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Parasitic Plants: Their Distribution, Economic Damages and Methods of Control

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Abstract. Parasitic plants are specialized flowering plants that depend partially or completely on host plants for water and nutrients through specialized structures known as haustoria ("pipettes"). They are classified into holoparasites (*Orobanche*, *Striga*) and hemiparasites (*Cuscuta*, *Rhinanthus minor*). These species are widely distributed in arid and semi-arid regions and are responsible for substantial agricultural yield losses, sometimes reaching 100%. This review aims to summarize the distribution of major parasitic plant species, evaluate their economic impacts on agricultural production, and discuss integrated control strategies. A comprehensive literature review was conducted, compiling studies on the biology, ecology, host-parasite interactions, and management of parasitic plants. Control measures discussed include preventive, mechanical, chemical, biological, and biotechnological approaches, with special attention to host plant resistance mechanisms. Key parasitic plants identified as major agricultural threats include *Cassytha filiformis*, *Cuscuta spp.*, *Striga spp.*, *Rhamphicarpa fistulosa*, and *Agalinis purpurea*. These species significantly reduce the productivity of cereals, legumes, and vegetable crops. Integrated management strategies, including herbicide application, biological control, and development of resistant varieties, have shown potential effectiveness. Resistance mechanisms involve inhibition of parasite seed germination, prevention of haustorial penetration, and restriction of parasite growth after attachment.

Keywords: *Parasitic plants, Pipettes, Whole parasites, Parasites*

INTRODUCTION

Parasitic plants occupy a unique position in the plant world due to their lifestyle, which differs from traditional vegetative plants, as they are able to penetrate the tissues of the host plant using specialized organs known as haustoria, to absorb water and organic and inorganic matter [1]. Parasitic plants are divided into obligate parasites, which depend entirely on the host, and facultative parasites, which can partially carry out photosynthesis [2]. Historically, agricultural records in the Mediterranean, sub-Saharan Africa, and South Asia regions have indicated a wide spread of these plants in fields planted with strategic crops such as wheat, barley, sorghum, legumes, and alfalfa [3]. The increased prevalence has been associated with changing cultivation

patterns, increased reliance on irrigation systems, as well as the limited effectiveness of some traditional control methods [4].

The geographical distribution of parasitic plants shows concentration in semi-arid and arid regions, where harsh environmental conditions contribute to their chances of reproduction and survival [5]. Their danger lies in their ability to produce huge amounts of small seeds that can remain in the soil for long periods, ranging from several years to more than a decade, making it difficult to eradicate them [6]. This review reviews the key aspects related to the classification and distribution of invasive plants, with a focus on the economic impacts of their spread, and reviews various control methods, ranging from traditional methods to the latest bioengineering techniques, with the aim of providing a comprehensive reference to support research and agricultural decisions in this field [7].

BIOLOGY OF PARASITIC PLANTS

A. Definition of Parasitic Plants

Plants (in addition to algae, blue-green algae, and photosynthetic bacteria) are considered one of the most important biological groups capable of supplying the biological system on Earth with the energy needed for life through their unique ability to exploit the energy of solar photons and store it in the form of chemical energy in the bonds of organic compounds that form or store them.This trait has made plants a target for parasites and throws that are always looking for energy sources and organic matter in various groups of organisms, including bacteria, fungi, primitive animals, nematodes, arthropods, including insects, invertebrates, vertebrates, humans, and even viruses and terrestrial life forms that are looking for survival. But plants, however, are species of flowering plants (high-end plants) that are not fully or partially capable of synthesizing carbon sources, they are non-autotrophic (heterotrophic) or autotrophic but are unable to obtain water, mineral elements or mechanical support. These species exhibit intrusive behavior on other plants, which often act as hosts directly to them, or on fungi that act as an intermediary that obtains food from another plant.

There are about 3500 species of parasitic flowering plants constitute about 1% of all flowering plant species [8]. Some parasitic plants are important agricultural pests, such as the parasitic Dwarf mistletoes.Arceuthobium spp causes more than 3.2 billion feet of annual wood board losses in the United States by reducing and distorting the growth of coniferous trees, and the largest losses caused by root parasitic plants globally are caused by the species of the two families, Scrophulariaceae Orobanchaceae, on cereal, legume, and vegetable crops. In Africa, parasitic plants are infected.Striga spp makes about two-thirds of the land under cereal and legume crops and causes losses of up to 100% of the crop, making it impossible to farm with such parasitic plants. This prompted the Food and Agriculture Organization of the United Nations (FAO) to declare that these parasitic plants threaten the lives of 100 million people in 25 African countries due to famine that causes crop loss

Through their exploitation of water and nutrients and their parasitic activity, parasitic plants affect the growth and reproduction of family plants and thus their competitiveness with non-parasitic family plants. Parasitic plants thus affect the structure of plant communities and the dynamics of their constituent populations. The environmental impact of parasitic plants extends to the behavior and diversity of animals that feed on grasses, pollinating insects, and seed-carrying biotics. Thus, parasitic plants can be considered as key species in biodiversity. The Important Role of Plants Parasitism is related to its familial ranges, preferences, and selection of certain family types. Parasitic plants also affect the physical composition of the surrounding environment by influencing soils, water and food resources, carbon dioxide concentration, and temperature, thus contributing to ecosystem engineering [9].

Parasite Probing for HIFS

Various phenols are found as important components of plant cell wall materials, where they play roles in the formation of laccanines and defense against pathogens, among others. P-hydroxy acids and flavones abound in the roots and exude from them to the soil around the root. However, experiments to isolate HIFs from healthy root exuders have not been successful, so most of the data and conclusions indicate that the enzymes of the parasitic plant secreted outside the root extract these compounds from the roots of the family plants [10].

In the case of the roots of the parasitic plant S. asiatica and possibly the rest of the parasitic plants, the epidermal cells produce hydrogen peroxide H2O2, where there is no peroxidase or phenols in or on the walls of these cells, which enables the H2O2 molecules to accumulate and spread in the vicinity of the root and act as a "radar detector" if you encounter the roots of the host that contain the enzyme peroxidase and phenols on their surface, the degradation of the H2O2 molecules will occur.Thus, the presence of host roots is sensed from the difference in the concentration of H2O2, the H2O2 molecules act on the surface of the host cells as adjuvant bases and lead to the oxidative release of Benzoquinone xenognosins molecules from the host cell walls, where a concentration slope of these molecules is obtained from the host root and an indicator of it. These substances are catalysts for the formation of pipettes.

The seeds of the parasitic plant Striga remain dormant until they are exposed to germination stimuli emitted by the host in the form of strigolactones molecules. There is a question that seems logical, why does the host plant produce stimuli for the germination of the seeds of parasitic plants that are harmful to it? The answer is that the plant's production of these and other substances, which benefit the parasitic plant and perhaps other pathogens, is not intended to provide a service to pathogens, but rather to the plant itself or to other organisms that are beneficial to it. They act as a stimulator for the branching of fungal hyphae of the shrubby mycorrhizal fungi that are essential for the growth of the host plant. These substances and/or their derivatives also act as plant hormones that regulate the branching of the airy system of family plants. The issue, then, is that the parasitic plant similarly does some other pathogens to recognize these substances inherent in the growth of the host plant .

Plant Resistance to Infection

Plant resistance to infection by parasitic plants is a complex process that results from the accumulation of many genes during the processes of interaction between the plant and the parasite. As the plant changes by introducing new resistance mechanisms, the parasitic plant develops new pathogenic mechanisms and virulence during the process of an arms race as is the case with other pathogens [11].

In resistance to parasitic plant infestation, plants use a strategy consisting of three lines of defense: the first line of defense is not to stimulate seed germination as is the case against the Hallock plant. The second line of defense is centered on preventing or inhibiting the penetration of host tissues and establishing connection with vascular tissues, and the third line of defense occurs to thwart the growth and spread of the parasite [12].

Identification of Resistant Plants

There are a number of chemosynthetic methods that can be used to study resistance and determine its mechanisms against parasites that parasitize the roots. In vivo resistance can be studied by placing the roots infected with the parasite in a petri dish and monitoring the progression of the infection at different stages. The infected roots can be fixed in a solution of Ethanol 50% (FAA Formaldehyde 5% + Gglacial Acetic Acid 10%, HO+) for 48 An hour, and immerse with paraffin, and then make sections with microtome, dye with different tissue and functional dyes, and examine with a light microscope or a fluorescent microscope.

1. **Alcian Green Safranin**
   In general, carbohydrates, including cell walls and gels, appear green, yellow, or blue, while cannabis, tannin-containing cell walls appear red.
2. **Toluidine Blue O (TBO**
   0.05% TBO in phosphate buffer (pH 5.5) is used before paraffin is removed. It is useful in sensitizing phenolic compounds, tannins, lecanines and superin.
3. **Aniline Blue Fluorochrome**
   It is used to detect the presence of calluses under UV flashing (340-380 nm).
4. **Ruthenium Red**
   It is used for the indirect detection of the activity of degrading enzymes of the middle lamina and cell walls where non-methylated pectinic substances appear pink-red.
5. **Detecting Binding Proteins**
   The presence of binding proteins in cell walls can be detected using the method). Hand-held models are cut and immersed in a 1% concentration of sodium dodecyl sulphate (SDS) solution for 24 hours at 80 °C. Stain for 3-5 minutes with Coomassie blue dye (1% in 40% ethyl alcohol / 10% acetic acid), wash with40% ethyl alcohol solution / acetic acid 10 % and it is loaded with water on a glass slide and checked. Treatment with SDS will remove

most of the soluble proteins while the binding proteins in the cell walls are colored deep blue.

6. **Detection of the presence of H2O2 and the activity of peroxidase enzymes**
   Soft forms are immersed in the form of 3,3-diaminobenzidine (DAB) (1 mg/ml distilled water, pH 3.8) for 2-3 hours. Models are washed with a mixture of lactic acid/glycerol/water (1:1:1) for 1 hour, cut by hand and loaded with the mixture onto the slide. Dark brown discoloration indicates the activity of Peroxidase enzymes and the presence of H2O2 in the tissues.
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B. Hamul Al- Cassytha (Laurel Dadder)

Laurel Dodder Cassytha
Sex Cassytha

The genus name Cassytha is derived from the Aramaic word for tangled hair [13]. The genus Cassytha includes 17 - 20 described species, most of which live in Australia and a few in South Africa, one of which is the global circulating C. filiformis. These plants are parasitic on other plants, missing roots except in the seedling, where they die after contact with the host plant or the death of the seedling. The stems of these plants are filamentous, containing chlorophyll. The leaves are reduced to small scales, the flowers are seated or carried in spike or formal inflorescences.

The parasitic plant Cassytha filiformis

The filiformis guar belongs to the Lauraceae family, the plant is leafless, curly, parasitive, autoparasitic and parasitic to other seed plants. The parasitic plant is widespread in coastal areas and is a global spread in the tropics. The plant parasitizes primarily on woody plants or trees. Economically important hosts include citrus and mangoes, Mangifera indica Eugenia aromatic, nutmeg Myristica fragrans, and its avocado relative Persea Americana, as they belong to the same

family, and many other trees, bushes, and grasses. Usually one plant parasitizes many species of plants adjacent to each other, and the plant has different medicinal uses.

Figure 1. represents the parasitic plant *Cassytha* filiformis

The stem is filamentous, green to orange branched, 1–3 mm in diameter and up to 3–6 m long. The flowers that form all year round, are seated and few in number in a spike inflorescence 1-2 cm long, with a canopy and 2 oval cane, the fruit is of the type of barra as large as a pea and is surrounded by succulent calytic leaves. The wilderness has one small black seed.

Disease Control

1. Remove the parasitic plant as soon as possible.
2. Chemical control with bush pesticides.
3. Removal of the family bush of the parasitic plant [13].

C. The Dodder *Cuscuta*

There is debate about the affiliation of the genus Cuscuta to the family Garcia) or the family Cuscutaceae, which is very close to the first family The genus Cuscuta includes more than 170 species divided into 3 subgenera that are distinguished on the basis of the appearance of the pen and the pestle in the flower: under the genus Monogyna it is characterized by united pens and includes 7 species, under the genus Grammica is characterized by free pens and spherical pistils and is not elongated and includes 130 species and under the genus Cuscuta is characterized by free pens and elongated pistils and includes 22 Sort. Molecular studies have demonstrated the unilateralism of the evolutionary origin of these subgenera [14].

Pathogen

The lizard is one of the most famous parasitic plants, as it parasitizes a wide range of economic and wild plants, including bicotyledonous plants, and to a lesser extent monocotyledonous plants. The lizard represents the most important parasitic plant on legume plants in temperate regions, as it is destructive on jute, alfalfa, flax, as well as potatoes and onions.

The body of the parasitic plant consists of a thin, yellow to orange stem that wraps heavily around the above-ground parts of the family plants. The stem is leafless or has triangular squamous leaves about 4 mm long. The flowers are bell-shaped and creamy in color, about 8 mm long and usually borne in bunches.The flower in the box consists of 2-4 seeds. The seed shell is coarse, contains different patterns, and varies in size depending on the species and its diameter is at a rate of 4 mm. The color of the seeds varies from light gray to yellow to red to brown, however, the dodder is a prolific seed producer as a single plant manages to produce a few thousand seeds, but only 5% of the previous season's seeds manage to germinate while the majority of the seeds remain in the soil and can retain their vitality for 20 year depending on the type and environmental

conditions. The reason for the long dormancy of seeds is due to the hardness of the coat, which can be disturbed by the activity of microorganisms.

Figure 2. Dense growth of the parasitic plant *Acacia,* Punjab, Pakistan (right) Acacia, (left)

Symptoms and Signs

The stem forms branches where its developing limbs look for the adjacent parts of the host plant or nearby plants, where they wrap around them and establish continuous foci, which leads to the expansion of the circle of affected plants to become about 3 m in diameter originating from a single carrier plant. The infestation in the field spreads in the form of patches that expand during the growing season while continuing to expand on perennials such as jet Medicago sativa each year.

Disease Control

1. Prevention by preventing the arrival of dodder seeds to the field by using seeds free of the parasite seeds.
2. Kill dodder plants in spots that appear early at the beginning of the growing season by spraying them with contact bush pesticides.
3. If the dodder is widespread in the field, it is disposed of by repeated tillage, burning, and spraying with bush pesticides that kill the young dodder plants when the seeds germinate.
4. Biocontrol, Fuscarium tricinctum, Alternaria alternata and *Geotrichum candidum* attack dodder plants and stuck fungi Colletotrichum gloeosporioides *C. australis* cuscuta chinensis selectively control the dodder plants on the soybean crop [15].

D. The witch's bush.*Striga spp*

Witchweed Striga spp.

It is considered a witch's bush.Striga spp is the most important parasitic plant because it attacks agricultural crops on which people's lives depend such as maize, sorghum, rice, millet, sugar cane, and leguminous plants such as cowpea and peanuts. This parasitic plant is widespread worldwide, especially in meadow lands in India, the Far East and Australia. This parasitic plant pollutes two-

thirds of the 73 million hectares of cereal crops in Africa, causing a loss of 70% of crops, which amounts to 4.1 percent million tons per year. The annual crop losses caused by this parasite in the African savanna alone are estimated at about $7 billion. The losses are most pronounced in poor and moisture-scarce soils [16].

Pathogen

The species of the parasitic plant Striga belongs to the family *Orobanchaceae* [17] (Seropulariaceae), the genus includes more than 30 described species, but two species are considered the most harmful species worldwide: *S. hermonthica S. asiatica. aspera* , [18].

E. The parasitic plant *Rhamphicarpa fistulosa*

The genus Rhamphicarpa belongs to the Scrophulariaceae family and is a relative of the parasitic plant Witch bush, these two parasitic plants are considered one of the most important parasitic plants that are especially threatened for rice production in Africa. Rhamphicarpa fistulosa is an optional parasitic plant on cereal crops adapted to grow in lowlands, while witch bush adapted to growing in highlands.

The parasite is widespread in Benin, Burkinovasso, Guinea and Mali and causes rice production losses of up to 40-100% [19]. The plant is fast growing and reproducing and is an invasive jungle plant in sub-Saharan Africa. Parasite seeds do not need a catalyst secreted from the host in order to germinate but they do need light. Seeds require dormancy of 6 months.

Figure 3. The parasitic plant *Rhamphicarpa fistulosa*

After germination of seeds and contact of the roots of the parasitic plant with the roots of the host plant, the roots of the parasitic plant swell and form pipettes that are able to achieve direct bonds with the xylem tissue of the host roots. In vivo experiments and potted experiments have shown that .R. fistulosa is a parasitic facultative plant that manages to complete its life cycle without the need for a host, however, under such conditions the parasitic plant is much smaller and

produces fewer seeds than in the parasitic condition. Field observations show that this parasite is destructive to cereal crops [20].

F. The parasitic plant *Rhinanthus minor*

The parasitic plant Rhinanthus minor or Yellow Rattle is an annual herbaceous herbaceous parasite of the , containing chlorophyll, belonging to the family Orobanchaceae and placed in the family Scrophulariaceae. The genus Rhinanthus includes about 43 species28 of which is in Britain. This parasite attacks a wide spectrum of family plants of more than 20 species and causes significant damage to them. The parasite infects the roots and is common in natural and semi-natural meadow lands in the northern diseased regions of Europe, Asia, and North America. This parasitic plant reduces the biomass of the family plants. The parasitic plant R. minor attacks cereal crops and leguminous plants as preferred hosts. This parasitic plant has an impact on the ecosystem as it determines the growth of the prevailing bushes in the meadows, giving way to the growth of other types of plants. Plant development is done by planting the seeds of the current season.

The parasitic plant Rhinanthus minor : herbaceous, annual, summery. Stem erect, simple or branched up to 50 cm long, quadrangular, showing a black outline or spot. Leaves are opposite, seated, oval to lanceolate, with full or serrated edges. The flowers are single, semi-seated in semi-leafy axils, borne in a terminal semi-spiked floral inflorescence. The calyx is tetraspinated, middle green tinged with red. The corolla is somewhat open labial tubular, yellow to yellow-brown, the upper labia has purple teeth It holds the matuc while the lower labrum is trilobed and moves away from the upper labrum. The fruit is in the form of a dry box that contains a few seeds that are curled when ripe, hence the popular name of the plant. The seeds are winged discs

Between that the preference of the parasitic plant Rhinanthus minor for leguminous plants as hosts is due to the poor resistance of these plants and its failure to infect non-leguminous plants to the strength of their defensive responses.

In addition to its parasitic nutritional damage, this growth of the parasitic plant inhibits the photosynthesis of the host and consequently reduces its biomass. Resistant plants such as plantain (plantago) are able to inhibit the growth of the parasite by inhibiting the rate of electron transport [21].

Figure 4. Hand drawing ofthe parasite *Rhinanthus minor*

G. The parasitic plant *Agalinis purpurea*

Popularly called Purple Gierardia, a member of the Scrophulariaceae family is an annual facultative parasitic plant. The length of the plant varies and depends on the availability of family trees, the well-growing adult plant reaches a height of 3 m. This parasitic plant grows on forest trees that are not dense due to its need for light. The flowers are purple and bloom at the end of summer and the beginning of autumn. The fruit of the box type bears seeds in a structure similar to beehives. Fruit Bearing 125 – 50 A large plant can produce 32,000 seeds. The seeds are mainly dispersed by the wind and possibly shallow water as well. The germination rate of seeds is very high after storage at 3 m for 21 days.

The root of the parasitic plant wraps around the root of the host and forms many pipettes on the roots of the host in rows. Interestingly, pipettes remain alive even after the other parts of the parasite die.

The parasitic plant Agalinis purpurea: It is not specific to the host, but it does not thrive in the absence of woody plants. The harmful effect of the parasite on the family plants represented by yellowing and poor growth is evident in the second year of its cultivation.

Figure 5. The parasitic plant *Agalinis purpurea*

H. *Balanophora* parasitic plants

The Balanophoraceae family consists of genera, including about 50 species of tropical and subtropical plants that parasitize the roots of trees. These plants are completely parasitized because they are completely devoid of green pigments. The visible part of the plant is the floral inflorescence, which is similar to a snail.

Figure 6. *Balamophora*, male plant (left) Female plant (right)

A dicotyledonous plant with 15 species endemic to the tropics of the Old World and parasitizes at least 74 species of plants belonging to 35 families. A widespread and well-known species is Balamophora fungosa, which parasitizes more than 25 species of plants (& Kipgen 2010, Balanophora indica Jibankumar It is a perennial plant that parasitizes coffee trees [22]. The perennial parasitic plant kuroiwai Balanophora parasitizes the roots of Pongumia pinnata of the legume family, Macaraanga tanarius of the Euphorbiaceae family, and B. tobiracola parasitizes Pittosporaceae tobira of the Pittosporum and Ligustrum families .

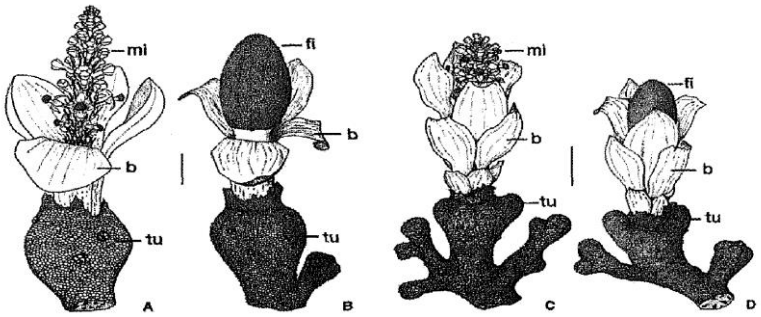

Figure 7. Hand drawing of the species *Balanophora*, the parasitic plant A) B. papuana (male plant). (B) Female plant, note the branching of the tuber. The parasitic plant Balanophora elongate (C) the male plant, (D) the female plant, note the branches of the tuber. The tubers are mostly subground. mi male bulb, fi female bulb, b bulb, tu tuber . font - 1 cm.

These parasitic plants are characterized by the formation of the connection with the roots of the host by a tuber. The aboveground part of the parasitic plant is represented by a thick, fleshy floral bulb with and sometimes without squamous leaves (cannabis) as in the two sexes, Lathrophytum chlamydophytum. The floral bulb arises from the tuber and bears male or female flowers.

I. The *Orobanche*

Broomrapes Orobanche

The parasitic plant Orobanche was described in 1753 by the well-known botanist Linnaeus, and its scientific name is derived from the Latin words orobos, which means ancho, which means diphtheria, i.e. the diphtheria of the robe, to reflect the effect of the parasitic plant on the host.

Hallock causes significant economic losses to family plants in southern Europe on beans and in the United States on tobacco, alfalfa, tomatoes, sunflowers and fava beans. Hallock also causes severe outbreaks on beans in Egypt, where the parasitic plant is 3.3 m high, and it is widespread in Iraq and causes significant economic losses, especially in the field tomato cultivation area in Dohuk, northern Iraq. The estimated losses from this parasite range from 5 to 100 % and severe injuries can lead to abandonment of fields. In Eastern Europe and Spain, the infestation of Hallock Cumana causes losses in sunflowers of up to 50% and is considered a threatening problem for its production, and the nodal Hallock causes losses to the tobacco crop in India up to 25% and causes a loss of the dandelion crop Taraxacum koksaghyz, which is grown for rubber up to 48%. Hallock also affects many bush plants. Significant losses on Central Asian watermelons and stimulates the plant to produce a toxin that lowers the marketability of the crop. Hallock generally attacks nightshade plants other than peppers and legumes, carrots, celery, mineralo, haliana, cauliflower, lettuce, sunflower and many bushes.

Pathogen

The parasitic plant Hallock belongs to the genus Orobanche, which is the largest genera of the Orobanchaceae family and includes 170 species, the genus Orobanche is not monophyletic in evolution, it includes two evolutionary lines, Orobanche is among its species. O. cumana crenata and the phylipanche evolutionary line include O. ramose and Schneeweiss.

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