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Fungal diseases associated with pea (*Pisum sativum* L.) under traditional farming system in Manipur hills

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Three hill districts of Manipur- Kangpokpi, Senapati and Churachandpur were surveyed quantitatively for the presence of fungal diseases of pea during the month of October to March,2021-2022. Surveys were done at three different growth stages:vegetative,flowering and podding stage for three varieties namely Arkel, Makhyatmubi (Local variety) and RE-10 through simple random samplings in pea growing areas.Pooled (average) disease severity under Kangpokpi for Powdery mildew, Rust, Fusarium wilt and Ascochyta ranges from 1.67% to 33.3% in Kangpokpi, from 2.3% to 30.67% in Senapati and from 4% to 33.67% in Churachandpur. Average disease severity for Powdery mildew in vegetative stage is highest under Kangpokpi district (10%), Kangpokpi (18.67%) in flowering stage and Churachandpur district (26.3%) in podding stage. Average disease severity for rust is highest under Churachandpur district (12.67%) in vegetative stage, Kangpokpi (22%) in flowering stage and Churachandpur district (33.67%) in podding stage. Average disease severity for Fusarium wilt is highest under Churachandpur district (4%) in vegetative stage, Senapati (7.3%) in flowering stage and Kangpokpi district (13.6%) in podding stage. Average disease severity for Ascochyta is highest under Kangpokpi and Churachandpur (6%) in vegetative stage,Churachandpur (12.3%) in flowering stage and Kangpokpi district (19%) in podding stage. Churachandpur and Kangpokpi shows the highest value of disease severity as they have slightly warmer conditions. Observation in the field shows higher incidence and severity for powdery mildew and rust in comparison to Fusarium wilt and Ascochyta blight.

Keywords: Ascochyta blight, flowering, fruiting, Fusarium wilt, Powdery mildew, Rust

INTRODUCTION

Pea (*Pisum sativum* L.) is a major annual pulse crop of temperate region of the world and was originally cultivated in the Mediterranean basin (Sardana *et al.* 2007). It is an important crop based on diversity of utilization and extensive production area (Boros and Wawer,2009).

The total cultivated dry pea area in the world is about 6.2 Mha with an average yield of 1.68t/ha. Young leaves and green pods are consumed as vegetables. The nutritional value of dry pea seed is similar to other grain legumes and contains18-30% proteins,35-50% starch and 4-7% fiber. The total cultivated dry pea area in the world is about 6.2Mha with an average yield of 1.68 t/ha producing an estimated 105MT.Garden pea is a cool weather

crop and grows best at optimum mean temperature of 10-18°C (Thumburaj and Singh, 2003) and hot dry weather lowers the quality of pods as they gets converted into starch and cellulose. In India, pea is grown over an area of 0.77 Mha with a production of 0.71 Mt and productivity of 1032 kg/ha (Anonymous,2009). The average yield of India is 9.15q/ha (Singh,2008) as compared to major pea growing countries like France (15.5q/ha) (Anonymous,2002).Despite the huge potential, they still face challenge due to competition from weeds,insect attack, disease incidence, instability of production and lack of successful nodulation (Date, 2000; Lemerle *et al.* 2006; Martin Sanz *et al.* 2011). Pea (*Pisum sativum* L.) suffers from various foliar and soil borne fungal diseases – namely Powdery mildew (*Erysiphe pisi*), Ascochyta blight complex(*Ascochyta pisi*, *Mycosphaerella pinodes*, *Phoma medicaginis* var. *pinodella*), Rust (*Uromyces fabae*), Downy mildew (*Peronospora*

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viciae), Fusarium wilt (*Fusarium oxysporum* sp *pisi*) and root rot of pea which may be caused by any one or a combination of several soil borne fungi (Kraft and Pflieger, 2001; Marcinkowska, 2002; Koike *et al.* 2007; Davidson *et al.* 2009; Liu *et al.* 2013; Melzer *et al.* 2016; Kamala and Indira, 2001). Among the various diseases of pea, Powdery mildew, Fusarium wilt and Rust are the major diseases leading to severe loss (Glawe, 2008; Singh and Tripathi, 2004; EPPO, 2012; Janila *et al.* 2001). In Australia the loss in yield caused by *Ascochyta* blight is estimated to be around 10% to 60% (Bretag *et al.* 2006). Powdery mildew is characterized by white floury patches initially on the leaves progressing to tendrils, pods, stem to aerial parts leading to subsequent reduction in yield. Rust usually appears during mid spring can cause substantial yield loss particularly in warm weather conditions which ranges from 56.8 to 100 % (Kushwaha *et al.* 2010). *Fusarium oxysporum* sp. *pisi* has the ability to produce deleterious yield loss in pea production all over the world (Dubey *et al.* 2007). Winter crop is mostly affected by Fusarium wilt and cause significant losses and is most prevalent in maximum varieties with yield losses upto 100% (Khan *et al.* 2002).

In Manipur, a north eastern hill state of India, field pea is the major pulse crop grown in 26,000ha area occupying about 85% of the total pulses area (Anonymous, 2015). Manipur as a whole lies in tropical wet evergreen forest and moist deciduous thus giving an acidic nature of soil. Due to low availability of rainfall, residual moisture plays a great role. A stray Reports on fungal diseases of pea namely powdery mildew, Fusarium wilt and rust (Nongmaithem *et al.* 2017) are less, but it has been acknowledged that there is occurrence of fungal diseases in the other hills, thus the present investigation was done to study the incidence and severity of different fungal diseases affecting pea at three hills districts of Manipur namely, Kangpokpi, Senapati and Churachandpur. The results thus achieved may be helpful in controlling the spread or mitigating the disease.

MATERIALS AND METHODS

Extended survey regarding the occurrence of fungal diseases have been conducted in almost all hill districts of Manipur beginning from November to March 2022 including fixed location experimental sites at Kangpokpi, Senapati and Churachandpur

at fortnightly intervals. Three varieties of pea namely Arkel, Makhayatmubi, and RE-10 were the pea varieties surveyed. Pre-prepared questionnaires related to the cultivation practices, preparation of land, use of organic manures, pea variety sown, sowing time, use of any fungicides or traditional control measures, etc. were the questions included in the questionnaires. Simple random sampling was followed in drawing the samples from the field for recording the disease parameters like incidence and severity. Sample size was 100 plants and from each plant 5 leaves were scored for disease severity using the disease severity scales. Separate disease scoring scales appropriate for specific disease were followed viz; disease scoring for Powdery mildew and *Ascochyta* blight were done following the procedure outlined by Mayee and Datar (1986). Disease scoring (1-9) for Fusarium wilt was done following the procedure outlined by Iqbal *et al.* (2005), while disease intensity for rust disease was worked out following procedure of Aduichy and Thakore (2000). After evaluation in the field, the plant part showing various symptoms or lesions are carried in the laboratory after wrapping in polythene bags for identification of different fungal pathogens through relevant literatures.

RESULTS AND DISCUSSION

During the survey, four major fungal diseases viz; Powdery mildew, Rust, Fusarium wilt and *Ascochyta* blight complex caused by *Erysiphe pisi* var. *pisi*, *Uromyces fabae*, *Fusarium oxysporum* sp. *pisi* and *Ascochyta pisi* were found. However, occurrence of fungal disease levels differ from one district to another in the hills but all districts recorded four major fungal diseases.

For Powdery mildew, the highest incidence in the vegetative stage is under Kangpokpi (30) and Churachandpur (30), both in Arkel variety followed by Senapati (10) of RE-10 variety which is lowest, and for DS the highest is under Kangpokpi (14), followed by Churachandpur (4) of Makhayatmubi variety. In the flowering stage, the highest incidence is under Kangpokpi (50) for both Arkel and Makhayatmubi variety and also RE-10 variety of Churachandpur followed by Senapati (40) for Arkel variety, and for DS the highest is under Kangpokpi (22) with Arkel variety followed by Churachandpur (19) for RE-10 variety. In the podding stage, the highest incidence is under Kangpokpi (70) and

Table 1: Disease incidence and severity of three pea varieties observed in different growth stages under Kangpokpi district

Powdery mildew						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	30	14	50	22	70	30
Makhyatmubi	20	7	50	16	60	23
RE-10	20	9	40	18	60	24
Average	23.3	10	46.6	18.67	63.3	25.67

Rust						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	PDI	DI	PDI	DI	PDI
Arkel	40	16	60	22	80	34
Makhyatmubi	10	5	30	24	60	30
RE-10	30	12	40	20	70	36
Average	26.67	11	43.3	22	70	33.3

Fusarium Wilt						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	0	0	10	5	30	14
Makhyatmubi	10	2	20	5	40	12
RE-10	10	3	20	6	50	15
Average	6.67	1.67	16.67	5.33	40	13.67

Ascochyta blight						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	20	7	30	15	70	22
Makhyatmubi	10	5	20	10	30	16
RE-10	10	6	20	9	40	19
Average	13.3	6	23.3	11.3	46.6	19

DI= Disease Incidence; DS= Disease Severity

Churachandpur (70) both for Arkel variety followed by Senapati (60) for Arkel, Churachandpur (60) for Makhyatmubi and RE-10 respectively and for disease severity the highest is under Churachandpur (31) for Arkel variety and lowest is under Senapati district (22) for RE-10 variety.

For rust, the highest incidence in the vegetative stage is under Kangpokpi (40), Senapati (40) both in Arkel variety and Churachandpur (40) for Makhyatmubi variety followed by Senapati (20) of RE-10 variety and Kangpokpi (10) for Makhyatmubi variety which is lowest and for disease severity the highest is under Kangpokpi (16) with Arkel variety

while the minimum is for Makhyatmubi variety (5) of Kangpokpi district. In the flowering stage, the highest incidence is under Kangpokpi (60) for Arkel variety while the minimum disease incidence is also for Kangpokpi (30) with Makhyatmubi variety and disease severity is highest under Kangpokpi (24) with Makhyatmubi variety and minimum disease severity is under Senapati (18) with RE-10 variety. In the podding stage, the disease incidence is highest under Kangpokpi (80) and Churachandpur (80) both for Arkel variety and disease severity is highest under Kangpokpi (36) for Makhyatmubi variety and Churachandpur (36) for Arkel variety and minimum disease severity is

Table 2: Disease incidence and severity of three pea varieties observed in different growth stages under Senapati district

Powdery mildew						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	PDI
Arkel	20	8	40	18	60	25
Makhyatmubi	20	5	20	13	50	20
RE-10	10	5	30	15	50	22
Average	16.6	6	30	15.3	53.3	22.3

Rust						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	PDI	DI	PDI	DI	PDI
Arkel	40	14	50	20	70	32
Makhyatmubi	30	10	50	21	60	27
RE-10	20	9	40	19	60	33
Average	30	11.67	46.7	20	63.3	30.67

Fusarium Wilt						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	10	3	20	8	40	13
Makhyatmubi	0	0	10	4	30	9
RE-10	20	4	30	10	40	16
Average	10	2.3	20	7.3	36.6	12.67

Ascochyta blight						
Varieties	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	20	6	30	12	40	16
Makhyatmubi	0	0	10	4	40	10
RE-10	10	4	20	10	50	18
Average	10	3.3	20	8.67	43.3	14.6

DI= Disease Incidence; DS= Disease Severity

Table3: Disease incidence and severity of three pea varieties observed in different growth stages under Churachandpur district

Varieties	Powdery mildew					
	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	30	9	40	20	70	31
Makhyatmubi	10	4	30	14	60	23
RE-10	20	10	50	19	60	25
Average	20	7.67	40	17.67	63.3	26.33

Varieties	Rust					
	Vegetative stage		Flowering stage		Podding stage	
	DI	PDI	DI	PDI	DI	PDI
Arkel	30	13	60	20	80	36
Makhyatmubi	40	14	60	23	70	31
RE-10	30	11	50	18	70	34
Average	33.33	12.67	56.67	20.3	73.3	33.67

Varieties	Wilt					
	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	20	5	30	8	40	13
Makhyatmubi	10	3	20	5	40	11
RE-10	20	4	40	8	50	11
Average	16.67	4	30	7	43.3	11.6

Varieties	Ascochyta					
	Vegetative stage		Flowering stage		Podding stage	
	DI	DS	DI	DS	DI	DS
Arkel	10	4	40	11	60	16
Makhyatmubi	20	5	40	12	50	15
RE-10	30	7	40	14	50	18
Average	20	5.3	40	12.3	53.3	16.3

DI= Disease Incidence; DS= Disease Severity

Table 4: Environmental factor, disease incidence and severity of three growth stages at Kangpokpi (Pooled data).

Temp°C	R.H.%	Rainfall (mm)	*P- DI%	*P-DS%	*R-DI%	*R-PDI%	*W-DI%	*W- DS%	*A-DI%	*A- DS%	Stages
15	77	120	23.3	10	26.67	11	6.67	1.67	13.3	6	Vegetative
10	72	18	46.6	18.67	43.3	22	16.67	5.33	23.3	11.3	Flowering
12	82	22	63.3	25.67	70	33.3	40	13.67	46.6	19	Podding

*P=Powdery mildew, R=Rust,W=Wilt, A=Ascochyta blight.

Table 5: Environmental factor, disease incidence and severity for the three growth stages at Senapati (Pooled data).

Temp (°C)	R.H. %	Rainfall (mm)	*P- DI%	*P- DS%	*R- DI%	*R- PDI%	*W- DI%	*W- DS%	*A- DI%	*A- DS%	Stages
12	79	108	16.6	6	30	11.67	10	2.3	10	3.3	Vegetative
8	76	13	30	15.3	46.7	20	20	7.3	20	8.67	Flowering
10	80	20	53.3	22.3	63.3	30.67	36.6	12.67	43.3	14.6	Podding

*P=Powdery mildew, R=Rust, W=Wilt, A=Ascochyta blight.

Table 6: Environmental factor,disease incidence and severity for the three growth stages at Churachandpur (Pooled data)

Temp °C	R.H. %	Rainfall (mm)	*P- DI%	*P- DS%	*R- DI%	*R- PDI%	*W- DI%	*W- DS%	*A- DI%	*A- DS%	Stages
17	86	122	20	7.67	33.33	12.67	16.67	4	20	5.3	Vegetative
11	76	15	40	17.67	56.67	20.3	30	7	40	12.3	Flowering
15	83	19	63.3	26.3	73.3	33.67	43.3	11.6	53.3	16.3	Podding

*P=Powdery mildew, R=Rust,W=Wilt, A=Ascochyta blight.

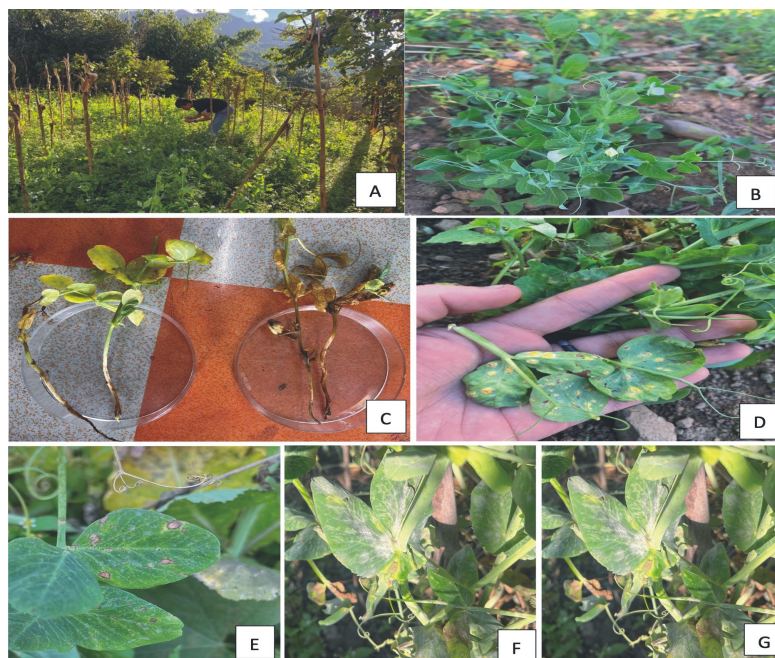


Fig 1:Major diseases of Pea. **A.**Survey site; **B.** A healthy pea plant; **C.** Wilted pea plant brought at laboratory; **D.** Rust disease on pea leaf; **E.** Ascochyta blight ; **F & G.** Powdery mildew disease in pea.

for Churachandpur (31) for Makhyatmubi variety. For wilt, the highest incidence in vegetative stage is under Senapati (20) and Churachandpur (20) for Arkel variety while minimum is under Kangpokpi (0) for Arkel variety and for disease severity the highest is under Churachandpur (5) for Arkel variety and minimum under Kangpokpi and Senapati for Arkel and Makhyatmubi variety.

In flowering stage, the highest incidence is under Churachandpur (40) with RE-10 variety and lowest under Kangpokpi (10) with Arkel variety, and disease severity is highest under Senapati (10) with RE-10 variety and lowest under Senapati (4) with Makhyatmubi variety. In the podding stage, the highest incidence is under Churachandpur (50) for RE-10 variety and the lowest is for Kangpokpi (30) for Arkel variety and Senapati (30) for Makhyatmubi variety while disease severity is highest under Senapati (16) for RE-10 variety and lowest under Senapati (9) for Makhyatmubi variety. For Ascochyta blight, the highest incidence in the vegetative stage is under Churachandpur (30) for RE-10 variety and the lowest is under Senapati (0) for Makhyatmubi variety and for disease severity it is highest under Kangpokpi (7) with Arkel variety and lowest for Senapati (0) with Makhyatmubi variety. In the flowering stage, Senapati (40) has the highest disease incidence in all the three varieties and lowest for Senapati (10) for Makhyatmubi variety while Kangpokpi (15) for Arkel variety has the highest disease severity. In the podding stage, disease incidence is highest for Kangpokpi (70) with Arkel variety while Makhyatmubi variety (30) of Kangpokpi has the lowest and Arkel variety (22) of Kangpokpi has the highest disease severity while Makhyatmubi variety (10) of Senapati has the lowest. The disease intensities of the different varieties growing in the different districts have been compiled in Tables 1-3.

Present investigation revealed four fungal diseases of pea (*Pisum sativum* L.) namely powdery mildew, rust, Fusarium wilt and Ascochyta blight found in all the growth stages, viz: vegetative, flowering and podding under three hills district of Manipur surveyed during November to March, 2021-2022 (Fig.1). Average (pooled) disease incidence of Powdery mildew, Rust, Wilt and Aschochyta ranges from 16.6% to 63.3%, 26.67% to 73.3%, 6.67% to 43.3% and 10% to 53.3% respectively. Average (pooled) disease severity of Kangpokpi for all diseases ranges from

1.67% to 33.3%, Senapati ranges from 2.3% to 30.67% and Churachandpur ranges from 4.67% to 33.67%. This report is in line with the fungal diseases that have been reported with different level of disease status (Rao, 2014; Rajalakshmi *et al.* 2016; Mishra *et al.* 2017; Upadhyay *et al.* 2016; Wani *et al.* 2003; Kripalini, 2019; Soylu *et al.* 2011; Nabakishor *et al.* 2017). Variation in disease incidence and severity levels at different locations maybe attributed to varying location specific climatic conditions such as rainfall, humidity, temperature, traditional cultivation practices and fertilizer inputs. Here reporting of diseases is from the natural setting without external inputs (Tables 4-6). These diseases were minor in earlier years but becoming major one which may be due to the effect of changing climatic conditions.

CONCLUSION

From the results, it can be confirmed that hilly areas of Manipur are also susceptible to various fungal disease and the variation in disease incidence and severity can be attributed to difference in weather conditions. Appropriate measures like proper sowing time, timely irrigation, use of disease free seeds, proper tilling are recommended to control the spread of disease.

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REFERENCES

- Anonymous. 2002. Project coordinator's report. All India coordinated Research project on MULLaRP. Published by IIPR (ICAR) Kanpur, 20.
- Anonymous. 2009. Project coordinator's report. All India coordinated Research project on MULLaRP. Published by IIPR (ICAR) Kanpur, 2.
- Anonymous. 2015. Annual Report (2014-15) on Promotion of Pulses in NE Region. ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh 208024 (India). 39pp.
- Audichya, P., Thakore, B.B.L. 2000. Management of powdery mildew of opium poppy by systemic fungicides. *J. Mycol. Pl. Pathol.* **30**: 103-104
- Boros, L., Wawer A. 2009. Garden pea varietal susceptibility to *Mycosphaerella pinodes* and its effect on yield components of single plants. *Veg. Crops Res. Bull.* **70**: 37-47.
- Davidson, J.A., Hartley, D., Priest, M., Herdina, M.K.K., McKay, A., Scott, E.S. 2009. A new species of *Phoma* causes Ascochyta blight symptoms on field peas (*Pisum sativum* L.) in South Australia. *Mycologia* **101**: 120-128. doi:10.3852/

- 07-199.
- Dubey, S.C., Suresh, M., Singh, B. 2007. Evaluation of *Trichoderma* species against *Fusarium oxysporum* f.sp. *ciceris* for integrated management of chick pea wilt. *Biol. Cont.* **40**:118-127.
- Date RA. 2000. Inoculated legumes in cropping system of the tropics. *Field Crops Res.* **65**:123-136.
- EPP O, 2012. Standards Pea http://archives.eppo.org/EPP O Standards / P P 2 _ G P P / p p 2 - 1 4 - e . d o c (accessed) December 13, 2002.
- Glawe, D.A. 2008. The powdery mildews: a review of the world's most familiar (yet poorly known) plant pathogens. *Phytopathology* **46**:27-32.
- Iqbal, S.M., Ikram-ul-Haq, Bakhsh, A., Ghafoor, A., Haqqani, A.M. 2005. Screening of chickpea genotypes for resistance against *Fusarium* wilt. *Mycopath* (Pakistan) **3**: 1-5.
- Janila, P., Sharma, B., Mishra, S.K. 2001. Inheritance of powdery mildew resistance in pea (*Pisum sativum* L.) *Ind. J. Gen.* **61**:129-131.
- Khan, I.A., Alam, S.S., Haq, A., Jabbar, A. 2002. Selection for resistance to *Fusarium* wilt and its relationship with phenols in chickpea. *Int. Chickpea Pigeonpea News Lett.* **9**: 19-20
- Kraft, J. M., Pflieger, F. L. 2001. Compendium of Pea Diseases and Pests. APS Press, St. Paul. 110pp.
- Kushwaha, C., Chand, R., Srivasta, C. P., Singh, A. K., Rai, R., Singh, B.D. 2010. Importance of aecial cups/pustules for selection of slow rusting in pea (*Pisum sativum* L.) against *Uromyces fabae*. *Ind. J. Agri. Sci.* **80**:933-936.
- Koike, S.T., Gladders, P., Paulus, A.O. 2007. Vegetable Diseases: A Colour Handbook. Manson Pub., London. 437pp.
- Kripalini, N., Biswas, M.K., Devi, S. Ph., Sinha, B. 2019. Studies on Survey of *Fusarium* wilt of Pea (*Pisum sativum* L.) and its Management by Native *Trichoderma* Isolates and Commercial *Trichoderma* under Pot Condition in Manipur. *Int. J. Bio Resource Stress Management* **10**: 001-008
- Kamala, T., Indira, S. 2001. Evaluation of indigenous *Trichoderma* isolates from Manipur as biocontrol agent against *Pythium aphanidermatum* on common beans. *3 Biotech.* **1**: 217-225. <https://doi.org/10.1007/s13205-011-0027-3>.
- Liu, J.F., Cao, T.S., Feng, J., Chang, K.F., Hwang, S.F., Strelkov, S.E. 2013. Characterization of the fungi associated with ascochyta blight of field pea in Alberta, Canada. *Crop Prot.* **54**:55-64. doi:10.1016/j.cropro.2013.07.016.
- Lemerle, D., Verbeek, B., Diffey, S. 2006. Influence of field pea (*Pisum sativum*) density on gram yield and competitiveness with annual rye grass (*Lolium rigidum*) in south-eastern Australia. *Austr. J. Exp. Agric.* **46**:1465-1472.
- Martin -Sanz, Luis P. J., Perez de la Vega, M., Caminero, C. 2011. Identification of pathovars and races of *Pseudomonas syringae*, the main casual agent of bacterial diseases in pea in north central Spain and the search for disease resistance. *Eur. J. Plant Pathol.* **129**:57-69.
- Melzer, M.S., Yu, H., Labun, T., Dickinson, A., Boland, G.J. 2016. Characterization and pathogenicity of *Rhizoctonia* spp. from field crops in Canada. *Can. J. Pathol.* **38**:367-374.
- Marcinkowska, J.Z. 2002. Foliar diseases of *Pisum sativum* L. in Poland. *Plant Breed. Seed Sci.* **46**:49-54.
- Mayee, C.D. and Datar, V.V. 1986. Phytopathometry. Technical Bulletin-1 (Special Bulletin 3), Marathwada Agric. Univ. Parbhani. pp78.
- Mishra, V., Lal, A.A., Simon, S., Mishra, S. 2017. Preliminary evaluation of incidence and severity of powdery mildew and rust disease of garden pea (*Pisum sativum* L.) in Allahabad. *J. Pharm. Phytochem.* **6**:645-647.
- Nongmaithem, N., BasudhaCh., Sharma, S.K. 2017. Incidence of Rust, Powdery Mildew and Wilt in Pea and Broadbean Plant of Manipur, India. *Int. J. Curr. Microbiol. App. Sci.* **6**: 2611-2616.
- Rajalakshmi, J., Parthasarathy, S., Narayanan, P., Prakasam, V. 2016. Survey of the incidence and severity of Bhendi (*Abelmoschus esculentus* L.) and Peas (*Pisum sativum* L.) Powdery mildew diseases in Tamil Nadu, India. *Adv. Life Sci.* **5**: 808-814.
- Rao, J.K. 2014. Studies on survey of *Fusarium* wilt of pea in Eastern Uttar Pradesh. *Int. J. Life Sci.* **2**:359-362.
- Singh BB. 2008. Project coordinator's report. All India coordinated Research project on MULLaRP, ICAR. Annual group meet, Rabi workshop, 7-9 Sept, Maharana Pratap Agriculture University, Udaipur (Rajasthan) India, 17.
- Sardana, S., Mahajan, R.K., Gautam, N.K., Ram, B. 2007. Genetic variability in pea (*Pisum sativum* L.) germplasm for utilization. *SABARO J. Breed. Gen.* **39**:31-41.
- Singh D., Tripathi, H.S. 2004. Epidemiology and management of field pea rust. *J. Mycol. Plant Pathol.* **34**:675-79.
- Soylu, S., Dervis, S. 2011. Determination of prevalence and incidence of fungal disease agents of pea (*Pisum sativum* L.) plants growing in Amik plain of Turkey. *Res. Crops* **12**:588-592.
- Upadhyay, V., Kushwaha, K.P.S., Pandey, P. 2015. Inspection of different localities in Uttarakhand and Uttar Pradesh for the prevalence of rust disease of pea (*Pisum sativum* L.). *Trends Biosci.* **8**: 4336-4340.
- Thumbaraj, S., Singh, N. 2003. Vegetables, Tubercrops and spices. Directorate of Knowledge Management in Agriculture, IARI, New Delhi, India, 4-198.
- Wani, A.H., Ashraf, M. 2003. Crop Management, Kalyani Publishers, New Delhi, 15-19.