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RESEARCH PAPER

Host range of *Uromyces phaseoli* var. *vignae* (Barcl.) arth., the causal agent of cowpea rust

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Abstract: Cowpea rust is one of the major biotic stress factors that occur wherever the crop is grown. The uredospores of *U. phaseoli* var. *vignae* was collected from *cv.* C 152 grown at MARS, Dharwad and maintained in the glasshouse on the susceptible cowpea *cv.* C 152. To know its host range, the uredospores of the pathogen was inoculated and evaluated for its reaction on 36 cultivars of 19 leguminous hosts including cowpea. Among the tested legumes, *U. phaseoli* var. *vignae* caused rust symptoms only on yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*) (*cv*. Arka Mangala). The symptoms on the horsegram (*Macrotyloma uniflorum*) (*cv*. Crida 18R) were very meager in the form of white specks however there is no further development in the symptom expression. The symptoms were nil in the remaining legumes such as blackgram (*Vigna mungo*), chickpea (*Cicer arietinum*), cluster bean (*Cyamopsis tetragonoloba*), dolichos bean (*Lablab purpureus*), french bean (*Phaseolus vulgaris*), garden pea (*Pisum sativum*), green gram (*Vigna radiate*), lentil (*Lens culinaris*), linseed (*Linum usitatissimum*), lucern (*Medicago sativa*), mothbean (*Vigna aconitifolia*), redgram (*Cajanus cajan*), soybean (*Glycine max*), sunhemp (*Crotolaria juncea*), sweet peas (*Lathyrus odoratus*), velvet bean (*Mucuna pruriens*). The outcome of the current study signifies the role of yard long bean as a collateral host in the absence of cowpea and also provides information on the narrow host range of cowpea rust pathogen.

Key words: Cowpea rust, Collateral host, Host range, Horsegram, Yard long bean

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp. subsp. *unguiculata*) is a key resource crop for a large number of people in the developing world, mainly in the arid/semi-arid tropical regions of the world. This indigenous Indian legume is economically, nutritionally and environmentally the foremost crop that serves as a source of essential human dietary nutrients and as a means of fodder for the livestock. It also presents with other multi-functional traits, including the maintenance of the soil ecological balance through nitrogen fixation by facilitating through a process of symbiosis (Ravelombola *et al*., 2017).

In India cowpea is grown over an area of 3.9 mha with a production of 2.21 mt and with a productivity of 566 kg/ha (Anon., 2022). However, relatively lower levels of productivity in India (566 kg/ha) as compared to global productivity (618 kg/ha) is a major concern. The factors influencing lower productivity are biotic (diseases, insect pest) and abiotic (moisture, soil fertility, *etc*) stresses. Among the biotic factors, diseases play a significant role in yield reduction. Among the diseases, fungal diseases like the rust caused by *Uromyces phaseoli* var. *vignae* (Barcl.) Arth. is economically important disease of cowpea, since there is 50.00 - 58.53 per cent grain yield loss worldwide (Chandra Mouli, 1992; Chandrashekhar *et al*., 1988; Ndalira *et al*., 2020).

The symptoms were characterized as appearance of reddish brown pustules occurs on all above ground plant parts. The initiation of infection appears on lower surface of the leaves in the form of small raised uredosori. Infection is evident as minute white, slightly raised pustules which later became distinct, reddish brown circular sori that are typical of rust pustule. These sori are initially covered with epidermis which ruptures and release as spore dust. Under favourable weather conditions numerous sori appear in rings around the first sorus. Similar sori also are encountered on the upper surfaces of the leaves on the same foci of infection. Both uredospores and teliospores were observed in the same sori (Sokhi and Sokhi, 1976; Opio, 1979). The disease was first reported in Shimla, Himachal Pradesh, India by Barclay, 1891. In Karnataka, Rangaswami, *et al.* (1970) reported this disease from Dharwad and Mysore. Knowledge of the host range of *U. phaseoli* var. *vignae* is essential for understanding its epidemiology, developing effective disease management strategies and breeding resistant varieties. However, information regarding this is limited. Therefore, the present investigation was carried out to evaluate the host range of *U. phaseoli* var. *vignae*.

Material and methods

Plant sources: The experiment was conducted in the Department of Plant Pathology, University of Agricultural Sciences (UAS), Dharwad under glasshouse condition. Seeds of different leguminous crop species were collected from Main Agricultural Research Station (MARS), UAS, Dharwad, The Regional Centre, Indian Institute of Pulses Research, Dharwad, The Indian Institute of Horticultural Research, Bengaluru. Seeds of all the crop species were sown in pots filled with soil + vermicompost in 2:1 ratio (w/w). Two pots were maintained for each crop species where each pot was having 3 seedlings. The seedlings with a minimum of two true leaves were artificially inoculated at 15 days after sowing by spraying spore suspension. List of crop species belonging to *Leguminaceae*

Table 1. Host range of *Uromyces phaseoli* var. *vignae* causing cowpea rust

Sl. No.	Common name	Scientific name	Cultivar	Reaction	Time taken for uredial production [days after inoculation (DAI)]	Colour of the pustules	Pustule size (mm^2)	Uredospore shape and colour	Uredo spore colour	Uredospore size (µm)
1	Blackgram	*Vigna mungo* (L.) Hepper	DBGV-16	-	-	-	-	-	-	-
2	Chickpea	*Cicer arietinum* L.	Jaki (JK-9218)	-	-	-	-	-	-	
3	Chickpea (Kabul type)	*Cicer arietinum* L.	Ujjawala	-	-	-	-	-	-	-
4	Cluster bean	*Cyamopsis tetragonoloba* (L.) Taub.	Pusa Navbahar	-	-	-		-	-	-
5	Cowpea	*Vigna ungiculata* (L.) Walp.	C 152	+	9	Dark brown	0.21	Globose to obovoid	Light brown	24.42× 18.71
6	Dolichos bean or lablab bean or Avare or hyacinth bean	*Lablab purpureus* (L.) Sweet	Hebbal Avare-4	-	-	-	-	-	-	-
7	Dolichos bean or lablab bean or Avare or hyacinth bean	*Lablab purpureus* (L.) Sweet	Arka Swagath	-	-	-	-	-	-	
8	Dolichos bean or lablab bean or Avare or hyacinth bean	*Lablab purpureus* (L.) Sweet	Arka Krishna	-	-	-	-	-	-	-
9	Dolichos bean or lablab bean or Avare or hyacinth bean	*Lablab purpureus* (L.) Sweet	Hebbal Avare	-	-	-	-	-	-	-
10	Dolichos bean or lablab bean or Avare or hyacinth bean	*Lablab purpureus* (L.) Sweet	DOLI POL AVT-III	-	-	-	-	-	-	-
11	Dolichos bean or lablab bean or Avare or hyacinth bean	*Lablab purpureus* (L.) Sweet	DOL BUSH AVT-III	-	-	-	-	-	-	-
12	French bean	*Phaseolus vulgaris* L.	Arka Sharath	-	-	-	-	-	-	-
13	French bean	*Phaseolus vulgaris* L.	Vaishali	-	-	-	-	-	-	-
14	Garden pea	*Pisum sativum* L.	Arka Apoorva	-	-	-	-	-	-	-
15	Green pea	*Pisum sativum* L.	AP-3	-	-	-	-	-	-	-
16	Green gram	*Vigna radiate* (L.) R. Wilczek	DGGV 2	-	-	-	-	-	-	-
17	Horsegram	*Macrotyloma uniflorum* (Lam.) Verdc.	Crida 18R	+	17	-	-	-	-	-
20	Lentil	*Lens culinaris* Medik.	Local	-	-	-	-	-	-	-
18	Linseed	*Linum usitatissimum* L.	DLV-6	-	-	-	-	-	-	-
19	Lucern	*Medicago sativa* L.	Local	-	-	-	-	-	-	-
21	Mothbean	*Vigna aconitifolia* (Jacq.) Marechal	IPM-2-14	-	-	-	-	-	-	-
22	Mothbean	*Vigna aconitifolia* (Jacq.) Marechal	Germplasm	-	-	-	-	-	-	-
23	Peas	*Pisum sativum* L.	Pea entry AVT	-	-	-	-	-	-	-

Host range of *Uromyces phaseoli* var. *vignae* causing cowpea rust

Sl. No.	Common name	Scientific name	Cultivar	Reaction	Time taken for uredial production [days after inoculation (DAI)]	Colour of the pustules	Pustule size (mm²)	Uredospore shape and colour	Uredo spore colour	Uredospore size (µm)
24	Pole bean	*Phaseolus vulgaris* L.	Var Mili (Ag bees seeds)	-	-	-	-	-	-	-
25	Redgram	*Cajanus cajan* (L.) Millsp.	TS-3R	-	-	-	-	-	-	-
26	Soybean	*Glycine max* (L.) Merr.	JS-335	-	-	-	-	-	-	-
27	Sunhemp	*Crotolaria juncea* L.	Local	-	-	-	-	-	-	-
28	Sweet peas	*Lathyrus odoratus* (L.)DC.	Prateek	-	-	-	-	-	-	-
29	Velvet bean	*Mucuna pruriens* (L.) DC.	Arka Dhanwantri	-	-	-	-	-	-	-
30	Velvet bean	*Mucuna pruriens* (L.) DC.	Arka Daksha	-	-	-	-	-	-	
31	Velvet bean	*Mucuna pruriens* (L.) DC.	Arka Aswini	-	-	-	-	-	-	-
32	Velvet bean	*Mucuna pruriens* (L.) DC.	Arka Charaka	-	-	-	-	-	-	-
33	Velvet bean	*Mucuna pruriens* (L.) DC.	Arka Shubra	-	-	-		-	-	-
34	Velvet bean	*Mucuna pruriens* (L.) DC.	Arka Shukla	-	-	-	-	-	-	-
35	Velvet bean	*Mucuna pruriens* (L.) DC.	CIM Ajar	-	-	-	-	-	-	-
36	Yard long bean	*Vigna unguiculata* (L.) Walp. subsp. *sesquipedalis*	Arka Mangala	+	9	Dark brown	0.19	Globose to obovoid	Light brown	25.23 × 18.93

family tested against *Uromyces phaseoli* var. *vignae* are presented in the table 1.

Preparation of inoculum: Fresh rust infected leaf samples were collected from highly susceptible cowpea *cv.* C 152 grown at MARS, Dharwad and maintained in the glasshouse on the susceptible *cv.* C 152. Fresh uredospores were collected in glass petriplate by scraping the freshly appeared rust pustules with sterile blades. The uredospores were further suspended in sterilized distilled water to obtain a concentration of 2.0×10^4 uredospores/ml.

Inoculation and disease assessment

Fifteen days old seedlings of leguminous crop species along with cowpea (*cv*. C 152) seedlings were also inoculated and kept as a positive control. Inoculated seedlings were covered with polythene bags for 48hrs to create high relative humidity and further water was sprayed at alternate days to keep the leaves wet and observed continuously for the appearance of uredial pustules. Morphological characters such as colour of the uredospores was observed under compound microscope (Olympus BX41) at Department of Plant Pathology, college of Agriculture, Dharwad whereas, size and shape of uredospores were observed by scanning electron microscope (SEM) at Centre for Nanotechnology, UAS, Raichur. The size of the pustule was calculated as the product of π (pi) × 1/2 length × 1/2 breadth (mm²) as adopted by Kochman and Brown (1976). The average pustule size of two replications was calculated and represented in the results.

Results and discussion

The survival of the pathogen on different leguminous hosts in the absence of primary host was tested and their reaction were recorded and presented in Table 1. Among the legumes tested, black gram (*Vigna mungo*, *cv* DBGV-1), Chickpea [*Cicer arietinum*, *cv.* Jaki (JK-9218)], Chickpea (Kabul type) (*Cicer arietinum*, *cv.* Ujjawala), Cluster bean (*Cyamopsis tetragonoloba*, *cv.* Pusa Navbahar), Dolichos bean or lablab bean or Avare or hyacinth bean [*Lablab purpureus*, *cv.* Hebbal Avare-4, *cv.* Arka Swagath, *cv.* Arka Krishna, *cv.* Hebbal Avare, DOLI POL AVT-III, DOL BUSH AVT-III, French bean (*Phaseolus vulgaris*, *cv.* Arka Sharath, *cv.* Vaishali), Garden pea (*Pisum*

Plate 1a. Symptoms on cowpea (*cv*. C 152)

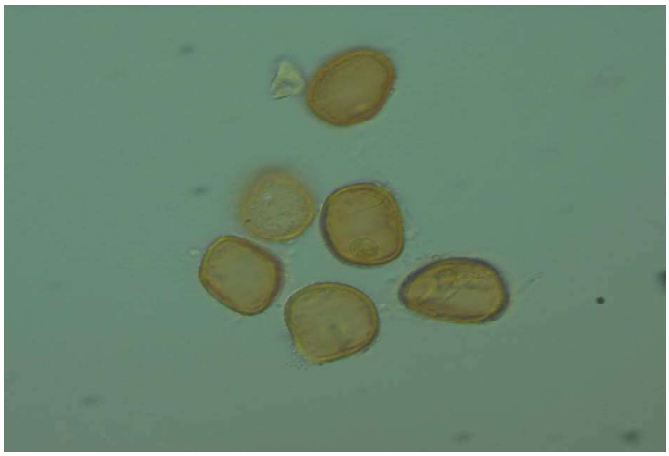

Plate 1b. Uredospores on cowpea (*cv*. C 152) under compound microscope (400X)

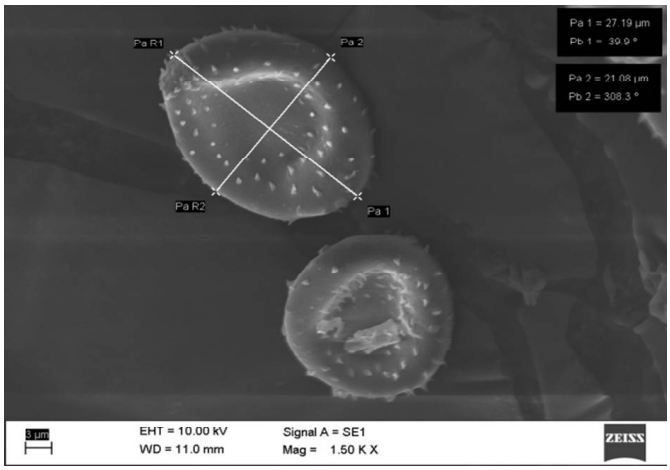

Plate 1c. Uredospores on cowpea (*cv*. C 152) under scanning electron microscope (SEM)

sativum, *cv.* Arka Apoorva, *cv.* AP-3), Green gram (*Vigna radiate*, variety- *cv.* DGGV 2), Lentil (*Lens culinaris*, Local *cv.*), Linseed (*Linum usitatissimum*, *cv.* DLV-6), Lucern (*Medicago sativa*, Local *cv.*), Mothbean (*Vigna aconitifolia*, *cv.* IPM-2-14, Germplasm), Peas (*Pisum sativum*, Pea entry AVT), Pole bean (*Phaseolus vulgaris*, *cv.* Mili), Redgram (*Cajanus cajan*, *cv.* TS-3R), Soybean (*Glycine max*, *cv.* JS-335), Sunhemp (*Crotolaria juncea*, Local *cv.*), Sweet peas (*Lathyrus odoratus*, *cv.* Prateek), Velvet bean (*Mucuna pruriens cv.* Arka Dhanwantri, *cv.* Arka Daksha, *cv.* Arka Aswini, *cv.* Arka Charaka, *cv.* Arka Shubra, *cv.* Arka Shukla, *cv.* CIM Ajar) showed a negative reaction with no spore and uredial production.

Plate 2a. Symptoms on yard long bean (*cv*. Arka Mangala)

Cowpea (*cv*. C 152) inoculated plants produced initial symptoms as white specks on 7th day of inoculation (DAI) and showed clear dark brown pustules on 9th DAI (Plate 1a). The size of the pustule was 0.21 mm^2; the morphological characters of uredospores of *U. phaseoli* var *vignae* were light brown in colour (Plate 1b) and globose to obovoid in shape (Plate 1c) measuring about 24.42 × 18.71 µm (Table 1).

Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*, *cv.* Arka Mangala) showed a positive reaction, producing initial symptom as white specks on 7th DAI and clear dark brown pustules were seen on 9th DAI (Plate 2a). The size of the pustule was 0.19 mm^2. The uredospores of *U. phaseoli* var *vignae* on *Vigna unguiculata* subsp. *sesquipedalis* (yard long bean) resembled like uredospores on cowpea and they were light

Plate 2b. Uredospores on yard long bean (*cv*. Arka Mangala) under compound microscope (400X)

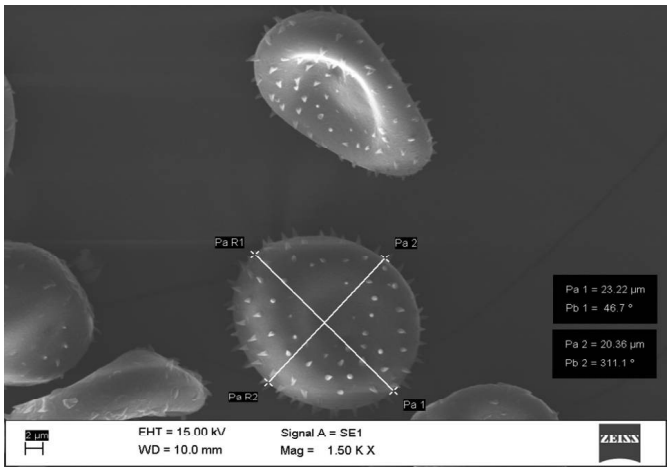

Plate 2c. Uredospores on yard long bean (*cv.* Arka Mangala) under SEM

Plate 3. Symptoms on horsegram (*cv*. Crida 18R)

brown in colour (Plate 2b), globose to obovoid in shape (Plate 2c) and measuring about 25.23 × 18.93 µm (Table 1).

In horsegram, (*Macrotyloma uniflorum*, *cv.* Crida 18R) the symptoms were observed as minute white specks at 10th DAI and these white specks were clearly visible at 17th DAI (Table 1 and Plate 3) but clear brown uredial pustules were not observed.

From the literature, according to Opio (1979), out of thirty three legumes tested against cowpea rust, only *Phaseolus aureus*, (older botanical name for mung bean, now it called as *Vigna radiata*), *Macroptilium atropurpureum* (Purple bush bean) and *Vigna parviflora* (small flowered bean) got infected. Symptoms appeared as necrotic flecks after 6, 8 and 10 days on *Vigna parviflora*, *Phaseolus aureus* and *Macroptilium atropurpureum*, respectively. He also found that there was no infection on inoculation made on *Cicer arietinum, Glycine max, Dolichos lablab, Medicago sativa, Cajanus cajan, Pisum sativum, Lathyrus odorontus, Crotolaria juncea* and several genotypes of *Phaseolus vulgaris.*

Heath (1974) inoculated non-host crops such as French bean, lima bean, peas and broad bean with cowpea rust spores and observed fungal growth under the microscope. The observations indicated that cowpea rust spores germinated on non-host plants, but fungal growth and development were often arrested early and failed to cause disease, demonstrating that non-host resistance operates through multistage defense mechanisms that inhibit pathogen infection at successive stages. In this study, similar observations were recorded in the horsegram *cv.* Crida 18R suggesting that non-host resistance operates through multiple barriers that block infection foci to halt the further growth and development.

Dolichos lablab (*Lablab purpureus*) has been reported to be affected by cowpea rust (Fromme, 1924; Hiratsuka and Shimabukubo, 1956). But this study did not observed any infection and symptom development on *Dolichos lablab* (*Lablab purpureus*) upon multiple inoculations. Barilli *et al*. (2012) reported that *U. phaseoli* var *vignae* can infect and reproduce on pea to a minor extent but in the present study the symptoms were not observed on pea (*Pisum sativum*). The reason may be either the genotype used in our study was resistant or the race of *U. phaseoli* var *vignae* capable of infecting *Dolichos lablab* or *Pisum sativum* is not present in Karnataka.

Conclusion

The host range study of cowpea rust demonstrated a high degree of host specificity, as successful infection was observed only on yard long bean among all plant species tested. None of the other inoculated hosts showed disease symptoms or supported pathogen development, indicating that the rust pathogen is likely restricted to closely related hosts within the same species complex. This narrow host range suggests that the pathogen is specialized and may have limited potential for cross-infection to non-host crops. Such specificity is epidemiologically significant because it reduces the risk of disease spread to non-host plants and supports targeted management strategies focused on susceptible cowpea and yard-long bean cultivars. Overall, the findings confirm that yard-long bean functions as collateral or additional susceptible host and should be considered in disease surveillance, crop rotation planning, and breeding programs for rust resistance.

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