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ANATOMICAL STUDIES ON THE PARASITISM OF FIELD DODDER (*CUSCUTA CAMPESTRIS* YUNCKER) TO HYACINTH BEAN (*LABLAB PURPUREUS* L. (SWEET)

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ABSTRACT: *Hyacinth bean (Lablab purpureus L. (Sweet) was found to be a highly susceptible host to field dodder (Cuscuta campestris Yuncker) (=FD). Microscopic examinations revealed that FD used certain anatomical mechanisms to establish successful parasitism on its host (hyacinth bean). One of the these mechanisms was the transformation of its epidermal cells into secretory trichomes which secreted a cementing material to connect the two partners (the host and the parasite) together, and consequently triggered a second mechanism, i.e. the development of the endophyte from the haustorial meristematic cells. The endophyte penetrated hyacinth bean stem and proceeded across different tissues and connected to its vascular tissues through searching hyphae. The connection of the searching hyphae to the vascular tissues of hyacinth bean enabled the parasite to withdraw water, minerals and organic compounds from both xylem and phloem tissues of the host. It was found that FD haustorium didn't encounter any resistance during its intrusion into hyacinth bean tissues thus, the latter could be considered as a highly compatible host to FD.*

KEYWORDS: Field Dodder, Hyacinth Bean, Parasitism, Endophyte, Haustorium, Searching hyphae.

INTRODUCTION

Field dodder (*Cuscuta camprestris* Yuncker), Cuscutaceae) is an obligate shoot parasite that subsists on various agricultural important crops, especially legumes and reduces their yield substantially. Among leguminous crops, hyacinth bean (*Lablab Purputreus* L. (Sweet), family Fabaceae) was found to be a highly susceptible crop to field dodder. Hyacinth bean is native to Africa, and grown in many African countries as an old domesticated pulse and as a fodder crop for livestock. FD has been reported to parasitize hyacinth bean and restrains its growth by withdrawing nutrients and water leading to drastic reduction of its yield components [1]. The parasite establishes successful attachment with its hosts' tissues by formation of modified roots known as haustoria. The development of the haustorium is controlled by the response of the host tissues towards the penetration of the parasite. The haustoria of FD in different host plants have been investigated by a number of research workers, e.g. [2]-[7]. The objective of the present work was to identify the anatomical mechanisms involved in the parasitism of field dodder to hyacinth bean.

MATERIAL AND METHODS

Samples of hyacinth bean shoots with attached FD shoots (= plant materials) were obtained from a pot experiment set to study the effect of FD on leguminous crops. The plant materials were excised and treated for light microscopy according to Berlynand and Miksche [8], with

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some modification. The samples were fixed in F.A.A. (Formaldehyde, Acetic acid, Alcohol) in the ratio of 5:5:90. They were dehydrated in gradual ethanol solutions ranging from 20% to 100%. Then, treated in mixtures of absolute ethanol (99.9%) and xylene in three different ratios, 3:1, 1:1, 1:3, respectively. The samples were infiltrated with xylene and embedded in paraffin wax. Sections (20 mμ thick) were prepared using Bright 5040 type rotary microtome. They were stained with safranin and light green stains, and mounted in Canada balsam. The stained sections were examined microscopically using an Olympus-12 Binocular Microscope. Micrographs were taken under 10x and 40x objective lenses using Leitz Laborlux Microscope supplemented with Camera.

RESULTS AND DISCUSSION

Based on morphological studies, hyacinth bean (*Lablab purpureus* L. (Sweet) has bean reported as a highly susceptible host to field dodder (*Cuscuta campestris* Yunker) (= FD) [1]. In the current study, the parasitized plants of hyacinth bean looked wilted, stunted, dried and yellowish in colour with few deformed pods (Figure 1). The present anatomical studies revealed that, the parasite (FD) formed well developed haustorium with searching hyphae and established connections with the vascular tissues of hyacinth bean (Figure 2). The functional haustorium of parasitic flowering plants has two parts, the upper haustorium and the lower endophyte [9]. In the current study, the parasitism of FD involved two mechanisms, (a) the transformation of FD epidermal cells into secretory trichomes and (b) the development of the endophyte that penetrated the host (hyacinth bean) tissues. The secretory trichome cells conformed with the shape of hyacinth bean surface cells and secreted an electron-opaque cementing substance which covered the host - parasite interface and adhered the two partners together. Similar results were reported by Vaughn [10]. Consequently, they (the trichome cells) secrete a stimulant which triggered the development of the endophyte from the haustorial meristematic cells, probably by tactile stimulation. This result is in accord with those reported by Heide-Jorgensen [11] in *C. gronovii* and *C. reflexa*, and Lee and Lee [12] in *C. australis*. Figure 3 depicts the linkage between hyacinth bean stem and FD which is characterized by the presence of phloem-phloem and xylem-xylem connections. Moreover, the xylem connection between the two partners was characterized by the presence of a conspicuous xylem-xylem bridge (i.e. host stem xylem- haustorial xylem - parasite stem xylem). Similar results were reported by Kuijt [13] who stated that true hosts, in general, are only those in which hyphal tracheary bridges are completed, and Tennakoon and Pate [14] who reported that xylem-tapping mistletoes develop xylem-xylem luminal continuities with hosts. Moreover, Dorr [15] working with *C. odorata* and Rey *et al*. [16] working with *Arceuthotium oxycedri* stated that water, minerals as well as organic compounds can be withdrawn by the endophyte of the parasite from both xylem and phloem of the host.

It is interesting to note that, FD haustorium initiated a new layer of 2-3 cells thick, in hyacinth bean stem between the layer of the starch sheath and the fibre cells of the pericycle, at both sides of the endophyte. Consequently the host (hyacinth bean) stem increased in thickness. Away from the area of the endophyte, this new layer was not formed (Figure 3). FD haustorium, during its intrusion into hyacinth bean stem cells, apparently, didn't encounter any resistance. It proceeded smoothly through different tissues of the host. The different composition and texture of cell walls and middle lamellae of the various tissues of the host, necessiate a flexible penetration mechanism [14]. The question commonly asked in this context is whether the intrusive cells of FD used mechanical pressure to force their way through the host (hyacinth

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bean) tissues or secreted enzymes to facilitate a smoother penetration? [14] suggested that the changes in host cells organization correlate with these two types of penetration.

On the basis of the results of this study, hyacinth bean could be classified as a highly compatible host.

CONCLUSION

It could be concluded that in highly compatible hosts, FD establishes hyphal connections with both phloem and xylem tissues of the hosts. Moreover, the formation of xylem-xylem linkage between the two partners is of paramount importance for successful dynamic host-parasite union. Further research work is needed to better understand the relations between FD and hyacinth bean, especially the new layer initiated by FD haustorium in the cortex of hyacinth bean stem.

Fig 1: The parasitized hyacinth bean plant looked wilted, dried and yellowish in colour, with few deformed pods.

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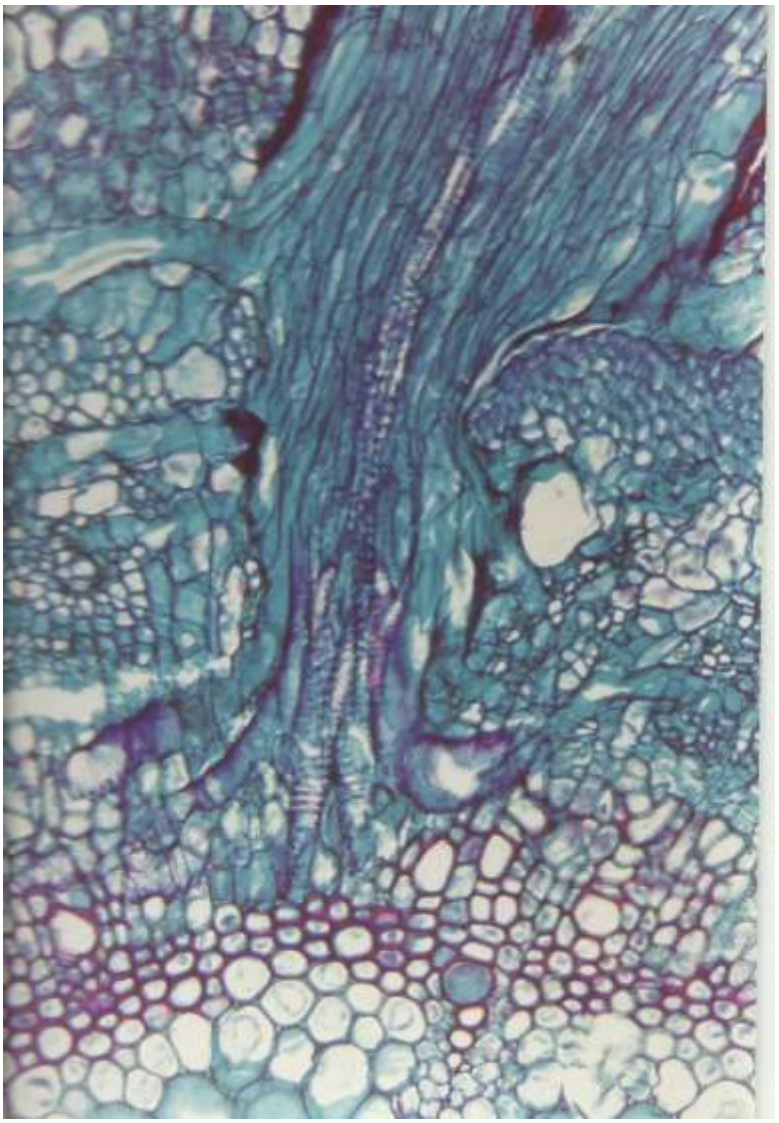

Fig 2: F.D formed well developed haustorium that established connections with the vascular tissues of hyacinth bean.

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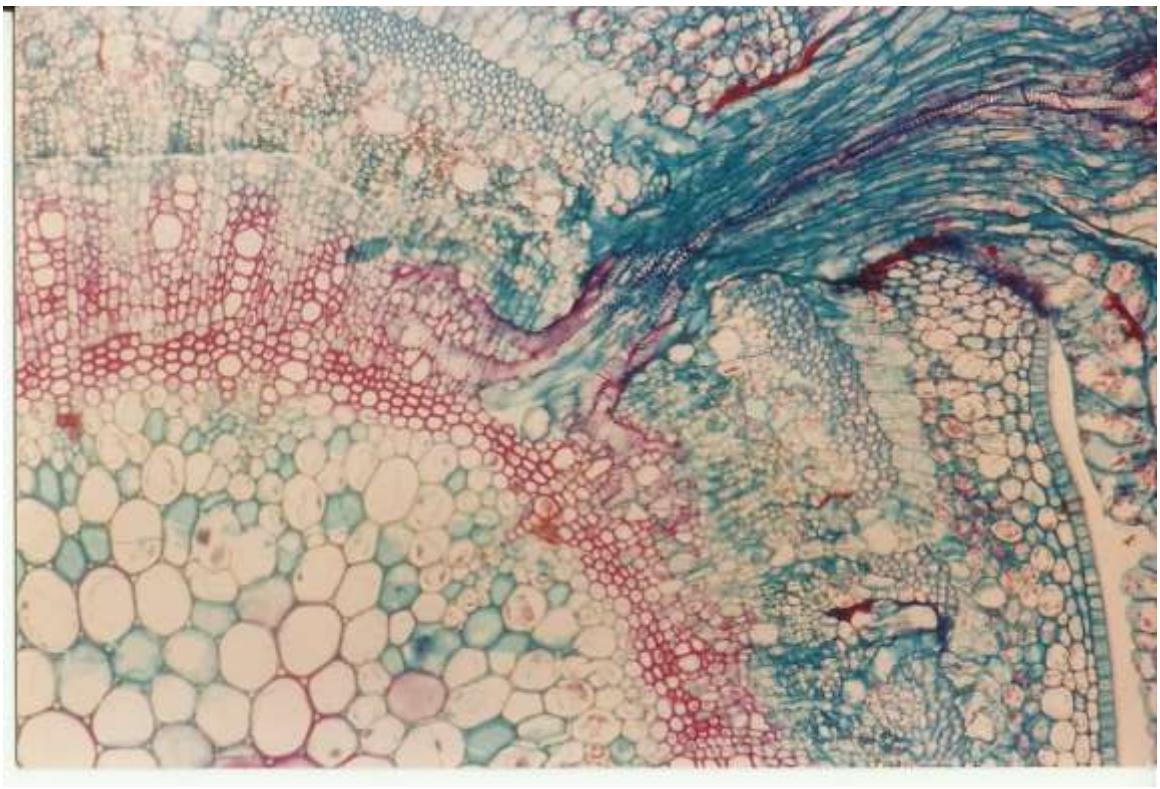

Fig 3: phloem-pholoem and xylem-xylem connections between FD and hyacinth bean, and the initiation of a new layer of cells in hyacinth bean stem.

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