Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

BIOECOLOGICAL CHARACTERISTICS OF SORGHUM VARIETIES

Norboyeva Umida Toshtemirovna,
Doctor of Biological Sciences, Professor,
Bukhara State University, Bukhara, Uzbekistan
E-mail: u.t.norboeva@buxdu.uz

Jurayeva Nilufar Oblakulovna
Master's Student at Bukhara State University, Bukhara, Uzbekistan

Abstract
The article contains information about the bioecological characteristics of sorghum varieties, in which it is expressed that the varieties adaptability to environmental conditions, the activity of soil and air drying, grain yield, productivity, the ability to accumulate sugar, the value of indicators of the chemical composition of the seed are directly related to the conditions of their cultivation, irrigation regime, soil and climate factors. properties and information about their changes in different degrees depending on the properties of resistance to stress factors.

Keywords: Sorghum varieties, sorghum biology, sorghum, productivity, grain chemical composition, environmental factors, dry matter unit, drought, seed production, blue mass, economic values, phytoimprovement, quality harvest.

Introduction

Sorghum (Sorghum bicolor L.), known for its exceptional drought resistance, is considered one of the most valuable cereal and fodder crops in global agriculture. This view is widely supported by researchers from various countries. Its biological characteristic—namely, its low demand for environmental conditions—has been confirmed through many years of field trials.

The practice of growing sorghum in arid and poorly irrigated regions demonstrates its active physiological response to dry soil and air, the stable process of transpiration, and its ability to tolerate high osmotic pressure due to the high concentration of cell sap. Compared to maize, cotton, sunflower, and Sudan grass, sorghum consumes significantly less water per unit of dry matter produced, yet it provides a high yield of both green biomass and grain.

Sorghum belongs to the group of crops with diverse applications. Its grain is a nutritious feed and a key component in compound fodders. It is also a valuable raw material for the starch-syrup and alcohol production industries. Furthermore, groats can be obtained from it. In several districts of Africa, India, and East Asia, sorghum is cultivated as the primary cereal crop. In the republics of Central Asia, it is also used for the aforementioned purposes. Globally, as a food crop, sorghum ranks third in importance after wheat and rice [1].

According to scientists, sorghum—unlike many other crops—can tolerate soil salinity levels ranging from 0.6% to 0.8%, while maize, in comparison, only withstands salinity up to 0.4%. Sorghum absorbs sodium, calcium, and magnesium from the soil, thereby helping to reclaim saline soils. In other words, while sorghum can reduce soil salinity by 0.6–0.8%, maize only achieves a 0.4% reduction, making sorghum an effective phytomeliorative crop [2].

One of the key objectives in sorghum seed production is not only to multiply high-quality varietal seeds but also to preserve their yield potential. Sowing zoned, high-quality varietal seeds of sorghum increases yield by 15–20% compared to non-zoned varieties and results in better economic outcomes. The theoretical foundation of seed production is genetics, which includes increasing and maintaining productivity potential, improving the biological and economic qualities of the variety, and breeding hybrid lines through heterosis [4].

The Kuban Experimental Station of the Institute of Plant Science has been conducting extensive research to improve the productivity and quality of sorghum. Their studies on the global sorghum collection confirmed that the grain protein content varies from 7% to 26%, lysine from 0.5% to 3.8%, and tryptophan from 0.34% to 4.51%. According to the American scientist Kos, the biochemical analysis of the global sorghum collection indicates that protein content in the

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

grain ranges from 8.8% to 13.6%, with an average of 10.5%. The lysine content in the protein reaches 2.62% [3].

Sorghum's ability to accumulate high amounts of sugar is a crucial biological trait. Because of this, its leafy stalks become highly nutritious and form an ideal component for high-quality silage. Research has shown that the sugar content in sorghum stalks ranges between 13% and 20%, while some local varieties in Uzbekistan have been found to contain up to 26% sugar.

Researchers believe that the biology and agronomic value of sorghum, particularly its sugar content, are closely linked to varietal characteristics and the soil-climatic conditions of the growing region. Although many sources report that sorghum typically contains a relatively low protein content (around 9–12%) of poor quality, recent observations have demonstrated that certain local varieties in Central Asia contain higher concentrations of nutrients—especially starch and protein. This indicates that selection efforts in recent years have significantly advanced in enhancing the nutritional composition and quality of sorghum [5].

Research Object and Methods

The study focused on different varieties of sorghum, emphasizing its agricultural importance, growth and development dynamics, and its bioecological characteristics. Particular attention was given to its valuable agronomic traits, such as high drought resistance and productivity.

The experiments were conducted on irrigated meadow-alluvial soils. The sowing methods and seeding rates of sorghum were carried out according to the experimental design. All agro-technical measures were implemented in accordance with the standard regional cultivation practices and technological recommendations adopted for sorghum farming.

Results and Discussion

According to data from state variety testing plots, grain yields of sorghum range from 2.5 to 5.0 tons per hectare, while the yield of green mass for silage reaches 20 to 30 tons per hectare. In well-irrigated areas, green mass yields can rise to 80–100 tons per hectare. Sorghum is mainly cultivated in Central Asia, the

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

southern regions of Ukraine and Moldova, the Northern Caucasus, Transcaucasia, and Kazakhstan. In Uzbekistan, four cultural types of sorghum are commonly grown for fodder, technical, and food purposes—these include *Kokand sorghum* and *Sudan grass* [6].

Sorghum has a fibrous root system that penetrates up to 2 meters deep and spreads 60–90 cm laterally. The plant's stem reaches 2–2.5 meters in height and can grow up to 6–7 meters in tropical regions. Its interior is filled with soft parenchymal tissue and is often highly branched. The leaves are broad and covered with a waxy coating; each plant bears 10 to 25 or more leaves. The inflorescence is a panicle, with each branch ending in two spikelets—one bisexual and one male, the latter falling off after flowering.

Sorghum is predominantly (about 70%) cross-pollinated. The grains may be hulled or hull-less, round or ovoid in shape, and vary in color—white, yellow, reddish-brown, or dark brown. A thousand grains weigh 25 to 45 grams, with each panicle bearing between 1,600 and 3,500 seeds. Grains with brown or reddish endosperm contain tannins—substances that reduce the nutritional value for feed but are beneficial in alcohol and maltose production as they inhibit fermentation spoilage.

Sorghum is among the most drought-tolerant crops. Its transpiration coefficient is approximately 200. The plant maintains photosynthesis during periods of intense heat and dry weather, whereas maize loses turgor and curls its leaves. Sorghum can yield successfully even in semi-desert regions without irrigation and efficiently utilizes summer and autumn rainfall. It is a heat-loving plant; seed germination begins at soil temperatures of 10–12°C. Young seedlings are sensitive to frost. Optimal flowering occurs at 14–15°C, and maturation at 10–12°C. The total sum of effective temperatures required for full vegetation ranges from 2,250 to 2,500°C [7].

Sorghum is relatively undemanding of soil conditions and grows even in saline environments. However, warm, loose, and well-aerated soils are most favorable. Like all grasses, it has a slow early growth phase and is vulnerable to weed competition during establishment.

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

Recent studies confirm that sorghum's high drought resistance and productivity are valuable biological and economic traits. For instance, during drought years, sorghum often outperforms maize in both grain and silage yields. Sorghum's adaptability to water-limited environments is due to several traits: a well-developed root system, wax-coated leaves and stems, and a specialized stomatal structure that minimizes water loss. These features are believed to have evolved under historically harsh environmental conditions. In arid zones, sorghum can produce up to 4.8 tons of grain, 30–35 tons of green mass, and 12 tons of hay per hectare, even when soil moisture is critically low [8].

Sorghum also surpasses maize in surviving prolonged droughts and quickly resumes normal growth once favorable conditions return. However, to ensure high-quality and abundant yields, proper agro-environmental conditions must be maintained—irrigation being one of the most crucial. Despite its drought tolerance, sorghum still benefits from timely watering, especially for achieving maximum grain and silage production.

Developing efficient irrigation strategies for sorghum in irrigated farming zones requires detailed knowledge of the plant's biological traits, soil-climatic conditions, water availability, and the efficiency of local irrigation systems. Irrigation norms and schedules must be designed based on crop requirements, water rotation priorities, and local hydromodule parameters.

Long-term field experiments indicate that sorghum, by its nature, is highly drought-tolerant and capable of producing up to 40 tons of silage mass per hectare with only a single pre-plant irrigation. Therefore, regions where such conditions can be created should consider including sorghum in crop rotation. Priority should be given to areas unsuitable for cotton cultivation or follow-up crops, such as saline, hot wind-affected, and marginal sloping foothill lands.

Sorghum has the ability to regrow quickly after harvest, allowing for multiple harvests (2–3 cuts) of green mass per year. This trait enables sorghum to be cultivated even on marginal lands where other crops, such as maize, fail to produce panicles or adequate biomass due to high salinity or shallow groundwater levels. Sorghum, on the other hand, maintains better productivity under such stress conditions due to its tolerance to salt and adverse hydrological factors.

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

In conclusion, based on the drought and salinity challenges of various regions within the province, sorghum is recommended as a suitable crop for cultivation. The plant can reduce soil salinity through phytomelioration, while also providing grain, green mass, and hay. Given its ability to reclaim degraded soils, sorghum serves as an effective phytoremediator. Therefore, findings from this study support broader recommendations for incorporating sorghum into agricultural systems, particularly on saline and drought-prone lands [9].

Long-term observations have shown that sorghum possesses a powerful root system, capable of penetrating up to 3 meters into the soil. The plant is able to absorb moisture from deeper soil layers and can also utilize rainfall occurring in the second half of summer. This demonstrates its relatively low dependence on irrigation. Despite its high drought tolerance, irrigation remains a key factor for obtaining high and stable yields. Under dryland farming conditions, the plant continues growing until the soil moisture accumulated during autumn, winter, and spring is depleted. In the event of a dry summer or autumn, plant growth slows or halts.

Experiments conducted at the Chimboy reference station and in real agricultural production conditions have confirmed the importance of pre-plant irrigation (leaching water) in establishing an optimal irrigation regime. In the trials, heavy leaching irrigation was applied twice between April 16 and April 24 to small field plots. The first application served to partially remove soil salinity, while the second aimed to fully flush salts and thoroughly saturate the soil. Leaching water applied to well-leveled fields ensured both maximum desalination and uniform soil moisture distribution.

Sorghum is sown in the second half of May. The second irrigation during the growing season is typically applied in the second decade of July. By this time, plants generally reach an average height of 150 cm, with some exceeding 170–180 cm. Green mass yields are correspondingly high. In Uzbekistan's conditions, applying leaching water before basic tillage can result in green mass yields of 30–40 tons per hectare by July 10–15. After the first harvest, the crop regenerates and begins accumulating a second batch of green biomass.

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

On light-textured soils with slight salinity and deep groundwater tables, early- and mid-maturing varieties (e.g., *Nayman*, *Matkhaer*, and others) perform well under two to three applications of leaching water in a high agro-fertility background. As soil salinity increases, the volume of leaching irrigation must also be adjusted accordingly. On heavier soils, leaching irrigation is conducted two to four times using furrow irrigation methods. On light-textured soils, the first and second irrigations must be carried out carefully to avoid crusting and compaction. In such conditions, sorghum develops an extensive root system and accumulates a large volume of vegetative biomass.

Based on extensive theoretical and practical research, it can be concluded that the yield of local sorghum varieties in terms of both grain and silage mass is highly dependent on the irrigation regime under various climatic conditions. This is well illustrated in tabulated experimental data. As vegetative biomass covers nearly 90% of the soil surface, evaporation losses are significantly reduced. This minimizes soil crust formation. When irrigation water is applied using basin (ponding) methods, the soil settles and compacts, enhancing root anchorage and reducing lodging.

Late-maturing sorghum varieties such as *Qattikbosh* and *Boyjo'xori* require three to seven irrigations. On light-textured soils with deep groundwater tables, initial irrigation can be conducted by basin method, while subsequent applications should use furrow irrigation. In moderately saline soils, 6 to 7 irrigations may be necessary.

On soils with shallow groundwater, basin irrigation is not suitable for any variety of sorghum. The number of irrigations depends on field conditions and the water requirements of the crop. As the plant grows, the irrigation norm increases from 750 to 1,200 m³ per hectare. When large volumes of water are applied per irrigation, the total number of irrigations during the growing season may be reduced to two or three. Total seasonal water applications amount to 3,150 m³ per hectare for three irrigations and 4,200 m³ for four irrigations. Depending on climatic conditions, both the pre-plant irrigation volume and the overall irrigation regime may be adjusted [9].

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

The timing of irrigation is crucial. Depending on soil characteristics and salinity levels, the first irrigation should be carried out 25–60 days after seedling emergence, typically between June 10 and July 15. If leaching irrigation was inadequate or if pest outbreaks occur, irrigation may need to begin earlier. The most intensive irrigation phase should coincide with the booting stage, particularly during flowering and the milk-to-dough grain maturity stages. In late-maturing varieties with heavy, drooping panicles (e.g., *Boyjo'xori*), the plant is prone to lodging under strong wind conditions. During this stage, close monitoring of water volumes is necessary to maintain structural stability and ensure optimal development.

Conclusions

In conclusion, sorghum maintains the green coloration and succulence of its leaves and stems up to the full maturity stage of its grain. The sugar content, which comprises approximately 16–18% or more of the plant's biomass, remains stable throughout the growing period. This makes sorghum a universal crop that can be harvested at full maturity for both green mass and grain production.

Sorghum is considered one of the most drought-tolerant crops. It withstands extreme heat and dry conditions of both soil and air. Even under intense heat, the process of photosynthesis in sorghum leaves continues uninterrupted. In comparison to other crops, sorghum demonstrates superior adaptability to saline soils, tolerating soil salinity levels ranging from 0.6% to 0.8%, while maize, for instance, tolerates up to only 0.4%.

Sorghum actively absorbs sodium, calcium, and magnesium from the soil through its biomass, thereby contributing to soil desalination. In this regard, the crop acts as an effective phytomeliorative plant, removing harmful salts from the soil and improving its quality. Given these advantageous traits, sorghum is recommended for cultivation in areas prone to drought and salinity to ensure high and stable yields.

However, in cases where irrigation is applied after prolonged periods of dryness, even without wind, the plant stems may lodge due to weakened structural support. Early-maturing varieties such as *Nayman*, with their compact panicles and shorter

Modern American Journal of Biological and Environmental Sciences
ISSN (E): 3067-7920
Volume 01, Issue 02, May, 2025
Website: usajournals.org

stems, are better suited for irrigation under moderately dry conditions and can be watered even during mild wind exposure, provided the soil is not excessively desiccated.

Mid- and late-maturing varieties, on the other hand, require more frequent irrigation than early-maturing ones. Additionally, saline soils demand more intensive irrigation regimes to support optimal crop development. The integration of these agronomic considerations with sorghum's biological resilience makes it a valuable crop for challenging agroecological environments, especially in arid and saline regions.

References

1. Жукова М.П., Дридигер В.К., Гурская О.А. Выбор и обоснование элементов агротехнических решений возделывания сорго // Научный журнал КубГАУ.2012. № 77.С. 566-575.

2. Алабушев А.В., Горпиниченко С.И., Ковтунов В.В. Состояние и проблемы селекции сорго зернового // Зерновое хозяйство России. 2013. №.5. С.5-14.

3. Soudek P., Petrova S., Vankova R., Song J. Accumulation of heavy metals usting Soghum sp. Chemosphere. 2014. 104, P. 15-24.

4. Алабушев А.А., Романюкин А.У., Ковтунова Н.А., Шишова У.А., Ковтунов В.В. Использование многокритериальной оценки в селекции сорго сахорного // Земледелие. № 2. 2019 г.-С. 39-41.

5. Ковтунова Н.А., Ковтунов В.В. Биоразнообразие сорго// Зернобоев хозяйство России. №5(59), 2018. -С.49-52.

6. Беляев А.В. Влияние азотных удобрений и регуляторва роста на продуктивность зернового сорго в степном Повольже. Аатоpефер. дисс. канд. с.х. наук. Саратов, 2013,-С. 22.

7. Atabaeva X., Umarov Z. O'simlikshunoslik. O'zbekiston milliy enstiklopediyasi davlat ilmiy nashriyoti.- Toshkent, 2004.- 228 b.

8. Atabaeva X.N. Donli ekinlar biologiyasi va etishtirish texnologiyasi.- ToshDAU, 1997.- 121 b.

9. Yormatova D. Dala ekinlari biologiyasi va etishtirish texnologiyasi.- DITAF. - Toshkent, 2000.- 222 b.