Agricultural Research & Technology
Open Access Journal
ISSN: 2471-6774

Juniper Publishers
key to the Researchers

Mini Review
Volume 26 Issue 5 - February 2022
DOI: 10.19080/ARTOAJ.2022.26.556346

Agri Res & Tech: Open Access J

Sweet Potato (Ipomoea Batatas) Biology and Importance in U.S. Agriculture

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Submission: February 21, 2022; **Published:** February 24, 2022

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Abstract

Sweet potato (*Ipomoea batatas* (L.) Lam) is a tuberous perennial grown as an annual throughout tropical to semi-tropical regions around the world. As a food crop, sweet potatoes are ranked seventh in the world, and the most widely grown root crop in the world. The growth cycle of sweet potatoes requires 3 to 5 months, with minimum nighttime air temperatures of 15°C necessary to optimize production. Sweet potato growth can be segregated into three distinct phases: establishment (0 to 4 weeks after transplanting); rapid growth (4 to 8 weeks after transplanting); and storage root development (8 to 16 weeks after transplanting). Worldwide, average yields are 14 metric tons per hectare, necessitating careful monitoring and replacement of soil nutrients. Sweet potatoes prefer well-drained soils, which are subject to nutrient deficiencies. Although established plants are somewhat drought tolerant, a total of 50cm of precipitation is optimal for production. Much of the world production is centered in Asia and Pacific islands, currently with the United States generating less than 4% of total production. U.S. production is focused in four states, predominantly led by North Carolina.

Keywords: Sweet potato; *Ipomoea batatas*; Growth phases; Storage roots; Production

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) is a dicot in the *Convolvulaceae* family and belongs to the genus *Ipomoea*, also represented by other species loosely referenced as morning-glories [1,2]. Of the 1000 species within the 45 genera comprising this family, only *Ipomoea batatas* has economic value as a food crop [2]. Sweet potato is thought to have originated in Latin America, where it was grown for many millennia [3,4]; molecular phylogeny studies [5] bolster this hypothesis. However, sweet potatoes today are widely grown throughout many tropical and subtropical regions of the world [2].

Discussion

Plants are considered tuberous-rooted herbaceous perennials, although sweet potato as a crop is grown as an annual [2]. Domestication pre-dates many crops, with widespread production identified around 2500 B.C. [6]. Cultivars of *I. batatas* vary in anthocyanin concentration, which contributes to variations in leaf and stem color [7]. All sweet potato cultivars exhibit a vining growth habit that varies from erect to spreading, with erect cultivars exhibiting vines approximately 1 meter long and the spreading cultivars generating vines exceeding 5 meters in length.

Agronomically, the commercial value of sweet potatoes is found below ground. The root system is comprised primarily of fibrous roots, whose function is to absorb water and nutrients that support plant growth. A second set of roots, referred to as pencil roots, are generated as plants develop and are characterized based on their lignification [7]. Adventitious roots are initiated as soon as 5 to 7 days after transplanting [DAT], and account for up to 89% of storage roots observed by 65 DAT [8]. Storage roots have a proximal end that connects to the stem, a more expanded central portion, and a distal end opposite to the root stalk. Similar to shoots, anthocyanin concentrations vary in storage roots between cultivars and strongly contribute to variable skin and flesh color: yellow, orange, red, brown, purple, white, beige and pink [7].

Although sweet potato is considered indeterminate, growth can be segregated into three distinct phases. The establishment phase occurs within the first 4 weeks following transplanting of slips or rooted cuttings and involves the rapid growth of young roots, differentiation of storage roots and slow growth of the vines. An intermediate phase follows between 4 and 8 weeks after establishment and is characterized by rapid expansion of plant

leaf area, extensive vining, and initiation of storage roots. The final phase encompasses storage root development and occurs 8 to 16 weeks after transplanting. Typically, by 12 weeks after planting, the leaf area is its maximum and any subsequent increase in plant biomass results from development of storage roots. In the latter part of the final phase, vine growth ceases, leaf area declines as leaves turn chlorotic and abscise, culminating in harvest of storage roots around 16 weeks after transplanting [9]. Both genetic and environmental factors influence the duration and timing of the growth phases [9]. Additionally, the concentration of plant hormones such as abscisic acid (ABA) and cytokinins are instrumental in transitioning plants between growth phases and contributing to the development of roots [10,11].

Several environmental factors affect the growth and yield of sweet potato. Light duration is a critical factor [12,13], directly linked to the formation of storage roots [13,14], and consequently yields. Night temperatures strongly influence photosynthetic partitioning, with temperatures between 15 to 25˚C promoting formation of storage roots, but temperatures greater than 25˚C benefitting shoot growth [15]. Sweet potato root yields are also influenced by the amount and timing of precipitation (16), with the water requirement over the growing season ranging from 360 to 800 mm [17]. Water availability is critical during plant establishment and expansion of storage roots, but periodic drought between these stages is not detrimental [15]. Water saturated soils negatively impact sweet potatoes, especially close to harvest.

Despite reports that sweet potatoes tolerate marginal soil nutrient levels, plants require adequate levels of macronutrients such as nitrogen, phosphorus and potassium to optimize storage root quality and yield [18, 19]. With an average yield worldwide of 14 metric tons per hectare, sustaining optimum sweet potato yields requires replenishment of soil nutrients following harvest [19]. It is important to note that among all nutrients, potassium is most abundant in storage roots and therefore critical for yield potential [18,19]. While potassium deficiencies directly impact yield, shortfalls of nitrogen and phosphorus are manifested in shoot growth [19]. Research shows that the balance of nitrogen and phosphorus is also important; low soil phosphorus may compromise yields [20,21], whereas elevated levels of nitrogen may result in abundant vine growth and lower root yield. On the other hand, low levels of nitrogen limit vine growth and root yields [18]. Micronutrients such as iron, zinc, manganese and boron are also important [22]. In a loamy sand with limited micronutrient content, sweet potato yield increased 75 to 160% following foliar applications of boron.

Sweet potato production occurs from 40° north to 32° south latitude, and up to elevations of 3000 m; this encompasses over 114 countries [15]. As a result, sweet potatoes are classified as a warm-season crop [17, 23]. Previous studies have demonstrated the effects of air temperature on plant growth and reported optimal growth at 24˚C [17]. In temperate regions, sweet potatoes require a minimum frost-free period of 3 to 5 months [1], with a minimum average daily temperature of 24°C. Nighttime air temperatures below 15˚C reduce both plant growth and yield [15]. Furthermore, sweet potatoes prefer a well-drained soil and tolerate a pH in the range of 4.5 to 7.5.

Global production of sweet potatoes is dominated by Asia and Pacific Islands (~75%), with China generating approximately 67% of total production [15]. Africa contributes another 20% of production distantly followed by North, Central, and South America (~3.6%). Although considered a minor crop in the U.S., per capita consumption of sweet potatoes increased by 78% between 2000 and 2015, much of that attributable to stated health benefits [24]. Within the U.S., production is concentrated in four states (North Carolina, Mississippi, Louisiana, and California), with North Carolina generating over 60% of all sweet potatoes grown between 2019 and 2021 [24].

Conclusion

Sweet potatoes are grown on over 9 million hectares worldwide in 114 countries. Plants require a long growing season but are adaptable to a wide range of growing conditions. Sweet potatoes are an important food crop in many developing countries. Increasing awareness of the health benefits of storage roots is fueling greater consumption in developed countries such as the United States.

Conflict of Interest: The authors declare there are no conflicts of interest.

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How to cite this article: Xi X, Waana K. Sweet Potato (Ipomoea Batatas) Biology and Importance in U.S. Agriculture. Agri Res & Tech: Open Access J. 2022; 26 (5): 556346. DOI: 10.19080/ARTOAJ.2022.26.556346

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DOI:10.19080/ARTOAJ.2022.26.556346

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