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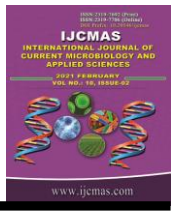

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Evaluation of Genotypes of Rose against Black Spot Powdery Mildew Diseases

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A B S T R A C T

Among the nine rose genotypes were evaluated for resistance to black spot and powdery mildew disease under natural field conditions, none of the genotype has shown immune or highly resistant reaction for any of the disease. Only one genotype Cherishma showed moderately resistant reaction to black spot. Against powdery mildew, seven genotypes showed moderately susceptible reaction, while genotype, Tajmahal and Papaya Red found showed susceptible reaction. Among the genotypes, Carlet recorded highest total phenols (5.19 mg/100g). Least phenols recorded in Tajmahal and Pappaya red with3.02 and 3.26 mg/100g, respectively. The higher amounts of total sugars were recorded in Tajmahal (49.41 mg/g) while, the least total sugars was noticed in Nobless, Carlet and Tineke with25.08, 25.89 and 25.92 mg/g, respectively. The maximum chlorophyll 'a' content was recorded in Nobless (2.83 mg/g). Maximum Chlorophyll 'b' content of leaves recorded in Bugati (1.26 mg/g) which was on par with Nobless (1.25 mg/g) and Tineke (1.24 mg/g). The maximum total chlorophyll content of 4.28 mg/g was observed in Nobless. Higher amount of phenols, total chlorophyll and lower amounts of sugars were found in resistant (Nobless) genotype.

Introduction

Over the last decade, the prevalence and severity of both (black spot and powdery mildew) diseases on rose have been increased to epidemic proportions and consequently, these two diseases have became one of the major limitations for quality rose flower production throughout the world. As limited sources of resistance were available to manage these fungal diseases, there is a need to concentrate towards evaluation of cultivars for resistance tothese fungal diseases.

Sharma and Singh (2002) evaluated 800 rose varieties, hybrids and selections of rose. They reported that none of the varieties showed resistance against black spot while 83 varieties were recorded as moderately resistant. Against powdery mildew, 12 were resistant and 36 moderate resistant.Schulz *et al.*, (2009) evaluated 581 accessions of rose and reported that11 accessions were found highly resistant to black spot while, 39 accessions were highly resistant to powdery mildew.

Kiani *et al.,* (2010) screened Damask rose genotypes from diverse regions of Iran against powdery mildew resistance using disease rating scale of 0-5. The East Azerbaijan (colder with higher rainfall and humidity) and Kerman (warmer and dryer region) genotypes were recognized as the most resistant and susceptible genotypes respectively.

Sunilkumar *et al.,* (2013) reported that among thirty seven varieties of rose evaluated against black spot in the field none of the varieties was found immune, very highly resistant, resistant and moderately resistant.

However, three varieties namely Paradise, Shabnam and Pixie showed moderately susceptible. Qiu *et al.,* (2015) evaluated 50 accessions of rose against powdery mildew and reported that six genotypes and two varieties were immune while, twelve accessions were highly resistant.

Li- Feng *et al.,* (2014) while investigating the effect of powdery mildew infection on the mitochondrial and chloroplast functions in rubber tree, found that powdery mildew damaged the structure and function of mitochondria prior to chloroplasts causing inner and outer membranes disruption. Chlorophyll contents were drastically decreased in the infected leaves. Gonti *et al.,* 1986 identified that amount of deposition of phenolic compounds is one of the factors of rose to resistance against powdery mildew. Shetty *et al.,* (2011) correlated increase in phenolic compounds to 46 per cent reduction in powdery mildew of rose.

Materials and Methods

Field experiments were conducted to identify resistant genotypes against blackspot and powdery mildew diseases. Laboratory experiments were carried out to assess chlorophyll, sugars and phenol content in the genotypes.

Nine genotypes were screened under natural disease pressure. Five plants from each genotype were selected for screening. For black spot disease, observations were recorded on three and four months after pruning *i.e.,* first week of August and September while for powdery mildew, observations were recorded on five and six months after pruning *i.e.,* first week of October and November.

The disease severity was recorded using 0-5 scale for black spot (Sharma and Singh, 2002)and 0-4 scale for powdery mildew (Sahni, 1987)as given below by randomly selecting the five plants in each genotype. Based on their reaction, genotypes were categorized into resistant, moderately resistant, moderately susceptible and highly susceptible.

Disease scoring scale for black spot disease of rose

Sl. No.	Grade	Per cent leaf area covered	Reaction type
1	0	0.00	Immune
2	1	Less than 1	Highly resistant
3	2	1-10	Resistant
4	3	11-25	Moderately resistant
5	4	26-50	Susceptible
6	5	Above 50	Highly susceptible

Disease scoring scale for powdery mildew disease of rose

Sl. No.	Grade	Per cent leaf area covered	Reaction type
1	0	0-5	Resistant
2	1	6-15	Moderately resistant
3	2	16-35	Moderately susceptible
4	3	36-50	Susceptible
5	4	Above 50	Highly Susceptible

Biochemical studies on estimation of chlorophyll, sugars and phenol content in leaves of all nine genotypes was carried out using standard procedures. Estimation of chlorophyll content was done while sugar content was estimated by using Anthrone Reagent method (Sadasivam and Manickam, 1996).Total phenol content was estimated by using Folin-Ciocalteau reagent (Sadasivam and Manickam, 1996).

Results and Discussion

Percent Disease Index for black spot and powdery mildew

Nine rose genotypes were evaluated for resistance to black spot and powdery mildew diseases of rose during 2016-17 under natural field condition at UHS Bagalkot. The observations on disease severity were recorded and data was converted into per cent disease index. Disease severity was recorded by using 0-5 scale (Sharma and Singh, 2002) for black spot and 0-4 scale (Sahni, 1987) for powdery mildew. Data are presented in table 1.

Table 1 revealed that there was significant difference found among the genotypes screened with respect to per cent disease index of black spot. None of the genotypes has shown immune or highly resistant reaction, but only one genotype Cherishma (11.76) showed moderately resistant reaction to black spot with least per cent disease index. Remaining genotypes, *viz.*, Bugati (28.36), Carlet (34.60), Folklar (27.86), Gold Strike (30.95), Nobless (22.12), Papaya Red (29.18), Tajmahal (32.23) and Tineke (33.08) found moderately susceptible for black spot disease with respect per cent disease index.

Out of nine rose genotypes evaluated with respect to per cent disease index of powdery mildew, seven genotypes, Bugati (33.52), Carlet (26.54), Cherishma (32.15), Folklar (28.88), Gold Strike (28.18), Nobless (26.78), and Tineke (33.33) showed moderately susceptible reaction to powdery mildew of rose. Two genotypes, Tajmahal (48.54) and Papaya Red (39.81) found susceptible which recorded maximum per cent disease index. None of the genotypes was has fond resistant or highly susceptible.

Estimation of phenols, sugars and chlorophyll in the rose genotypes

Biochemical traits such as total phenols, total sugars and total chlorophyll of leaf were estimated for all the screened genotypes to know their relation with respect to resistant and susceptible reaction. The results of the analysis were depicted in table 2.

Total phenols, total sugars, chlorophyll 'a', chlorophyll 'b' and total chlorophyll content of leaves were found to vary significantly across the genotypes. Among the genotypes, Carlet recorded highest total phenols (5.19 mg/100g) and it was significantly superior over all the genotypes evaluated except Nobless (4.87 mg/100g) which was on par.

The genotypes Bugati, Gold Strike and Cherishma recorded 4.35, 4.28 and 4.08 mg/100g, respectively and these were found on par to each other. The least phenols were recorded in Tajmahal and Papaya Red with3.02 and 3.26 mg/100g, respectively which were on par.

The maximum total sugars of leaves were recorded in Tajmahal (49.41 mg/g) which was significantly superior to all other genotypes. The genotypes Papaya Red, Folklar, Cherishma and Gold Strike recorded 39.79, 37.77, 36.09 and 34.75 mg/g, respectively and were on par to each other. The least total sugars were noticed in Nobless, Carlet and Tineke with25.08, 25.89 and 25.92 mg/g, respectively.

Maximum chlorophyll 'a' content of 2.83 mg/g was recorded in Nobless and it was significantly high among all the genotypes followed by Bugati (2.27 mg/g) and Carlet (1.86 mg/g). The least chlorophyll 'a' noticed in Pappaya Red (1.40 mg/g) and Tajmahal (1.44 mg/g).Highest Chlorophyll 'b' content of leaves recorded in Bugati (1.26 mg/g) followed by Nobless (1.25 mg/g) and Tineke (1.24 mg/g) which were on par. The least Chlorophyll 'b' content was noticed in Tajmahal and Pappaya Red with0.62 and 0.65 mg/g, respectively.

The maximum total chlorophyll content of 4.28 mg/g observed in Nobless was significantly high compare to all other genotypes followed by Bugati (3.71 mg/g). Tineke (2.87 mg/g) and Carlet (2.76 mg/g) were next in order. The genotypes Cherishma, Gold Strike, Folklar and Tajmahal recorded 2.41, 2.39, 2.34 and 2.24 mg/g respectively which were on par with each other.

Table.1 Reaction of genotypes against black spot and powdery mildew

Sl. No.	Genotype	Black spot		Powdery mildew	
		August 1st week (PDI)	September 1st week (PDI)	October 1st week (PDI)	November 1st week (PDI)
1	Bugati	31.87 (34.34)*	28.36 (32.15)	10.52 (18.87)	33.52 (33.52)
2	Carlet	46.48 (42.96)	34.60 36.006	14.56 (22.35)	26.54 (26.54)
3	Cherishma	18.67 (25.58)	11.76 (20.35)	18.81 (25.66)	32.15 (32.15)
4	Folklar	33.28 (35.21)	27.86 (31.83)	12.50 (20.73)	28.88 (28.88)
5	Gold strike	39.85 (39.12)	30.95 (33.73)	33.33 (35.22)	28.18 (28.18)
6	Nobless	32.46 (34.71)	22.12 (28.03)	16.4 (23.89)	26.78 (26.79)
7	Pappaya Red	36.16 (36.95)	29.18 (32.63)	15.12 (22.88)	39.81 (38.57)
8	Tajmahal	44.20 (41.65)	32.23 (34.57)	21.25 (27.44)	48.54 (48.55)
9	Tineke	45.32 (42.29)	33.08 (35.08)	32.2 (34.59)	33.33 (33.33)
SEm±		0.96	1.31	0.74	1.36
CD (0.05)		2.91	3.97	2.24	4.11

*Figures in parenthesis are in angular transformed values

Table.2 Amount of phenols, sugars and chlorophyll in different genotypes of rose

Sl. No.	Genotype	Phenols (mg/100g)	Sugars (mg/g)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll (mg/g)
1	Bugati	4.35	28.3	2.27	1.26	3.71
2	Carlet	5.19	25.89	1.86	0.70	2.76
3	Cherishma	4.08	36.09	1.66	0.89	2.41
4	Folklar	3.91	37.77	1.59	0.76	2.34
5	Gold strike	4.28	34.75	1.71	0.77	2.39
6	Nobless	4.87	25.08	2.83	1.25	4.28
7	Papaya Red	3.26	39.79	1.40	0.65	2.59
8	Tajmahal	3.02	49.41	1.44	0.62	2.24
9	Tineke	4.62	25.92	1.48	1.24	2.87
SEm ±		0.12	2.26	0.04	0.04	0.06
CD (0.01)		0.35	6.76	0.11	0.13	0.17

The management of the disease through host plant resistance has been the best choice in all the crop improvement programs. Utilization of resistant cultivars in farming system is the most simple, effective and economical method in the management of disease. Besides this, these resistant cultivars conserve natural resources and reduce the cost, time and energy when compared to the other methods of disease management.

The observations revealed that among nine genotypes screened with respect to per cent disease index of black spot, none of genotype has shown immune or highly resistant reaction but only one genotype *i.e.*, Cherishma showed moderately resistant reaction to black spot with least per cent disease index and remaining all genotypes found moderately susceptible for black spot disease incidence. The same results were found in the study conducted by Rehman *et al.,* (2012) who reported that out of 8 varieties none was found to be immune or highly resistant. Only one variety Paradise was resistant, while two varieties showed moderately resistant reaction and three varieties showed susceptible reaction while two varieties Casino and Angle Face showed highly susceptible reaction. Colbaugh *et al.,* (2001) reported among the 107 cultivars screened, 90% were moderately susceptible, while 10% were considered highly tolerant to black spot disease. In the present study one miniature rose, Cherishma showed moderately resistant reaction. This result was in agreement with Chatani *et al.,* (1996), who reported that generally, level of resistance was varying among the different classes of roses and locality as he noticed *R. multiflora* and some miniature roses showing moderate resistance under Delhi conditions.

Observations on resistance to powdery mildew disease revealed that among nine genotypes screened, seven genotypes showed moderately susceptible. One genotype, Tajmahal showed susceptible and Gold strike recorded maximum per cent disease index, which showed highly susceptible reaction for powdery mildew disease. Chandrakala (2008), reported that out of 65 rose genotypes screened under natural condition 4 genotypes showed resistant reaction and 12 genotypes showed moderately susceptible reaction. In present results genotype Nobless showed moderately susceptible reaction. This was supported by above mentioned findings.

Zhang *et al.*, (2002) reported that out of eleven rose cultivars screened, five cultivars were found immune, one cultivar was highly resistant, two cultivars were moderately resistant and three cultivars were highly sensitive to powdery mildew.

The common biochemical constituents like chlorophyll, sugars and phenols are important in imparting resistance to the plants against disease. Among the genotypes, Carletand Nobles recorded highest total phenols. While east phenols in Tajmahal and Pappaya Red. Phenols have been found to play an important role in determining the resistance or susceptibility of a host to pathogen infection. One of the major properties of phenolic compounds is their antimicrobial activity in plants to act as protective compounds against disease causing agents such as fungi, bacteria and viruses. The high concentration of phenols causes an instant lethal action by a general tanning effect. If the concentration does not occur in toxic level the inhibition will be low and pathogens readily detoxify low concentration of toxicant rather than high concentrations (Dasgupta, 1988).

Sugars are precursors and basic molecules for the synthesis of phenols, phytoalexines and form a skeleton for the synthesis of nucleic acids. Sugars play an important role in inhibition of pectiolytic and cellulolytic enzymes which are essential for pathogenicity (Vidyasekaran, 1987). In general, infection by pathogen bring about changes in respiratory pathway and photosynthesis, which are important vital processes taking place inside the plant leading to wide fluctuations in sugar content in plant system. In present study the genotype Tajmahal found susceptible, while Nobless and Carlet were found resistant and reason may be attributed to their sugar content in leaves. These findings are in agreement with Chandrakala (2008), who reported that genotype Tajmahal found susceptible for powdery mildew disease which contains higher amount of sugars, while Nobless, Carlet and Tineke found moderately resistant as they contain lower amount of sugars.

In the present study, chlorophyll a, chlorophyll b and total chlorophyll were found in higher amounts in resistant genotypes than in susceptible genotypes. Abnormalities in the form of destruction of chloroplasts were common features of diseased tissues of plants infected by pathogen, which usually exhibit reduced photosynthetic rate, photophosphorylation, Hill reaction and CO_2 assimilation (Bawden, 1999). With regard to total amount of phenols, sugars and chlorophyll present in the leaves, the genotypes, Nobless and Bugati were found resistant, while Tajmahal found susceptible in present study.

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