Int.J.Curr.Microbiol.App.Sci (2018) *7*(9): 1441-1450

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 09 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.709.173

Evaluation of Powdery Mildew Resistant Lines of Garden Pea (*Pisum sativum* L.) under Mid Hill Conditions of Himachal Pradesh

Aziz-Ur-Rahman[1*], R. Rathour[2], Viveka Katoch[1] and S.S. Rana[3]

[1]Department of Vegetable Science and Floriculture, [2]Department of Agricultural Biotechnology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur – 176062, HP, India
[3]Department of Agronomy, Forage and Grassland Management, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur – 176062, HP, India

**Corresponding author*

Keywords

Garden pea, Powdery mildew, Yield, Yield attributes, Quality, Resistant lines

Article Info

Accepted:
10 August 2018
Available Online:
10 September 2018

A B S T R A C T

Field study consisting of seven lines *viz.*, APL-55, APL-69, APL-80, APL-64, APL-84, Line 1-2-SPS5, Line 1-2-SPS11, along with four checks viz., Azad Pea-1, Lincoln, Punjab-89 and Palam Priya was conducted to identify high yielding powdery mildew resistant line(s) under conventional and natural farming conditions at Palampur during *rabi* seasons 2015-16 and 2016-17. Data were recorded on yield and related yield contributing traits including powdery mildew incidence. Experimental findings revealed higher yield under conventional farming condition in comparison to the natural farming condition. Under conventional farming conditions, highest number of pods per plant (19.2) with maximum length of pod (10.2 cm), higher number of seeds per pod (9.3) and more number of primary number of branches per plant (2.2) was observed in Line 1-2SPS5. Line 1-2SPS5 gave significantly highest yield (211.5 q/ha) followed by Line 1-2SPS11 (206.0 q/ha). Similarly in natural farming condition maximum number of pods per plant (9.2), higher length of pod (7.5 cm), more number of seeds per pod (7.0), more number of primary branches per plant (1.1) and higher pod yield (78.0 q/ha) was noted in Line 1-2SPS5 followed by Line 1-2SPS11 (72.3 q/ha). Line 1-2-SPS5 exhibited resistance to powdery mildew disease and was also superior with respect to yield contributing traits like pod length, number of seeds/pod, number of pods/plant, pod yield/plant (g) and pod yield (q/ha) under both conventional and natural farming conditions.

Introduction

Garden pea (*Pisum sativum* L.), a member of Papilionaceae family, is one of the principal vegetable crops originated in Central Asia and Abyssinian region, grown during cool season throughout the world. At the global level, garden pea covers an area of about 2.58 million hectares with a production of 19.87 million tonnes and productivity of 7.67 tonnes per hectare (Anonymous 2016). Pea is an important vegetable crop grown throughout India for its tender and immature pods. It is grown as winter vegetable in the plains of

northern India. In India, it occupies an area of 545.89 thousand hectares with the production of 5451.62 thousand tonnes and productivity of 9.99 tonnes per hectare (Anonymous 2017a). In Himachal Pradesh garden pea is cultivated in 30 per cent of the total area under vegetable crops in the state and ranks first in acreage by covering an area of 23.65 thousand hectares with annual production of 277.20 thousand tonnes and productivity of 11.87 tonnes per hectare (Anonymous 2017b).

Of late, garden pea production has suffered because of attack of a number of fungal and bacterial diseases but powdery mildew disease caused by *Erysiphe pisi* DC is one of the most important and widely prevalent which affect fresh pea production all over the world. The disease also significantly reduces the quality of marketable produce. Under Indian conditions, sweet, long, well filled and dark green pods are preferred by the consumers. The age old varieties like 'Azad P-1', 'Lincoln' and 'Arkel' are still popular amongst the growers though they are highly susceptible to powdery mildew diseases. Therefore, it is pertinent to develop suitable variety(ies) possessing sweet, long, well filled and dark green pods coupled with high yield and resistance to powdery mildew. In the recent past, the organic or natural farm produce has gained much popularity and is fetching premium price. Thus cultivation of resistant cultivars under organic conditions would be highly desirable. Keeping these facts in mind, present study was undertaken to evaluate promising pea genotypes both under conventional and natural farming conditions.

Materials and Methods

The present investigation was carried out at Palampur (1290.8m above mean sea level with 32^{o} 6' N latitude and 76^{o} 3' E longitude) during *rabi* 2015-16 and 2016-17. The location represents the mid-hill zone of Himachal Pradesh and is characterized by humid and temperate climate with an annual rainfall of 2,500 mm of which 80% is received during June to September. The mean weekly (45^{th} standard week to 12^{th} standard week) daily max and min temperature ranged from 13.1 to 23.2 and 3.2 to 11.0 °C during 2015-16 and from 11.6 to 24.1 and 1.7-14.7°C during 2016-17. Relative humidity ranged from 39.3-70.1 and 53.1 to 87.4% during the first and second year, respectively. Weekly daily sunshine hours ranged from 5-8 and 2.3-9.6 during the first and second season, respectively. A total of 917.7 and 246.5 mm rainfall was received during the cropping cycle of 2015-16 and 2016-17, respectively. The soil is classified as Alfisolstypic Hapludalf clay having a pH of 5.7.

Seven lines *viz.,* APL-55, APL-69, APL-80, APL-64, APL-84, Line 1-2-SPS5, Line 1-2-SPS11, along with four checks namely, Azad Pea-1, Lincoln, Punjab-89 and Palam Priya were evaluated in randomized block design (RBD) with three replications under conventional and as a separate experiment under natural farming conditions. Every genotype was grown in rows 45cm apart with intra-seed distance of about 5cmconstituting six rows (2.2 m each) per plot (2.70 × 2.30 m) under both conventional and natural farming conditions during *rabi* 2015-16 and 2016-17. Under conventional system, the recommended NPK @ 25:60:60 kg of N, P_2O_5 and K_2O were applied in the rows at the time of sowing. Irrigation was provided prior to sowing and as per the need thereafter. 'Pendimethalin' 1.5 kg /ha was applied immediately after sowing followed by two hand weedings to keep the field weed free. The rest of the management practices were in accordance with the recommended Package of Practices for Vegetable Crops by CSK HPKV, Palampur. Under natural farming conditions *Gan Jeevamrit* @ 494 kg/ha was applied in the rows at the time of sowing and *Jeevamrit* @

494 L/ha was sprayed once before sowing, then later on after 20 days after sowing and 45 days after sowing for better growth. The data were analyzed as per Gomez and Gomez (1984) for randomized complete block design.

The powdery mildew reaction was evaluated by the detached leaf technique of (Vaid and Tyagi, 1997) using a single colony isolate of *Erysiphe pisi* collected from the naturally infected plants of garden pea (Table 1). The culture of the pathogen was propagated and maintained on plants kept under spore-proof chambers. Two-four detached leaflets from garden pea lines/genotypes evaluated in the present study were floated on 40ppm solution of benzimedazole in 90 mm petridishes. The leaflets were dusted with powdery mildew inoculum using a camel hair brush and incubated at 25 ± 1°C under 16 hours photoperiod. After 10 days of inoculation, the disease reaction of the leaflets was assessed microscopically under a stereo-scopic microscope using a 0-4 scale (Vaid and Tyagi, 1997).

Results and Discussion

The data on growth, development, yield and yield attributing traits, and quality of different genotypes evaluated in the present investigation under conventional and natural farming situation are presented in Table 2 and Table 3, respectively.

Growth and development

Significant variation amongst genotypes was observed for plant height both under conventional (Table 2) and natural farming conditions (Table 3). Under conventional farming conditions Line 1-2SPS5 produced tallest plants (74.1 cm) and was statistically at par with APL-64 (72.9 cm), Lincoln (72.4 cm), APL-84 (71.5 cm), APL-55 (71.1 cm), Azad Pea-1 (69.2 cm) and APL-80 (68.4 cm). Under natural (zero budget) farming conditions also Line 1-2SPS5 produced tallest plant (37.2 cm) and was statistically at par with Line 1-2SPS11 (36.1 cm) and Punjab-89 (35.8 cm). Shortest plants were recorded in check Punjab-89 (63.7 cm) under conventional farming and in APL-80 (32.4 cm) under natural farming conditions. Variation in plant height among the evaluated lines may be attributed to their variable genetic makeup and response to environmental conditions. These findings are in conformity with (Natarajan and Arumugam, 1983); Khokhar *et al.,* (1988); Wadan *et al.,* (1993); (Kumar and Kohli, 2001); Hussain *et al.,* (2005) and Singh *et al.,* (2016).

Days to 50 per cent flowering under conventional farming condition varied from 87.3 to 95.5 days (Table 2). APL-80 took minimum days to 50 per cent flowering (87.3 days). The maximum number of days to 50 per cent flowering was observed in the Line 1-2SPS5 (95.5 days). The possible reason for early flowering in few genotypes indicated adaptability of these genotypes in a particular environment. The results corroborate the findings of Qasim *et al.,* (2001) and (Chaudhary and Rana, 2004). Under natural farming conditions also APL-69 took minimum days to 50 per cent flowering (93.7 days) and overall maximum days (100.0 days) to 50 per cent flowering were taken by Line 1-2SPS11 (Table 3). Though, limited research work is available in the literature pertaining to evaluation of garden pea germplasm under organic farming conditions but no systematic research work has been conducted on zero budget farming.

Under conventional farming conditions, check Punjab-89 took significantly lesser number of days (124.0 days) for first picking than all the other lines and checks. Among the lines, Line 1-2SPS5 took 127.0 days to first picking. The variation in number of days to first picking

may be attributed to climatic and genetic factors. Moreover, the early flowering cultivars took lesser days to first picking. These findings are in conformity with the findings of Haq *et al.*, (1997) and Arshad *et al.*, (1998).Under natural (zero budget) farming conditions, APL-69 was found to be the earliest in days to first picking (142.5 days). Under zero budget farming, it is evident from Table 3 that the genotypes which were earlier in days to 50 per cent flowering, in general, took less number of days to first picking.

Yield attributing characters

Under conventional farming conditions maximum pod length (10.2 cm) was recorded in the Line 1-2SPS5. In the present study, the lines varied in respect of pod length because of differences in their genetic make-up. These results are in conformity with those of earlier workers, (Natarajan and Arumugam, 1983) and (Kumar and Kohli, 2001). Under natural (zero budget) farming conditions Line 1-2SPS5 had longest pods. Line 1-2SPS11 was the next desirable strain having long pods to the extent of 7.2 cm. The minimum pod length was recorded in APL-84 (6.4 cm). Line 1-2SPS5 (9.3) excelled in number of seeds per pod over all the other lines under conventional farming conditions. Minimum number of seeds per pod was observed in APL-80 (6.3). Consistent performance of the lines depicted their wider stability/adaptability over varied environments. It was observed that the lines having long pods had more number of seeds than small poded lines. (Natarajan and Arumugam, 1983); Khokhar *et al.*, (1988); Haq *et al.*, (1997); Ali *et al.*, (2003); (Chaudhary and Rana, 2004) and Khan *et al.*, (2013) have also recorded varied number of seeds per pod in their respective studies. Number of seeds per pod was less in all the lines and standard checks under natural farming in comparison to conventional farming conditions. The maximum number of seeds per pod was observed in Line 1-2SPS5 (7.0).

The minimum number of seeds per pod was recorded in APL-84 (5.3). Under conventional farming conditions, maximum pooled shelling percentage was recorded in APL-69 (53.2%) which was statistically at par with APL-55 (51.9%), APL-64 (51.6%), Line 1-2SPS5 (51.5%), APL-84 (51.3%), check Lincoln (50.9%) and APL-80 (50.3%). These results may be supported by the findings of (Natarajan and Arumugam, 1983); (Chaudhary and Rana, 2004) and (Gupta and Singh, 2007) who had also reported varied shelling percentage in their respective studies. Singh *et al.*, (2015) recorded the maximum shelling percentage to the extent of 50.04 per cent in the variety DDR-62. Under natural (zero budget) farming conditions significantly more shelling percentage was recorded in Line 1-2SPS5 (54.4%) than all other lines.

Table.1 Disease rating scale for evaluation of resistance to powdery mildew in garden pea

Scoring scale	Symptoms	Reaction type
0	Macroscopically or microscopically no mycelial growth is evident.	Resistant
1	Microscopically sparse mycelial growth with rare conidiophores is seen.	Resistant
2	Microscopically slight growth of mycelium with a little sporulation is seen and individual conidiophores on a colony can be easily counted.	Resistant
3	Microscopically moderate development of mycelium with moderate to heavy sporulation is seen.	Susceptible
4	Microscopically abundant development of mycelium with heavy to very heavy sporulation is visible.	Susceptible

Table.2 Effect of genotypes on different traits of garden pea under conventional farming condition (mean of 2015-16 and 2016-17)

Trait / Genotypes	Plant height (cm)	Days to 50 % flowering	Days to first picking	Pod Length (cm)	Number of seeds per pod	Shelling percentage	Number of branches per plant	Number of pod per plant	Pod yield per plant (g)	Pod yield (q/ha)
APL-55	71.1	94.0	133.5	8.2	6.7	51.9	1.2	14.8	75.1	150.2
APL-69	65.0	89.0	129.8	8.3	6.8	53.2	1.3	14.3	72.8	145.7
APL-80	68.4	87.3	127.7	8.3	6.3	50.3	1.2	14.7	73.9	147.8
APL-64	72.9	93.5	133.7	8.4	6.9	51.6	1.2	13.7	71.7	143.3
APL-84	71.5	94.3	134.5	8.2	6.6	51.3	1.1	13.5	69.2	138.3
Line 1-2SPS5	74.1	95.5	127.0	10.2	9.3	51.5	2.2	19.2	105.8	211.5
Line 1-2SPS11	64.1	92.5	128.3	10.1	9.1	48.6	1.8	18.8	103.0	206.0
Azad Pea-1	69.2	94.8	134.0	8.8	7.1	46.5	1.2	13.3	72.3	144.7
Lincoln	72.4	88.3	129.3	8.3	7.0	50.9	1.2	15.7	81.5	163.0
Punjab-89	63.7	87.8	124.0	10.1	9.2	48.1	1.6	15.3	83.0	166.0
Palam Priya	65.7	95.0	134.7	8.0	7.4	40.9	1.2	13.2	70.5	141.0
Range	63.7 - 74.1	87.3 - 95.5	124.0-134.7	8.0 - 10.2	6.3 - 9.3	40.9 - 53.2	1.1 - 2.2	13.2 - 19.2	69.2 - 105.8	138.3-211.5
Mean	68.9	91.4	129.3	9.1	7.8	47.1	1.6	16.2	87.5	174.9
SE (m+-)	2.8	0.7	0.6	0.1	0.3	2.2	0.3	0.9	4.7	9.5
LSD (P=0.05)	5.9	1.4	1.4	0.3	0.6	4.6	0.5	2.0	10.1	20.2
CV (%)	5.4	1.0	0.7	2.1	5.2	5.8	24.2	8.1	8.0	8.0

Table.3 Effect of genotypes on different traits of garden pea under natural farming condition (mean of 2015-16 and 2016-17)

Trait / Genotypes	Plant height (cm)	Days to 50 % flowering	Days to first picking	Pod Length (cm)	Number of seeds per pod	Shelling percentage	Number of branches per plant	Number of pod per plant	Pod yield per plant (g)	Pod yield (q/h)
APL-55	33.1	96.3	145.0	6.7	5.3	53.7	1.0	7.8	30.3	60.7
APL-69	32.7	93.7	142.5	6.6	5.2	53.6	1.0	7.8	30.7	61.3
APL-80	32.4	95.2	144.0	6.5	5.2	53.7	1.0	8.0	31.1	62.2
APL-64	32.8	97.5	146.0	6.7	5.2	53.3	1.0	7.7	29.7	59.3
APL-84	32.5	96.8	145.2	6.4	5.3	53.1	1.0	8.1	30.9	61.8
Line 1-2SPS5	37.2	97.5	146.5	7.5	7.0	54.4	1.1	9.2	39.0	78.0
Line 1-2SPS11	36.1	100.0	149.0	7.2	6.9	53.5	1.0	8.7	36.2	72.3
Azad Pea-1	34.1	96.8	145.5	6.9	6.2	53.2	1.0	8.5	33.8	67.5
Lincoln	34.8	95.2	144.0	7.0	5.5	52.8	1.0	8.0	31.0	62.0
Punjab-89	35.8	96.8	145.5	7.2	6.7	53.2	1.0	8.6	33.2	66.3
Palam Priya	33.1	97.8	146.5	6.8	5.3	53.5	1.0	8.3	31.6	63.2
Range	32.4 - 37.2	93.7 - 100.0	142.5-149.0	6.4 - 7.5	5.2 - 7.0	52.8 - 54.4	1.0 - 1.1	7.7 - 9.2	29.7 - 39.0	59.3 - 78.0
Mean	34.8	96.8	145.8	7.0	6.1	53.6	1.0	8.5	34.3	68.7
SE (m+-)	0.8	1.2	0.9	0.1	0.1	0.3	0.03	0.3	0.9	1.8
LSD (P=0.05)	1.7	2.5	1.8	0.2	0.2	0.7	NS	0.5	1.9	3.7
CV (%)	3.2	1.6	0.8	1.4	2.7	0.8	4.6	4.1	3.6	3.6

Table.4 Powdery mildew resistance score of garden pea genotypes

Genotypes	Scores	Reaction
APL-55	1	Resistant
APL-69	1	Resistant
APL-80	1	Resistant
APL-64	2	Moderately Resistant
APL-84	4	Susceptible
Line 1-2SPS5	1	Resistant
Line 1-2SPS11	2	Moderately Resistant
Azad Pea-1	4	Susceptible
Lincoln	4	Susceptible
Punjab-89	4	Susceptible
Palam Priya	4	Susceptible

Under conventional farming conditions, there were significant differences for number of primary branches per plant. However, difference for number of primary branches per plant under natural farming condition was not observed during both the years. Significantly higher number of primary branches per plant under conventional farming was recorded in Line 1-2SPS5 (2.2). The minimum number of primary branches per plant was under APL-84 (1.1).

Pod yield

Significant difference between varieties for number of primary branches per plant has also been reported by earlier workers *viz*., (Chaudhary and Rana, 2004); (Gupta and Singh, 2007); Khan *et al.*, (2013) and (Pal and Singh, 2013).

The data presented in Table 2 showed significant differences among the genotypes for number of pods per plant under conventional farming conditions. Line 1-2SPS5 being statistically at par with Line 1-2SPS11 excelled over all other genotypes with the number of pods per plant to the tune of 19.2 and 18.8, respectively. The minimum number of pods per plant was recorded in the check Palam Priya (13.2). Highest number of pods per plant was recorded in the lines with maximum number of primary branches per plant which might be due to the genetic make-up of the plants. These finding confirmed the results of Nandpuri *et al.*, (1974); Ashfaq *et al.*, (1990) and Arshad *et al.*, (1998). Under natural (zero budget) farming conditions, maximum number of pods per plant was also recorded in Line 1-2SPS5 (9.2), which was significantly different from all other lines and standard checks evaluated in the present study.

Significant differences for pod yield per plant were observed both under conventional and natural farming conditions. The maximum pod yield per plant (105.8 g) was recorded in Line 1-2SPS5. Line 1-2SPS5 was statistically at par with Line1-2SPS11. The minimum pod yield per plant was recorded in the APL-84 (69.2 g). In general, pod yield is a varietal character, but it is also affected by the vigour of plants. Availability of nutrients in adequate amount and other yield contributing traits resulted in optimum performance of few lines. Line 1-2SPS5 and Line 1-2SPS11 had luxuriant growth, more number of pods per plant, long pods, more number of seeds per pod, more number of primary branches per

plant and thus produced highest yield. These findings are in conformity with those of (Natarajan and Arumugam, 1983); Ashfaq *et al.,* (1990) and Kazmi *et al.,* (2002).Under natural (zero budget) farming conditions also Line 1-2SPS5 gave significantly higher pod yield per plant (39.0 g) than all other lines and the standard checks. The other line which gave higher pod yield per plant was Line 1-2SPS11 having 36.2 g pod yield per plant. APL-64 gave the minimum pod yield per plant (29.7 g). Among the check varieties, Azad Pea-1 gave the highest pod yield per plant (33.8 g). Similar trend in pod yield (q/ha) was observed as it was for pod yield per plant. Under conventional farming conditions significant differences were noticed for pod yield (q/ha). The maximum pod yield was recorded in Line 1-2SPS5 (211.5 q/ha) and Line 1-2SPS11 (206.0 q/ha) under conventional farming conditions whereas under natural farming conditions Line 1-2SPS5 recorded the maximum and significantly higher pod yield (78.0 q/ha) than all other lines and the standard checks.

Reaction to powdery mildew

Screening of seven lines along with four commercial checks indicated that all the four commercial checks *viz*., Azad Pea-1, Lincoln, Punjab-89 and Palam Priya, along with APL-84 were susceptible to powdery mildew disease, while APL-64 and Line 1-2SPS11 exhibited moderately resistant reaction (Table 4). The remaining four lines *viz*., APL-55, APL-69, APL-80 and Line 1-2SPS5 exhibited resistant reaction. APL-55, APL-69, APL-80 and Line 1-2SPS5 showed resistant reaction as these lines harbour gene er_2. The results of the present study are supported by the results of earlier researchers who have confirmed expression of resistance to powdery mildew conferred by gene er_2 in pea (Heringa *et al.,* (1969); Ali *et al.,* (1994) and Fondevilla (2006).

The better performance of Line 1-2SPS5 both under conventional and natural farming conditions was exhibited due to more number of pods per plant, long pods with more number of seeds per pod and more number of primary branches per plant and resistant reaction to powdery mildew disease.

References

Ali A, Ishtiaq M and Jan NE. 2003. Effect of *Rhizobium leguminosarum* inoculum on the growth and yield of different pea cultivars. *Sarhad Journal of Agriculture* 19: 55-59

Ali SM, Sharma B and Ambrose MJ. 1994. Current status and future strategy in breeding pea to improve resistance to biotic and abiotic stresses. *Euphytica* 73: 115-126

Anonymous. 2016. Food and Agricultural Organization Quarterly Bulletin of Statistics. FAO, Rome

Anonymous. 2017a. Indian Horticulture Database. National Horticulture Board, Ministry of Agriculture, Government of India, Gurgaon, India

Anonymous. 2017b. Area and production of vegetables in Himachal Pradesh. Directorate of Agriculture (H.P.), Shimla-5

Arshad M, Hussain SA, Asghar S, Ali N, Muhmmad N and Ziaullah. 1998. Screening of pea (*Pisum sativum* L.) cultivars in Kohat valley, Pakistan. *Sarhad Journal of Agriculture* 14: 559-562

Ashfaq M, Asi AR, Tariq M and Ahmad S. 1990. Response of pea cultivars to ergostim (Farmoplant) application. *Journal of Agriculture Research* 28: 441-446

Chaudhary DR and Rana SS. 2004. Genetic variability in some early maturing elite genotypes of garden pea (*Pisum sativum*

L.). *Himachal Journal of Agricultural Research* 30: 60-64

Chaudhary J and Banyal DK. 2017. Evaluation of pea genotypes for resistance against powdery mildew caused by *Erysiphe pisi*. *Indian Phytopathology* 70: 69-74

Fondevilla S, Carver TLW, Moreno MT and Rubiales D. 2006. Macroscopic and histological characterisation of genes er_1 and er_2 for powdery mildew resistance in pea. *European Journal of Plant Pathology* 115: 309–321

Gomez KA and Gomez AA. 1984. Statistical Procedure for Agricultural Research. John Wiley and Sons, New York, p 357-427

Gupta AJ and Singh YV. 2007. Evaluation of garden pea (*Pisum sativum* L.) genotypes for earliness, yield and quality attributes. *Haryana Journal of Horticultural Sciences* 36: 106-110

Haq L, Rehman H and Hussain SA. 1997. Screening of suitable pea cultivars for spring cultivation at Chitral, Pakistan. *Sarhad Journal of Agriculture* 13: 31-34

Heringa RJ, Norel AV and Tazelaar MF. 1969. Resistance to powdery mildew (*Erysiphe polygoni* DC) in peas (*Pisum sativum* L.). *Euphytica* 18: 163-169

Hussain SA, Hussain M, Qasim M and Hussain B. 2005. Performance and economic evaluation of pea varieties at two altitudes in Kaghan Valley. *Sarhad Journal of Agriculture* 21: 587-589

Kazmi MR, Jeelni G and Bhatti MH. 2002. Yield potential of some promising pea cultivars against powdery mildew. *Pakistan Journal of Agriculture Research* 17: 97-98

Khan TN, Ramzan A and Mehmood T. 2013. Morphological performance of peas (*Pisum sativum* L.) genotypes under rainfed conditions of Potowar region. *Journal of Agricultural Research* 51: 51-60

Khichi P, Chandan PM, Chauhan J, Srinivas J and Bhagat M. 2016. Varietal evaluation of garden pea under semi-arid conditions of Vidharba region. *International Journal of Farm Sciences* 6: 20-24

Khokhar KM, Khan AM, Hussain SI, Mahmood T and Rehman H. 1988. Comparative evaluation of some local and foreign pea cultivars. *Pakistan Journal of Agricultural Research* 9: 549-551

Kumar A and Kohli UK. 2001. Evaluation of garden pea genotypes for horticultural traits and resistance against *Fusarium* wilt. *Haryana Journal of Horticultural Science* 30: 217-219

Nandpuri KS, Kumar JC, Singh H and Thakur JC. 1974. Evaluation of pea (*Pisum sativum* L.) varieties for some economic characters in Punjab. *Journal of Research Punjab Agricultural University* 11: 35-40

Natarajan S and Arumugam R. 1983. Evaluation of pea (*Pisum sativum* L.) cultivars for Kodaikanal hills. *South Indian Horticulture* 31: 7-10

Pal AK and Singh S. 2013. Assessment and genetic variability in garden pea (*Pisum sativum* L. var. *hortense*). *International Journal of Agricultural Sciences* 9: 293-296

Qasim M, Zubair M and Wadan D. 2001. Evaluation of exotic cultivars of pea in Swat valley. *Sarhad Journal of Agriculture* 17: 545-548

Ranganna S. 1979. Manual of analysis of fruits and vegetables products. Tata McGraw Hill Book Company, New Delhi

Shahid M, Shah SFA, Ghufranulhaq, Ali H and Ishtiaq S. 2010. Resistance in pea germplasm/lines to powdery mildew

under natural conditions. *Mycopathology* 8: 77-80

Singh J, Dhall KR and Aujla IS. 2015. Characterization of resistance response of garden pea (*Pisum sativum* L.) against powdery mildew (*Erysiphe pisi* DC) in sub-tropical plains of India. *SABRAO Journal of Breeding and Genetics* 47: 384-393

Singh P. 2013. Evaluation of recombinant inbred lines for yield and horticultural traits in garden pea (*Pisum sativum* L.). *M. Sc. Thesis.*, Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India p 57

Singh V, Shah KHN and Rana DK. 2016. Morphological performance of pea (*Pisum sativm* L.) genotypes under valley condition of Garhwal Himalaya region. *Environment and Ecology* 34: 854-857

Tiwari KR, Penner GA and Warkentin TD. 1997. Inheritance of powdery mildew resistance in pea. *Canadian Journal of Plant Science* 77: 307-310

Vaid A and Tyagi PD. 1997.Genetics of powdery mildew resistance in pea. *Euphytica* 96: 203-206

Wadan D, Khan M, Khan S and Majeed A. 1993. Performance of pea cultivars in various agroclimatic conditions of Swat, Pakistan. *Sarhad Journal of Agriculture* 9: 139-143

How to cite this article:

Aziz-Ur-Rahman, R. Rathour, Viveka Katoch and Rana, S.S. 2018. Evaluation of Powdery Mildew Resistant Lines of Garden Pea (*Pisum sativum* L.) under Mid Hill Conditions of Himachal Pradesh. *Int.J.Curr.Microbiol.App.Sci.* 7(09): 1441-1450.
doi: https://doi.org/10.20546/ijcmas.2018.709.173