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Screening of lentil (*Lens culinaris* Medik) genotypes against *Fusarium oxysporum* f. sp. *lentis* under natural as well as artificial epiphytotic condition

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Abstract
Out of 300 hundred genotypes under wilt sick plot technique, none of entries were found immune or disease free. Out of 300 genotypes screened under natural condition as well as under artificial inoculated condition, none of the entries were found immune. However, fifty entries *viz*., IPL 213, KLS 2003-3, KLS 218, SL 73-3, WBL 77, SL94-08, KLS97-7, JL 30, JL 31, DPL 62, IPL -525, KLS-224, KLS 227, IPL 81, LL 1049, SLC 38, L 4580, L 4076, JL 3, L 4689, NDL 6-1-8, DPL 15, L 4679, LL 985, LL 968, LY 688, NDL 6-1-5, LH-3-11, L 4687, PL-01, LH 3-12, VL 133, RLG 62, LH 4-4, LY 4685, L 4581, LH 84-8, PL 024, PL 063, LL 931, LH 4-1, LH 4-1, LH 84-8, VL 132, VL 515, L 4682, NDL 6-1-5, L 4147, VL-514, LH 3-38 were recorded resistance reaction against *Fusarium oxysporum* f. sp. *Lentis* under natural condition. Where 73 genotypes were noticed moderately resistant, 61 genotypes were recorded moderately susceptible, 59 genotypes were expressed susceptible and 57 were found highly susceptible. None of the genotypes was found immune against the disease.

Keywords: Epiphytotic, *fusarium*, genotypes, resistant

Introduction
Legumes occupy unique crops in the world by virtue of their high protein content (15-35), carbohydrates, fiber, minerals and nutrients in seeds and it have capability to fix atmospheric nitrogen in symbiotic association with root nodule bacterium (Rhizobium). According to the Indian Council of Medical Research optimum requirement of the pulses for person to maintain his health is 10 µg/days. However not even half of this quantity is available to the people. In India most of the population is primarily vegetarian pulses has a special place in the daily diet about (7-15%) of food grain, of people due to its high protein contents and several uses. India is a major pulse growing country of the world. During 1996-97 pulses occupied 71.4 million hectares of the world with a total production of 57 million tones and average yield of 806 kg /ha. (FAO, 1997), while in India pulses were grown on 1.51 million hectare with the production of 1.56 million tones and average yield 1032 kg/ha (Anonymous, 2019) [1].
In Utter Pradesh it grown about 4.47 lakh hectare with 4.60 lakh tones production and productivity 1029 kg/hectare (Anonymous, 2019) [1]. In India, it is grown in winter season. Mostly lentil is grown in India as a rain fed crop by marginal formers in their marginal lands using their local seeds without any input like improved seeds, fertilizers, irrigation and pesticides and consequently economic return is poor. A number of factors are responsible for this low yield. Depredations by diseases are one of them.
The lentil crop is infected by a large number of pathogens such as fungi, bacteria, Virus & nematodes which significantly contribute to poor yields. Among the disease wilt, Anthracnose, Alternaria blight, Ascochyta blight, black root rot, gray mold, rust, powdery mildew and collar rot are important in different part of the country. In this region *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *lentis*, Rust caused by *Uromyces fabae*, Alternaria blight caused by *Alternaria alternate*, collar rot is caused by *scloricium rolfsii* and powdery mildew is caused by *Erysiphe pisi* are widely distributed in Rabi season, The crop suffers heavily due to *Fusarium* wilt in the major growing areas resulting into huge production losses by Gorden (1965) [7] and Grewal (1988) [8].

Materials and Methods
Seeds of three hundred genotypes of lentil were obtained from the Department of Genetics and

Plant Breeding, N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) and Indian Institute of Pulse Research, Kanpur. The genotypes were screened under artificial epiphytotic conditions (Sick plot technique) and two test entries after two line of susceptible check (L 9-12) are sown. After germination, observation, were recorded regularly up to 24 days for the appearance of wilt symptoms and severity. The disease was recorded using 1-9 scale for the wilt disease of lentil as described in (Table-1).

Table 1: Disease rating scale for *Fusarium* wilt

S. No.	Scale	Description	Disease reaction
1.	0	Free from the disease	Immune
2.	1	No symptoms on any plant	Resistant
3.	3	10% or less mortality	Moderately Resistant
4.	5	11-20% mortality	Moderately susceptible
5.	7	20-50% mortality	Susceptible
6.	9	51% or more mortality	Highly Susceptible

Results and Discussion

Studies on screening of available germplasm of rice were carried out under natural as well as under artificial inoculated conditions, to find out the source of resistance against *Fusarium oxysporum* f. sp. *lentis* by evaluating three hundred genotypes. Out of these entries tested under natural conditions, none were found to be immune. However, fifty entries were recorded resistant, seventy three were noticed moderately resistant, sixty one were noticed moderately susceptible, fifty one were found susceptible and expressed highly susceptible reaction against *F. oxysporum* f. sp. *lentis* in the crop season- 2019-20 (Table 2).

It is evident from the results presented in table-3 that out of one hundred thirty four entries which were found to be moderately resistant (73) and moderately susceptible under natural conditions further screened against *Fusarium oxysporum* f. sp. *lentis* were tested under artificial inoculated conditions during *Rabi*-2020-21, by mixing of conidia in soil and rest of the environmental factors etc. were natural. In this experiment again none of the entries showed immune and resistant, however, seventy three entries scored as moderately resistant, sixty one entries found moderately susceptible, fifty nine entries noticed susceptible and rest fifty seven entries were expressed highly susceptible reaction against *F. oxysporum* f. sp. *lentis.*

None of the genotypes was found immune against the disease. The similar results were also screened by Kaur and Sharma (1993) [10]. The above findings are similar as described by Khare (1981) [11], Bhat *et al.*, (2006) [3], Bayaa *et al.*, (1997) [2], Neelakanth, S. (2018) [12], Iqbal *et al.* (2010), Chandra *et al.*, (2019) [4], Chandra *et al.* (2019) [5] and Chandra *et al*, (2019) [6].

Table 2: Varietal identification of lentil genotype(s) resistant to *Fusarium oxysporum* f. sp. *lentis* under natural condition during- 2019-20

Rating scale	No. of Genotype	Host Reaction	Name of genotypes
0	0	Immune	Nil
1	50	resistant	IPL 213, KLS 2003-3, KLS 218, SL 73-3, WBL 77, SL94-08, KLS97-7, JL 30, JL 31, DPL 62, IPL -525, KLS-224, KLS 227, IPL 81, LL 1049, SLC 38, L 4580, L 4076, JL 3, L 4689, NDL 6-1-8, DPL 15, L 4679, LL 985, LL 968, LY 688, NDL 6-1-5, LH-3-11, L 4687, PL-01, LH 3-12, VL 133, RLG 62, LH 4-4, LY 4685, L 4581, LH 84-8, PL 024, PL 063, LL 931, LH 4-1, LH 4-1, LH 84-8, VL 132, VL 515, L 4682, NDL 6-1-5, L 4147, VL-514, LH 3-38
3	73	Moderately Resistant	L 4169, WBL 77, LL 1320, LL 1397, L 4751, VL 525, L 1374, PL 194, DL 14-2, LL 1373, VL 526, L 4717, L 4771, K 75, VL 126, L 4076, PL 024, RLG 191, VL 150, TRCL-1, RKL 1003-24, L 4726, PL 220, L 4764, L 4735, IPL 534, KLS 14-23, PL-406, LH 84-8, DPL 15, L 4755, BPL 15, DL 16-7, RL 3-5, IPL 334, RVL 13-5, LL 1404, L 4762, KLB 1442, KLS 14-1, PL 063, DPL 62, IPL 316, PL 175, PL 218, BPL 14, RKL 24C-59, PL 221, L 4710, KLS 218, L-3, PL 210, LL 1318, HUL 57, NDL14-22, KLS 1445, IPL 227, IPL 225, RVL 13-7, PL 4, L 4147, VL 26, VL 148, LL 1320, NDL 14-12, L 4751, LL 1370, PL 406, PL 063, LL 1397, IPL 230, NDL2016-15, NDL 2016-24,
5	61	Moderately Susceptible	KLS 1431, LL 1388, VL 152, VL 153, BRL-1, BRL-2, L 4756, L 4757, BPL 16, KLS 218, HUL 57, L 4076, JL 3, DPL 62, IPL 316, RKL 14-20, RVL 13-7, L 4727, RVL 14-4, DPL 15, IPL 406, PL 024, LL 1373, IPL 336, PL 221, LH 84-8,VL 507, RL 6-1, RL 3-5-1, LH 1407, KLB 112, RVL 15-1, RVL 15-4, LL 1396, LL 1467, JLS -1, JLS -3, IPL 340, RKL 603-5, RKL 605-3, PL 245, PL 237, VL 527, VL 528, L 4728, L 4729, L 4769, L 4771, RL 7-3, IPL 535, IPL 536, RVL 15-5, L 4772, L 4773, IPL 537, RKL 611-13, IPL 81, LL 1318, PL 165, KLS 1305,
7	59	Susceptible	VL 146, RVL -11-6, LH 84-8, KLS 13-1, RLG 147, PL 164, PL 138, LL 1255, KLS 09-5, PL-157, KLS 113, PL 160, KLB 13-2, HUL 57, VL 523, LL 1223, PL 153, RLG 161, IPL 531, RL-3CC, PL 166, LL 1277, VL 1209, VL 147, LL 1242, RL 6-4, RVL 11-5, IPL 346, IPL 221, IPL 226, IPL 328, IPL 220, IPL-406, DPL 62, DPL 15, RL 7-2, IPL 327, IPL 81, IPL 225, IPL 329, IPL 330, IPL 533, IPL 315, IPL 532, IPL 219, IPL 325, L 4710, IPL 526, IPL 321, IPL 215, IPL 331, IPL 332, IPL 534, IPL 222, L 4721, L 4712, L 4717, L 4076,
9	57	Highly Susceptible	L9-12, PL 166, LL 1277, VL 1209, VL 147, LL 1242, RL 6-4, RVL 11-5, IPL 346, IPL 221, IPL 226, IPL 328, IPL 220,
			IPL-406, DPL 62, DPL 15, RL 7-2, IPL 327, IPL 81, IPL 225, IPL 329, IPL 330, IPL 533, IPL 315, IPL 532, IPL 219, IPL 325, L 4710, IPL 526, IPL 321, IPL 215, IPL 331, IPL 332, IPL 534, IPL 222, L 4721, L 4712, L 4717, L 4076, LL 1054, LL 921, L 4678, L 4686, NDL 5-5, VL 148, LL 1370, VL 151, IPL 333, PL 4, LL 1375, RLG 195, L 4727, RVL 14-4, L 4737, RKL 607-1, L 4147,

Table 3: Varietal identification of lentil genotype(s) resistant to *Fusarium oxysporum* f. sp. *lentis* under artificially inoculated conditions during- 2020-21.

Rating scale	No. of Genotype	Host Reaction	Name of genotypes
0	0	Immune	Nil
1	0	resistant	Nil

3	73	Moderately Resistant	L 4169, WBL 77, LL 1320, LL 1397, L 4751, VL 525, L 1374, PL 194, DL 14-2, LL 1373, VL 526, NDL 14-12, L 4717, L 4771, K 75, VL 126, NDL2016-15, L 4076, PL 024, RLG 191, VL 150, TRCL-1, RKL 1003-24, L 4726, PL 220, L 4764, L 4735, IPL 534, KLS 14-23, NDL14-22, PL-406, LH 84-8, DPL 15, L 4755, BPL 15, DL 16-7, RL 3-5, IPL 334, RVL 13-5, NDL 2016-24,LL 1404, L 4762,
5	61	Moderately Susceptible	KLB 1442, KLS 14-1, PL 063, DPL 62, IPL 316, PL 175, PL 218, BPL 14, RKL 24C-59, PL 221, L 4710, KLS 218, L-3, PL 210, LL 1318, HUL 57, KLS 1445, IPL 227, IPL 225, RVL 13-7, PL 4, L 4147, VL 26, VL 148, LL 1320, L 4751, LL 1370, PL 406, PL 063, LL 1397, IPL 230, KLS 1431, LL 1388, VL 152, VL 153, BRL-1, BRL-L 4756, L 4757, BPL 16, KLS 218, HUL 57, L 4076, JL 3, DPL 62, IPL 316, RKL 14-20, RVL 13-7, L 4727, RVL 14-4, DPL 15, IPL 406, PL 024, LL 1373, IPL 336, PL 221, LH 84-8,VL 507, RL 6-1, RL 3-5-1, LH 1407, KLB 112, RVL 15-1, RVL 15-4, LL 1396, LL 1467, JLS -1, JLS -3,
7	59	Susceptible	IPL 340, RKL 603-5, RKL 605-3, PL 245, PL 237, VL 527, VL 528, L 4728, L 4729, L 4769, L 4771, RL 7-3, IPL 535, IPL 536, RVL 15-5, L 4772, L 4773, IPL 537, RKL 611-13, IPL 81, LL 1318, PL 165, KLS 1305, VL 146, RVL -11-6, LH 84-8, KLS 13-1, RLG 147, PL 164, PL 138, LL 1255, KLS 09-5, PL-157, KLS 113, PL 160, KLB 13-2, HUL 57, VL 523, LL 1223, PL 153, RLG 161, IPL 531, RL-3CC, PL 166, LL 1277, VL 1209, VL 147, LL 1242, RL 6-4, RVL 11-5, IPL 346,
9	57	Highly Susceptible	IPL 221, IPL 226, IPL 328, IPL 220, IPL-406, DPL 62, DPL 15, RL 7-2, IPL 327, IPL 81, IPL 225, IPL 329, IPL 330, IPL 533, IPL 315, IPL 532, IPL 219, IPL 325, L 4710, IPL 526, IPL 321, IPL 215, IPL 331, IPL 332, IPL 534, IPL 222, L 4721, L 4712, L 4717, L 4076,L9-12, PL 166, LL 1277, VL 1209, VL 147, LL 1242, RL 6-4, RVL 11-5, IPL 346, IPL 221, IPL 226, IPL 328, IPL 220, IPL-406, DPL 62, DPL 15, RL 7-2, IPL 327, IPL 81, IPL 225, IPL 329, IPL 330, IPL 533, IPL 315, IPL 532, IPL 219, IPL 325, L 4710, IPL 526, IPL 321, IPL 215, IPL 331, IPL 332, IPL 534, IPL 222, L 4721, L 4712, L 4717, L 4076, LL 1054, LL 921, L 4678, L 4686, NDL 5-5, VL 148, LL 1370, VL 151, IPL 333, PL 4, LL 1375, RLG 195, L 4727, RVL 14-4, L 4737, RKL 607-1, L 4147,

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