

Short Communication

Effect of leaf wetness and soil temperatures on pea rust development caused by *Uromyces viciae-fabae* (Pers.) de Bary

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Uromyces viciae-fabae (Pers.) de Bary is autoecious, macrocyclic, heterothallic rust fungus having wide range of collateral hosts including pea crop and causes significant yield losses up to 20 to 100 % by affecting all the green plant parts including the pods (Sharma, 1998). It forms all the four spores viz., pycniospores/spermatiospores, aeciospores, urediospores and teliospores on pea plant. The pycnial stage was inconspicuous in nature occurring for a very short duration quickly followed by formation of aecia. The disease spread rapidly and aecia developed on all the above ground parts of the pea plants including pods (Singh, 2003). In India, it has been reported that aeciospores act as repeating spores and play an important role in the outbreak of the disease (Kushwaha *et al.*, 2006). In nature, the uredia were produced for very short duration quickly followed by telia and the teliospores are generally formed when the plant reaches towards maturity and environmental conditions are unfavourable for the propagation of the rust in the uredial stage. Hence, it is also known as resting spore.

This disease is normally not serious and may assume epidemic proportions in certain years because of favourable climatic conditions for their development and spread. Infected inert plant debris mixed with seed can act as basic inoculum for the recurrence of the disease in most years due to germination and survival of *Uromyces viciae-fabae* (Khare, 1981). Pathogen survives in different forms during unfavourable environmental condition and the appearance and progress of disease is region-specific. The predominant form of survival, therefore, varies with the environment and location. Moisture is a prerequisite for growth and development of both plants and pathogens (Vanderwall, 1978). Leaf surface humidity refers to dew or moisture on aerial plant surface. Leaf wetness period is important for infection in many foliar diseases. Leaf wetness duration has been reported to increase number of pustules and intensity of rust pathogens such as *Uromyces phaseoli* on bean,

Puccinia arachidis on groundnut and *P. striiformis* on wheat (Nagarajan and Murlidharan, 1995). Hence, it is important to find out the effect of different duration of leaf wetness on pea rust development under glasshouse and natural conditions.

The role of environmental factors is more complex with air borne diseases than soil borne. In addition to the direct influence of humidity and temperature on germination, dissemination and pathogenicity of the organism, the complexity of the soil itself is the most important, because the soil environment is a barrier to survival of organism. Obviously all these factors interact, as has been hypothesized as an explanation for the survivability of the fungus. Keeping this fact in view, an effort was made here to find out the effect of soil temperature at different soil depths on the survivability of pathogen.

This experiment was conducted in humid chambers and glass-house of Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, MPKV, Rahuri.

Effect of duration of leaf wetness on rust development

An experiment was conducted to find out the effect of duration of leaf wetness on disease development. Fifteen seeds of pea cultivar were grown in 10 cm plastic pots. One set of pots was placed in glasshouse while other was kept outside under natural conditions. Four week old plants were inoculated uniformly with a spore suspension of aeciospores (10^4 spores ml⁻¹) using an atomizer to provide complete leaf wetness and maintained for different durations in humid chambers. The pots were taken out of the humid chambers after 4, 6, 12, 18, 24, 30 and 36 h, respectively and the leaves were dried in open and placed in glasshouse at a particular temperature regime for disease development. The experiment was replicated three times with 10 plants per replication.

Observations were recorded in respect to incubation

Table 1: Effect of duration of leaf wetness on pea rust development caused by *Uromyces viciae fabae*

Duration (hours)	Disease severity (%)		Pustules/plant		Incubation period (Days)	
	Glass house	Natural condition	Glass house	Natural condition	Glass house	Natural condition
4	0.81 (5.17)	0.52 (4.50)	3.47 (10.56)	2.23 (8.31)	11	13
6	1.85 (7.80)	1.19 (6.21)	5.83 (13.83)	4.63 (12.37)	11	13
12	2.30 (8.70)	1.93 (7.94)	9.13 (17.53)	8.17 (16.56)	11	12
18	3.63 (10.97)	2.67 (9.39)	16.33 (23.82)	11.67 (19.96)	10	12
24	6.30 (14.52)	4.89 (12.77)	52.37 (46.35)	35.67 (36.67)	10	11
30	7.19 (15.24)	5.48 (13.54)	61.67 (51.75)	41.83 (40.29)	10	11
36	7.63 (16.01)	5.85 (13.99)	66.63 (54.72)	45.33 (42.31)	10	11
CV %	6.17	6.31	5.64	6.46		
SE _±	0.40	0.35	1.01	0.94		
CD at 5%	1.21	1.07	3.08	2.85		

Figures in parenthesis are arc-sine transformed values

period at the initial appearance of symptoms. The disease severity and number of pustules plant⁻¹ were recorded 20 days after inoculation.

Effect of different soil depths on survival of the pathogen

Small pieces of infected plant debris were placed in nylon mesh bags and buried in soil at different depths *viz.*, 5, 10, 15 and 20 cm, respectively with different soil temperature levels in plastic pots filled with natural soil during the month of March. These inoculated pots were kept in glasshouse. At weekly interval, one gram of debris was taken out from each sample and germination of spore was recorded by dilution technique as described above up to two months (8 weeks) to ascertain the survival of aeciospores, urediospore and teleospore at different depths, if any.

Effect of duration of leaf wetness on rust development

The experimental findings on the effect of duration of leaf wetness on pea rust development are presented as following (Table 1).

Disease severity (%)

The data recorded (Table 1) in respect to disease severity at different durations of leaf wetness on plant kept

in glass house revealed that the severity of disease increased progressively with an increase in duration of leaf wetness. Maximum disease severity (7.63 %) was recorded at 36 h of leaf wetness followed by 30h (7.19 %) and 24h (6.30 %), respectively. While, minimum disease severity was recorded at 4h leaf wetness (0.81 %). The disease severity increased significantly with an increase in duration of leaf wetness up to 36 h but the increasing rate of disease severity was observed more up to 24h. Similar trend was followed in the plants kept under natural conditions. Maximum disease severity (5.85 %) was recorded at 36 h of leaf wetness followed by 30 h (5.48 %) and 24 h (4.89 %), respectively. While, minimum disease severity was recorded at 4 h leaf wetness (0.52 %). The disease severity increased significantly with an increase in duration of leaf wetness upto 36 h but the increasing rate of disease severity was observed more upto 24 h.

Pustules plant⁻¹

There was significant increase in number of pustules plant⁻¹ with an increase in duration of leaf wetness up to 36h but the increasing rate of pustules plant⁻¹ was observed more up to 24 h under glass house condition. Maximum pustules

Table 2: Per cent survival of *Uromyces viciae-fabae* in infected crop debris buried in soil at different depth

Duration (Week)	Aeciospore				Urediospore				Teliospore			
	5 cm	10 cm	15 cm	20 cm	5 cm	10 cm	15 cm	20 cm	5 cm	10 cm	15 cm	20 cm
I	17.83 (24.96)	22.61 (28.36)	11.23 (19.56)	7.01 (15.34)	45.83 (42.60)	58.49 (49.89)	18.33 (25.34)	11.85 (20.12)	62.26 (52.11)	67.63 (55.37)	46.49 (42.98)	38.88 (38.56)
II	11.70 (19.99)	14.94 (22.73)	8.81 (17.26)	0.00 (0.00)	37.87 (37.96)	46.25 (42.84)	15.21 (22.95)	10.11 (18.51)	55.74 (48.32)	58.39 (49.84)	39.07 (38.67)	31.08 (33.88)
III	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	31.43 (34.07)	38.34 (38.25)	10.87 (19.21)	5.16 (13.14)	41.49 (40.08)	45.81 (42.57)	34.14 (35.70)	26.58 (31.00)
IV	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	18.17 (25.19)	21.15 (27.33)	6.22 (14.37)	0.00 (0.00)	33.75 (35.51)	38.39 (38.27)	26.97 (31.27)	19.21 (25.95)
V	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	10.18 (18.54)	16.03 (23.52)	0.00 (0.00)	0.00 (0.00)	29.42 (32.82)	32.65 (34.84)	19.27 (26.00)	15.49 (23.17)
VI	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	24.66 (29.77)	28.77 (32.43)	15.60 (23.25)	11.90 (20.15)
VII	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	18.51 (25.47)	23.40 (28.92)	11.40 (19.71)	0.00 (0.00)
VIII	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	10.99 (19.32)	14.41 (22.30)	0.00 (0.00)	0.00 (0.00)
CV %	5.08	6.79	5.95	5.29	6.38	5.52	6.53	6.14	5.99	5.80	6.27	5.67
SE ±	0.23	0.42	0.24	0.13	0.86	0.85	0.49	0.32	1.06	1.10	0.86	0.64
CD at 5%	0.70	1.29	0.73	0.40	2.56	2.54	1.45	0.97	3.10	3.22	2.53	1.87

Figures in parenthesis are arc-sine transformed values

plant⁻¹ 66.63 was recorded at 36 h of leaf wetness followed by 30h (61.67 pustules plant⁻¹) and 24h (52.37 pustules plant⁻¹), respectively, while, minimum pustules plant⁻¹ was recorded at 4h leaf wetness i.e. 3.47.

Similar trend was followed in the plants kept under natural conditions. Maximum pustules plant⁻¹ 45.33 was recorded at 36h of leaf wetness followed by 30h 41.83 pustules plant⁻¹ and 24h 35.67 pustules plant⁻¹, respectively, while minimum pustules plant⁻¹ was recorded at 4 h leaf wetness i.e. 2.23. The pustules plant⁻¹ increased significantly with an increase in duration of leaf wetness up to 36 h but the increasing rate of pustules/plant was observed more up to 24h.

Incubation period

Incubation period of the pathogen ranged between 10 to 13 days. The incubation period was ½ day more in the plants kept outside under natural conditions as compared to plants maintained inside glasshouse.

Thus, 24 h leaf wetness after inoculation was found optimum for rust development in pea plants. Joshi and

Tripathi (2012) have reported similar results in lentil rust. Negussie *et al.* (2005) reported that at 20 °C a dew period of at least 3 h was required for infection of lentil rust, whereas, maximum infection occurred with a dew period of 24 h. Infection efficiency increased linearly as the duration of dew period increased from 0 to 24 h. Chauhan and Singh (1994) and Silva *et al.* (2001) have also reported similar results with rust of pea and common bean, respectively. Silva *et al.* (2001) reported that a humidity period of 163 h with a temperature of 22 °C was optimum for development of rust in common bean and the number of lesions increased up to 24 h of humidity period.

Therefore, this positive relationship between severity of pea rust and duration of leaf wetness can be useful in predicting the outbreak of the disease if the initial inoculum is present. This basic information if supplemented with field data on disease development can be used for constructing epidemiological models (Vanderplank, 1963).

Effect of different soil depths on survival of *Uromyces viciae fabae*

The experiments were conducted under glasshouse

condition to observe the survivability of *Uromyces viciae fabae*, when buried at 5, 10, 15 and 25 cm depth in natural soil with different temperature level. Data on per cent survival of *Uromyces viciae-fabae* at different soil depth, at weekly interval are presented in Table 2. The data revealed that per cent survivability of *Uromyces viciae-fabae* declined sharply over a period of time and also with increase in depth of placement of the debris.

Maximum viability of aeciospores was recorded in the samples buried at 10 cm soil depth, which recorded 14.94 per cent germination after second week followed by at 5 cm soil depth (11.70 %) and at 15 cm soil depth (8.81 %), respectively, while, minimum viability of aeciospores was recorded in the sample buried at 20 cm soil depth, which recorded 7.01 per cent germination after first week. There is no earlier report on survival of aeciospores of *Uromyces viciae-fabae* in infected crop debris buried in soil at different depth.

Maximum viability of urediospores was recorded in the samples buried at 10 cm soil depth, which recorded 16.03 per cent germination after fifth week followed by at 5 cm soil depth (10.18 %) after fifth week and at 15 cm soil depth (6.22 %) after fourth week, respectively. While, minimum viability of urediospores was recorded in the sample buried at 20 cm soil depth, which recorded 5.16 per cent germination after third week. However, the survivability was significantly declined with increase in soil depth and exposure period. The survivability of urediospore was maximum (58.49 %) when it was buried at 10 cm soil depth in the first week followed by at 5 cm soil depth (45.83 %), at 15 cm soil depth (18.33 %) and at 20 cm soil depth (11.85 %), respectively. There was gradual decrease in survivability with increase in soil depth as well as lapse of time. These results are in line with the findings of Singh (2003) and Singh *et al.* (2013). Kumar *et al.* (2018) observed that the shallow depth of planting, disease incidence and severity of black scurf of potato was minimum as compared to deep planting of tubers..

Maximum viability of teliospores was recorded in the samples buried at 10 cm soil depth, which recorded 14.41 per cent germination after eight week followed by at 5 cm soil depth (10.99 %) and at 15 cm soil depth (11.40 %) after seven week, respectively. While, minimum viability of teliospores was recorded in the sample buried at 20 cm soil depth, which recorded 11.90 per cent germination after six week. The survivability of teliospores was maximum (67.63 %) when it was buried at 10 cm soil depth in the first week followed by at 5 cm soil depth (62.26%), at 15 cm soil depth

(46.49 %) and at 20 cm soil depth (38.88 %), respectively. There was also observed gradual decrease in survivability with increase in soil depth as well as lapse of time. Similarly, Kushwaha *et al.* (2006) observed, rust disease appeared on pea plant at the late vegetative phase (50-60 DAS) when pea seedlings are sown in the soil where the upper layer of soil surface mixed with plant debris infected by telia. Khare (1981) observed that the infected plant debris mixed with seeds or residues in crop fields are act as the primary source of inoculums.

Loss of survivability of spore of *Uromyces viciae-fabae* through infected crop debris at 15 and 20 cm soil depth might be due to decomposition of crop debris by saprophytic fungi like *Aspergillus*, *Rhizopus*, *Mucor*, *Penicillium* etc. present in soil. Leakage of nutrients in addition to exhausting food reserves, favours the growth of their antagonistic microorganism. It is presumed that the low percent in survivability of spore at depth of 5 cm in a result of higher temperature and competition with other microorganism, because the activity of soil microflora remain optimum at the depth of 1 to 5 cm. It is presumed that maximum survivability at 10 cm due to less competition with other micro organisms and comparatively lower temperature than other soil depths tried.

Based on the study, it can be concluded that duration 24 h of leaf wetness after inoculation was found optimum for rust development in pea plant under glasshouse and natural condition. Aeciospore, urediospore and teliospore infected plant debris buried in soil at 10 cm depth showed higher rate of survive and germinate 14.94 per cent after second week, 16.03 per cent after fifth week and 14.41 per cent after eight week, respectively due to less competition with other microorganisms and comparatively lower temperature than other soil depths tried

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