

ARACHIS HYPOGAEA L.

MONOGRAPH



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Agricultural science

2017-2018

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1.0 INTRODUCTION

Arachis Hypogaea L. is the scientific name for the groundnut or most commonly known as the peanut. *A hypogaea* is produced in all around the world, but the main producers are Argentina, African countries, India and China being its lead producer. Only in China there are more than 3.6 hectares destined for peanut production. Its export sales internationally are close to US\$1 billion yearly. Most of its production is destined to European countries and the United States were it is eaten like a nut or used to create peanut butter. The Groundnut mostly known because it is a great source for protein and calories.

This monograph will cover many topics that are divided in 6 chapters; Chapter one covers the introduction. Chapter two will cover *A. hypogaea*'s ecology the environmental factors that influence its growth. Chapter three is dedicated to its biology, this chapter will cover its chromosome complement, life cycle, phenology and its reproductive biology. Chapter four will focus on its propagation and management, its planting and harvesting. Chapter five is devoted to its market and economy, its uses, imports and exports. The final chapter will cover the references and all the data researched.

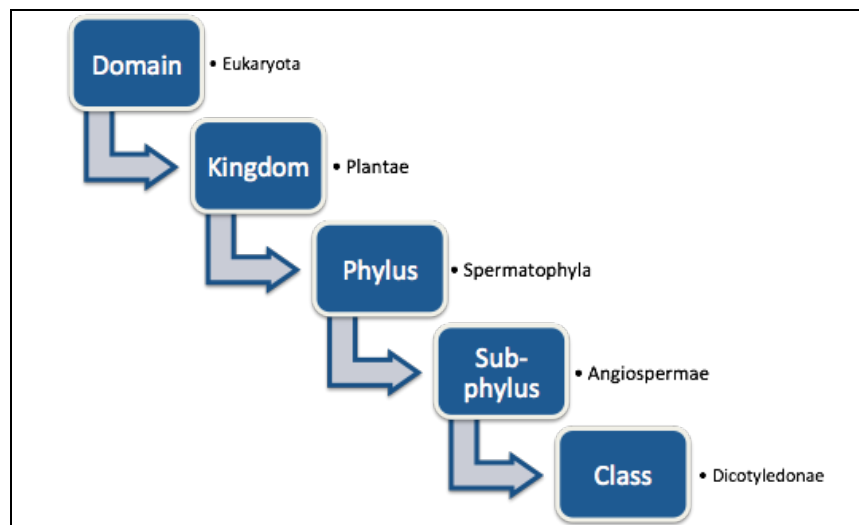
2.0 ECOLOGY

2.1 Districutional Content

2.1.1 Affinities

Arachis hypogaea L. commonly known as peanut or the groundnut is an annual oil seed that was first described by Carl Linnaeus. It is a member of the Leguminosae family and member of the Papilionaceae subfamily commonly known as Legume or Bean family (The Herbarium Catalogue, Royal Botanic Gardens, Kew., 2006). The Leguminosae family is the third largest family in the “Domain Plantae”, containing over 600 genera and 14,000 known species. It is divided into 3 main subfamilies called Papilionaceae containing about 400 genera and 9,000 species, Caesalpiniaceae commonly known as Cassia family with 152 genera and 2300 species and Alimosaceae also known as Acacia containing 56 genera and 2800 species. (Sidra, 2016). Currently there are around 70 species in the genus *Arachis*, *A. hypogaea* being the common one (Origin, Distribution, and Taxonomy of *Arachis*, 2011). Even though it is referred to as a nut, it is actually an underground pod of a legume (Courteau, 2012).

Table 1. Taxonomic placement of *Arachis hypogaea*



2.1.2 Origins

Arachis hypogaea is a legume originated and native of South America (Argentina, Paraguay, Uruguay, Brazil and Bolivia) over 3,500 years ago. The headwaters of the Paraguay river in the region of Mato Grosso is considered to be the birthplace of the genus. There expanding to other regions and mutating giving the birth of other types of *Arachis*. The cultivated *A. hypogaea* originated in an area of southern Bolivia and northwestern Argentina on the slopes of the mountain range called Andes (Origin, Distribution, and Taxonomy of *Arachis*, 2011). From its humble beginning it was able to migrate into other continents and can now be grown in tropical and warm temperatures worldwide for its seeds and its oil (*Arachis hypogaea* - Peanut, 2012). *Ar. Hypogaea* was introduced in pre-Columbian times to west Indies and Mexico, in early post-Columbian times to Africa and eastern Asia and during the colonial period to North America (Duke, 1997).

2.1.3 Present Distribution

The total commercial production of *A. hypogaea* worldwide was 37.6 million metric tons, harvested from 24.1 million hectares («*Arachis hypogaea* - Peanut», 2012). China is the leading country harvesting 13,336,860 peanuts annually in metric tons. China produces annually 50% more than the second leading country, India («Top Peanut (Groundnut) Producing Countries», 2017). In the United States *A. hypogaea* is an important crop in the southeastern states, partly due because of the African-American botanist George Washington Carver. Carver promoted the groundnut as an alternative crop to cotton, which was declining in productivity due to soil depletion and insect devastation. Carver described 145 different products made from peanuts («*Arachis hypogaea* - Peanut», 2012).

Table 2 Main producers of *Arachis Hypogaea* («Top Peanut Producing Countries», 2017)

Rank	Country	Annual Peanut Harvest in Metric Tons
1	China	13,336,860
2	India	7,156,448
3	Nigeria	2,755,649
4	United States	1,837,519
5	Sudan	1,399,500
6	Indonesia	1,274,271
7	Myanmar	841,925
8	Senegal	694,147
9	Argentina	463,227
10	Vietnam	414,968

2.2 Environmental Factors and Distribution

2.2.1 Elevation and Climate

Arachis hypogaea can grow in a wide range of climate conditions and is grown between latitudes 40° N and 40° S and up to 1500 meters in altitude (Pradesh, 2016).

A. hypogaea is best grown in tropical climate and warm weather, but it is suitable for subtropics and warm temperate regions (Duke, 1997). Although, there are other species of *Arachis* that are more cold tolerant, but the most common ones are located in warm temperate regions. *A. hypogaea* ideal temperature is between 25°- 30° but can withstand other temperatures, its growth ceases when the temperature drops below 15° (Ntare, B.R., 2007).

2.2.2 Temperature regime

Arachis hypogaea's ideal temperature is between 25°-30°, being able to withstand other temperatures. *A. hypogaea* can withstand other temperatures but being exposed to these may result harmful. Low temperatures, below 15°, can retard seed germination and increase the risks of seedling diseases, (Ntare, B.R., 2007). According to Fortanier's investigation, *A. hypogaea*

does not have a response to a day-night temperature fluctuation (De Beer, s. f.). *A hypogaea* is a heat tolerant legume being able to withstand a temperature of 40° during its reproductive phase, as it is proven by the research conducted by Elsevier Science B.V. (Craufurd, 2002).

2.2.2.1 Rainfall, Potential Evapotranspiration and Water Deficit

The low yields of this crop are mainly attributed to unreliable rainfall patterns with frequent droughts (Pradesh, 2016). *Arachis hypogaea* is mainly grown in areas with an average annual rainfall of 500-1000 mm; 500-600 mm of rain reasonably well distributed over the growing seasons allowing satisfactory production. It can tolerate an annual precipitation of 3.1-41 dm. *A. hypogaea* is drought-tolerant and can withstand severe lack of water, but yields are severely reduced (Ntare, B.R., 2007).

2.2.3 Geology and Soils

The optimal soil temperature is 25-30 for seed germination, other temperatures may lead to causes that can harm the seed (Ntare, B.R., 2007). The best soils for *Arachis hypogaea* are deep (30cm-40cm), friable and well drained sandy loams, well supplied with calcium and moderate organic matter. Another important aspect towards the soil is that it maintains a near to neutral soil pH levels and Ca:K “ratio” lower than 3 (Ntare, B.R., 2007). Ca:K ratios represent homeostatic balances and help predict disease trends.

2.3 As a Vegetation Component

2.3.1 Associated Species (“Arachis hypogaea - Peanut,” ND)

Arachis hypogaea has some particular growth requirements that limit the amount of companions. Any plant grown nearby must like full sun, well drained soil and deeply fertilized sandy loam. These companions must not cover up the plant and reduce sun exposure (Grant, 2018). According to Bonnie L. Grant,

“Ideal plants with peanut crops might be other in-ground crops like beets and carrots. Potatoes are another good in-ground plant with similar growth needs. In-ground crops to avoid are onions and other members of the Allium family.” (Grant, 2018).

2.3.2 Interactions and Effects on Soils

In order for *Arachis hypogaea* to be cultivated, it requires a near to neutral soil pH level and Ca:K ratios lower than 3. These soils require calcium and moderate amounts of organic matter (Ntare, B.R., 2007). *A. hypogaea* should preferably not in the same field more than once in 3 years to limit damage by soil borne disease, nematodes and weeds (Ntare, B.R., 2007).

2.3.3 Relationship with animals and insects

The most important interaction *Arachis hypogaea*, as well as all legumes have is between themselves and rhizobial bacteria that inhabit their roots. These bacteria take on the job of nitrogen fixation for the plant («Peanut Arachis Hypogaea», 2007). Nitrogen in the atmosphere is an unusable form due to the extremely strong triple bonds between the two nitrogen atoms. To solve this problem legumes have formed a mutualistic relationship with rhizobia; rhizobia are provided with a safe place to live and carbohydrates for energy from *A. hypogaea* in exchange of usable nitrogen, generally ammonia («Peanut Arachis Hypogaea», 2007).



Figure 1 Legumes mutualistic relationship with rhizobia

3.0 BIOLOGY

3.1 Chromosome Complement

Arachis hypogaea was the first to report the chromosome number $2n=40$, unlike other *Arachis* species that have a chromosome number of $2n=20$. Its ancestral chromosome number is $2n=20$. Husted (1931-1933) found pairs of chromosomes smaller than the rest and named them A chromosomes and another pair called B chromosomes. (Murphy, 1982). This research suggested that all presently known subspecies and varieties of *A. hypogaea* came to be from a unique allotetraploid plant or from different allotetraploid populations that originated from the same specie (Murphy, 1982).

3.2 Life Cycle and Phenology

3.2.1 Life Cycle

Arachis hypogaea's life cycle is divided into vegetative and reproductive phases. The cycle begins with seed germination and it's followed by the vegetative phase, shoot and root development and later with the reproductive phase (Hisajima, 1992). The reproductive phase can be divided in two, the first is flower induction and seed formation, and the second when the cycle when the seeds become mature. Peanut seedlings rise out of the soil about 10 days after planting. They grow into a green leafed plant that after 40 days after planting will become a yellow look alike flower. After a certain amount of time the petals flow off and the peanut ovary emerges (Hisajima, 1992). 120-160 days after planting the plant has matured and is ready for harvest. In order for farmers to harvest, they have to wait for the right conditions, soil can't be too wet or too dry. After its harvest the peanut contains 25-50 percent of moisture and has to be dried to 10 percent or less in order to be stored.

3.2.2 Phenology

3.2.2.1 Deciduousness

Arachis hypogaea is not deciduous, they are an annual legume. *A. hypogaea* grows a yellow or white flower that can be affected by heavy rainfall and drastic temperature changes (Garrett, 2004).

3.2.2.2 Flowering and Fruiting

Flowering occurs shortly after the seed is planted, the number of days it takes is heavily influenced by the temperature. Normally, it can take 24 to 35 days for the flower to emerge (Kotzamanidis, 2006). The podding zone is located near the surface, leading to possible changes in to podling zone because of the temperature and moisture. The optimal soil temperature for podling is 31- 33°C and a soil moisture of 40% (Kotzamanidis, 2006).

3.3 Reproductive Biology

3.3.1 Pollen

Arachis hypogaea is normally a self-pollinating species because of its inability to be pollinated by other flowers (Van der Stock, 1919). Pollen parents that grow outdoor provide fresh pollen so the breed could make polinations immediately after the flower emasculation. Pollination is often more effective in early morning, to be more exact between 7 a.m. to 10 a.m. (DeBeer, 1963).

3.3.2 Anthesis

Arachis hypogaea flowering period begins around 40 days after planting, flowers pollinate themselves leading to the fall of the petals as the peanut ovary begins to form (Corcoran,2018).

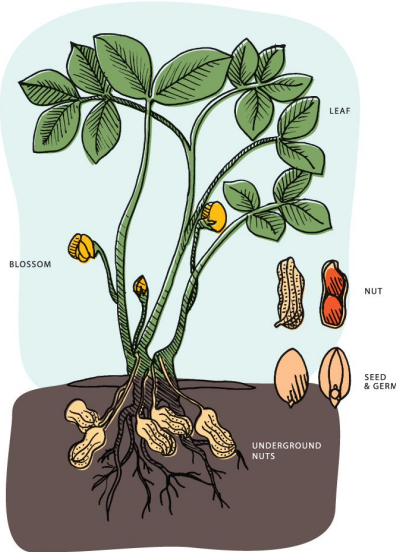


Figure 2 A. *hypogaea* growth (Whitley's Peanut Factory)

4.0 PROPAGATION AND MANAGEMENT

4.1 Natural Regeneration

In vitro regeneration of *Arachis hypogaea* was achieved from different tissues both through organogenesis and embryogenesis (“In vitro Regeneration of Peanut (*Arachis hypogaea* L.),” 1999). Both physical and environmental factors can affect the plants production; light intensity, quality and photoperiod, media nutrients, pH and culture temperature.

4.2 Nursery Propagation

4.2.1 Propagation from seeds

Although *A. hypogaea* can be propagated by seed, it would be extremely costly because seeds are expensive and they only produce one inedible peanut as its seed (Hoyt, 2017).

4.2.2. Pre-preparation and implications for germination

Well drained soil with sandy or sandy-clay subsoil is recommended so the nut-forming pegs (Figure 3, below) to penetrate the soil easily. Nitrogen in soil is crucial in order to support the plantations needs (Hoyt, 2017).



Figure 3. *A. hypogaea* pegs penetrating soil

4.3 Planting and Harvesting

Arachis hypogaea is an early season crop, which means that it doesn't grow well in wet soils (The Organic Garden, 2015). Before planting it is important to know that *A. hypogaea* has a long growing season that can consist of 100 to 130 days of frost-free days. Another aspect to keep in mind is that it is important to plant in a site that receives full sunlight. *A. hypogaea* seeds have to be planted two inches deep and eight inches apart (The Organic Garden, 2015). It is recommended to plant in soft and loose soil in order for the roots to penetrate easier, to achieve this soil sand and aged compost can be added.

After *A. hypogaea* has matured, the nut should be dry and brown on the outside of the pod and grey on the inside. In order to harvest, the nuts have to be dug out carefully in order for them not to break. The nut should be dried for two days and then the outer shell has to be removed by hand in order to remove damaged, broken or dirty nuts. The final product has to be stored in clean and dry conditions in order to avoid fungal growth that can be harmful to humans (The Organic Garden, 2015).

4.4 Management

4.4.1 Tending

The soil has to be kept dry in order for *Arachis hypogaea* to grow healthily. It is important to create soft soil before planting to facilitate the seed and root growth. The land has to be constantly maintained so that weeds do not grow and overtake the plantation. *A. hypogaea* at its early stage can not compete against weeds and as a result the weeds have to be pulled out by hand. It is recommended to use fertilizers that contain calcium to ensure good crop establishment, high yield and good seed quality (Pradesh, 2016).

4.4.2 Flowering

The last stage of *A. hypogaea* can be called the flowering stage; during this period the seed grows into a green leafed plant. Forty days after planting will become a yellow flower. After a certain amount of time the petals fall off and the peanut ovary emerges (Corcoran, 2018).

4.4.3 Pest and Disease Control

Groundnut is susceptible to a number of diseases, such as early leaf spot (*Cercospora arachidicola*), late leaf spot (*Cercosporidium personatum*, synonym: *Cercospora personata*), rust (*Puccinia arachidis*), groundnut rosette (caused by a complex of 3 agents: groundnut rosette virus (GRV), groundnut rosette assistor virus (GRAV) and a satellite RNA) and aflatoxin contamination caused by *Aspergillus* fungi (Pradesh, 2016) (Table 3, below). These pests and diseases are more common in African countries and can cause more than 70% of yield loss. As a solution farmers have figured out natural ways to fight these diseases.

Table 3 Most common pests and diseases (Agro-Environment Initiative, 2008)

Pest and disease	Stage attacked	Type of damage	Control measures
White grubs	All stages	Roots, pods, young nuts	Decomposed manure
Termites	All stages	Roots, stem base, pods	Early planting, field huggiene
Millipedes	Seedling and plant	Pods, flower	Cover exposed pods
Aphids	Early growth stage	Vector of rosette virus	Early planting,
Damping off disease		Rotting of stem seeds	Certified seeds, crop rotation
Leaf spot	Leaves	Brown ring spots, shedding leaves	Crop rotation, field huggiene
Rust	All aerial parts except flower	Leaves, stem	Crop rotation,
Aspergillus crown rot	All growth stages	Plant wilting	Rapid drying of nuts
Bacterial wilt	All stages	Plant wilting	Rotating with cereals
Groundnut rosette virus	All growth stages	Yellowing, stunting	Early planting, control of vector-aphids

5.0 MARKETS AND ECONOMY

5.1 Exports

Arachis hypogaea export sales internationally is close to US\$1 billion dollars per year (Maftai, Micaela, 2001). China overtook India as the world's largest producer by the use of high yield seed varieties and agricultural inputs: currently there are over 3.6 million hectares under *A. hypogaea* cultivation, producing over 6 million tonnes per year. (Maftai, Micaela, 2001). In second place is India with around 4.4 million more hectares but producing an average of 5.6 million tons (Maftai, Micaela, 2001). Africa is one of the main producers of groundnut but it never exceeds 8% of the world output due to unreliable rains, little mechanization, pests, diseases and many other factors (Maftai, Micaela, 2001).

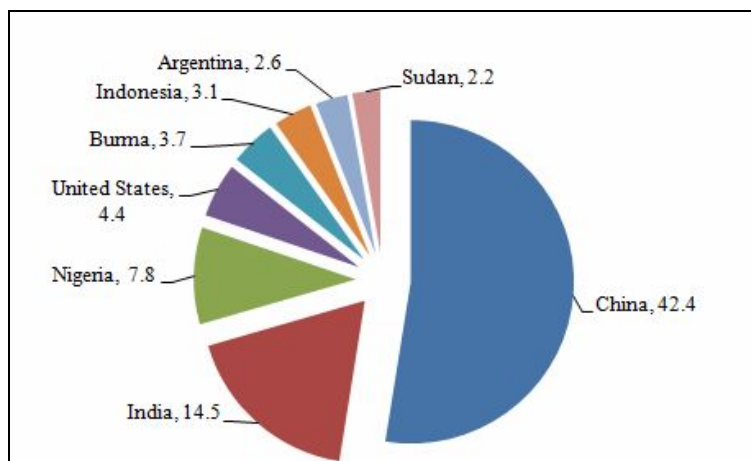


Figure 4 Major producing countries of *A. hypogaea* (by percentage)

5.2 Imports

The European market is the biggest importer of *A. hypogaea* and it is steadily increasing (CBI, 2018). The European market of the groundnut is concentrated by three main importers; the Netherlands, Germany and the United Kingdom (CBI, 2018), these three countries control over 60% of the total imports.

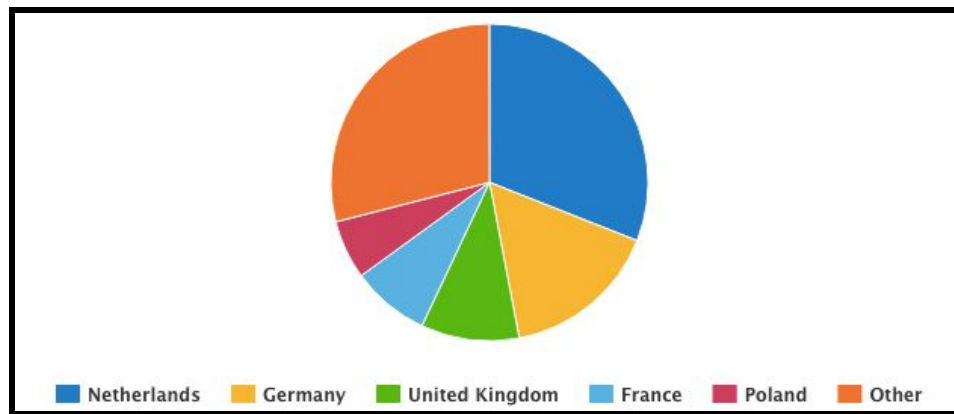


Figure 5 Major importing countries of *A. hypogaea*

5.3 Uses

A lot of people do not know about the wide variety of uses for *A. hypogaea*. Most of them only know of it as a food source; as a nut or modified into peanut butter. *A. hypogaea* can be used for other things, for example as a paint, varnish, lubricating oil and many other things.

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