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Screening of okra genotypes for powdery mildew resistance under field conditions and morphological characterization

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Abstract

The present investigation was carried out on 30 genotypes of okra to study powdery mildew and their morphological characterization under natural field conditions at Palampur aiming at the development of high yielding, powdery mildew resistant lines of okra. Based upon the mean performance, genotypes 9801, Kashi Vibhuti, DPO-5, Palam Komal and Punjab Suhawani were found to be top yielders and resistant to powdery mildew disease. All the genotypes taken for study were found to be resistant and moderately resistant to powdery mildew disease except Kashi Pragati, Shitla Uphar, Shitla Jyoti, Kashi Satdhari, DPO-6, DPO-8, DPO-9, DPO-13, DPO-19 and Punjab-8. Okra germplasm contained sufficient genetic variability and can be used for crop improvement. Coincidently, among the top five high yielding lines most showed dark green or green coloured pods along with downy pubescence. Thus, these genotypes can be further used for breeding programmes and can be directly used after multi-location testing as these possess inherent ability to high yielding, superior quality along with powdery mildew resistance.

Key words: Okra, powdery mildew, resistance, characterization, colour, pubescence, ridges, descriptor.

Okra [*Abelmoschus esculentus* (L.) Moench] a member of the Malvaceae family is a fast growing warm and rainy season annual herb whose immature green pods are used as a common vegetable. It is a sexually propagated crop plant with bisexual flowers and commonly worldwide known as Lady's finger. It was originated in Ethiopia de Candolle (1883) and Vavilov (1951). However, according to Zeven and Zhukovsky (1975) it originated from Hindustani centre of origin, mainly India, Pakistan and Burma region. Okra is an often cross pollinated vegetable crop with somatic chromosome number 2n=130 and is amphidiploid of Abelmoschus tuberculatus with 2n = 58 and an unknown species with 2n=72. Flower bud appears in the axil of each leaf node and takes about 22-26 days from initiation to full bloom. The time of anthesis ranges from 8 to 10 am which varies with cultivar, temperature and humidity (Purewal and Randhawa 1947). Okra is extensively cultivated for tender immature fruits, which are largely used as fresh vegetable. Its fruit contains water (89 g), protein (2-4 g), fat (0.3 g), carbohydrate (7.6 g), calcium (92 mg), phosphorus (51 mg), iron (0.6 mg) and potassium (249 mg) of 100 gram edible fruits. It is also a rich source of iron and vitamin A, B and C by Aykroyd (1963). Besides fancy dishes, it is also gaining popularity as salad, pickled, frozen, boiled or fried vegetable. The seeds of okra are used in the preparation of perfumes, protein, milk, oil and a number of baked products. Dried seeds of okra contain about 20 % protein and 20 % oil and are used to prepare vegetable curd or roasted and ground to be used as coffee additive or substitute. The roots and stems are used for clarification of sugarcane juice before it is converted into jaggery and brown sugar (gur). Carbohydrate is present in the form of mucilage and is used in the paper industries. Stem of the plant is used for the extraction of fibre. Besides these, different plant parts of okra have got a lot of medicinal properties. Due to high iodine content, its fruits are considered useful for the

control of goitre by Chaudhary (1979).

During the growing season, the crop is attacked by a number of fungal, bacterial and viral diseases of which powdery mildew has been found to be predominant and destructive disease leading to low yields and economic losses especially during warm and dry weather conditions (Lande *et al*., 1977). Three different fungi are known to cause powdery mildew in okra i.e. *Leveillula taurica* by Bremer *et al*. 1974, *Erysiphe cichoracearum* DC by Allison (1953) and Sphaerotheca fuliginea by Tarr (1954) of which E. cichoracearum is the pathogen involved in Himachal Pradesh as reported by Raj *et al*. (1992). Yield losses are significant under favourable weather conditions if the infection takes place in early stages of plant growth (Gupta and Thind 2006). It affects plants at all growth stages and yield losses to the tune of 17 to 86.6 per cent had been reported by Sridhar and Sinha (1989). In Himachal Pradesh up to 43 per cent disease severity of powdery mildew has been reported by Raj *et al*. (1992). The disease is favoured by low temperature (11-28°C) and dry weather conditions. Under these circumstances, selection of resistant lines would pave the way in overcoming this problem. Hence, identification and development of new improved disease resistant cultivars possessing desirable horticultural traits is very important to boost the production and productivity of the crop.

The morphological characterization of germplasm is a very essential first step in crop improvement programme and provides ample scope for improvement for horticultural traits (De Vicente *et al*. 2005; Oppong-Sekyer *et al*. 2011). Morphological descriptors are the base for characterization of plant genotypes on the basis of their characters (external appearance). Moreover, information obtained on genetic relatedness among genetic resources of crop plants is useful, both for breeding and germplasm conservation (Brown *et al*. 1990) and such variation can be exploited in breeding programmes to develop improved, high yielding varieties. Further characterization of okra varieties is required for their description under plant variety protection legislation, because varietal testing for distinctness, uniformity and stability is the basis for protection for a new plant variety under Indian law by Protection of Plant Varieties and Farmer's right Act (2011). Proposed new varieties are compared against a set of relevant characteristics (Srivastava *et al*. 2001). Therefore, the present study was undertaken on 30 genotypes of okra on the basis of morphological traits to measure the extent of genetic variability and to select the most promising germplasm for use in improvement programs and cultivation (Table 1).

Materials and Methods

The present investigation was carried out under natural field conditions at the Vegetable Experimental Farm, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (HP) during summer-rainy season, 2018. The experimental site is located at an altitude of about 1290.8 m amsl. Geographic position of the experimental site lies between 32º6' N latitude and 76º3' E longitude under mid hill zone of Himachal Pradesh, India. The climate is humid sub-temperate. The mean monthly minimum and maximum temperature varied between 2.0 to 22.0 and

Table 1. List of okra genotypes and their sources

Genotype	Source
Punjab Suhawani, Punjab-8	Punjab Agricultural University, Ludhiana (Punjab)
Kashi Vibhuti, Kashi Pragati, Shitla Uphar, Shitla Jyoti, Kashi Satdhari	Indian Institute of Vegetable Research, Varanasi (UP)
DPO-1, DPO-2, DPO-3, DPO-4, DPO-5, DPO-6, DPO-7, DPO-8, DPO -9, DPO -10, DPO -11, DPO -12, DPO -13, DPO-14, DPO -15, DPO -16, DPO -17, DPO -18, DPO-19, DPO-20, 9801, Palam Komal	CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (HP)
Arka Anamika	Indian Institute of Horticultural Research, Bangalore (Karnataka)

9.5 to 34.5ºC, respectively during the cropping season. The experimental site received average rainfall of 250 cm annually, out of which about 80 % was received during monsoon period. Monsoon arrives in the second fortnight of June and ends in September. The summer is mild and winter is very severe. The soil of the experimental block was acidic with pH ranging from 5.0 to 5.6 and soil texture is silty clay to silty loam. The experimental materials comprised of 30 genotypes. The trial was laid out on June 5, 2018 comprising of 30 okra genotypes sown in Randomized Complete Block Design (RCBD) with three replications in plot size of 2.70 m × 1.95 m. The parents were spaced at 45 cm between row to row and 15 cm plant to plant. The experiment field was prepared by ploughing twice with power tiller upto a depth of 20 cm followed by levelling. The Farm Yard Manure (10 t/ha) was mixed in the soil at the time of field preparation with first ploughing. The chemical fertilizer (75 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha) were applied as basal dose at the time of final field preparation. Half of N, full dose of P_2O_5 and K_2O is applied at the time of final field preparation. Remaining half of N was top dressed in two equal amounts and added after 30 and 45 days of sowing respectively.

Disease intensity of powdery mildew was recorded on different genotypes by measuring the percent area infected using 0-9 scale. The genotypes were categorized into highly resistant (0), resistant (<1), moderately resistant (1-10%), moderately susceptible (11-25%), susceptible (26-50%) and highly susceptible (>51%) as per the scale given by Mayee and Datar (1986). The observations on disease reaction of powdery mildew were recorded at weekly intervals.

For immature pod colour five pods were taken at random from each entry per replication and through visual observation they were classified into six different categories namely yellowish green (1), green (2), dark green (3), red (4), dark red (5) and others (99) according to Minimal Descriptors for Agri-Horticultural Crops by Srivastava *et al.* (2001). The pods used same as above were classified as downy (3), slightly rough (5), prickly (7) and others (99) for fruit pubescence and ridges according to Minimal Descriptors for Agri-Horticultural Crops by Srivastava *et al.* (2001).

Results and Discussion

The results of field experiment revealed that there was sufficient genetic diversity among the genotypes for all attributes (Table 2 & 3). Powdery mildew is a limiting factor in cultivation of okra, which sometimes causes 43.2 per cent loss to the crop. On the basis of mean performance, twelve genotypes viz., Punjab Suhawani, Kashi Vibhuti, DPO-1, DPO-4, DPO-5, DPO-10, DPO-11, DPO-14, DPO-17, DPO-18, 9801 and Palam Komal were found to be resistant from powdery mildew under field conditions whereas Shitla Uphar was found to be highly susceptible. Among visual characters Immature pod colour(green to dark green), pod pubescence (downy) and ridges per pod (5-10 ridges / ridgeless) are most desirable horticultural attributes from consumer's point of view. Immature pods of three colour intensities were observed. These were grouped as yellowish green, green and dark green. The genotypes Shitla Uphar, DPO-4, DPO-12 and DPO-18 produced yellowish green pods, whereas the genotypes Punjab Suhawani, Kashi Vibhuti and Palam Komal produced dark green pods. Other genotypes produced green pods. On the basis of pod pubescence, okra genotypes have been grouped into two categories *viz*., downy and slightly rough. The genotypes Punjab Suhawani, Kashi Vibhuti, Kashi Pragati, Shitla Uphar, Shitla Jyoti, Kashi Satdhari, Arka Anamika, DPO-2, DPO-3, DPO-4, DPO-5, DPO-6, DPO-9, DPO-10, DPO-12, DPO-14, DPO-15, DPO-16, DPO-18, DPO-19, 9801, Palam Komal and Punjab-8 produced pods with downy pubescence, while rest of the genotypes produced pods with slightly rough pubescence. Attractive dark green pod colour, 5 ridges per pod and smooth pod surface were the desirable horticultural attributes from consumer's point of view. Pod colour, pod pubescence and ridges per pod and smooth pod surface are the most important quality factors on the basis of which consumer prefer and these observations often provide preconceived idea about other quality attributes. The colour of immature fruit varied between dark green, green, yellowish green and dark red. Pods of all genotypes showed downy to slightly rough pubescence. All high yielding genotypes 9801, Kashi Vibhuti, DPO-5, Palam Komal and Punjab Suhawani had green or dark green pods with downy pubescence. Variation was observed for fruit ridges. All the genotypes had 5 ridges per fruit except Kashi Satdhari (Table 2). Similar results have been reported by various workers (Chandra *et al*. 2014, Sawant *et al.* 2014, Khajuria *et al.* 2015, Bagwale *et al.* 2016, Patil *et al.* 2016, Badiger *et al.* 2017 and Thulasiram *et al*. 2017). From above information, it is clear that there exists a considerable scope in the parent material studied for identifying desirable genotypes since significant differences were observed among the

Table 2. Pod colour and pod texture in different genotypes of okra

Genotypes	Immature pod colour	Pod pubescence	Ridges
Punjab Suhawani	3	3	5.00
Kashi Vibhuti	3	3	5.40
Kashi Pragati	2	3	5.40
Shitla Uphar	1	3	5.53
Shitla Jyoti	2	3	5.03
Kashi Satdhari	2	3	9.87
Arka Anamika	2	3	5.73
DPO-1	2	5	5.16
DPO-2	2	3	5.00
DPO-3	2	3	4.90
DPO-4	1	3	5.10
DPO-5	2	3	5.00
DPO-6	2	3	5.03
DPO-7	2	5	5.13
DPO-8	2	5	4.83
DPO-9	2	3	5.07
DPO-10	2	3	5.00
DPO-11	2	5	4.97
DPO-12	1	3	5.40
DPO-13	2	5	5.20
DPO-14	2	3	5.00
DPO-15	2	3	5.53
DPO-16	2	3	5.40
DPO-17	2	5	5.03
DPO-18	1	3	5.10
DPO-19	2	3	4.93
DPO-20	2	5	5.00
9801	2	3	5.00
Palam Komal	3	3	5.47
Punjab-8	2	3	4.93

Immature pod colour: 1= yellowish green, 2= green, 3= dark green and 5= dark red
Pod pubescence: 3= downy, 5=slightly rough

genotypes for all the traits studied. Sufficient genetic variability for many of the traits studied had also been reported by earlier workers (Singh *et al.* 2007, Bendale *et al.* 2008, Yadav *et al.* 2010, Ramanjinappa *et al.* 2011, Reddy *et al.* 2012, Olayiwola *et al.* 2014, Mallesh *et al.* 2015, Chandramouli *et al.* 2016 and Badiger *et al.* 2017). (Kalia and Padda 1962; Abdelmageed 2010) provided information on genetic characters and plant habit in okra.

All high yielding genotypes possessed good quality attributes with green or dark green pods, downy pubescence and 5 ridges. Salameh and Kasrawi (2007), Adeoluwa and Kehinde (2011) reported variability 12% to 81.2% and 7.1%, respectively for ridges per fruit in okra. Except Kashi Satdhari high

Table 3. Reaction of different genotypes of okra to powdery mildew

Genotypes	Disease Score	Disease reaction
Punjab Suhawani	1	Resistant
Kashi Vibhuti	1	Resistant
Kashi Pragati	5	Moderately Susceptible
Shitla Uphar	9	Highly Susceptible
Shitla Jyoti	5	Moderately Susceptible
Kashi Satdhari	5	Moderately Susceptible
Arka Anamika	3	Moderately Resistant
DPO-1	1	Resistant
DPO-2	3	Moderately Resistant
DPO-3	3	Moderately Resistant
DPO-4	1	Resistant
DPO-5	1	Resistant
DPO-6	5	Moderately Susceptible
DPO-7	3	Moderately Resistant
DPO-8	5	Moderately Susceptible
DPO-9	7	Susceptible
DPO-10	1	Resistant
DPO-11	1	Resistant
DPO-12	3	Moderately Resistant
DPO-13	5	Moderately Susceptible
DPO-14	1	Resistant
DPO-15	3	Moderately Resistant
DPO-16	3	Moderately Resistant
DPO-17	1	Resistant
DPO-18	1	Resistant
DPO-19	5	Moderately Susceptible
DPO-20	3	Moderately Resistant
9801	1	Resistant
Palam Komal	1	Resistant
Punjab-8	5	Moderately Susceptible

0= no symptom: Highly Resistant; <1 % =1: Resistant; 1-10 % = 3: Moderately Resistant
11-25 % =5: Moderately Susceptible; 26-50% = 7: Susceptible; >51 % = 9:Highly Susceptible

yielding genotypes were resistant to powdery mildew under field conditions.

It can be inferred that sufficient variability existed in the material, which could be exploited through either selection or hybridization. The genotypes, Punjab Suhawani, 9801 and Kashi Vibhuti were most desirable and likely to perform better in Himachal Pradesh after multi- location testing as these possess inherent ability to yield high along with powdery mildew resistance and superior quality traits and these genotypes can be utilized in further breeding programmes.

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