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New reports of rust genera from Chhattisgarh, India

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Linseed (*Linum usitatissimum* L.), in the family Linaceae, is an annual herbaceous plant grown primarily for fibre (flax) and its seed, which is rich in oil. Rust pustules were observed on *L. usitatissimum* in March 2023 at Bemetara and Kanker campuses of Indira Gandhi Krishi Vishwavidyalaya.The pustules were bright yellow or orange in color. Uredinospores are stalked, ovate, broadly ellipsoid or obovoid, 15-22.5×13-18 µm in size, yellowish-orange colored, and mixed with paraphyses. The telia on the stems are irregularly elongated, and form a brown-black solid crust which is spread along the stem. The velvet bean(*Mucuna pruriens*) belongs to the Fabaceae family and is an annual and perennial legume. It is considered a viable source of dietary proteins. In January 2023, chlorotic spots on the upper leaf surface and small, irregular black spots were observed on *Mucuna pruriens* at IGKV, Raipur. Telia are minute black-brown, scattered on the lower surface of leaf. Teliospores are globose to subglobose, ovate or ellipsoidal, thick wall, densely verrucose, brown-metallic brown, papillate apex, 16-23.5 × 13-19 µm; pedicels are thick, hyaline, longer than spores. As it was not previously reported from Chhattisgarh, therefore, this is the new report of *Melampsora lini* and *Uromyces mucunae* from Chhattisgarh, India.

Keywords: *Melampsora lini*, Paraphyses, Pustules, Telia,Uredinospores, *Uromyces mucunae*

INTRODUCTION

Among all the fungal groups, rust fungi have highly specialized obligate characteristics.Linseed, often known as flax (*Linum usitatissimum* L.), is a member of the family Linaceae and is commonly referred to as alsi in India. India is ranked fifth in area and production, after the Russian Federation, Kazakhstan, Canada, China mainland (FAO Stat., 2021). In India, Madhya Pradesh, Chhattisgarh, Maharashtra, Uttar Pradesh, Odisha, are major linseed producing States (about 83% area) (Singh,2016). In terms of acreage and productivity, it ranks second to rapeseed-mustard as the most significant rabi (winter) oilseed crop in India (Naik, *et al*. 2017). Although linseed plants serve a variety of purposes such as manufacturing of paints, varnishes, soaps and printing inks (Wakjira, 2007), the flax type is commercially grown for the extraction of fiber, whereas the linseed is meant for the extraction of oil from seeds and then used as a high-protein cattle feed.

Alpha-linolenic acid and linoleic acid (Bloedon and Szapary, 2004), two crucial fatty acids, are abundant in the oil content of linseed, which varies from 36 to 48 per cent.

Linseed production is affected by various diseases including Wilt, Powdery mildew, Rust, and *Alternaria* blight (Saharan and Mehta, 2002). *Melampsora lini* (Ehrenb.) Lev. which causes rust disease in linseed (*Linum usitatissimum* L.) is currently placed in the family Melampsoraceae, in the order Pucciniales, in the class Pucciniomycetes of the phylum Basidiomycota. In addition to its economic importance the rust disease in linseed is interesting from a scientific standpoint as well. The disease causes severe losses in seed production as well as a reduction in quality of linen fibre produced from flax plants. There have been reports of 28% reductions in flax seed yields as a result of the disease in India, almost as important as black stem rust of wheat.

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A serious disease in the northern regions, linseed rust, caused by *M. lini*, lead to losses of between 70 and 100% during epidemics (Singh, 2016). The disease in moderately to highly susceptible varieties, yields were reduced by 16-100 and 70-100 percent, respectively but no loss was observed in resistant one. In light infection, oil content is not affected, whereas in heavy infection it is reduced by 10-34% . A heavily infected linseed variety that was artificially infected with *Melampsora lini* lost 13.1% of its oil content.

Mucuna pruriens (Velvet bean) is a tropical legume native to Africa and tropical Asia and widely naturalized and cultivated. The genus *Mucuna*, belongs to the Fabaceae family, sub family Papilionaceae, includes approximately 150 species of annual and perennial legumes. It is considered a viable source of dietary proteins (Janardhanan *et al*. 2003; Pugalenthi *et al*. 2005) due to its high protein concentration (23–35%) in addition its digestibility, which is comparable to that of other pulses such as soybean, rice bean, and lima bean (Gurumoorthi *et al*. 2003). Rust of velvet bean (*Mucuna pruriens*) caused by *Uromyces mucunae* is a serious disease in India and is currently placed in Family Pucciniaceae, Order Pucciniales, Class Pucciniomycetes, Phylum Basidiomycota.

MATERIALS AND METHODS

Infected samples of Velvet bean (*Mucuna pruriens*) and linseed (*Linum usitatissimum*) were collected into paper bags and brought to the laboratory. Photographs were taken with a camera in the field as well as in laboratory. An examination of the rust sori was performed using a stereomicroscope and magnifying lenses.Thin sections through spots were made to examine the fungus microscopically and digital images were captured.Free hand sections were taken along with rust symptoms.The specimen sections were mounted on glass slide with lactophenol cotton blue stain.Following this, microscopic observations were made by using LABOVISION made trinocular microscope model SENSE i4000.

RESULTS AND DISCUSSION

In Linseed rust, initially little pustules are surrounded by chlorotic patches but later they become more generalized (Fig. 1a) and the leaves die prematurely. As the leaves shed early, teleuto-pustule formation is generally not to be seen on leaves. However, the stem is where they are most prevalent and noticeable (Fig. 1b). Scattered bright yellow or orange-coloured pustules are observed in leaves of infected plants, grown at Indira Gandhi Krishi Vishwavidyalaya Campus, Bemetara and Kanker (Fig.2a-d). The infected plants are easily identified from the presence of these bright yellow or orange coloured pustules (Fig.2e-f) that bear uredia on both surfaces of the leaves as well as on other aerial parts of the plant. The uredopustules on leaves are round and small. The telia on the stems are irregularly elongate, sub-epidermal and forming brown-black colored solid crust which is spread along the stem (Fig.2g-j). Under favourable conditions, the entire plant is covered by yellow orange pustules. Uredinospores are stalked, ovate, broadly ellipsoid or obovoid, 15-22.5×13-18 µm in size, yellowish-orange-coloured (Fig.3a,b,e,f) and mixed with paraphyses (Fig.3c). Paraphyses are clavate to somewhat capitate at the apex (Fig.3d). Teliospore are oblong, smooth, sessile, under epidermis, 28-35 x 15-18 µm in size (Fig.3g-h).Symptoms and pathogen description were found similar to the description given by earlier workers (Rashid, 2003; Math and Awasthi, 2020).Its occurence in India was first time recorded in 1914. In Northern India's Indogangetic Plains in 1961, the disease was epiphytotic. Jammu and Kashmir, the northern highlands of Himachal Pradesh and Uttar Pradesh, the nearby region of Punjab, Bihar, West Bengal, Odisha, and some portions of Uttar Pradesh are now experiencing a significant rust problem.

In *Uromyces mucunae,* the first symptoms observed are chlorotic spots on the upper leaf surface. The disease begins in the lower part of the plant and progress to the upper tissues.The telia are small, irregularly scattered black to brown spots occurred on mature leaves covering the whole lower surface (hypophyllous)(Fig. 4a-c). Teliospores are globose to subglobose, ovate or ellipsoidal,thick wall, densely verrucose, brown to metallic-brown, papillate apex, 16-23.5× 13-19 µm; pedicels are thick, hyaline, longer than spores(Fig. 4d-i).On the basis of symptoms and morphological characteristics of teliospores the pathogen was identified as *Uromyces mucunae.*The symptoms and description of the

pathogen were found to be similar to those reported earlier on *M. pruriens* (L.) DC., and on *M. hirsuta* Wight & Arn. caused by *U. mucunae* Rabenh. Pawan *et al*. (2014) reported a new host for *U. mucunae* on *M.sanjappae*.

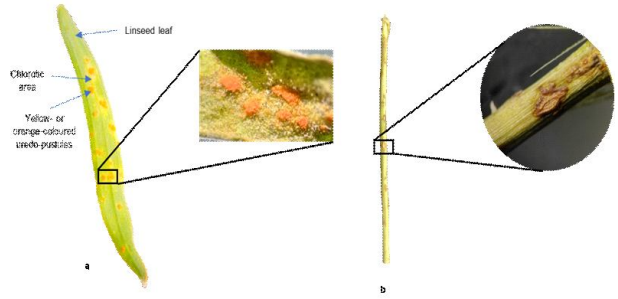

Fig. 1. a) Linseed leaf with chlorotic area and uredosorus. b) brown colored crusts of Telial pustules on the stem.

Fig. 2: (a-d) Symptoms in the field and laboratory, IGKV, Raipur. (e-f) Closer view of yellow- or orange coloured uredosorus on the leaf. (g-h) Brown-black colored solid crust bearing teleuto-pustule which is spread along the stem. (i-j) Closer view of brown colored crusts of teleuto-pustule.

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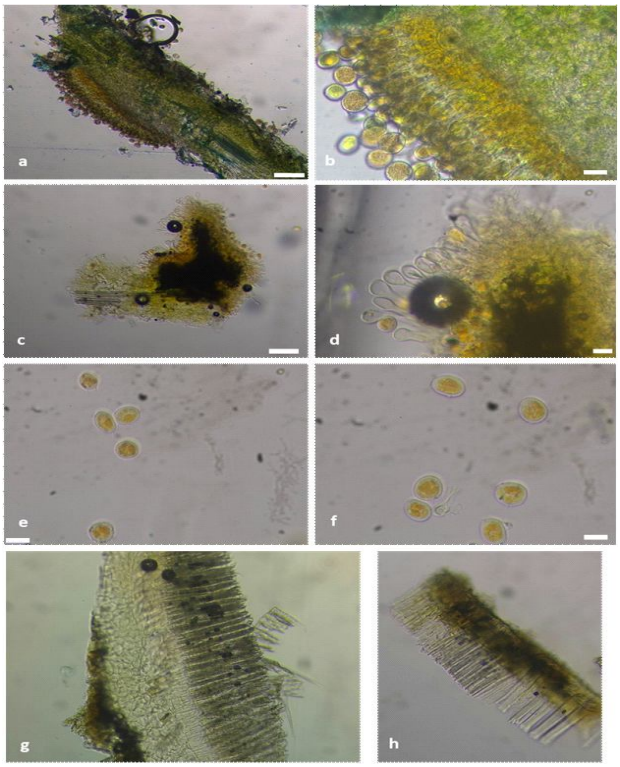

Fig.3 : (a, b) - Section of infected leaf bearing yellow-or orange coloured stalked uredinospores. (c,d) Clavate to capitate paraphyses mixed with uredinospores. (e,f) Uredinospores. (g, h) Section of infected stem showing teliospores. Scale bar- a and c-100µm; b, d, e, f-20µm

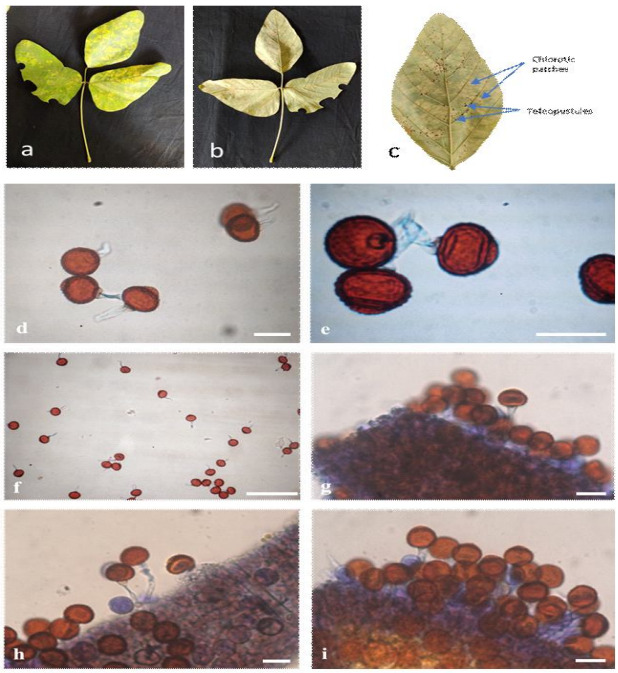

Fig. 4: a.Chlorotic spots on the upper leaf surface. b. Chlorotic patches with irregular minute black to brown scattered spots on lower surface of leaf. c. showing symptoms.d-i. Globose to subglobose, ovate or ellipsoidal, densely verrucose, brown to metallic-brown Telio spores with papillate apex and hyaline pedicels. g-i. leaf section showing teliospores. Scale bar: d,e,g,h and i- 20µm; f-100µm

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