

Evaluation of pomegranate germplasm for resistance against leaf spot and dry fruit rot (*Coniella granati*)

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ABSTRACT

Among the different pomegranate cultivars screened under natural field conditions for resistance against leaf spot and dry fruit rot caused by *Coniella granati* (Sacc) Petrak and Sydow the cultivars Bush Dwarf, Dalim and Anar Shirin showed moderately resistant reaction. Among the exotic cultivars the accession number A-29, A-19 and C-124 were moderately resistant to the disease. Maximum area under disease progress curve (AUDPC) and apparent infection rate (r) were observed in Kandhari Kabuli and exotic cultivar with accession number A-32 whereas minimum was found in Anar Shirin and exotic cultivar with accession number C-124.

Keywords: Apparent infection rate (r); *Coniella granati*; AUDPC; pomegranate; resistance; disease

INTRODUCTION

Pomegranate is a favourite table fruit of Mediterranean, tropical and subtropical regions of the world grown commercially for its sweet acidic fruits and medicinal properties. Several fungi are reported to be associated with pomegranate and the important fruit rot pathogens prevailing are *Glomerella cingulata*, *Penicillium expansum* and *Aspergillus nidulans* (Kanwar and Thakur 1972) but dry fruit rot caused by *Coniella granati* (Sacc) Petrak and Sydow had resulted in substantial losses after harvest and is threatening the upcoming

pomegranate cultivation in Himachal Pradesh (Sharma 1998). The present investigation was undertaken to screen the existing germplasm against *C. granati* under field conditions.

MATERIAL and METHODS

Twenty three different cultivars and forty exotic cultivars of pomegranate maintained at the germplasm block of Department of Fruit Science Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan were evaluated for their resistance against the disease under natural

field conditions during the cropping season of 2012 and 2013. Disease severity data (on leaves and fruits) were recorded at random on each cultivar by using 0-5 scale. Per cent disease index (PDI) was also calculated according to McKinney (1923). On the basis of PDI pomegranate cultivars were categorized into different reaction classes viz resistant (0-5%), moderately

resistant (5.1-10%), moderately susceptible (10.1-25%), susceptible (25.1-50%) and highly susceptible (≥50%).

Area under disease progress curve (AUDPC)

AUDPC was calculated for all the screened cultivars by the formula given by Shanner and Finney (1977) as follows:

$$\text{AUDPC} = \sum_{i=1}^n \frac{[(Y_{i-1} + Y_i)]}{2} [X_{i-1} - X_i]$$

where

Y_i = Disease severity (%) at the i th observation

X_i = Time (days) at the i th observation

n = Total number of observations

Apparent infection rate (r)

Apparent infection rate was calculated for all the screened cultivars of pomegranate by the formula given by Vander Plank (1963) as follows:

$$r = \frac{2.3}{t_2 - t_1} \log_{10} \frac{X_2}{1 - X_2} - \log_{10} \frac{X_1}{1 - X_1}$$

where

r = Apparent infection rate per unit per day

$t_2 - t_1$ = Time interval between first and last observations

X_1, X_2 = Proportion of diseased plant parts

$1 - X_1$ and $1 - X_2$ = Proportion of healthy plant part at t_1 and t_2 time interval respectively

RESULTS and DISCUSSION

From the mean severity data (Table 1 and 2) taken on leaves as well as on fruits revealed that Ganesh, Kandhari Kabuli, Kandhari Hansi, G-137 and Mridula expressed susceptible disease reaction whereas Bush Dwarf, Dalim and Anar Shirin were moderately resistant to the disease. Rest of the cultivars were moderately susceptible to the disease. Maximum area under disease progress curve (AUDPC) and apparent infection rate (r) were observed in Kandhari Kabuli (8.990 and 0.0685 on leaves, 13.918 and 0.114 on fruits) followed by Kandhari Hansi (8.942 and 0.0658 on leaves, 12.463 and 0.077 on fruits) whereas minimum was observed in Anar Shirin (3.368 and 0.016 on leaves, 3.347 and 0.014 on fruits).

Resistance of pomegranate to leaf spot, dry fruit rot

Table 1. Screening of pomegranate cultivars against *Coniella granati* under natural field conditions (leaves)

Cultivar	Date of observation*					Overall mean	AUDPC	Apparent infection rate (r)	Disease reaction
	3 July	10 July	17 July	24 July	31 July	7 Aug			
Musket White	8.06	10.46	14.59	16.54	20.01	25.7	15.89	5.493	MS
Ganesh	6.60	16.44	24.12	27.57	35.33	41.00	25.18	8.909	S
Chawla	5.68	9.67	13.08	19.47	25.56	26.67	16.69	5.877	MS
Gulshah	8.87	9.87	12.84	17.05	22.78	27.97	16.56	5.667	MS
Anar Shirin	8.67	10.40	13.78	15.84	16.77	27.23	15.45	5.232	MS
Mohammad Ali									
Anar Shirin	7.69	7.51	7.35	10.76	12.23	12.86	9.73	3.368	MR
Kandhari Kabuli	5.77	22.70	19.56	30.57	32.53	40.35	25.25	8.990	S
G-137	6.58	17.65	23.25	26.03	36.52	40.41	25.08	8.887	S
Anar Alok	8.26	10.40	13.78	15.84	16.77	21.90	14.49	5.031	MS
Ichkdana	8.74	10.09	13.49	15.89	21.33	27.51	16.17	5.525	MS
Kandhari Hansi	6.50	17.89	23.15	27.53	35.39	41.08	25.24	8.942	S
Mridula	6.39	17.66	22.42	25.64	38.55	40.50	25.19	8.940	S
Nabha	7.95	11.29	14.89	17.03	21.21	25.58	16.33	5.683	MS
Jodhpur Red	8.86	10.03	13.38	16.38	17.10	26.89	15.44	5.234	MS
Dalim	8.50	7.21	8.61	9.65	11.37	14.20	9.92	3.373	MR
Anar-post-e-safed-shirin	8.61	9.99	11.90	13.88	15.95	22.6	13.82	4.712	MS
Surakh Anar	6.15	10.37	16.10	21.47	26.2	31.53	18.64	6.509	MS
P-75-K-5	7.90	7.85	10.41	12.39	16.23	20.70	12.58	4.282	MS
Dholka	9.09	8.58	10.47	13.32	16.36	23.64	13.58	4.557	MS
Uthukalla	8.20	7.41	8.12	13.25	18.55	21.57	12.85	4.355	MS
Hakubotan	6.22	9.51	11.01	13.19	15.93	16.77	12.11	4.279	MS
Bedana Sadana	7.75	6.80	10.22	13.29	17.75	20.51	12.72	4.353	MS
Bush Dwarf	6.72	8.55	9.91	11.33	11.15	12.05	9.95	3.522	MR
Overall mean	7.53	10.95	13.83	16.98	20.97	25.57			

*Mean severity data of two years (2012-2013)

S= Susceptible, MS= Moderately susceptible, MR= Moderately resistant, AUDPC= Area under disease progress curve

Table 2. Screening of pomegranate cultivars against *Coniella granati* under natural field conditions (fruits)

Cultivar	Date of observation*					Overall mean	AUDPC	Apparent infection rate (r)	Disease reaction
	3 July	10 July	17 July	24 July	31 July	7 Aug			
Musket White	5.98	11.18	14.59	17.33	21.73	24.63	15.91	5.609	MS
Ganesh	10.41	16.47	20.78	25.41	33.67	56.51	27.21	9.086	S
Chawla	6.47	10.64	21.56	25.08	28.93	35.34	21.34	7.499	MS
Guleshah	6.51	9.62	15.58	19.39	28.58	33.55	18.87	6.524	MS
Anar Shirin	6.31	9.79	11.83	16.31	23.22	25.49	15.49	5.394	MS
Mohammad Ali									
Anar Shirin	7.75	7.40	8.51	9.49	11.45	14.19	9.80	3.347	MR
Kandhari Kabuli	6.90	21.18	33.29	44.29	56.69	79.86	40.37	13.918	S
G-137	8.73	12.53	17.14	26.89	39.72	47.02	25.34	8.691	S
Anar Alok	6.55	11.64	12.62	15.43	17.90	23.13	14.55	5.070	MS
Ichkdana	7.27	9.79	13.79	16.70	23.35	29.63	16.75	5.745	MS
Kandhari Hansi	8.54	23.08	32.80	40.64	48.09	58.30	35.24	12.463	S
Mridula	10.72	17.56	25.83	34.78	49.84	61.81	33.42	11.499	S
Nabha	5.47	11.84	14.53	19.51	22.33	28.64	17.05	5.969	MS
Jodhpur Red	6.64	12.25	13.40	15.54	19.45	25.53	15.47	5.370	MS
Dalim	8.02	7.49	8.75	9.49	11.51	14.25	9.92	3.386	MR
Anar-post-e-safed-shirin	6.25	9.37	12.55	14.61	18.85	21.51	13.86	4.848	MS
Surakh Anar	6.57	13.27	17.63	24.66	31.58	37.79	21.92	7.652	MS
P-75-K-5	7.03	10.18	11.01	12.69	14.59	20.64	12.69	4.362	MS
Dholka	6.31	9.03	12.55	14.61	18.85	20.51	13.64	4.792	MS
Uthukalla	6.87	7.41	11.79	13.58	17.88	21.13	13.11	4.526	MS
Hakubotan	7.12	8.48	9.35	13.79	16.26	20.31	12.55	4.311	MS
Bedana Sadana	6.27	7.88	11.57	14.59	17.50	19.20	12.84	4.500	MS
Bush Dwarf	7.46	4.96	9.55	12.50	12.68	12.50	9.94	3.477	MR
Overall mean	7.22	11.44	15.70	19.88	25.42	31.80			

*Mean severity data of two years (2012-2013)

S= Susceptible, MS= Moderately susceptible, MR= Moderately resistant, AUDPC= Area under disease progress curve

Resistance of pomegranate to leaf spot, dry fruit rot

Table 3. Screening of exotic cultivars of pomegranate against *Coniella granati* under natural field conditions (leaves)

Cultivar (accession #)	Date of observation*						Overall mean	AUDPC	Apparent infection rate (r)	Disease reaction
	3 July	10 July	17 July	24 July	31 July	7 Aug				
A-238	8.06	11.76	27.28	32.59	41.67	45.61	27.83	9.811	0.0644	S
A-424	6.60	19.78	28.12	31.81	39.63	50.04	29.33	10.336	0.0756	S
A-125	5.68	19.67	26.88	31.94	42.57	44.83	28.60	10.242	0.0742	S
A-334	8.87	18.87	22.10	25.93	45.79	49.89	28.58	9.945	0.0663	S
A-314	8.67	13.07	17.48	36.14	43.11	47.24	27.62	9.643	0.0640	S
A-32	5.77	28.70	19.56	43.18	32.53	49.89	29.94	10.626	0.0796	S
A-228	6.58	18.32	23.25	33.03	44.19	49.52	29.15	10.279	0.0751	S
A-430	8.26	10.40	24.94	34.17	40.77	44.76	27.22	9.576	0.0627	S
A-711	8.74	16.78	21.78	32.26	41.34	47.84	28.12	9.831	0.0645	S
A-322	6.50	23.47	29.76	32.96	35.39	50.24	29.72	10.496	0.0763	S
A-733	6.39	21.49	24.42	32.97	42.22	49.63	29.52	10.439	0.0762	S
A-313	7.95	11.29	23.56	36.64	43.07	46.59	28.18	9.928	0.0660	S
A-338	8.86	10.03	17.88	37.04	43.88	47.52	27.54	9.592	0.0637	S
A-67	8.61	17.19	22.17	29.55	39.48	45.27	27.04	9.472	0.0620	S
A-721	6.15	14.37	21.77	39.31	44.19	47.45	28.87	10.251	0.0748	MS
A-29	7.53	8.21	8.51	9.85	10.90	13.04	9.67	3.343	0.0174	MR
A-332	9.09	15.90	20.20	30.09	40.03	46.03	26.89	9.365	0.0611	S
A-17	8.87	12.47	25.45	30.79	38.08	44.57	26.71	9.346	0.0602	S
A-420	8.22	16.83	24.11	30.65	35.94	42.10	26.31	9.288	0.0598	MS
A-19	7.75	6.80	8.89	9.96	11.08	13.29	9.63	3.307	0.0172	MR
A-226	8.86	16.61	21.24	29.59	38.81	44.33	26.58	9.300	0.0600	S
A-223	7.78	18.68	21.24	30.59	38.01	40.02	26.05	9.269	0.0590	S
A-324	7.65	16.81	25.53	29.69	36.93	39.73	26.06	9.286	0.0592	S
A-115	7.44	21.21	25.57	28.93	33.48	38.04	25.78	9.235	0.0580	S
A-312	6.89	20.18	26.01	30.68	33.59	35.68	25.51	9.223	0.0575	S
A-422	7.70	14.76	25.74	31.62	36.44	39.49	25.96	9.251	0.0587	S
A-519	6.56	13.14	21.45	26.54	30.17	34.33	22.03	7.822	0.0573	MS
A-428	5.70	16.51	17.72	22.80	25.56	30.67	19.82	7.054	0.0568	MS
A-234	8.20	10.28	13.22	19.07	25.02	39.22	19.17	6.390	0.0564	MS
A-117	6.92	10.60	14.48	24.48	30.30	35.59	20.40	7.079	0.0572	MS

A-119	5.77	9.01	19.56	12.55	32.53	29.02	18.07	6.373	0.0542	MS
A-118	6.70	9.65	13.45	17.04	21.74	31.72	16.72	5.676	0.0533	MS
A-81	7.79	10.83	14.52	16.17	18.11	35.70	17.19	5.696	0.0537	MS
A-215	7.72	10.14	13.53	15.94	22.12	29.24	16.45	5.615	0.0456	MS
A-336	8.45	9.55	11.48	17.46	21.06	37.93	17.65	5.792	0.0539	MS
A-436	8.02	9.66	12.09	15.64	19.22	29.21	15.64	5.266	0.0443	MS
A-78	5.95	11.62	15.22	17.04	21.11	23.48	15.74	5.580	0.0450	MS
C-124	7.29	8.70	9.07	9.45	9.77	12.52	9.47	3.283	0.0171	MR
C-121	8.61	9.99	11.90	13.88	15.95	28.34	14.78	4.913	0.0409	MS
C-133	6.45	10.04	13.44	16.80	19.53	24.04	15.05	5.254	0.0435	MS
Overall mean	7.49	14.33	19.61	26.17	32.13	38.34				

*Mean severity data of two years (2012-2013)

S= Susceptible, MS= Moderately susceptible, MR= Moderately resistant, AUDPC= Area under disease progress curve

Table 4. Screening of exotic cultivars of pomegranate against *Coniella granati* under natural field conditions (fruits)

Cultivar (accession #)	Date of observation*					Overall mean	AUDPC	Apparent infection rate (r)	Disease reaction
	3 July	10 July	17 July	24 July	31 July				
A-238	7.40	12.43	27.95	33.26	47.12	29.37	10.393	0.0699	S
A-424	6.90	21.11	29.45	34.11	40.97	31.04	10.916	0.0785	S
A-125	6.36	18.34	27.15	38.27	42.57	30.2	10.763	0.075	S
A-334	8.44	19.97	23.77	27.60	47.45	30.19	10.497	0.0725	S
A-314	8.24	14.40	18.81	39.15	45.44	29.16	10.246	0.0675	S
A-32	5.77	28.70	19.56	50.52	32.53	32.45	11.410	0.0885	S
A-228	6.56	19.32	24.75	36.37	46.19	30.79	10.897	0.0775	S
A-430	8.29	11.41	25.61	35.51	43.76	28.78	10.114	0.0664	S
A-711	8.40	17.44	22.78	36.59	41.68	29.80	10.404	0.0703	S
A-322	6.63	24.43	30.77	35.28	39.40	31.79	11.221	0.0803	S
A-733	6.69	21.49	28.42	36.97	43.12	31.67	11.200	0.079	S
A-313	7.52	14.63	24.05	37.30	44.74	29.67	10.455	0.0713	S
A-338	8.51	13.05	19.55	39.02	44.22	28.92	10.128	0.0668	S

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A-67	8.48	18.19	23.17	31.21	43.11	47.94	28.68	10.072	0.0655	S
A-721	6.82	15.38	23.48	38.42	47.91	51.62	30.61	10.809	0.0765	MS
A-29	6.16	9.87	10.51	11.90	10.58	10.92	9.99	3.599	0.0178	MR
A-332	9.11	17.73	21.87	30.76	43.36	49.03	28.64	9.995	0.0645	S
A-17	8.90	14.48	26.82	31.79	41.09	48.23	28.55	9.992	0.0643	S
A-420	8.96	17.82	25.44	32.32	37.27	47.30	28.19	9.869	0.0631	MS
A-19	7.75	8.70	9.22	9.54	11.75	12.84	9.97	3.465	0.0160	MR
A-226	8.93	18.28	23.58	30.26	41.81	47.99	28.48	9.968	0.0640	S
A-223	8.55	19.35	22.24	32.26	39.01	44.68	27.68	9.762	0.0615	S
A-324	8.02	19.58	26.53	30.02	38.96	43.54	27.78	9.861	0.0622	S
A-115	8.44	21.58	25.91	30.92	35.81	41.38	27.34	9.739	0.0581	S
A-312	9.56	20.22	26.35	30.71	33.93	43.02	27.30	9.625	0.0561	S
A-422	8.60	15.20	29.04	31.89	37.27	43.20	27.53	9.751	0.0596	S
A-519	9.90	19.12	23.96	27.20	34.85	43.33	26.39	9.223	0.0554	MS
A-428	9.73	16.84	22.16	24.47	27.56	41.68	23.74	8.171	0.0540	MS
A-234	9.87	14.94	18.55	22.41	33.67	41.04	23.41	8.052	0.0528	MS
A-117	9.27	16.28	22.15	25.29	36.40	40.59	25.00	8.754	0.0542	MS
A-119	5.77	17.14	19.56	21.55	32.53	27.54	20.68	7.520	0.0521	MS
A-118	7.70	10.99	13.78	18.37	30.13	32.38	18.89	6.532	0.0499	MS
A-81	8.79	12.83	17.19	20.81	24.77	35.70	20.01	6.849	0.0500	MS
A-215	7.72	10.14	15.53	20.60	27.25	31.57	18.80	6.523	0.0487	MS
A-336	9.19	13.89	16.81	19.13	25.93	37.93	20.48	6.952	0.0513	MS
A-436	7.69	11.00	14.75	16.64	24.88	29.88	17.47	6.024	0.0466	MS
A-78	6.62	12.96	15.89	17.71	24.78	27.48	17.57	6.187	0.0478	MS
C-124	7.53	8.70	8.01	11.38	11.34	11.89	9.81	3.439	0.0144	MR
C-121	8.60	9.99	12.90	16.83	22.61	31.34	17.05	5.761	0.0451	MS
C-133	6.78	11.04	16.11	19.14	23.20	26.38	17.11	6.024	0.0455	MS
Overall mean	7.98	15.97	21.35	28.34	35.02	41.48				

*Mean severity data of two years (2012-2013)

S= Susceptible, MS= Moderately susceptible, MR= Moderately resistant, AUDPC= Area under disease progress curve

From the mean severity data taken on leaves and fruits of exotic cultivars (Table 3 and 4) maximum disease severity was found in the cultivar with accession number A-32 (29.94% on leaves, 32.45% on fruits) followed by A-322 (29.72% on leaves, 31.79% on fruits) whereas minimum severity was observed in cultivar with accession number C-124 (9.47% on leaves, 9.81% on fruits). Cultivars with accession number C-124, A-29 and A-19 showed moderately resistant disease reaction. Maximum AUDPC and apparent infection rate (r) were observed in cultivar with accession number A-32 (10.626 and 0.0796 on leaves, 11.410 and 0.0885 on fruits) followed by A-322 (10.496 and 0.0763 on leaves, 11.221 and 0.0803 on fruits) and minimum was observed in C-124 (3.283 and 0.0171 on leaves, 3.439 and 0.0144 on fruits) respectively.

CONCLUSION

Varietal behavior of twenty three different cultivars and forty exotic cultivars of pomegranate revealed that Bush Dwarf,

Dalim, Anar Shirin and cultivars with accession number A-29, A-19 and C-124 showed moderately resistant reaction against the disease. Kandhari Kabuli, Kandhari Hansi, Mridula, Ganesh and G-137 were found susceptible whereas all the other cultivars were moderately susceptible under natural field conditions.

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