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Screening of rose genotypes for resistance against powdery mildew disease

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Abstract

A total of fifty five rose genotypes were screened against natural incidence of powdery mildew disease caused by *Podosphaera pannosa*, under a naturally ventilated polyhouse. Evaluation trial was conducted for two seasons during 2015-16 and 2016-17 to screen rose genotypes for their reaction to powdery mildew. The pooled apparent infection rate (r) of disease calculated for both seasons has showed a wide variation among genotypes. Based on per cent disease index (PDI), genotypes were categorized into different classes as tolerant (0-10 PDI), moderately tolerant (10.1-20 PDI), moderately susceptible (20.1-30 PDI) and highly susceptible (>40 PDI) to powdery mildew. Further, it was found that the accumulation of disease was low in case of moderately susceptible varieties compared to highly susceptible ones as indicated by the area under disease progression curve (AUDPC).

Keywords: Rose, field screening, powdery mildew, *Podosphaera pannosa*, AUDPC, resistance

Introduction

Powdery mildew, caused by an obligate parasite *Podosphaera pannosa* (Wallr.: Fr.) de Bary (syn.: *Sphaerotheca pannosa* (Wallr.: Fr.) Lév.) is one of the most serious diseases of roses grown in polyhouse and open field. The symptoms appear as white, conspicuous powdery growth that affects all aerial parts of plant predominantly the new soft growth, producing chains of conidia that spread the disease. Affected parts of leaves show reddish discolored areas and heavily infected leaves become twisted and distorted. Mature leaves are less frequently infected. Heavily infected flower buds fail to open properly. This results in reduced plant vigor and yield and unsightly appearance of plants. To control this disease, it needs repeated sprays of preventive fungicides depending upon the environmental conditions and disease severity. This leads to increased cost of cultivation, environmental contamination and evolution of resistance in pathogens against fungicides. This can be addressed by developing resistant varieties through disease resistance breeding which needs a resistance source. This study was conducted to identify the powdery mildew resistance source by evaluating the available germplasm against natural infection of powdery mildew under a naturally ventilated polyhouse.

Material and Methods

The present investigation was carried out during 2015-2017 at ICAR-IIHR, Bengaluru, which is geographically located at 13° 58' N Latitude, 78° 0' E Longitude and at an elevation of 890 m above mean sea level with an average rainfall of about 890 mm. The weather data recorded during the investigation period was as followed; maximum temperature 27.77 °C, minimum temperature 17.04 °C and relative humidity 80.55% (during November 2015 to January 2016) and the maximum temperature 27.28 °C, minimum temperature 16.20 °C and relative humidity 70.41% (during November 2016 to January 2017).

i. Plant material

The rose genotypes investigated in the present study were part of rose breeding programme at ICAR-Indian Institute of Horticultural Research, Bengaluru. A total of fifty-five rose genotypes were used in present study. Plants were provided with all inputs as per the package of practices for rose cultivation except for fungicidal sprays during the period of investigation. A total of five observations were taken at fortnight intervals from November-January during two seasons i.e., 2015-16 and 2016-17.

ii. Observations recorded

a) Disease severity

Selected plants from each genotype were labeled and same plants were evaluated against natural infection of powdery mildew under a naturally ventilated polyhouse during each season. The genotypes were given scores for disease severity at fortnight intervals on a 0-5 rating scale (Leus, 2005) [6]. Per cent disease index of genotypes was worked out (FAO, 1967) [4] and the genotypes were categorized as tolerant (0-10% PDI), moderately tolerant (10.1-20% PDI), moderately susceptible (20.1-30% PDI), susceptible (30.1-40% PDI) and highly susceptible (>40% PDI) (Amin *et al.*, 2016) [1].

$$PDI = \frac{\text{Sum of Scores} \times 100}{\text{Maximum rating Number of observations}}$$

b) Apparent infection rate (r)

The speed of the disease spread was measured by calculating apparent infection rate (r). Disease incidence data recorded at fortnight intervals during two seasons was used and the apparent infection rate was calculated as described by Van der Plank (1968) [9].

$$r = 2.3/t_2 - t_1 \{ \log (X_2(1-X_1)/X_1(1-X_2)) \}$$

Where, *r* is the apparent infection rate in non-logarithmic phase, *X₁* is the disease index at time *t₁*, *X₂* is the disease index at subsequent time *t₂*.

c) Area under disease progression curve (AUDPC)

AUDPC is the measure of speed the pathogen progresses in the plant tissues. The AUDPC was computed based on the disease scores using the following formula (Jeger and Rollinson, 2001) [5].

$$AK = \sum_{i=1}^{N_i-1} \frac{(y_i + y_{i+1})}{2} (t_{i+1} - t_i)$$

where, *y_i* is the proportion of disease on the *ith* observation, *t_i* is the time (days) of observation and *n* is the total number of readings taken throughout the experimental period.

Results and discussion

a) Disease severity

The genotypes screened against natural incidence of powdery mildew disease showed differential response to the disease during two seasons.

The perusal of screening data during 2015-16 revealed that with progression of observation time period, there was increasing trend in disease severity also (Table 1). Further, the mean disease severity (mean PDI of five intervals) of genotypes ranged between 26.00 to 43.60 per cent (Table 1). The variety Five Star recorded the lowest disease severity (26%) while highest severity was recorded in variety White Tineke (43.60%), White Miniature (43.20%) and Aczatica (43.20%) which were on par with each other. Further, the variety Red Five Star recorded the next minimum disease severity of 26.80 per cent.

The same increasing trend in disease severity was observed during 2016-17 also with progression of observation time period (Table 2). The mean disease severity (mean PDI of five intervals) ranged between 28 to 46 per cent (Table 2). The variety Five Star recorded the lowest disease severity (28%) whereas the variety Grand Gala recorded the highest

severity (46%). Further the variety Orange Baby recorded a disease severity of 28.80 per cent.

Further, the analysis of pooled data for two seasons (Table 3), indicated that maximum disease severity was recorded in Taj Mahal (42.70%), which was on par with White Miniature (42.60%), Royal Circus (42.40%) and Grand Gala (42.20%). The variety Five Star recorded lowest disease severity (27.00%).

Similar results were reported by Amin *et al.* (2016) [1] who evaluated 36 rose cultivars against natural incidence of powdery mildew and reported First red and Confetti as highly susceptible to disease. Deepali (2014) [3] also reported varied per cent disease intensity among the rose cultivars evaluated against powdery mildew infection.

Further, the genotypes were categorized into different classes of resistance based on the PDI values. The analysis of pooled data of two years revealed that none of the varieties was found to be tolerant (0-10%) and moderately tolerant (10.1-20%) to the disease. Two varieties namely Five Star and Red Five Star were found moderately susceptible to powdery mildew disease. Eight varieties namely Sophia Gold, IIHRR 9-6, White Tineke, Aczatica, Grand Gala, White Miniature, Taj Mahal and Royal Circus were found highly susceptible (>40%) to the disease whereas the remaining 45 varieties namely Orange Baby, Charisma, Ruby Star, IIHRR 301, Bugatti, Yellow Babe, IIHRR 9-8, IIHRR 9-22, IIHRR 13-31, Red Venessa, Odilla, Modi Red, IIHRR 9-16, IIHRR 9-2, Fancy, Aishwarya, Shanthi, Ruby Pink, IIHRR 9-1, IIHRR 13-24, Shakira, Rubycon, Mirable, IIHRR 9-11, Tomota, IIHRR 13-39, Single Orange, IIHRR 9-5, Gold Strike, Confetti, Gilli, Kulchi Red, Noblesse, IIHRR 9-4, Mango Yellow, Venessa, Carvetti, IIHRR 9-24, Scent Rose, IIHRRSG, First Red, Bonear, IIHRR 9-9, IIHRR 13-28 and Tropical Amazone showed susceptible (30.1-40% PDI) reaction to the disease.

The present findings are in agreement with the findings of Amin *et al.* (2016) [1] who evaluated 36 rose cultivars against powdery mildew and categorized genotypes on similar scale into different classes of resistance. Similarly screening of rose genotypes against natural incidence by *P. pannosa* was done at Ahrensburg, Germany by Schulz *et al.* 2009 [8], who reported 56 accessions as resistant to the pathogen.

b) Apparent infection rate (r)

The pooled apparent infection rate (r) of powdery mildew disease calculated per unit per day for both seasons has showed a wide variation among genotypes (Table 3). The highest apparent infection rate was observed in Taj Mahal (0.51), White Miniature (0.51), Aczatica (0.51), Arka Ivory (0.51), Grand Gala (0.51), Royal Circus (0.51), Sophia Gold (0.51) and White Tineke (0.51) which were categorized as highly susceptible to the disease. Five Star which was moderately susceptible has recorded lowest 'r' value as 0.34. Further, other two moderately susceptible varieties i.e. Red Five Star and Ruby Star have recorded 0.44 and 0.45 respectively. These results revealed that the disease kept on progressing at a faster rate in case of susceptible ones and comparatively at a slower rate in case of the moderately susceptible genotypes. It was assumed that the host-pathogen interactions and susceptibility of host coupled with climatic conditions might have triggered disease infection at more speed in highly susceptible cultivars compared to moderately susceptible cultivars. Nagesha and Nargund (2005) [7] reported highest average 'r' value in susceptible sunflower varieties

and lowest average 'r' value in slow rust varieties of sunflower.

c) Area under disease progression curve (AUDPC)

Regarding pooled mean of AUDPC over two seasons (Table 3 & fig 1), it was found that Taj Mahal variety has highest AUDPC (2613.75) which was highly susceptible to disease. Five Star has recorded lowest AUDPC of 1597.50 followed by Red Five Star (1657.50) which were found as moderately

susceptible. Results revealed that no variety was found to be tolerant or resistant to powdery mildew. As indicated by the AUDPC, the accumulation of disease was comparatively low in case of moderately susceptible varieties than highly susceptible ones. Nagesha and Nargund (2005) [7] and Chandramouli (1992) [2] also reported lower values of AUDPC in slow rust varieties and higher values in susceptible varieties of sunflower and cowpea, respectively.

Table 1: Incidence of powdery mildew in different rose genotypes screened under polyhouse during 2015-16

S. No.	Genotype	*Per cent disease index (PDI) at fortnight intervals					*Mean PDI during the season
		I	II	III	IV	V	
1.	Aczatica	18.00 (10.37) c	32.00 (18.66) c	48.00 (28.67) a	56.00 (34.05) a	62.00 (38.30) a	43.20 (26.01) a
2.	Aishwarya	12.00 (6.89) f	26.00 (15.06) f	34.00 (19.87) h	48.00 (28.68) ed	52.00 (31.32) ef	34.40 (20.36) urtsv
3.	Arka Ivory	22.00 (12.70) a	36.00 (21.09) b	44.00 (26.09) c	52.00 (31.32) cb	56.00 (34.05) cd	42.00 (25.05) dc
4.	Bugatti	8.00 (4.59) h	18.00 (10.37) j	32.00 (18.66) i	42.00 (24.83) g	54.00 (32.67) ed	30.80 (18.22) z
5.	Bonear	14.00 (8.04) e	29.00 (16.85) de	41.00 (24.20) de	49.00 (29.33) d	54.00 (32.68) ed	37.40 (22.22) jki
6.	Charisma	20.00 (11.53) b	28.00 (16.25) e	32.00 (18.66) i	46.00 (27.38) ef	54.00 (32.68) ed	36.00 (21.30) nmo
7.	Corvette	18.00 (10.37) c	24.00 (13.88) g	38.00 (22.33) f	48.00 (28.68) ed	56.00 (34.05) cd	36.80 (21.86) kl
8.	Fancy	10.00 (5.74) g	20.00 (11.53) i	34.00 (19.87) h	48.00 (28.67) ed	58.00 (35.45) cb	34.00 (20.25) uwtsv
9.	First Red	12.00 (6.89) f	26.00 (15.06) f	38.00 (22.33) f	48.00 (28.68) ed	58.00 (35.44) cb	36.40 (21.68) ml
10.	Five Star	18.00 (10.37) c	14.00 (8.04) l	22.00 (12.70) l	36.00 (21.09) h	40.00 (23.57) i	26.00 (15.16) c
11.	Gilli	12.00 (6.89) f	24.00 (13.88) g	36.00 (21.09) g	46.00 (27.38) ef	62.00 (38.32) a	36.00 (21.51) nml
12.	Gold Strike	14.00 (8.04) e	32.00 (18.66) c	36.00 (21.09) g	42.00 (24.82) g	46.00 (27.38) h	34.00 (20.00) wv
13.	Grand Gala	18.00 (10.37) c	28.00 (16.25) e	36.00 (21.09) g	54.00 (32.67) ab	56.00 (34.05) cd	38.40 (22.89) gf
14.	IIHRR 13-24	14.00 (8.04) e	24.00 (13.88) g	36.00 (21.09) d	42.00 (24.83) g	52.00 (31.32) ef	33.60 (19.83) wx
15.	IIHRR 13-28	20.00 (11.53) b	32.00 (18.66) c	42.00 (24.83) g	50.00 (29.99) cd	62.00 (38.30) a	41.20 (24.66) d
16.	IIHRR 13-31	12.00 (6.89) f	24.00 (13.88) g	40.00 (23.57) e	46.00 (27.38) ef	48.00 (28.68) gh	34.00 (20.08) uwv
17.	IIHRR 13-39	12.00 (6.89) f	22.00 (12.70) h	34.00 (19.87) h	48.00 (28.67) ed	62.00 (38.31) a	35.60 (21.29) nmo
18.	IIHRR 301	10.00 (5.74) g	24.00 (13.88) g	38.00 (22.32) f	42.00 (24.83) g	56.00 (34.05) cd	34.00 (20.16) uwtv
19.	IIHRR 9-1	14.00 (8.04) e	22.00 (12.70) h	38.00 (22.33) f	44.00 (26.09) gf	58.00 (35.44) cb	35.20 (20.92) qpo
20.	IIHRR 9-11	14.00 (8.04) e	28.00 (16.25) e	38.00 (22.32) f	48.00 (28.68) ed	52.00 (31.32) ef	36 (21.32) nmo
21.	IIHRR 9-16	12.00 (6.89) f	24.00 (13.88) g	32.00 (18.66) i	44.00 (26.10) gf	58.00 (35.44) cb	34.00 (20.19) uwtsv
22.	IIHRR 9-2	12.00 (6.89) f	18.00 (10.37) j	36.00 (21.09) g	44.00 (26.10) gf	60.00 (36.86) ab	34.00 (20.26) uwtsv
23.	IIHRR 9-22	14.00 (8.04) e	26.00 (15.06) f	34.00 (19.87) h	44.00 (26.10) gf	50.00 (29.99) gf	33.60 (19.81) wx
24.	IIHRR 9-24	10.00 (5.74) g	22.00 (12.70) h	36.00 (21.09) d	48.00 (28.68) ed	56.00 (34.04) cd	34.40 (20.45) uqrtsv
25.	IIHRR 9-4	20.00 (11.53) b	30.00 (17.45) d	42.00 (24.83) d	48.00 (28.68) ed	56.00 (34.05) cd	39.20 (23.31) f
26.	IIHRR 9-5	16.00 (9.20) d	22.00 (12.70) h	34.00 (19.87) h	46.00 (27.38) ef	58.00 (35.45) cb	35.20 (20.92) qpo
27.	IIHRR 9-8	12.00 (6.89) f	22.00 (12.70) h	32.00 (18.66) i	44.00 (26.10) gf	54.00 (32.67) ed	32.80 (19.40) yx
28.	IIHRR 9-9	14.00 (8.04) e	28.00 (16.25) e	36.00 (21.09) g	48.00 (28.67) ed	58.00 (35.44) cb	36.80 (21.90) jkl
29.	IIHRSG	14.00 (8.04) e	26.00 (15.06) f	38.00 (22.32) f	52.00 (31.33) cb	60.00 (36.86) ab	38.00 (22.72) gh
30.	Confetti	16.00 (9.20) d	20.00 (11.53) i	34.00 (19.87) h	48.00 (28.68) ed	56.00 (34.05) cd	34.80 (20.67) qrps
31.	Kulchi Red	18.00 (10.37) c	26.00 (15.06) f	38.00 (22.33) f	46.00 (27.38) ef	52.00 (31.32) ef	36.00 (21.29) nmo
32.	Mango Yellow	18.00 (10.37) c	26.00 (15.06) f	34.00 (19.87) h	46.00 (27.38) ef	54.00 (32.67) ed	35.60 (21.07) npo
33.	Mirable	12.00 (6.89) f	32.00 (18.66) c	36.00 (21.09) g	48.00 (28.68) ed	52.00 (31.32) ef	36.00 (21.33) nmo
34.	Modi Red	12.00 (6.89) f	28.00 (16.25) e	38.00 (22.33) f	44.00 (26.09) gf	52.00 (31.32) f	34.80 (20.58) qrts
35.	Noblesse	12.00 (6.89) f	26.00 (15.06) f	38.00 (22.33) f	52.00 (31.32) cb	58.00 (35.45) cb	37.20 (22.21) jki
36.	Odilla	14.00 (8.04) e	24.00 (13.88) g	32.00 (18.66) i	44.00 (26.09) gf	58.00 (35.44) cb	34.40 (20.42) urtsv
37.	Orange Baby	14.00 (8.04) e	26.00 (15.06) f	38.00 (22.33) f	44.00 (26.09) gf	54.00 (32.68) ed	35.20 (20.84) qrpo
38.	Red Five Star	10.00 (5.74) g	16.00 (9.20) k	26.00 (15.06) k	34.00 (19.87) h	48.00 (28.67) gh	26.80 (15.71) b
39.	Red Venessa	12.00 (6.89) f	26.00 (15.06) f	36.00 (21.09) g	42.00 (24.83) g	48.00 (28.67) gh	32.80 (19.31) y
40.	Royal Circus	18.00 (10.37) c	30.00 (17.45) d	42.00 (24.83) d	54.00 (32.67) ab	58.00 (35.45) cb	40.40 (24.15) e
41.	Ruby Pink	18.00 (10.37) c	26.00 (15.06) f	38.00 (22.32) f	48.00 (28.67) ed	54.00 (32.67) ed	36.80 (21.82) kl
42.	Rubycon	16.00 (9.20) d	28.00 (16.25) e	36.00 (21.09) g	48.00 (28.67) ed	54.00 (32.67) ed	36.40 (21.58) ml
43.	Ruby Star	14.00 (8.04) e	18.00 (10.37) j	28.00 (16.25) j	34.00 (19.87) h	56.00 (34.04) cd	30.00 (17.72) a
44.	Scent Rose	16.00 (9.20) d	24.00 (13.88) g	36.00 (21.09) g	50.00 (29.99) cd	58.00 (35.44) cb	36.80 (21.92) jkl
45.	Shakira	16.00 (9.20) d	28.00 (16.25) e	36.00 (21.09) g	42.00 (24.83) g	56.00 (34.04) cd	35.60 (21.08) npo
46.	Shanthi	12.00 (6.89) f	20.00 (11.53) i	34.00 (19.87) h	48.00 (28.68) ed	58.00 (35.44) cb	34.40 (20.48) uqrtsv
47.	Single Orange	12.00 (6.89) f	22.00 (12.70) h	34.00 (19.87) h	46.00 (27.38) ef	56.00 (34.04) cd	34.00 (20.18) uwtv
48.	Sophia Gold	14.00 (8.04) e	38.00 (22.33) a	44.00 (26.09) c	56.00 (34.05) a	60.00 (36.87) ab	42.40 (25.48) bc
49.	Taj Mahal	18.00 (10.37) c	35.00 (20.48) b	46.00 (27.38) b	53.00 (32.00) b	57.00 (34.74) c	41.80 (24.99) dc
50.	Tomota	14.00 (8.04) e	32.00 (18.66) c	42.00 (24.83) d	48.00 (28.67) ed	54.00 (32.68) ed	38.00 (22.58) ghi
51.	Tropical Amazon	20.00 (11.53) b	26.00 (15.06) f	38.00 (22.33) f	46.00 (27.38) ef	58.00 (35.44) cb	37.60 (22.35) jhi
52.	Venessa	14.00 (8.04) e	24.00 (13.88) g	38.00 (22.33) f	52.00 (31.32) cb	60.00 (36.86) ab	37.60 (22.49) ghi
53.	White Miniature	20.00 (11.53) b	36.00 (21.09) b	48.00 (28.67) a	52.00 (31.32) cb	60.00 (36.86) ab	43.20 (25.90) ba
54.	White Tineke	22.00 (12.70) a	36.00 (21.09) b	48.00 (28.67) a	52.00 (31.33) cb	60.00 (36.86) ab	43.60 (26.13) a
55.	Yellow Babe	18.00 (10.37) c	24.00 (13.88) g	38.00 (22.32) f	44.00 (26.10) gf	50.00 (29.99) gf	34.80 (20.53) uqrts

Total mean	14.84 (8.53)	25.96 (15.07)	36.96 (21.72)	46.80 (27.94)	55.44 (33.71)	36.00 (21.39)
SE(m)	0.12	0.23	0.30	0.49	0.59	0.051
C.D @ 5%	0.34	0.65	0.86	1.40	1.70	0.147

*Mean of five fortnight intervals (November-January) during each season. Figures within parentheses are arc sine transformed values.

Table 2: Incidence of powdery mildew in different rose genotypes screened under polyhouse during 2016-17

S. No.	Genotype	*Per cent disease index (PDI) at fortnight intervals					*Mean PDI during the season
		I	II	III	IV	V	
1.	Aczatica	22.00 (12.70) b	32.00 (18.66) c	42.00 (24.83) c	48.00 (28.67) ef	58.00 (35.44) cd	40.40 (24.06) gh
2.	Aishwarya	14.00 (8.04) f	26.00 (15.06) f	36.00 (21.09) f	48.00 (28.68) ef	56.00 (34.05) de	36.00 (21.39) vstuywx
3.	Arka Ivory	18.00 (10.37) d	28.00 (16.25) e	42.00 (24.83) c	54.00 (32.67) bc	60.00 (36.86) bc	40.40 (24.19) gf
4.	Bugatti	14.00 (8.04) f	24.00 (13.88) g	38.00 (22.32) e	54.00 (32.67) bc	60.00 (36.87) bc	38.00 (22.76) lmn
5.	Bonear	18.00 (10.37) d	26.00 (15.06) f	40.00 (23.57) d	52.00 (31.33) cd	56.00 (34.04) de	38.40 (22.87) lmk
6.	Charisma	10.00 (5.74) h	18.00 (10.37) j	32.00 (18.66) h	38.00 (22.33) i	48.00 (28.68) hi	29.20 (17.15) ed
7.	Corvette	20.00 (11.53) c	28.00 (16.25) e	38.00 (22.32) e	44.00 (26.09) gh	58.00 (35.44) cd	37.60 (22.33) pon
8.	Fancy	22.00 (12.70) b	30.00 (17.45) d	36.00 (21.09) f	44.00 (26.10) gh	48.00 (28.68) hi	36.00 (21.20) vazywx
9.	First Red	14.00 (8.04) f	28.00 (16.25) e	34.00 (19.87) g	54.00 (32.67) bc	64.00 (39.78) a	38.80 (23.32) ijk
10.	Five Star	10.00 (5.74) h	22.00 (12.70) h	28.00 (16.25) i	34.00 (19.87) j	46.00 (27.38) i	28.00 (16.39) f
11.	Gilli	16.00 (9.20) e	24.00 (13.88) g	32.00 (18.66) h	56.00 (34.04) ab	60.00 (36.87) bc	37.60 (22.53) pomn
12.	Gold Strike	20.00 (11.53) c	32.00 (18.66) c	42.00 (24.83) c	48.00 (28.68) ef	50.00 (29.99) gh	38.40 (22.74) lomn
13.	Grand Gala	24.00 (13.88) a	38.00 (22.33) a	48.00 (28.68) a	58.00 (35.45) a	62.00 (38.30) ab	46.00 (27.73) a
14.	IIHRR 13-24	14.00 (8.04) f	24.00 (13.88) g	40.00 (23.57) d	52.00 (31.32) cd	58.00 (35.44) cd	37.60 (22.45) pomn
15.	IIHRR 13-28	18.00 (10.37) d	24.00 (13.88) g	36.00 (21.09) f	48.00 (28.68) ef	64.00 (39.78) a	38.00 (22.76) lmn
16.	IIHRR 13-31	14.00 (8.04) f	28.00 (16.25) e	36.00 (21.09) f	42.00 (24.83) h	58.00 (35.44) cd	35.60 (21.13) vazywx
17.	IIHRR 13-39	16.00 (9.20) e	28.00 (16.25) e	36.00 (21.09) f	50.00 (29.99) de	52.00 (31.32) fg	36.40 (21.57) vstur
18.	IIHRR 301	14.00 (8.04) f	26.00 (15.06) f	34.00 (19.87) g	48.00 (28.68) ef	50.00 (29.99) gh	34.40 (20.33) cb
19.	IIHRR 9-1	12.00 (6.89) g	26.00 (15.06) f	38.00 (22.32) e	46.00 (27.38) gh	58.00 (35.44) cd	36 (21.32) vtzywx
20.	IIHRR 9-11	16.00 (9.20) e	24.00 (13.88) g	42.00 (24.83) c	48.00 (28.68) ef	50.00 (29.99) gh	36.00 (21.42) vstuwx
21.	IIHRR 9-16	12.00 (6.89) g	24.00 (13.88) g	38.00 (22.33) e	44.00 (26.10) gh	62.00 (38.31) ab	36.00 (21.50) vstuw
22.	IIHRR 9-2	14.00 (8.04) f	26.00 (15.06) f	34.00 (19.87) g	48.00 (28.68) ef	58.00 (35.44) cd	36.00 (21.42) vstuwx
23.	IIHRR 9-22	16.00 (9.20) e	24.00 (13.88) g	36.00 (21.09) f	48.00 (28.68) ef	54.00 (32.68) ef	35.60 (21.11) vazywx
24.	IIHRR 9-24	16.00 (9.20) e	34.00 (19.87) b	42.00 (24.82) c	52.00 (31.32) cd	58.00 (35.44) cd	40.40 (24.13) gh
25.	IIHRR 9-4	14.00 (8.04) f	22.00 (12.70) h	34.00 (19.87) g	46.00 (27.38) fg	60.00 (36.86) bc	35.20 (20.97) azyx
26.	IIHRR 9-5	14.00 (8.04) f	26.00 (15.06) f	34.00 (19.87) g	50.00 (29.99) de	62.00 (38.30) ab	37.20 (22.25) poq
27.	IIHRR 9-8	12.00 (6.89) g	24.00 (13.88) g	38.00 (22.32) e	48.00 (28.67) ef	60.00 (36.86) bc	36.40 (21.72) stur
28.	IIHRR 9-9	20.00 (11.53) c	32.00 (18.66) c	42.00 (24.83) c	52.00 (31.32) cd	60.00 (36.86) bc	41.20 (24.64) ef
29.	IIHRSG	22.00 (12.70) b	28.00 (16.25) e	34.00 (19.87) g	46.00 (27.38) fg	54.00 (32.67) ef	36.80 (21.78) stqr
30.	Confetti	14.00 (8.04) f	26.00 (15.06) f	38.00 (22.33) e	52.00 (31.32) cd	60.00 (36.87) bc	38.00 (22.72) lomn
31.	Kulchi Red	10.00 (5.74) h	24.00 (13.88) g	44.00 (26.09) b	52.00 (31.32) cd	58.00 (35.44) cd	37.60 (22.49) pomn
32.	Mango Yellow	20.00 (11.53) c	34.00 (19.87) b	38.00 (22.33) e	46.00 (27.38) fg	56.00 (34.05) de	38.80 (23.03) ljk
33.	Mirable	14.00 (8.04) f	28.00 (16.25) e	38.00 (22.33) e	48.00 (28.67) ef	50.00 (29.99) gh	35.60 (21.06) azywx
34.	Modi Red	12.00 (6.89) g	24.00 (13.88) g	36.00 (21.09) f	48.00 (28.67) ef	56.00 (34.05) de	35.20 (20.92) azy
35.	Noblesse	14.00 (8.04) f	20.00 (11.53) i	36.00 (21.09) f	54.00 (32.67) bc	60.00 (36.86) bc	36.80 (22.04) pqr
36.	Odilla	18.00 (10.37) d	26.00 (15.06) f	34.00 (19.87) g	46.00 (27.38) fg	52.00 (31.33) fg	35.20 (20.80) ab
37.	Orange Baby	12.00 (6.89) g	26.00 (15.06) f	32.00 (18.66) h	34.00 (19.87) j	40.00 (23.57) j	28.80 (16.81) ef
38.	Red Five Star	12.00 (6.89) g	20.00 (11.53) i	26.00 (15.06) j	38.00 (22.33) i	52.00 (31.32) fg	29.60 (17.43) d
39.	Red Venessa	14.00 (8.04) f	32.00 (18.66) c	38.00 (22.33) e	48.00 (28.67) ef	52.00 (31.33) fg	36.80 (21.81) stqr
40.	Royal Circus	22.00 (12.70) b	38.00 (22.32) a	42.00 (24.83) c	56.00 (34.05) ab	64.00 (39.78) a	44.40 (26.74) b
41.	Ruby Pink	22.00 (12.70) b	24.00 (13.88) g	32.00 (18.66) h	42.00 (24.83) h	50.00 (29.99) gh	34.00 (20.01) c
42.	Rubycon	18.00 (10.37) d	22.00 (12.70) h	34.00 (19.87) g	46.00 (27.38) fg	56.00 (34.05) de	35.20 (20.87) az
43.	Ruby Star	12.00 (6.89) g	22.00 (12.70) h	36.00 (21.09) f	48.00 (28.68) ef	60.00 (36.86) bc	35.60 (21.24) vazuywx
44.	Scent Rose	18.00 (10.37) d	26.00 (15.06) f	34.00 (19.87) g	50.00 (29.99) de	62.00 (38.30) ab	38.00 (22.72) lomn
45.	Shakira	12.00 (6.89) g	24.00 (13.88) g	38.00 (22.33) e	46.00 (27.38) fg	60.00 (36.86) bc	36.00 (21.47) vstuwx
46.	Shanthi	18.00 (10.37) d	28.00 (16.25) e	32.00 (18.66) h	44.00 (26.10) gh	58.00 (35.45) cd	36.00 (21.36) vstzuywx
47.	Single Orange	22.00 (12.70) b	32.00 (18.66) c	36.00 (21.09) f	44.00 (26.10) gh	56.00 (34.04) de	38.00 (22.52) pomn
48.	Sophia Gold	14.00 (8.04) f	28.00 (16.25) e	38.00 (22.33) e	54.00 (32.68) bc	62.00 (38.30) ab	39.20 (23.52) ij
49.	Taj Mahal	20.00 (11.53) c	34.00 (19.87) b	48.00 (28.67) a	54.00 (32.67) bc	62.00 (38.30) ab	43.60 (26.21) c
50.	Tomota	12.00 (6.89) g	24.00 (13.88) g	32.00 (18.66) h	44.00 (26.09) gh	58.00 (35.44) cd	34.00 (20.19) c
51.	Tropical Amazone	24.00 (13.88) a	32.00 (18.66) c	42.00 (24.83) c	52.00 (31.32) cd	60.00 (36.87) bc	42.00 (25.11) ed
52.	Venessa	20.00 (11.53) c	28.00 (16.25) e	36.00 (21.09) f	42.00 (24.82) h	58.00 (35.44) cd	36.80 (21.83) sqr
53.	White Miniature	18.00 (10.37) d	28.00 (16.25) e	44.00 (26.10) b	58.00 (35.44) a	62.00 (38.31) ab	42.00 (25.29) d
54.	White Tineke	18.00 (10.37) d	28.00 (16.25) e	42.00 (24.82) c	52.00 (31.32) cd	58.00 (35.44) cd	39.60 (23.64) ih
55.	Yellow Babe	16.00 (9.20) e	28.00 (16.25) e	32.00 (18.66) h	46.00 (27.38) fg	50.00 (29.99) gh	34.40 (20.30) c
	Total mean	16.22 (9.34)	26.95 (15.64)	37.09 (21.79)	48.07 (28.78)	56.65 (34.57)	37.00 (22.02)
	SE(m)	0.150	0.22	0.36	0.50	0.57	0.174
	C.D @ 5%	0.43	0.63	1.02	1.42	1.62	0.151

*Mean of five fortnight intervals (November-January) during each season. Figures within parentheses are arc sine transformed values.

Table 3: Incidence of powdery mildew in different rose genotypes screened under polyhouse during 2015-16 and 2016-17

S. No	Genotype	*Pooled PDI of two seasons	**Pooled AUDPC	**Pooled apparent rate of infection 'r'	Class of resistance
1.	Aczatica	41.80 (24.70) ab	2535.00	0.51	Highly Susceptible
2.	Aishwarya	35.20 (20.60) hijkl	2137.50	0.49	Susceptible
3.	Arka Ivory	41.20 (24.32) abcd	2505.00	0.51	Highly Susceptible
4.	Bugatti	34.40 (20.13) ijkl	2070.00	0.48	Susceptible
5.	Bonear	37.90 (22.26) bcdefghi	2310.00	0.49	Susceptible
6.	Charisma	32.60 (19.03) klm	1950.00	0.47	Susceptible
7.	Corvette	37.20 (21.83) defghij	2220.00	0.49	Susceptible
8.	Fancy	35.00 (20.48) hijkl	2107.50	0.48	Susceptible
9.	First Red	37.60 (22.08) bcdefghi	2265.00	0.50	Susceptible
10.	Five Star	27.00 (15.66) n	1597.50	0.35	Moderately susceptible
11.	Gilli	36.80 (21.58) efghijk	2197.50	0.49	Susceptible
12.	Gold Strike	36.20 (21.22) fghijkl	2227.50	0.49	Susceptible
13.	Grand Gala	42.20 (24.97) a	2565.00	0.51	Highly Susceptible
14.	IHR 9-11	36.00 (21.09) fghijkl	2205.00	0.49	Susceptible
15.	IIHRR 13-24	35.60 (20.85) fghijkl	2152.50	0.49	Susceptible
16.	IIHRR 13-28	39.60 (23.32) abcdefg	2355.00	0.50	Susceptible
17.	IIHRR 13-31	34.80 (20.36) hijkl	2115.00	0.49	Susceptible
18.	IIHRR 13-39	36.00 (21.09) fghijkl	2167.50	0.49	Susceptible
19.	IIHRR 301	34.20 (19.99) ijkl	2077.50	0.43	Susceptible
20.	IIHRR 9-1	35.60 (20.85) fghijkl	2137.50	0.49	Susceptible
21.	IIHRR 9-16	35.00 (20.48) hijkl	2085.00	0.49	Susceptible
22.	IIHRR 9-2	35.00 (20.48) hijkl	2085.00	0.48	Susceptible
23.	IIHRR 9-22	34.60 (20.24) cdefghi	2092.50	0.48	Susceptible
24.	IIHRR 9-24	37.40 (21.97) cdefghi	2280.00	0.49	Susceptible
25.	IIHRR 9-4	37.20 (21.84) defghij	2227.50	0.49	Susceptible
26.	IIHRR 9-5	36.20 (21.22) fghijkl	2152.50	0.49	Susceptible
27.	IIHRR 9-8	34.60 (20.24) ijkl	2077.50	0.48	Susceptible
28.	IIHRR 9-9	39.00 (22.95) abcdefgh	2355.00	0.50	Susceptible
29.	IIHRSG	37.40 (21.95) cdefghi	2242.50	0.49	Susceptible
30.	Confetti	36.40 (21.34) fghijkl	2182.50	0.49	Susceptible
31.	Kulchi Red	36.80 (21.58) efghijk	2242.50	0.49	Susceptible
32.	Mango Yellow	37.20 (21.83) defghij	2235.00	0.49	Susceptible
33.	Mirable	35.80 (20.97) fghijkl	2205.00	0.49	Susceptible
34.	Modi Red	35.00 (20.48) hijkl	2130.00	0.48	Susceptible
35.	Noblesse	37.00 (21.71) defghijk	2235.00	0.49	Susceptible
36.	Odilla	34.80 (20.36) hijkl	2077.50	0.48	Susceptible
37.	Orange Baby	32.00 (18.67) lm	1950.00	0.47	Susceptible
38.	Red Five Star	28.20 (16.38) mn	1657.50	0.45	Moderately susceptible
39.	Red Venessa	34.80 (20.36) hijkl	2137.50	0.49	Susceptible
40.	Royal Circus	42.40 (25.08) a	2572.50	0.51	Highly Susceptible
41.	Ruby Pink	35.40 (20.73) hijkl	2115.00	0.48	Susceptible
42.	Rubycon	35.80 (20.97) fghijkl	2145.00	0.49	Susceptible
43.	Ruby Star	32.80 (19.15) jkl	1927.50	0.47	Susceptible
44.	Scent Rose	37.40 (21.95) cdefghi	2227.50	0.49	Susceptible
45.	Shakira	35.80 (20.97) fghijkl	2145.00	0.49	Susceptible
46.	Shanthi	35.20 (20.60) hijkl	2092.50	0.48	Susceptible
47.	Single Orange	36.00 (21.10) fghijkl	2152.50	0.49	Susceptible
48.	Sophia Gold	40.80 (24.07) abcde	2497.50	0.51	Highly Susceptible
49.	Taj Mahal	42.70 (25.27) a	2613.75	0.51	Highly Susceptible
50.	Tomota	36.00 (21.10) fghijkl	2182.50	0.49	Susceptible
51.	Tropical Amazone	39.80 (23.45) abcdef	2377.50	0.50	Susceptible
52.	Venessa	37.20 (21.83) defghij	2220.00	0.49	Susceptible
53.	White Miniature	42.60 (25.20) a	2595.00	0.51	Highly Susceptible
54.	White Tineke	41.60 (24.58) abc	2527.50	0.51	Highly Susceptible
55.	Yellow Babe	34.60 (20.24) ijkl	2092.50	0.48	Susceptible
	Total mean	36.50 (21.41)	2200.57		
	SE(m)	0.94			
	C.D @ 5%	2.70			

*Mean of two seasons. Figures within parentheses are arc sine transformed values.

**Pooled AUDPC = Average of area under disease progression curve during 2015-16 and 2016-17.

**Pooled 'r' = Average of two years apparent rate of infection values in 2015-16 and 2016-17.

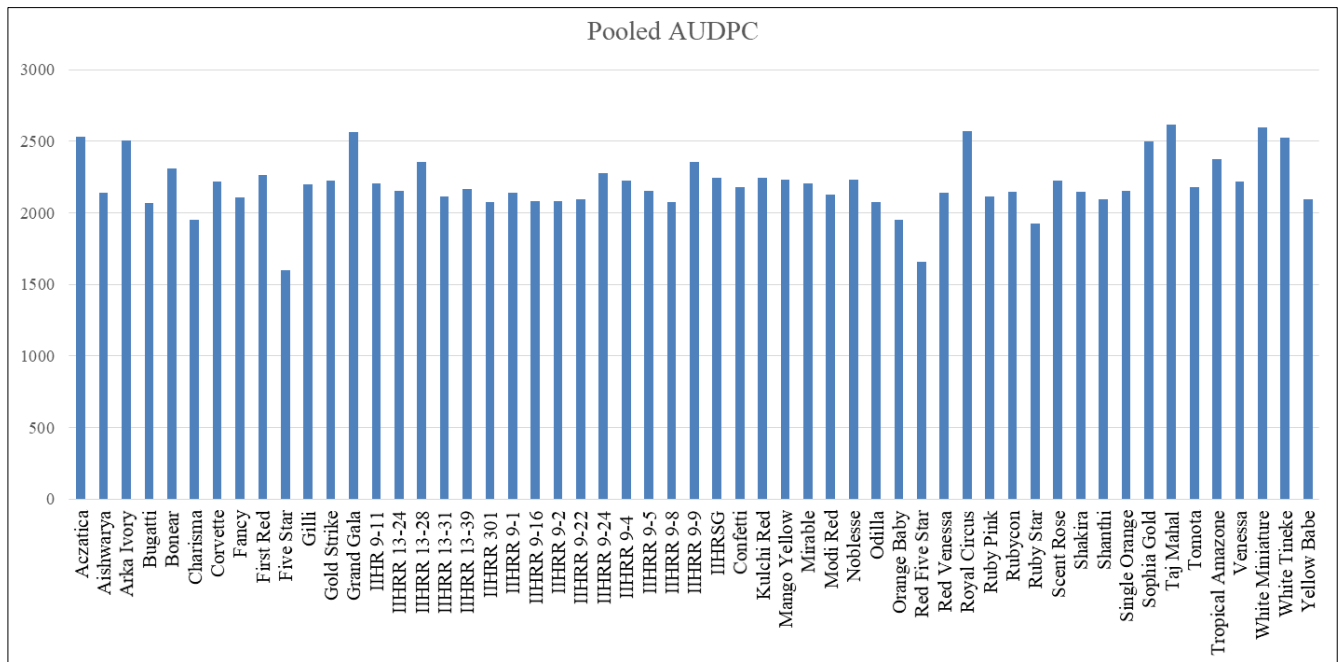


Fig 1: Pooled AUDPC values in rose genotypes screened for powdery mildew incidence over two seasons during 2015-16 and 2016-17

Conclusion

Powdery mildew is one of the serious problems in rose cultivation. Keeping in view of increased cost of cultivation and environmental safety issues with the chemical control of the disease, development of resistant cultivars/varieties through resistance breeding can be a solution for this.

References

1. Amin F, Qazi NA, Dar SH, Gani MY, Talib S. Evaluation of genus *Rosa* germplasm for resistance to black spot and powdery mildew. *Int. J Agric. Sci* 2016;8(42):1859-1862.
2. Chandramouli MA. Studies on slow rusting mechanism in cowpea. M.Sc. (Agri.) Thesis, Univ. Agril. Sci., Dharwad (India) 1992.
3. Deepali KP. Management of powdery mildew of rose under polyhouse condition. M.Sc. (Hort.) Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri (India) 2014.
4. FAO. Crop losses due to diseases and pest. Food and Agricultural Organization, Rome 1967.
5. Jeger MJ, Rollinson SLH. The use of the area under disease progress curve (AUDPC) to assess quantitative disease resistance in crop cultivar. *Theor. Appl. Genet.* 2001;102:32-40. <https://doi.org/10.1007/s001220051615>.
6. Leus L. Resistance breeding for powdery mildew (*Podosphaera pannosa*) and black spot (*Diplocarpon rosae*) in roses. Ph.D. Thesis. Faculty of Bioscience Engineering, Ghent University, Belgium 2005.
7. Nagesha GK, Nargund VB. Apparent rate of infection and area under disease progress curve: A measure of slow rusting in sunflower. *Karnataka J Agric. Sci* 2005;18(1):158-161.
8. Schulz DF, Linde M, Blechert O, Debener T. Evaluation of genus *Rosa* germplasm for resistance to black spot, downy mildew and powdery mildew. *Europ. J Hort. Sci* 2009;74(1):1-9.
9. Van Der Plank JE. *Plant Diseases, Epidemics and Control*. Academic Press. New York and London, 1968, 349.