

## Survey of Wilt (*Fusarium udum*) and the Cyst Nematode (*Heterodera cajani*) Incidence on Pigeonpea of Prayagraj District

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### Authors' contributions

This work was carried out in collaboration among all authors. Author AKM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SS and VJ managed the analyses of the study. Author AAL managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

A survey was conducted in selected villages of Prayagraj district to evaluate the disease incidence of Fusarium (*Fusarium udum*) wilt and cyst nematode (*Heterodera cajani*) of pigeon pea (*Cajanus cajan*). Soil and roots were collected from the rhizosphere of infested pigeonpea plants. The maximum wilt incidence was recorded (57.6%) in Dari village followed by Pump House (56%), Pahluka Purwa (51.2%) and the lowest incidence of wilt was recorded in Chaka (12.8%), Naini (11.2%) and Jhusi (9.6%) in the year 2016. For cyst nematode, soil samples were collected from selected fields, the soil was mixed thoroughly and 500 g of the soil was processed following Cobb's sieving and decanting method where cyst and J<sub>2</sub>'s were separated in separate mesh size sieves. It was observed that infestation of *Heterodera cajani* was very high in Jari (51%) followed by Naini (41%). The minimum infestation of *Heterodera cajani* was found in Meza village which was responsible for wilt disease in pigeonpea concluding that Fusarium wilt of pigeonpea is a major problem in Prayagraj district of U.P. India.

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## 1. INTRODUCTION

Pigeon pea (*Cajanus cajan*, [L], Mills.), is an important pulse crop providing high quality vegetable protein to human beings and its products is used as animal foods and fire wood. Pigeon pea is cultivated mainly for their dal purpose by small and marginal farmers in semi-arid tropical and sub tropical farming regions. Pigeon pea belongs to family Fabaceae, one of the important *kharif* pulse crop with higher productivity values commonly known as red-gram, arhar or tur. India rank first in area (64%) and production (57%) at global level. Myanmar stands second position in area (8.07%) followed by Tanzania (3.23%) respectively. Malawi occupy forth position in area (2.97%) and 3rd position in production (4.36%). In productivity, Kenya ranked first with 1612 kg/ha followed by Malawi (1506 kg/ha) and Burundi (1229 kg/ha) while, India's productivity is only 913 kg/ha [1].

In India, Pigeon pea (*Cajanus cajan*), total area coverage and production of tur dal were 41.90 lakh hectares and 32.88 lakh tones respectively. The state-wise trend shows that Maharashtra ranked first both in respect of area and production (29.61% and 29.07%). Madhya Pradesh stood second position in production (15.82%), followed by Karnataka (15.68%). The lowest yield observed in the state of Andhra Pradesh (489 kg/ha) followed by Chhattisgarh (581 kg/ha) and Karnataka (632 kg/ha) [1].

Pigeon pea is affected by numerous diseases caused by fungi, bacteria, nematodes and viruses. Wilt (*Fusarium udum*) is one of the most prominent diseases of pigeon pea and can cause losses up to 30 to 40%. The crop has been reported to suffer severe damage due to complex wilt disease caused by *Fusarium udum* and *Heterodera cajani* [2,3,4]. Surveys have indicated that major losses in the pigeon pea cultivated in India are due to wilt incidence caused by *Fusarium udum*, losses varying from 0.2 to 100% [5,6].

*Fusarium* wilt is the most important and wide spread fungal disease in all pigeon pea growing areas. The primary sources of inoculum overwinter in soil. Infected plant seeds can also transmit the disease. Symptoms like drooping and subsequent drying of the plants can be observed in field conditions. The stem of infected

plant when cut vertically, shows black lines which indicate infection of *Fusarium* wilt [7].

Nematodes, are widely distributed in most of the pigeon pea growing regions in India. Pigeon pea is vulnerable to many plant parasitic nematodes such as root knot nematode species (*Meloidogyne* spp., and particularly *M. javanica*) and pigeon pea cyst nematodes (*Heterodera cajani*). It has been commented that about 70 genera and 160 species of fungi have been found to be associated with nematodes [8]. Beside plant pathogens plant parasitic nematodes interact and associate their action with several microorganisms including root exudates [9,10,11].

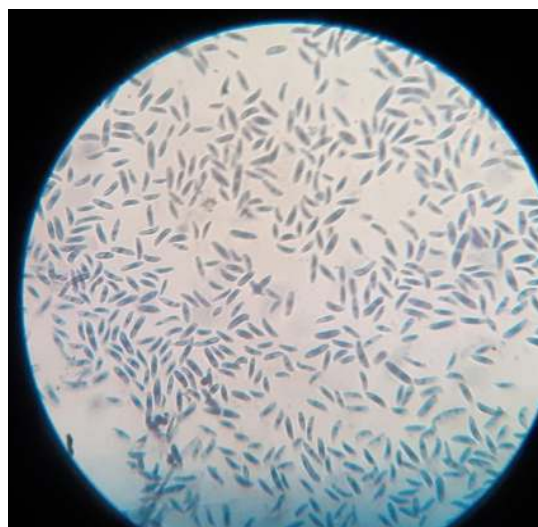
The main symptoms of the *H. cajani* infection are stunted growth and reduced yield due to damage to the host plant's root system. Flowers and pods are reduced in size and number and the root system may also be poorly developed. The main objective of this survey was to estimate and observe the wilt incidence and their association with cyst nematode.

## 2. MATERIALS AND METHODS

Survey on pigeon pea (*Fusarium udum*) wilt was carried out on short as well as long duration crop growth during 2016 crop season to record the occurrence and its distribution in fifteen villages viz., Handha, Thanthanwa, Mahewa, Power house, Naini, Ghoorpur, Chaka, Pahluka purwa, Karchana, Jari, Meza, Soraon, Saidabad, Dari and Jhusi of Prayagraj district. Five farmer's field of pigeon pea in each village was selected, and 500 g of soil sample from the rhizosphere area of the wilted plant, showing partial wilting as well as complete wilting and the wilt incidence, was recorded. Symptoms of stunting, yellowing and wilting plants were recorded during survey from each field. Root and soil samples were collected after removing 5 cm of surface soil. Cysts nematodes were extracted from soil samples using Cobb's sieving decantation techniques (25 and 60 mesh sieve) according to method [12]. Different developmental stages of *H. cajani* were determined using standard techniques. Presence of *Fusarium udum* in roots was also confirmed. Extent of yield loss was estimated on the basis of data recorded for nematode population levels and its composition, extent of wilting, crop growth and grain yield.



**Fig. 1. Pure culture of *Fusarium udum***



**Fig. 2. Microscopic view of *Fusarium udum***

**Calculation of disease incidence (DI):** The percent disease incidence of wilt disease was calculated by using the formula described by [13].

$$\text{Disease incidence \%} = \frac{\text{Total no. plants wilted}}{\text{Total no. of plants examined}} \times 100$$

### 2.1 Isolation and Identification of Wilt Pathogen

The pathogen (*F. udum*) involved in the studies was obtained from infected plant and soil samples by tissue isolation and serial dilution method, respectively. Culture of fungal pathogen was purified by following hyphal tip method [14], and pure culture was maintained on PDA slant at room temperature. Seven days and 3 days old cultures were used for further studies. On the basis of microscopic observations regarding fungus morphology, the fungal pathogen was identified as *F. oxysporum* f.sp. *udum* [15]. Microconidia borne on simple phialides arising laterally on the hyphae or from short sparsely branched conidiphores. Microconidia generally abundant, variable, oval ellipsoid, cylindrical, straight to curved, 5-2 x 2.2-3.5 mm. Macroconidia, sparse in some strains are borne on more elaborately branched conidiphores or on the surface of sporodochia (Figs. 1 and 2).

### 3. RESULTS AND DISCUSSION

The systematic survey was conducted in 15 pigeon pea growing villages of Prayagraj district during *rabi* season of 2016. The disease was

prevalent at all the locations surveyed (total 125 field and average 25 plants/field) and the pigeon pea wilt disease incidence varied from minimum 9.6% to maximum 57.6%. The highest disease incidence during 2016 was found in Dari (57.6%) followed by Pump house (56%), Pahlu ka purwa (51.2%), Mahewa (50.4%), Saidabad (49.6%), Karchana (48.8%), Meza (46.6%), Thanthanwa (44.8%), Jari (36.8%), Handha (34.4%), Ghoorpur (22.4%) and the lowest incidence of *Fusarium* wilt was observed in Chaka (12.8%), Naini (11.2%) and Jhusi (9.6%) respectively (Table 1). Identification of morphological structures of *F. oxysporum* showed that *Fusarium* wilt is present in all plots surveyed in the villages of Prayagraj.

Symptoms are present at all physiological stages with varying degrees from one field to another. The symptoms observed were identical to those described earlier by [16,17,18]. Diseased plant roots when split opened showed discoloration of internal tissues. The symptoms of chickpea wilt observed were similar to those recorded earlier by [19]. Resolution studies revealed the presence of the same fungus identical to the original one obtained from naturally wilted plants.

The intensive survey was conducted in 15 pigeon pea growing villages of Prayagraj district during 2016. The occurrence of important genera *H. cajani* associated with rhizosphere of pigeon pea. *H. cajani* was observed with 100% occurrence of cyst/ soil sample varied from minimum 14 to maximum 51 cysts. The cysts numbers observed during 2016 in Jari were (51 cysts) / soil sample

**Table 1. Survey on the incidence of Fusarium wilt (*Fusarium udum*) of pigeon pea in villages of Prayagraj district**

S.N	Name of villages	Number. of field surveyed	Number of wilted plant in each field	Number. of wilted plants/infected area (10 m <sup>2</sup> ) in surveyed fields					Wilt incidence (%)
				F1	F2	F3	F4	F5	
1.	Handha	5	25	11	14	8	10	---	34
2.	Thanthanwa	5	25	8	10	18	10	10	45
3.	Mahewa	5	25	10	12	16	9	16	50
4.	Pump house	5	25	15	12	12	18	13	56
5.	Naini	5	25	10	4	---	---	7	11
6.	Ghoorpur	5	25	7	10	---	4	17	22
7.	Chaka	5	25	---	---	16	---	10	13
8.	Pahlu ka purwa	5	25	16	10	11	15	12	51
9.	Karchana	5	25	10	12	13	16	10	49
10.	Jari	5	25	8	12	13	7	6	37
11.	Dari	5	25	19	10	9	16	18	58
12.	Meza	5	25	10	12	16	10	10	47
13.	Soraon	5	25	13	---	---	17	---	24
14.	Saidabad	5	25	12	10	13	18	9	50
15.	Jhusi	5	25	---	---	---	12	---	10

**Table 2. Survey on the incidence of cyst nematode (*Heterodera cajani*) of pigeon pea in villages of Prayagraj district**

S.N.	Name of villages	Number of field surveyed	Number. of plant surveyed in each field	Number. of cyst/500 g soil	Number. of larvae/cyst
1.	Handha	5	5	28	250
2.	Thanthanwa	5	5	30	353
3.	Mahewa	5	5	35	556
4.	Pump house	5	5	38	659
5.	Naini	5	5	41	664
6.	Ghoorpur	5	5	19	239
7.	Chaka	5	5	-	-
8.	Pahlu ka purwa	5	5	39	461
9.	Karchana	5	5	37	579
10.	Jari	5	5	51	670
11.	Dari	5	5	-	-
12.	Meza	5	5	14	178
13.	Soraon	5	5	18	153
14.	Saidabad	5	5	-	-
15.	Jhusi	5	5	29	347

followed by Naini (41), Pahlu ka Purwa (39), Pump house (38), Karchana (37), Mahewa (35), Thanthanwa (30) and the lowest incidence of cyst was showed in Jhusi (29), Handha (28), Ghoorpur (19), Soraon (18), Meja (14) and in Chaka, Saidabad and Dari no cyst incidence were found respectively (Table 2). The symptoms produced were identical to those described in previous study conducted by [20], who reported the distribution of *H. cajani* from the different pigeon pea growing areas of Varanasi and Mirzapur of Uttar Pradesh. Similarly,

[21,22,23] reported the occurrence of *H. cajani*, *Rotylenchulus reniformis* and *Meloidogyne sp.*

#### 4. CONCLUSIONS

From the present study, it can be concluded that *Heterodera cajani* and *F. udum* isolates isolated from different villages of Prayagraj districts of Uttar Pradesh, were varied in the appearance of wilting symptoms. Cysts nematodes were extracted from soil samples and wilt disease incidence was measured by root dip method or

soil inoculation method. In root dip method early appearance of disease symptoms and wilt were observed as compared to the soil inoculation method. These isolates were found to be highly variable in their cultural characteristics like radial growth and radial growth rate of fungal mycelium keep for further study.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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