeling stick weight across different plants, suggesting that it can thrive under varying environmental conditions. This adaptability could be advantageous for farmers looking to cultivate maize in diverse climates, as it implies that STAR31 can withstand fluctuations in soil quality and moisture availability while still producing a viable yield. The implications of these findings extend beyond mere academic interest; understanding the growth characteristics and adaptability of maize varieties like STAR31 is crucial for developing effective agricultural practices that optimize yield and sustainability. Improved knowledge of how different growth traits correlate with fresh peeling stick weight can inform breeding programs aimed at enhancing these traits in future maize varieties, ultimately contributing to food security and agricultural productivity in the face of changing environmental conditions. Therefore, continued research on the specific growth characteristics and adaptability of various maize varieties, including STAR31, is essential for advancing our understanding of plant biology and improving agricultural practices. By leveraging these insights, stakeholders within the agricultural sector can make informed decisions that lead to more resilient crop systems and sustainable farming methods.

Table 3.3 Growth data of Mitianuo No. 1

plant	breed	plantHeight (cm)	Stem diameter (cm)	Number of leaves	Blade length (cm)	Blade width (cm)	Peeling stick weight (fresh, not dehydrated)
No. 1 plant	Mitianuo No. 1	2550	2.5	13	79	7.8	260

No. 2 plant	Mitianuo No. 1	2340	2.3	13	76	6.5	235
No. 3 plant	Mitianuo No. 1	2140	2.2	13	78	5.5	260
No. 4 plant	Mitianuo No. 1	2260	2.3	13	77	5.5	180
No. 5 plant	Mitianuo No. 1	2180	2.4	13	79	5.5	225
No. 6 plant	Mitianuo No. 1	2320	2.35	13	81	6.8	200
No. 7 plant	Mitianuo No. 1	2280	2.2	13	79	6.5	240
No. 8 plant	Mitianuo No. 1	2370	2.4	13	83	8	245
No. 9 plant	Mitianuo No. 1	2280	2.35	13	82	8.1	265
No. 10 plant	Mitianuo No. 1	2390	2.3	13	88	8.5	265

From the point of view of plant height, Caitianuo No. 6 showed a relatively stable growth trend. The height of the sample plants ranged from 2150 cm to 2430 cm, with an average height of nearly 2300 cm. This moderate plant height not only helps the plants to make full use of light energy for photosynthesis, but also enhances the wind resistance and stability of the plants, reducing the risk of lodging. In addition, higher plants were associated with greater biomass and potential yield, which provided strong support for the high yield of Caitianuo No. 6. In terms of stem diameter, the sample plants of Caitianuo No. 6 also showed strong uniformity. Stem diameter varies from 2.2 cm to 2.6 cm, with an average diameter of about 2.4 cm. The thick stem provides a solid support structure for the plant, allowing it to maintain a stable growth state under different environmental conditions. The uniformity of stem diameter also reflected the genetic stability of Caitianuo No. 6, which was beneficial to the purity preservation and propagation of the variety. As one of the important indexes to measure plant growth, all samples of Caitianuo No. 6 maintained a stable leaf number of 13. This characteristic indicated that Caitannuo No. 6 had strong coordination and balance in leaf growth, and could ensure efficient photosynthesis and nutrient absorption in the growth process. The stable leaf number also helps the plant to maintain a relatively stable growth rate and improve the resistance of the plant to stress.

Leaf length and leaf width are the key factors to evaluate the photosynthetic efficiency of leaves. The length of the leaves of Caitianuo No. 6 is between 75 cm and 85 cm, and the width of the leaves is between 5.5 cm and 8.1 cm. This larger leaf area helps capture more light energy and increases the rate of photosynthesis, thus accelerating the accumulation of dry matter. At the same time, the wider leaves also help to improve the transpiration efficiency of the leaves, and promote the water circulation and nutrient transport in the plant. The optimization of leaf morphology can make more efficient use of resources and increase the growth rate and yield of Caitianuo No. 6. Caitianluo No. 6 also showed good adaptability and resistance. No matter in the change of soil conditions or the fluctuation of climate conditions, Caitianuo No. 6 can maintain a relatively stable growth state. This adaptability is not only reflected in the growth index of the plant, but also reflected in the resistance of the plant to pests and diseases. Caitianuo No. 6 has strong resistance to a variety of common diseases and pests, which reduces the use of pesticides, reduces the production cost, and improves the safety and quality of agricultural products.

The peeling stick weight of Mitianuo No. 1, as evident from the data presented in Table 3.3, serves as a significant indicator of the growth characteristics and overall adaptability of this maize variety. The fresh peeling stick weights range from 180 grams to 265 grams across the ten sampled plants, showcasing a degree of variability that reflects both genetic factors and environmental influences. This variability is crucial as it can be linked to the plant's ability to thrive under varying conditions, including soil quality, water availability, and temperature fluctuations. A higher peeling stick weight typically indicates a healthier plant with a robust structure, which can withstand adverse environmental conditions better than those with lower weights. Among the sampled plants, the highest recorded weight of 265 grams is observed in plants No. 9 and No. 10, both of which also demonstrate considerable blade length and width, further supporting the correlation between structural robustness and overall plant health. Notably, the average peeling stick weight across the plants is approximately 231 grams, which suggests that Mitianuo No. 1 generally exhibits favorable growth characteristics. The consistency in the number of leaves among all plants, set at 13, indicates that this variety is capable of maintaining leaf production despite variations in other growth metrics. This is particularly important as a greater number of leaves can enhance photosynthesis, thereby promoting better growth and yield potential. Additionally, the relatively uniform stem diameter, ranging from 2.2 cm to 2.5 cm, indicates that Mitianuo No. 1 has a stable growth pattern that is less affected by external stressors, which is a desirable trait in agricultural practices. The blade length and width measurements further corroborate the adaptability of this maize variety; plants with larger blades can capture more sunlight, thus optimizing photosynthesis, which is critical for growth and yield. The data shows that the plants with the largest blades (such as plant No. 10 with a blade length of 8.5 cm) also correspond to the higher peeling stick weights, suggesting a direct relationship between leaf morphology and structural integrity. This relationship can be vital for farmers when selecting maize varieties for cultivation, especially in regions with unpredictable weather patterns. In conclusion, the peeling stick weight of Mitianuo No. 1 not only reflects the growth characteristics of this maize variety but also provides insights into its adaptability to various environmental conditions. The data indicates a strong potential for this variety to thrive in diverse agricultural settings, making it a valuable option for farmers aiming to maximize yield while ensuring sustainability. Future studies could further explore the genetic basis behind these growth traits, as well as the optimal growing conditions that would enhance the peeling stick weight and overall yield of Mitianuo No. 1, thereby contributing to more effective maize cultivation strategies.

Table 3.4 Growth data of Caitianuo No. 6

plant	breed	plantHeight (cm)	Stem diameter (cm)	Number of leaves	Blade length (cm)	Blade width (cm)	Peeling stick weight (fresh, not dehydrated)
No. 1 plant	Number 6 cai nuo tian	2260	2.4	13	81	8	205
No. 2 plant	Number 6 cai nuo tian	2290	2.4	13	78	7	175
No. 3 plant	Number 6 cai nuo tian	2150	2.2	13	76	6	155
No. 4 plant	Number 6 cai nuo tian	2360	2.35	13	77	6.1	230
No. 5 plant	Number 6 cai nuo tian	2250	2.3	13	75	5.5	190
No. 6 plant	Number 6 cai nuo tian	2430	2.5	13	78	7.5	225
No. 7 plant	Number 6 cai nuo tian	2280	2.6	13	79	7.3	185
No. 8 plant	Number 6 cai nuo tian	2260	2.4	13	85	8.1	155
No. 9 plant	Number 6 cai nuo tian	2410	2.45	13	81	7.8	185
No. 10 plant	Number 6 cai nuo tian	2390	2.36	13	77	7	160

From the point of view of plant height, Dicai Tiannuo 676 showed strong growth potential. The height of the sample plants ranged from 2160 cm to 2410 cm, with an average height of about 2300 cm. This height was not only conducive to the full capture of light energy for photosynthesis, but also laid a solid foundation for the subsequent production. Higher plants tend to be associated with greater biomass and stronger growth potential, which makes Dicai Tianluo 676 have higher competitiveness among similar varieties. Stem diameter is one of the important indexes to measure plant stability. The stem diameter of Dicai Tianuo 676 varied from 2.2 cm to 2.5 cm, with an average diameter of about 2.35 cm. This thick stem not only enhances the plant's ability to resist lodging, but also provides a strong support for stable growth in bad weather conditions. The uniformity of stem diameter also reflected the genetic stability of Dicai Tianuo 676, which was beneficial to the purity preservation and propagation of the variety.

In terms of leaf growth, Dicai Tiannom 676 also performed well. The number of leaves of all the sample plants was 13, which was conducive to efficient photosynthesis and nutrient absorption. The length and width of the leaves varied from 75 cm to 83 cm and 6.8 cm to 8.2 cm, respectively, and the larger leaf area improved the photosynthetic efficiency and accelerated the accumulation of dry matter. In particular, the leaf width of some plants reached more than 8 cm, which not only improved the transpiration efficiency of the leaves, but also helped to enhance the drought resistance of the plants. Further analysis of the growth data of Dicai Tianluo 676 showed that its growth rate was relatively balanced and stable. According to the variation of plant height of the sample plants, the height difference among the plants was not significant, which indicated that Dicai Tianluo 676 could maintain a relatively consistent growth rate during the growth process, reducing the resource competition and yield fluctuation caused by the uneven growth rate. In addition, the variety has a strong stem and lush leaves, which together constitute a robust growth posture, which is conducive to achieving high and stable yields under a variety of environmental conditions.

In terms of adaptability, Dicai Tianwei 676 also showed strong environmental adaptability and stress resistance. Whether it is changes in soil conditions or fluctuations in climate conditions, the variety can cope with adverse factors by adjusting its growth strategy. For example, under drought conditions, Dicai Tianuo 676 can maintain water balance by deep rooting and reducing transpiration; In rainy weather, its wide leaves can more effectively drain water to prevent flooding and avoid root damage. These adaptive characteristics make Dicai Tianluo 676 can achieve good growth performance and yield in a wide range of planting areas.

The peeling stick weight of the Caitianuo No. 6 maize variety provides significant insights into its growth characteristics and adaptability. Analyzing the fresh peeling stick weight, which is a crucial indicator of the plant's overall health and productivity, reveals variations among individual plants within the same variety. For instance, the recorded weights range from 155 grams to 230 grams, showcasing a notable discrepancy that may be attributed to several factors including genetic variability, environmental conditions, and agronomic practices. Understanding these variations is essential for evaluating the potential yield and performance of this maize variety under different cultivation scenarios.

The highest recorded peeling stick weight of 230 grams in No. 4 plant suggests that this particular specimen exhibited optimal growth conditions, possibly benefiting from favorable soil nutrients, adequate water supply, and effective pest management. Conversely, the lowest weight of 155 grams in No. 3 plant could indicate potential stress factors or suboptimal growth conditions that may have hindered its development. This disparity underscores the importance of monitoring individual plant performance to identify strengths and weaknesses within a given variety, which can inform breeding programs aimed at enhancing yield and adaptability.

Moreover, the consistent number of leaves across all plants, averaging 13, suggests that this trait may be a stable characteristic of the Caitianuo No. 6 variety, contributing positively to its photosynthetic capacity. However, the variation in peeling stick weight indicates that leaf count alone does not directly correlate with the weight, highlighting the complexity of plant growth dynamics. Factors such as blade length and width may play a more significant role in influencing biomass accumulation, as larger leaves can capture more sunlight, thus enhancing photosynthesis and ultimately leading to greater growth.

In addition, the stem diameter, which ranged from 2.2 cm to 2.6 cm, can be indicative of the plant's structural integrity and ability to support the weight of the leaves and ears as they develop. Thicker stems, such as those observed in plants No. 6 and No. 7, may provide better resistance to lodging, a common problem in maize cultivation, particularly in adverse weather conditions. This resilience is vital for ensuring that the plants can withstand environmental stresses, thereby maintaining productivity.Furthermore, the adaptability of the Caitianuo No. 6 variety can be assessed through its performance under varying environmental conditions. The significant differences in peeling stick weight among plants suggest that while the variety has a certain level of resilience, individual plant responses to environmental factors such as soil fertility, water availability, and climate conditions may vary. This adaptability is critical for farmers who may face fluctuating conditions throughout the growing season.

Table 3.5 Growth data of Dicai Tianuo 676

plant	breed	plantHeight (cm)	Stem diameter (cm)	Number of leaves	Blade length (cm)	Blade width (cm)	Peeling stick weight (fresh, not dehydrated)
No. 1 plant	Number 676 di cai tian nuo	2240	2.5	13	75	8	200
No. 2 plant	Number 676 di cai tian nuo	2340	2.3	13	83	8.2	180
No. 3 plant	Number 676 di cai tian nuo	2160	2.2	13	76	7.3	185
No. 4	Number 676 di cai tian	2230	2.3	13	75	6.8	185

plant	nuo						
No. 5 plant	Number 676 di cai tian nuo	2280	2.2	13	77	7.5	210
No. 6 plant	Number 676 di cai tian nuo	2410	2.4	13	78	7	205
No. 7 plant	Number 676 di cai tian nuo	2310	2.3	13	76	6.8	160
No. 8 plant	Number 676 di cai tian nuo	2230	2.35	13	80	7.5	205
No. 9 plant	Number 676 di cai tian nuo	2390	2.35	13	79	7.8	190
No. 10 plant	Number 676 di cai tian nuo	2260	2.4	13	78	7.6	195

The analysis of the peeling stick weight (fresh, not dehydrated) of the different maize varieties, specifically focusing on the Dicai Tianuo 676, reveals significant insights into the growth characteristics and adaptability of this particular breed. The data collected from ten individual plants demonstrates a range of weights, highlighting the variability inherent in crop production. The weights of the peeling sticks vary from a minimum of 160 grams to a maximum of 210 grams, indicating that environmental factors, genetic traits, and cultivation practices may influence the final yield of this maize variety. Notably, the average peeling stick weight for the Dicai Tianuo 676 plants stands at around 195 grams, with plant number 6 exhibiting the highest weight at 205 grams and plant number 7 showing the lowest at 160 grams. This variation could be attributed to differences in soil fertility, water availability, and exposure to pests or diseases throughout the growing season. The morphological measurements, including plant height, stem diameter, number of leaves, blade length, and blade width, provide a comprehensive understanding of how these factors interact to influence the overall health and productivity of the plants. For instance, plants with greater height and stem diameter, such as plant number 6, tend to have a higher peeling stick weight, suggesting a correlation between vegetative growth and the development of biomass. Furthermore, the number of leaves and their respective dimensions also play a crucial role in photosynthesis, ultimately affecting the energy available for growth and the subsequent yield. The consistency in the number of leaves across the samples (all having 13 leaves) indicates that this trait is stable for the Dicai Tianuo 676 variety, yet the differences in other growth parameters highlight the adaptability of this maize breed to varying environmental conditions. This adaptability is essential for farmers who face unpredictable climatic patterns and changing agricultural landscapes. By understanding the growth characteristics of the Dicai Tianuo 676, farmers can make informed decisions regarding cultivation practices, such as the optimal planting density and fertilization strategies to maximize yield potential. Additionally, the peeling stick weight can serve as an important indicator of the plant's overall health and vigor, allowing for early intervention if any growth irregularities are observed. This study underscores the importance of continuous monitoring and assessment of growth metrics to ensure sustainable maize production. In conclusion, the analysis of the fresh peeling stick weights of the Dicai Tianuo 676 variety provides valuable insights into its growth characteristics and adaptability. Such data not only contributes to the scientific understanding of this maize breed but also equips agricultural practitioners with the knowledge necessary to optimize their farming strategies, ensuring resilience in the face of environmental challenges. Future research could expand on these findings by examining the genetic mechanisms underlying these growth traits, as well as exploring the impacts of different agricultural practices on the performance of various maize varieties under diverse environmental conditions.

(4) Comparative analysis

Plant height is one of the important indexes to measure the growth of maize. Sukotian 1506 as a national fruit corn, its plant height performance is excellent, up to 2440 cm, the average height is more than 2300 cm, showing a strong growth potential. The average height of Sta 31 and Midanuo No. 1 was slightly lower than that of Suketian 1506, but within a reasonable range, while the height of Caitianuo No. 6 and

Dicaitianuo No. 676 were relatively similar, and the fluctuation range was smaller, reflecting better growth stability. The difference of plant height may be related to the genetic characteristics of the varieties and the ability to respond to the external environment.

Stem diameter is an important parameter for evaluating lodging resistance of maize plants. Among the five varieties, the stem diameter of Sucotian 1506 is generally large, between 2.3 and 2.5 cm on average, which helps to enhance its ability to resist wind and fall. The stem diameter of Stara 31 and Midanuo 1 was also relatively thick, but slightly inferior to that of Suketian 1506. The stem diameter of Caitianuo No. 6 and Dicaitianuo 676 showed good consistency, indicating that they had high stability in stem development. The difference of stem diameter not only reflects the genetic difference of varieties, but also may be related to the growth environment and nutrient supply. Maize plants of all varieties maintained a stable number of leaves (13), indicating that leaf development patterns of different varieties were similar under the same management conditions. However, in terms of leaf length and width, the varieties showed significant differences. The leaves of Suketian 1506 and Dicai Tianuo 676 were longer and wider, which was conducive to capturing more light energy for photosynthesis. The leaves of Stara 31 and Midanuo 1 are relatively short or narrow, which may be related to their growth habits and ability to adapt to the environment. The length and width of the leaves of Caitianuo No. 6 varied widely, which showed certain growth plasticity.

From the point of view of growth rate, Suketian 1506 and Dicai Tianuo 676 showed faster growth rate in terms of plant height and leaf expansion, while Sita 31 and Midanuo 1 were relatively stable. This difference may be related to the physiological characteristics and growth cycle of the varieties. It is worth noting that while maintaining rapid growth, Dicai Tianuo 676 also showed high growth stability, which provided strong support for its wide cultivation under different environmental conditions. In terms of adaptability, all varieties showed certain environmental adaptability. However, Dicai Tiannom 676 stands out for its strong environmental adaptability and stress resistance. Whether it is drought, high temperature or rainy weather conditions, Dicai Tianuo 676 can adjust the growth strategy to cope with adverse factors and maintain a stable growth situation. This adaptability not only improves the yield stability, but also reduces the planting risk and brings more economic benefits to farmers.

In terms of yield, the cultivation of southern glutinous mixed-color corn on a large scale is rare in the country, and its limited commercial planting area may be attributed to economic factors. Although two specific varieties, Cai Tian Guo No. 6 and Di Cai Tian Guo 676, have been selected for cultivation, their yields only reach half that of commercial corn, such as Su Ke Tian 1506, the yellow large-ear variety. The economic viability of growing glutinous mixed-color corn is further diminished by the higher demand and profitability associated with traditional corn varieties, which are favored for their versatility in food production and livestock feed. Farmers often opt for crops that promise greater returns on investment, leading to a preference for high-yielding, well-established varieties. As a result, the growth of glutinous mixed-color corn remains constrained, despite its unique taste and potential market niche. This situation highlights a broader trend in agriculture where economic incentives drive crop selection, often at the expense of biodiversity and the cultivation of traditional varieties. While there is a growing consumer interest in specialty crops, including glutinous corn for its unique flavor and texture, the challenge lies in balancing profitability with the preservation of agricultural diversity. To enhance the viability of glutinous mixed-color corn, there may be a need for targeted marketing strategies, improved agronomic practices to boost yields, and possibly government support to incentivize farmers to diversify their crops. Without such initiatives, the future of glutinous mixed-color corn in the agricultural landscape remains uncertain, as farmers weigh the risks and rewards of venturing into less conventional crops against the backdrop of economic pressures and market demands.

Chapter four Analysis of influencing factors

4.1 Genetic characteristics

Maize has a strong genetic diversity, which is the basis for its adaptation to a variety of ecological environments. Different varieties of corn show rich variation in form, color, health status and so on. For example, the varieties Suketian 1506, Sta 31, Midanuo No. 1, Caitianuo No. 6 and Dicai Tianuo 676 mentioned in the study had differences in plant height, stem diameter, leaf number, leaf length and width, which were reflected in genetic diversity. This diversity allows corn to grow in different climate, soil, and water conditions, improving its overall adaptability. Maize is a typical male dicotyledonous plant with low natural cross rate, but artificial hybridization can significantly improve its genetic advantage. Through the cross between father and mother, the offspring often show better traits than the parents, such as higher yield, stronger stress resistance and so on. Sukotian 1506 and Star31, for example, are excellent varieties bred through artificial hybridization. In the process of hybridization, the combination of different genotypes produced heterozygous advantages, which made the offspring perform well in growth rate, disease resistance, drought tolerance and so on.

The gene expression patterns of maize are complex and diverse, and genes in different loci control the traits of maize in dominant or recessive ways. For example, yellow corn may be caused by an imbalance in the expression of specific genes, while red and purple corn are associated with a lack of fat-soluble anthocyanidins. These differences in gene expression patterns not only affect the quality traits of maize such as color and shape, but also have important effects on the quantitative traits such as yield and stress resistance. Through the study of gene expression pattern, we can understand the growth regulation mechanism of maize more accurately, and provide theoretical basis for breeding. The external environment also plays an important role in the genetic characteristics of maize. Environmental factors such as temperature, light, water and soil affect the physiological metabolism process of maize, and then regulate its genetic expression. For example, under high temperature conditions, maize respiration is enhanced and photosynthesis is weakened, which may lead to a decrease in yield. In the soil with sufficient water, the root system of corn is developed, which is conducive to the absorption and utilization of nutrients, thus increasing the yield. Therefore, in the planting process, appropriate varieties should be selected according to the local climate and soil conditions, and scientific management measures should be taken to give full play to their genetic advantages. There were also significant differences in adaptability among different maize varieties. Varieties such as Sukotian 1506 and Star31 show a strong ability to adapt to a variety of climate and soil conditions. This adaptability is not only reflected in growth rate and yield, but also in resistance to pests and diseases. For example, Sucotian 1506 has a high lodging resistance, while Star31 shows a strong drought resistance. These excellent characteristics enable these varieties to achieve good yield performance in a wide range of planting areas.

4.2 Environmental Factors

Temperature is one of the key factors affecting the growth and development of maize. In the planting records for 2024, we found that temperature fluctuations in Nanning City had a significant impact on corn growth. For example, the temperature in Nanning during February-March is higher than the usual. Although the temperature in early February is lower, the average daily temperature in the middle of February is stable above 15℃, which provides favorable conditions for the sowing and rapid growth of spring corn. However, it is worth noting that the temperature fluctuates greatly in spring, especially in the early and middle of April, there may be reverse cold and frost phenomenon, which poses a threat to the growth of corn seedlings. Therefore, it is necessary to pay close attention to the weather forecast and adjust the sowing time appropriately to avoid damage to the seedlings caused by frost. Precipitation is also important for corn growth. The continuous rainy weather in Nanning from the end of February to the beginning of March provided the necessary moisture for spring corn sowing, and promoted the emergence and seedling growth of corn. However, the overall rainfall in March was low, which may have adverse effects on subsequent growth. In addition, according to the meteorological data of Shapotou district, the spring precipitation is less and the soil moisture is poor, so it is necessary to ensure the water required for corn sowing through irrigation. Therefore, in the planting process, it is necessary to timely replenish water according to the precipitation situation to ensure the normal growth of corn. Light is an important factor affecting the photosynthesis and yield of maize. The number of light hours in March in Nanning city is more than usual, which is very favorable to the growth of maize seedlings. However, in the case of more rainy weather, the lack of light may limit the maize photosynthesis and growth rate. Therefore, in the planting process, it is necessary to reasonably plan the planting density to ensure that each corn plant can get enough light. Soil is the foundation of corn growth. Soil moisture, nutrient content and texture have direct effects on the growth characteristics of maize. In Shapotou area, due to the windy and dusty weather in spring, soil moisture was lost quickly, which posed a challenge to maize sowing and seedling growth. Therefore, it is recommended to take measures such as film seeding to reduce soil water evaporation and maintain soil moisture. In addition, reasonable fertilization according to soil nutrient status is also an important measure to ensure high yield of corn. At seedling stage, water and fertilizer containing phosphorus and nitrogen should be applied to promote the growth of roots and seedlings. In the large trumpet stage, the fertilizer should be applied heavily to increase the yield. The adaptability of different maize varieties to climate, soil and other environmental factors is different. In this study, the selected corn varieties include Suketian 1506, Ziyunuo 839, Dicai Tiannuo 676 and other varieties. These varieties have their own advantages in growth characteristics, yield and quality. For example, Suketian 1506, as a national fruit corn, has the characteristics of high yield and high quality; Dicai Tianluo 676 is welcomed by the market because of its good taste and adaptability. In the planting process, the appropriate varieties should be selected according to the local climate and soil conditions to improve the planting efficiency. Pests and diseases are important factors affecting the growth and yield of maize. In recent years, with the change of climate and the adjustment of planting structure, the occurrence trend of diseases and pests has also changed. In the planting process, it is necessary to strengthen the monitoring and control of pests and diseases. In view of the common diseases and pests of maize, such as Armyworm, corn borer, dry blight, etc., comprehensive control measures should be taken, including physical control, chemical control and biological control. At the same time, strengthen field management, timely removal of disease residues and weeds, reduce the spread and spread of diseases and pests.

4.3 Management Measures

Sowing is the beginning of the growth cycle of maize, and its time and density have a direct effect on subsequent growth. First, it is important to choose the right planting time according to local climatic conditions and variety characteristics. In this study, spring sowing was chosen, which is in line with the growth needs of most corn varieties. At the same time, the sowing density needs to be determined according to the variety characteristics and soil fertility to ensure that each corn plant can get enough nutrients and light. For high-stem and large-leaved varieties such as Suketian 1506 and Midanuo No. 1, the sowing density should be appropriately reduced to avoid fierce competition among plants, which would affect the growth and yield. Water is an indispensable factor in the growth of corn. During the growth process, timely irrigation is required according to soil moisture and rainfall conditions to ensure that the water needs of the corn plant are met. Especially during the dry season, irrigation is crucial. At the same time, drainage is also a link that cannot be ignored. Low-lying or poorly drained fields are prone to water accumulation, resulting in blocked root respiration and affecting corn growth. Therefore, it is necessary to establish a perfect drainage system to ensure smooth drainage in the field.

Reasonable fertilization is the key to improve the yield and quality of maize. In the process of fertilization, scientific fertilization scheme should be formulated according to soil nutrient status, variety characteristics and growth stage. Apply base fertilizer before sowing to provide basic nutrients for corn growth. During the growth process, topdressing is carried out according to the nutrient requirements of maize, especially in the large trumpet stage and the male stage, which are the two stages that require the largest amount of maize fertilizer. At the same time, pay attention to the application of potassium fertilizer and phosphate fertilizer to promote root development and improve stress resistance. Pests and diseases are important factors affecting the growth and yield of maize. In the process of management, it is necessary to strengthen the monitoring and control of pests and diseases. First, the risk of pests and diseases is reduced by selecting disease-resistant and insect-resistant varieties. Secondly, take physical, chemical and biological control measures, such as light trapping, chemical pesticide spraying and the introduction of natural enemies, to effectively control the occurrence and spread of diseases and pests. In addition, strengthen field management, timely removal of disease residues and weeds, reduce the breeding environment of pests and diseases.

Weeds compete with corn for nutrients, water and light, severely affecting corn growth and yield. Therefore, weed management should be strengthened. Do deep tillage before sowing to destroy the living environment of weeds. In the process of growth, weeds in the field are removed in time by ploughing or chemical weeding. At the same time, pay attention to the selection and use of herbicides to avoid damage to corn plants. Harvest is the end of the corn production cycle and an important link to achieve yield and quality. In the harvest process, it is necessary to choose the right harvest time according to the maturity of the corn and weather conditions. At the same time, the adoption of mechanized harvesting can increase efficiency and reduce losses. After harvest, the corn needs to be dried and stored in a timely manner to prevent mildew and insect infestation.

4.4 Adaptability Analysis

Climate is one of the key factors affecting the growth of maize. Sukotian 1506 as a national fruit corn, its adaptability is relatively wide, can grow in a variety of climate conditions, especially in the warm and humid environment is better. Star31, as a non-GMO national nuo, has strong cold resistance, suitable for planting in spring and autumn, and can effectively resist the adverse effects of low temperature on growth. Midannuo No. 1 showed good adaptability to moderate light and temperature conditions, and was neither too dependent on high temperature nor susceptible to low temperature damage. Caitianuo No. 6 and Dicaitianuo 676, as colorful varieties of waxy corn, are more suitable for planting in warm and humid climate with sufficient sunlight because of their bright colors. Soil texture, fertility and pH value also directly affect the growth of maize. Sucotian 1506 has higher requirements for soil fertility, and is suitable for growing in fertile and well-drained soil to ensure its high yield and quality. Star31 is relatively barren and can grow in a variety of soil conditions, but in order to improve yield and quality, appropriate fertilization is still needed. Mitianuo No. 1 has strong adaptability to soil, which can not only produce high yield in fertile soil, but also maintain stable growth performance under general soil conditions. Caitianuo No. 6 and Dicaitianuo 676 have similar soil requirements, both prefer neutral or slightly acidic fertile soil to fully display their color and taste advantages.

Pests and diseases are important factors affecting maize yield. Both Sucotian 1506 and STAR31 showed certain resistance to pests and diseases, but the specific resistance level should be evaluated according to the occurrence of local pests and diseases. Mitianuo No. 1 showed strong resistance to some diseases and insect pests, which was helpful to reduce pesticide use and improve production efficiency. Caitianuo No. 6 and Dicaitianuo 676, as colorful waxy corn, may attract specific pests, so it is necessary to strengthen the monitoring and control of pests and diseases to ensure the safety of the growth process. Water is an essential element of corn growth. Sucotian 1506 has a large demand for water, especially in the growth period to keep the soil moist. Star31 showed strong drought tolerance and could maintain growth under relatively poor water conditions. The water adaptability of Mitianuo No. 1, Caitianuo No. 6 and Dicaitianuo 676 was between the two, which not only needed to ensure sufficient water supply, but also could withstand drought to a certain extent.

Conclusion and prospect

Through detailed observation and analysis of the growth characteristics of Suketian 1506, Sita 31, Mitianuo No. 1, Caitianuo No. 6 and Dicaitianuo 676 maize varieties, the significant differences in plant height, stem diameter, leaf number, leaf length and width were obtained, and how these characteristics affected their growth adaptability and potential yield. It was found that as a fruit corn, the remarkable plant height and wide leaves of Sucotian 1506 not only enhanced the photosynthetic efficiency, but also predicted higher biomass accumulation and potential high yield. However, its higher requirements for soil fertility and moisture suggest that special attention should be paid to water and fertilizer management in the planting process to ensure the best growth state. Star31 stands out for its moderate plant height, strong stem diameter and resistance (such as drought and cold tolerance), showing its potential to grow steadily under a variety of environmental conditions, especially in areas with limited resources or harsh climatic conditions.

With its stable growth rate and moderate leaf size, Mitianuo No. 1 showed good comprehensive adaptability and extensive planting potential. No matter in fertile soil or general soil conditions, Mitianuo No. 1 can show a good growth state, providing farmers with a relatively loose planting choice space. Caitianuo No. 6 and Dicaitianuo 676, as colorful waxy maize, not only have unique leaf color, but also show certain specificity in leaf morphology and growth habits. The leaves of Caitianuo No. 6 were long and wide, which was conducive to the accumulation of photosynthetic products. On the other hand, Dicai Tianluo 676 was more balanced in stem diameter and leaf width, showing good growth balance and stability. From the point of view of adaptability, the response and tolerance of each species to the environment are different. The high soil and moisture requirements of Sucotian 1506 limit its planting range in some areas. The wide adaptability of STAR31 makes it the preferred variety under various ecological conditions. The stable growth characteristics of Mitianuo No. 1 ensured its good performance under different soil and climate conditions. Caitianuo No. 6 and Dicaitianuo 676 have high planting value and economic potential in specific markets (such as the demand market for Caitianuo corn).

Looking forward to the future, the research on the growth characteristics and adaptability of different maize varieties will further promote the scientific and refined agricultural production. On the one hand, by optimizing planting technology and management measures, such as reasonable dense planting, precise fertilization, green prevention and control of diseases and pests, we can give full play to the growth potential and advantages of various varieties. On the other hand, the combination of modern biotechnology methods, such as molecular marker-assisted breeding, gene editing, etc., can accelerate the cultivation and promotion of new varieties, and provide more high-quality, high-yield and stress-resistant corn varieties for agricultural production. In addition, changes in market demand and consumer preferences will also have a profound impact on the planting structure of corn varieties. Therefore, in the future research and extension work, more attention should be paid to market demand research and variety adaptability assessment, so as to scientifically guide agricultural production practices and promote sustainable agricultural development and farmers' income. At the same time, strengthening brand building and the formulation of marketing strategies is also an important way to enhance the added value of corn products and market competitiveness.

Reference

[1] 唐文烨,陈结实.玉米新品种生态适应性研究[J].作物研究, 2007, 21(1):3.

[2] 梁宗锁,高俊凤,荆家海.渭北旱地不同玉米品种苗期抗旱适应性的研究[J].西北植物学报, 1996(6):62-66.

[3] 王平,陈举林,李平海,等.泰安市不同玉米品种适应性分析[J].现代农业科技, 2016(2):2.

[4] 张金霞,李世恩,耿智广,等.不同玉米品种在陇东干旱区的生长适应性研究[J].现代农业科技, 2023(7):31-33.

[5] 高赟,张建明."三盛 308"饲用玉米营养成分及生长特性研究[J].畜牧兽医杂志, 2018, 37(2):3.

[6] 高星.玉米籽粒灌浆特性演变规律研究与遗传基础解析[D].中国农业科学院,2017.

[7] 吕新,李宏伟,张伟.基于 GIS 的玉米品种生态适应性计算机信息管理及综合评价系统建立的研究[C]//中国科协 2005 年学术年会"新疆现代农业论坛"论文专集.2005.

[8] 杨晴,韩金玲,李彦生,王文颇,史凤玉,孙强.不同夏玉米品种在冀东地区适应性研究[J].玉米科学(6):37-39[2024-08-04].

[9] 王空军.玉米高产优质生产中若干生理生态问题的研究[J].植物生态学研究中心, 2005.

[10] 陈静,马钦,鲁富宽,等.不同氮效率玉米品种穗三叶生理特性研究[J].吉林农业科学, 2021(006):046.

[11] 刘文成.高产高淀粉玉米新品种郑单 21 生态适应性研究[J].中国农学通报, 2005.

[12] 关琦.贵州部分玉米品种生态适应性研究[D].贵州大学,2009.

[13] 唐文烨,陈结实.玉米新品种生态适应性研究[J].作物研究, 2007, 21(1):14-15,18.

[14] 白彩云.中国东北地区玉米种植的气候适应性研究[J].石河子大学, 2010.

[15] 梁爱华.不同玉米品种适应干湿交替水分逆境的根系特征差异研究[D].石河子大学,2007.

[16] 陶志强,闫鹏,张学鹏.不同年代玉米品种灌浆期的光合特征对高温适应性的初步研究[J].作物杂志, 2021.

[17] 潘蒙英健,高峰,李长忠,等.黄淮海地区不同青贮玉米品种播期及其适应性研究[J].青岛农业大学学报：自然科学版, 2018, 35(3):7.

[18] 刘建丽.河北省不同类型区夏玉米高产品种筛选及适应性研究[D].河北农业大学,2010.

[19] 乔胜.玉米根系性状多样性及其对干旱胁迫的响应[D].西北农林科技大学[2024-08-04].

[20] 陶佩琳.低磷胁迫下玉米叶片的光合特性及叶蛋白质组学研究[D].山东大学,2009.

[21] 朱韵哲.不同基因型玉米品种光合物质生产和生理特性的研究[D].西北农林科技大学,2012.

[22] 朱丽丽,张业猛,李万才,等.39 个我国不同生态区培育的青贮玉米品种在青海高原适应性研究[J].草业学报, 2023, 32(4):11.

[23] 王晶晶,李凤海,史振声,等.辽宁省不同生态区玉米品种适应性研究[J].干旱地区农业研究, 2015(04):65-69.

[24] 徐川峰,萨日那,何佳玥,等.草地贪夜蛾对不同品种玉米的适应性比较研究[J].环境昆虫学报, 2021, 43(4):10.

[25] 何天祥,蔡光泽,陈从顺.不同玉米品种在攀西地区的适应性研究[J].大麦与谷类科学, 2011(1):3.

[26] 梁宗锁,高俊凤,荆家海.渭北旱地不同玉米品种苗期抗旱适应性的研究[J].西北植物学报, 1996(6):5.

[27] 姜宇鹏.不同种植密度下玉米品种适应性研究[D].东北农业大学[2024-08-04].

[28] 黄历.生物质的特性分析及其热裂解产物的研究[D].上海交通大学,2014.

[29] Balestre M , Souza J C D , Garcia R ,et al.Yield stability and adaptability of maize hybrids based on GGE biplot analysis characteristics[J].Crop breeding and applied biotechnology, 2009, 9:219-228.

[30] Wang Q , Xia Z Q , Zhang S B ,et al.Elevated Temperature during Seedling Stage in Different Maize Varieties: Effect on Seedling Growth and Leaf Physiological

Characteristics[J].Russian Journal of Plant Physiology, 2022.

[31] Wang Chang Lin Qiuping Gong DonghuaCrops Institute,Luoyang).A Study on Drought Adaptability and Its Physiological Mechanism of Summer Maize[J].Acta Agriculturae Boreali—Sinica, 1990.

[32] Kim W S , Hwang J H , Lee J H ,et al.A Comparative Study on the Growth Characteristics and Nutritional Components of Corn Hybrids for Silage at Paddy Field Cultivation[J].Journal of the Korean Society of Grassland & Forage Science, 2012, 32(1):15-28.

[33] 王平生.Study on the Maize Yield-Increasing Mechanism of Annual Degradation Characteristics about Different Biodegradable Film in the Northern Irrigation Area[J].Hans Journal of Agricultural Sciences, 2017, 07:55-65.

[34] Feng-Bin S , Jun-Ying D .Response and Adaptability of the Growth of Leaves, Stems and Roots of Maize to Drought Stress[J].Arid Zone Research, 2005.

[35] Liu H , Zheng F , Sun X .Effects of acclimation on the growth characteristics of maize seedlings during seawater stresses[J].Transactions of the Chinese Society of Agricultural Engineering, 2007, 261(1):317-321.

[36] Zhao Z , Zhang X , Liu Z ,et al.Spatial sampling of multi-environment trials data for station layout of maize variety[C]//2017 6th International Conference on Agro-Geoinformatics.IEEE, 2017.DOI:10.1109/Agro-Geoinformatics.2017.8047002.

[37] Do Couto D P , Oliveira W B D S ,de Oliveira, Jessika SantosGuilhen, Jose Henrique SolerBernardes, Carolina de OliveiraPosse, Sheila Cristina PrucoliFerreira, Marcia Flores da SilvaFerreira, Adesio.Analysis of the Effect of the Interaction of Genotype and Environment on the Yield Stability of Maize Varieties; Genetic Resources for Breeding[J].Agronomy, 2023, 13(8).

[38] Ibrahim A , Abdalla A , M. Khalafalla M ,et al.Assessment of Genetic Diversity and Adaptability of Inbred Lines and their F1- hybrids of Grain Maize (Zea mays L.), Using Molecular Markers (RAPD) and AMMI Analysis[J]. 2014.

[39] Yun G , Ming-Xia L I .Effects on Nutrient Composition and Growth Characteristics of Cutting Methods of "Sansheng 308" Forage Maize Varieties[J].China Cattle Science, 2018.

[40] Yanli F , Hui D , Baishan L ,et al.Effects of Sowing Date on Starch Gelatinization Characteristics of Different Waxy Maize Varieties[J].Crops, 2018.

[41] Guang-Xiao B , Hong R , Zhong-Mu L ,et al.Study on genetic variation of main characteristics of local maize germplasm in Guizhou[J].Southwest China Journal of Agricultural Sciences, 2007, 47(5):212-215.

[42] Zai-Yan D , Lin Z , Shun-Sheng L U .Study on Contrast Test of Maize New Varieties in Different Altitudes[J].Journal of Anhui Agricultural Sciences, 2016.

[43] Zhao-Fu H , Bo M , Ke-Ru W ,et al.Characteristics of maize grain dehydration and prediction of suitable harvest period in Liao River Basin[J].Acta Agronomica Sinica, 2019.

[44] Yang Z , Huilin Y , Yanbo W .Study on Yield and Related Traits of Maize Varieties in Different Ecological Regions of Eastern North China[J].Crops, 2019.

[45] Xisheng G .Study on Different Maize Varieties and Agricultural Measures Applied in Red yellow Soil in South Anhui[J].JOURNAL OF ANHUI AGRICULTURAL SCIENCES, 1999.

[46] Cheng-Qiao S , Yong-Ai Q , Bing-Wei W ,et al.Study on Present Status of Maize Breeding from Perspectives of Guangxi Maize Regional Trial(GMRT)[J].Southwest China Journal of Agricultural Sciences[2024-08-04].

[47] Li Y , Tian-Yu C , Huai-Peng W ,et al.Analysis of Adaptability and Quality Characteristics of Fresh Eating Waxy Maize in the Cold Area of China[J].Journal of Maize Sciences, 2019.

[48] Yunpeng L , Xiaogui L , Si S ,et al.Diurnal Variation and Directivity of Photosynthetic Carbon Metabolism in Maize Hybrids Under Gradient Drought Stress[J].Scientia Agricultura Sinica[2024-08-04].

[49] Yun G , Jian-Ming Z , School L A .Research of Nutrients and Growth Characteristics on Forage Maize of "Sansheng 308"[J].Journal of Animal Science and Veterinary Medicine, 2018.

[50] Tian-Xiang H E , Bo C , Cong-Shun C .Assessment of the Ecological Adaptability of Different Maize Varieties to the Areas Along Anlin River[J].Barley and Cereal Sciences, 2019.

[51] Xiao-Li W .Growth and Development Characteristics and Cultivation Techniques of the New Maize Varieties E-yu 25[J].Hubei Agricultural Sciences, 2009.

[52] Qing-Chao L I , Yu-Qiong X , Shan Y ,et al.Construction of evaluation model of principal component analysis on multi environment testing in maize varieties and its application[J].acta agriculturae zhejiangensis, 2016.