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Parasitic Plants in Agriculture and Management

Pervin Erdogan

Abstract

Parasitic plants are among the most problematic pests of agricultural crops worldwide. They are found worldwide in all plant communities except aquatic. Parasitic plants are the organisms that settle in the host plant by means of the special organs they have developed and penetrate the vascular tissues of the hosts and meet their nutritional, water and mineral needs from the host plant. This particular body they have is called a haustorium. The discovery and investigation of the haustorium structures led to the evaluation of many heterotrophic plant species previously defined as parasitic plants in different groups. Host organisms are very important in completing the life cycle of parasitic plants. In general, the parasite weakens the host, so it produces fewer flowers and viable seeds or the value of the timber is reduced. However, some parasites, mostly annual root parasites belonging to the Orobanchaceae, can kill the host and cause significant economic damage while attacking monocultures in agriculture, and much effort is put into controlling these harmful parasites. Parasitic weeds are difficult to control because there are few resources for crop resistance and it is difficult to apply sufficiently selective control methods to kill weeds without physically and biochemically damaging the crop to which they are attached.

Keywords: Plants, Parasitic, Species, Agriculture

1. Introduction

Parasitic plants are among the most problematic pests of agricultural crops worldwide. About 4000 parasitic plants exploit another plant vascular system to fulfill their nutrient requirements. The majority, about 90% of these species are hemiparasites retaining photosynthetic capacity while the rest, 390 species are holoparasites with obligate dependence on the host to obtain all their nutrients [1, 2]. They are extremely morphologically diverse and range from diminutive herbaceous plants to large trees, as well as highly reduced parasites that grow embedded in their host and lack leaves and roots. Parasitic plants can be divided according to whether they are photosynthetically active (hemiparasites) or lack of photosynthetic activity, and whether they are completely attached to a host for carbon (holoparasites), whether they are optional or obligate parasites, and whether they are attached to the roots or stem of the host. In natural ecosystems, parasitic plants form a component of the plant community and contribute to the overall community balance of parasitism. Conversely, when parasitic plants are established in low biodiverse agroecosystems, their persistence causes enormous yield losses and renders agricultural land inoperable. It has been determined that many features from seed germination

to haustorium formation, from feeding patterns to host selection are based on the relationships between the host and the parasite [3].

Parasitic plants change in host dependence of and the rate at which they can attach. Facultative hemiparasites complete their life cycle without the need for a host. Also, obligate parasites (can be hemi- or holoparasites) need host to survive and reproduce. Most of facultative parasites have a broad range of hosts. For example, *Rhinanthus* attach to more than fifty species of herbaceous plants and grasses. Obligate parasites (especially holoparasites) more likely to specialize in a single host plant species or a narrow host range, and host shifts can be included speciation. Parasitic plants should synchronize their life cycle with the host for maximum fitness. Tiny seeds of obligate root parasites such as *Striga* germinate only after a conditioning period at the appropriate temperature, then are exposed to host-derived chemical signals such as strigalactones that are extruded by the host's roots to signal symbiotic arbuscular mycorrhiza in the soil [4].

Holoparasities and hemiparasites develop haustoria. There are two types of haustoria. Primary haustorium develops directly from the primary root apex. It is the only haustorium to function during the parasite's lifetime. When only the primary haustorium is present, the parasite is considered evolutionarily more advanced. The development of primary haustorium made holoparasitism possible because holoparasites with small seeds usually require water, and nutrients from a host immediately after germination [5].

Parasitism appeared several times independently during angiosperm evolution, and the lifestyles of parasitic plants vary widely between taxa [1]. Some species are optional parasites that can survive in the absence of a host, others are necessarily parasitic and cannot develop independently. A distinction can be made between hemiparasitic herbs containing chlorophyll and can produce some of the essential nutrients through photosynthesis, and holoparasitic plants that do not contain chlorophyll and are completely dependent on host sources, but this distinction is not always clear [6, 7]. They pose a tremendous threat to the world economy because they are virtually uncontrollable at the moment [8, 9]. They belong to a variety of plant families and are attached to host roots, shoots or branches. The mistletoes like *Viscum* and *Arceuthobium* that parasitise trees, climbers like *Cuscuta* that parasitise shoots, and parasites like *Striga* and *Orobanch*e that connect to host roots [3].

1.1 Parasitic plants

Weed parasites, usually unique to the host, do their greatest damage before they emerge; therefore, most crop yield loss may occur before infection is diagnosed. Despite intense efforts in the twentieth century, effective ways to selectively control various parasitic weed species are still scary or absent. While all agricultural weeds compete with crops for the field to obtain water, nutrients and light, parasitic weeds are also particularly harmful as they extract valuable water and nutrients directly from the host plant. To extract nutrients from host plants, parasitic weeds have developed a unique multicellular structure called the haustorium that invades the host, connects with the host vascular system and draws the water and nutrients it needs [10, 11]. A successful haustorial connection to the host causes permanent damage to a large part of the crop's life cycle, lowering the harvested yield, lowering the crop value, and contaminating it with parasitic seeds. Parasitic weed infection strongly reduces crop harvest by disrupting crop orchestration of resource allocation by altering dry matter partitioning between crop organs that prioritize those adjacent to the [12].

1.1.1 Mistletoe

Mistletoe (*Viscum album* L.), (Viscaceae) whose distribution areas are widening in the world, is a semi-parasitic plant that lives by sucking the sap of the host plants it lives in, thus harming its host. It has small bushes, leaves and is an evergreen plant. “Zodiac sign” and are also known by the names of “chekem”. Rosaceae like apple and pear (Rosaceae) family trees semi parasitic lives on its branches. It can also be found in other trees. The plant can withstand several seasons leathery leaves, narrow and is long. The flowers, the seats of the shoots and yellowish-green is colored. The end of autumn and the beginning of winter the size of a pea. It was white and bright (**Figure 1**). Mistletoe lives as a semi-parasite on nearly 200 plant species, including fruit and forest trees and ornamental plant. This plant can cause losses in many economically important crops. Pear, plum, apricot, apple, almond, pear, walnut, chestnut is some of them. Along with these, the wood quality of trees such as willow, poplar and oak decreases [15].

The way mistletoe spreads are quite interesting, with all leaves, flowers monogamous and sticky, juicy and soft fruit. Thanks to its sticky structure, the seeds that stick to the beaks and feet of the birds or the birds that eat the fruits, especially the junipers, leave their feces on the trees they put on, and the seeds continue to grow by germinating on the tree they are transported. The germinated mistletoe seeds pierce the bark of the tree and reach their suckers down to the wood pipes and share the water and mineral substances of the host. Yield losses of up to 50 percent can be seen in sensitive fruits due to mistletoe Mistletoe provides its food by inserting its

Figure 1.
a) Entry of triple suckers from *Viscum album* seed to plant tissue, b) *Viscum album* L., [13], c) swelling in the branch of the Ankara pear of *V. album*., [14], d) damage of the *V. album* damage (tr.wikipedia.org).

suckers into the trunks and branches of fruit, park and forest trees. Swelling is seen in these parts. It weakens the host tree, decreases the yield, and sometimes causes the old trees to dry. The fruits are spherical and the abundant viscin substance in the fruit flesh provides the stickiness of the fruit and the seed [16]. The stem of the plant lives dependent on the host, if it cannot find a host, it cannot survive. Seed need to attach to the host in germination the duration is known to be 3–5 weeks. By moving the jab body end counterclockwise hugs the host he reaches. Of the held body parasitic plant from the host facing surface, it dips suckers to his host and these suckers connects with its host phloem and xylem. They typically exhibiting broad host ranges, and inflict serious damage to many crops, including forage legumes (alfalfa, clover, lespedeza), potato, carrot, sugar beets, chickpea, onion, cranberry, blueberry, and citrus [17].

1.1.2 *Cuscuta* spp

Cuscuta spp. leafless, thin, threadlike wrapper has the body. The flowers are small and flower collected in cases. Petals (corolla) combined, usually five-piece rarely four or in three parts. Ovary (ovarium) two carpel and two seed pods in each compartment takes place. Fruit, capsule shaped, seed without cotyledons or in traces, embryos are in the form of threads (**Figure 2**) [17]. This plant is taxonomically the most difficult parasitic is one of the groups. *Cuscuta* breed diagnosis

Figure 2. *Cuscuta* spp. a, b,) damage of *Cuscuta* spp., c) damage of *Cuscuta* spp. of in tomato d) damage of *Cuscuta* spp. of in potato (niscole.com; projectnoah.org; Cittaslav botanic; iriss.ca, Erdogan, P).

mostly is carried out according to flower and fruit characteristics. These features; stigma shapes, staminal braces shape and condition of filaments, capsules. Whether it is turned on or not depends on features such as [6]. In China, several *Cuscuta* species inflict severe damage on soybeans [18].

Seeds of *Cuscuta* spp. have been spread worldwide in contaminated shipments of crop plant seeds. *Cuscuta pentagona* is a major weed of tomatoes in California, causing yield losses of 50–75% [19]. Nemli and Ongen [20] reported that cayenne in alfalfa causes yield losses up to 91%. It was determined that *Cuscuta* species caused 60–70% decrease in the yield of alfalfa in India [21]. It has been reported that poisoning cases are encountered in animals fed with plants contaminated with coals [22]. In Turkey, species of *Cuscuta campestris* Yunck. and *Cuscuta approximata* Bab. are very common [23].

1.1.3 *Orobanche* spp

Orobanche spp. and *Phelipanche* spp. the most damaging weedy root parasites belong to the Orobanchaceae. One of the most important experts in the *Orobanche* taxonomy, Prof. Dr. Edward S. Teryokhin divided the genus *Orobanche* into two important parts, *Orobanche* and *Phelipanche*. *Phelipanche* was first given to *P. ramosa* by Auguste Pomel (1821–1898), and with the support of increasing molecular studies in recent years, *Orobanche* genus *Orobanche* and *Phelipanche*. It was accepted to be divided into two generals and *P. ramosa* (L.) Pomel and *P. aegyptiaca* (Pers.) Pomel started to be used instead of *O. ramosa* and *O. aegyptiaca* in weed research. The broomrapes (*Orobanche* and *Phelipanche*) are widespread in Mediterranean areas in Asia Southern and Eastern Europe [3, 8].

As a full parasitic weed, *Orobanche* spp. have not green leaves, so they do not contain chlorophyll and cannot perform photosynthesis. Therefore, its life depends on the food and water it receives from the host. In order for the seeds of *Orobanche* spp., which are among the smallest seed plants in the world, to germinate, the host plant they prefer must be planted. When it is a suitable host, the seeds under the soil germinate and attach to the root of the host plant by forming a tube, and then it continues its life with ready-made food from the host. An *Orobanche* plant produces between 5,000 and 100,000 seeds, and these seeds can remain in the soil for more than 10 years without losing their viability. Four types of *Orobanche* cause significant damage in agriculture. These species are *O. ramosa* L. and *O. aegyptiaca* Pers. Some vegetables, mainly tobacco and tomatoes, and lentils, *O. crenata* Forsk. mainly broad beans and other legumes and *O. cernua* Loefl. causes significant damage to sunflower. It is possible to see *Orobanche* spp. in many broad-leaved cultivated plants, but it causes significant damage especially in sunflower, tobacco, tomato, eggplant, pea, lentil, broad bean, chickpea, cabbage, oilseed rape, parsley, watermelon, common vetch and carrot [6]. In cases where contamination with this weed is very heavy, yield loss in cultivated plants can reach up to 100%. *Orobanche* spp. may cause loss of yield in the host plant as well as decrease in quality as in tobacco and sunflower. The yield loss they cause in *Orobanche* spp. culture plants may vary between 5 and 100% depending on the time and density of this parasite weed to attach to the culture plant. It was revealed that *Orobanche* spp. caused 33% in tobacco, 50–100% of the bean, sunflower at 33%, 24%, carrots, and tomatoes in the United States 21% 29 and 24% in Turkey [24]. It has been established that the seeds completely lose their vitality when *Orobanche* spp. is harvested fresh. It has been reported that the vitality of the seeds decreased only by 10% within the first 5 years of storage, and this rate decreased to 50% after 9 years. It is stated that the vitality will decrease if the seeds are kept at high temperature and humidity (Figure 3) [26].

Figure 3.

a) *Cuscuta* sp. in potato (Karahana. A.), b, c) *Cuscuta* spp. (coms.wikipedi.org., d) eggplant in *Cuscuta* sp. [25].

1.1.4 *Striga* spp

The witchweeds (*Striga* spp.) plants are herbaceous plants. The genus is characterized with contrasting leaves, irregular bright-colored flowers corolla, divided into a tube that spreads lobes, herbaceous habitat, small seeds and parasitism. *S. hermonthica* has shiny to dark green leaves, erect and often branched stems grow 77 cm or more. Stems are sturdy and rectangular. The leaves are linear, lanceolate or lanceolate and 1–3 inches long, with acuminate or acuminate tips, multi-shell. The inflorescences have 6–10 open flowers, 1–2 cm in diameter. The flowers are pink, red, white, purple or yellow. The spike has occasionally more than 10 open flowers and the corolla normally drops a few days after fertilization [6]. The infection caused by some hemiparasitic weeds such as *Striga* causes more crop biomass depression than the biomass accumulated by the parasite. *Striga*, like other plant herbivores and pathogens, reduces host productivity by lowering crop photosynthesis rates (press). The impact of *Striga* is complicated further by its predilection for attacking crops already under moisture and nutrient stress, the conditions that prevail throughout the semi-arid tropics [27].

Figure 4.
 a, b, c, d) *Striga* spp. (photo: Oisat.org.; Africanplants.sckenberg.de; researchgate; tr.Gaz.Wiki).

In tropical Africa the most damaging parasitic weeds are *Striga* spp. obligate root parasites of grain grasses and legumes, which endanger food supply in many developing countries. The most destructive species on cereals are *S. hermonthica* and *S. asiatica*, followed by *S. aspera* and *S. forbesii*, parasitising important food crops like rice, pearl millet, sorghum and maize in much of Africa and some parts of Asia. *S. gesnerioides* is an important pest of Fabaceae, especially cowpea). Moreover, the *Striga* epidemic is going to increase and the parasite is likely going to become a more serious threat to crop production [9]. The area infested by *Striga* in sub-Saharan Africa is estimated to be more than 50 million hectares of arable farmland under grains [28]. The area infested by the parasite in West Africa is estimated to be about 17.2 million hectares, and sorghum and millet cover about 64% of the total area [29]. The parasite also causes indirect losses, including human migrations in response to changes in production strategies, land abandonment, and severe invasions in extreme cases (Figure 4) [30].

2. Management

Viscum album L.; the way to prevent the spread of mistletoe, which is mostly propagated by birds, is also through birds. At this point, it is very important to create alternative food sources for birds. Mechanical control is the most effective control technique. Mechanical control is done by removing the mistletoe before the seed binds and pruning the infected branches 20–30 cm below. In severe epidemics,

the tree should sometimes be removed completely to prevent contamination to other trees. Kotan et al. [31] reported that five bacterial strains (two *Burkholderia cepacia*, one each of *Bacillus megaterium*, *Bacillus pumilus* and *Pandoraea pulmini-cola*) were HR and pathogenicity positive when injected but none of them when sprayed on mistletoe. When fungi were injected, 32 isolates were pathogenic but only thirteen when sprayed on mistletoe. *Alternaria alternata* VAS, -202, VAS, -205, VAS, -217 and *Acremonium kiliense* VA-11 fungal isolates were the most effective ones and caused strong disease symptoms on mistletoe (**Figure 5**).

Orobancha spp.; prevent contamination is the most important method to control *Orobancha* spp. Clean seeds and seedlings should be used, and firstly should be preferred certified seed. Beast agricultural tool used in the field contaminated with grass, or machines, without using in the dishwasher field make sure that it is very well cleaned first. in the fields contaminated with monster weeds long-term with non-host cultivars alternation should be made. Seen in fields or greenhouses before the beast weeds bloom, pull them separately by hand It must be burned somewhere or buried very deep. Especially resistant in sunflower cultivation attention should be paid to the use of varieties. In the control against monster weeds solarization is a highly effective method especially in greenhouse plants cultivation solarization should be carried out. *Linum usitatissimum* L. (Lineaceae) is used as a trap plant to control *Orobancha* spp. [24].

Cuscuta spp.; control dodder is also particularly effective in preventing spreading. Emphasis on measures and methods of cultural practice should be given. Plants that are found to be dull by visiting the areas contaminated with dodder should be cut in a way that does not leave any residue behind and destroyed immediately. In the vineyards, in the spring at the beginning of May, in order to prevent the germination of the seeds that have fallen to the soil or clinging to the grape branches before the grape leaves take off, they should first pour straw 5–10 cm thick, wider than the crown width, under the vines that are found to be dull, and the straw should be burned after the sprouts are formed and wrapped in straw. Sticks should not be taken from dish washed ties and vines for the purpose of production and should avoid contamination of uncontaminated areas with this path and other

Figure 5.
Infected mistletoe plant samples used for isolating of bacteria and fungi [31].

forms. Similarly, dodder is an important factor in clover. If alfalfa is to be grown, control should be a problem. Clean and certified seeds should be used the weeds in which there is dodder in the area around the clover field are removed and should be burned [32].

Striga spp.; Oswald [33] reported that planting nonhost trap crops that induce suicidal germination is perhaps the most effective strategy currently available for *Striga* control. Recent researchers in this field focused on identifying and assessing the effectiveness of potential trap crops [34, 35]. Botanga et al. [36] revealed that the possibility of breeding for increased Parasitic Plants in Agriculture 131 production of germination stimulants.

The use of nitrogen-binding legumes as trap crops has the advantage of increasing soil fertility, which can further assist in *Striga* spp. control because *Striga* spp. thrives in poor soils [6]. Legumes have also proven useful as part of a novel “push-pull” (stimulodeterrent) pest management approach that illustrates the utility of increased plant diversity, simultaneously reducing *Striga* spp. and lepidopteran stemborer infestations [37].

3. Conclusions

Parasitic plants are the biggest threats to important crops and can cause crop losses until complete failure of crop productivity. Integrated pest management systems seem to be the best solution to find effective, long-lasting, widely applicable and environmentally friendly methods for parasitic weed control. Considering the life cycle of parasitic weeds, prevention of seed germination and/or host binding would be ideal targets for the successful management of parasites. Recently, some fungal metabolites are in *Striga* spp. and for the first time in *Orobanch* spp. This strategy can be an alternative means of bio-control of parasitic plants and reduce the likelihood of host contact disrupting the fine-tuned process of host recognition.

Conflict of interest

The authors declare no conflict of interest.

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References

- [1] Nickrent D. L. Parasitic Plants of the World [Internet]. 1998. Chapter 2, pp 7-27 in: J A. López-Sáez, P. Catalán and L. Sáez [eds.], Parasitic Plants of the Iberian Peninsula and Balearic Islands.
- [2] Cimmino A, Masia M, Rubiales M, Evidente A. Fernández-Aparicio M. Allelopathy for Parasitic Plant Management. Natural Product Communications. 2018; 13 (3):289-294.
- [3] Rubiales, D., Heide-Jorgensen, HS. Parasitic Plants. In Encyclopedia of Life Sciences (ELS), John Wiley & Sons, Ltd:Chichester. 2011; DoI:10.1002/9780470015902.a0021271.
- [4] Tawfyord, A. Parasitic Plants.2018; DOI: 10.1016/j.cub.2018.06.030.
- [5] Kuijt J. The Biology of Parasitic Flowering Plants. Berkeley:1969; University California Press.
- [6] Parker, C., Riches CR. Parasitic weeds of the world: biology and control. Wallingford, UK: CAB. International. 1993; 332 p.
- [7] Press MC, Graves JD. Parasitic plants.1995. Chapman and Hall, London.
- [8] Joel DM, Hershenhorn J, Eizenberg H. Biology and management of weedy root parasites. Horticultural Reviews. 2007; 33:267-349.
- [9] Parker, C. Observations on the current status of *Orobanch* and *Striga* problems worldwide. Pest Management Science. 2009; 65:453-459.
- [10] Riopel, JL., Timko, MP. Haustorial initiation and differentiation. In Press, MC., Graves, JD. Parasitic Plants. Chapman and Hall, London, 1995; 39-79.
- [11] Joel, DM., Gressel, J., Musselman, LJ. eds. Parasitic *Orobanchaceae*, 2013; (Berlin Heidelberg: Springer-Verlag).
- [12] Jeschke, WD.; Hilpert, A. Sink-stimulated photosynthesis and sink dependent increase in nitrate uptake: Nitrogen and carbon relations of the parasitic association *Cuscuta reflexa*–*Ricinus communis*. Plant Cell Environ. 1997, 20, 47-56.
- [13] Heide-Jørgensen, H.S.; Kuijt, J. The haustorium of the root parasite *Triphysaria* (Scrophulariaceae), with special reference to xylem bridge ultrastructure. Am. J. Bot. 1995, 82, 782-797.
- [14] Üstüner, T., Düzenli, S., Kitis, YE. Determination of Infection Rate of Mistletoe (*Viscum album*) on Hosts in Niğde. Turkish Journal of Weed Science. 2015; 18(1): 6-14.
- [15] Barney, CW. Hawksworth, FG., Geils, BW. European Journal of Forest Pathology. 1998; 28(3):187-208.
- [16] Baser, KHC. Ökseotu (*Viscum album* L.) **BagBahce** 2014.54:22-23.
- [17] Nemli Y. Çiçekli Parazitlerden *Cuscuta* L.'nın Anadolu Türleri Üzerinde Morfolojik ve Sistematik Araştırmalar. Ege Üniversitesi Ziraat Fakültesi. 1978; 108 p. İzmir.
- [18] Dawson JH., Musselman LJ., Wolswinkel P., Dorr I. Biology and control of " *Cuscuta*, Rev Weed Sci. 1994; 6:265-317.
- [19] Goldwasser Y. Tolerance of tomato varieties to lespedeza dodder. *Weed Sci*. 2001; 49 520-523.
- [20] Nemli Y, Öngen N. Türkiye'nin Trakya Bölgesi Küsküt Türleri (*Cuscuta* spp.) Üzerinde Taksonomik Çalışmalar. Doğa Bilimleri Dergisi. 1982; 6(3): 147-154.
- [21] Mishra J. S., (2009) Biology and Management of *Cuscuta* species, Indian Journal of Weed Science, 41 (1-2):1-11.

- [22] Töngel, MÖ., Ayan, İ., Samsun ili çayır ve meralarında yetişen bazı zararlı bitkiler ve hayvanlar üzerindeki etkileri. Ondokuz Mayıs Üniversitesi Ziraat Fakültesi Dergisi, 2005; 20(1): 84- 93.
- [23] Kaya I., Nemli Y. and Demir I. Taxonomic characteristics, distributions and hosts of dodder species (*Cuscuta spp.*) seen in agricultural and nonagricultural areas in Turkey. (In Turkish with English Abstract). Turk J Weed Sci, 2018; 21(1):1-7.
- [24] Aksoy, E., Arslan ZF., Tetik O., Eymirli S. Utilization Opportunities from Allelopathic Features of Some Catch and Trap Crops for Controlling Egyptian Broomrape [*Phelipanche aegyptiaca* (Pers.) Pomel] in Tomato Fields. Journal of Agricultural Sciences. 2014;20: 126-135
- [25] Kadioğlu, I., Küsküt (*Cuscuta sp.*) ve mücadelesi. Herboloji Haberleri, Ç. Ü., Ziraat Fak., Bitki Koruma Bölümü, 1992; 3(5): 1-11.
- [26] Linke KH, Singh KB, Saxena MC. Screening technique for resistance to *Orobanche crenata* Forsk., in chickpea. International Chickpea Newsletter. 1991;24, 32– 34.
- [27] Dafaallah, AB., Babiker, AGT, Zain El abdeen, MH. Variability in *Striga hermonthica* (Del.) Benth, Populations in Gadarif Area, Eastern Sudan. *Sudan University of Science and Technology Journal of Agricultural and Veterinary Sciences*. 2015; 16 (2),119-132.
- [28] Westwood, JH., Yoder, JI., Timko, MP., Pamphilis, CW. The evolution of parasitism in plants. *Trend. Plant Sci*. 2010; 15 (4);227-235.
- [29] Gressel J. Crops with target-site herbicide resistance for *Orobanche* and *Striga* control. *Pest Management Science*. 2009; 65:560-565.
- [30] Sounders, AR. Studies in phanerogamic parasitism, with particular reference to *Striga lutea* Lour, South Africa Department of Agriculture Science Bulletin, 1993; 128:1-56.
- [31] Kotan, R., Okutucu, A., Gormez, AA., Karagoz, K., Dadasoglu, Karaman, I., Hasanekoglu, I., Kordali, S. Parasitic Bacteria and Fungi on Common Mistletoe (*Viscum album* L.) and Their Potential Application in Biocontrol. *Journal of Phytopathology*, 2012; doi: 10.1111/jph.12048.
- [32] Watson, AK. Biocontrol. In *Parasitic Orobanchaceae*; Joel, DM., Gressel, J., Musselman, LJ., Eds.; Springer: Berlin/ Heidelberg, Germany, 2013; 469-497.
- [33] Oswald A *Striga* control: technologies and their dissemination. *Crop Prot*. 2005; 24:333-342.
- [34] Khan ZR, Pickett JA, Wadhams LJ, Hassanali A, Midega CAO. Combined control of *Striga hermonthica* and stemborers by maize *Desmodium spp.* intercrops. *Crop Prot*. 2006; 25:989-995.
- [35] Lins RD, Colquhoun JB, Mallory-Smith CA (2006) Investigation of wheat as a trap crop for control of *Orobanche minor*. *Weed Research* 46: 313-318.
- [36] Botanga, C.J., S.O. Alabi, C.A. Echekwu and S.T.O. Lagoke, 2003. Genetics of suicidal germination of *Striga hermonthica* (Del.) benth by cotton. *Crop Sci.*, 43: 483-488.
- [37] Khan, ZR., Pickett, JA., Van den Berg, J., Wadhams LJ., Woodcock CM. **Exploiting chemical ecology and species diversity: stemborer and *Striga* control for maize and sorghum in Africa** *Pest Manage. Sci*. 2000; 56: 957-962.