Original Research Article

Morphological Characterization and Diversity Analysis in Pea Germplasm

ABSTRACT:

An experiment was conducted to identify the diverse morphological breeding lines. A total of Fifty-two germplasm lines were characterized morphologically as per DUS guidelines, and Shannon's diversity indices (mean value=0.612) were estimated using Microsoft Excel. The results revealed that maximum variability and diversity were present in foliage colour, pod intensity of green colour, seed cotyledon colour and plant height. Minimum variability was reported for stem anthocyanin colouration, seed testa mottling, leaf axial colour and flower standard petal colour. The traits of foliage waxy bloom and stipule type were present in all the genotypes. Stem anthocyanin colouration, seed testa mottling, flower standard petal colour, and leaf axial colour were unique traits and were reported in only a few of the genotypes. It may be concluded that these traits would be considered diverse morphological traits during the selection of lines in segregating generations for the development of pea lines /Variety.

Key words: *Morphological Characterization, Pea, DUS Guideline, Shannon's diversity indices*

1. INTRODUCTION:

The pea (*Pisum sativum*) is widely grown worldwide and is the second most-consumed legume after chickpea. This crop belongs to the family *Fabaceae*, sub-family *Papillionaceae*, and tribe *Vicieae*, which comprises two species, *Pisum fulvum* Sibth and *Pisum sativum* L. The Genetic composition of pea is ca. 4800 Mbp spread across 2n=2x=14 chromosomes. Peas are an important legume crop in India, after chickpeas and pigeon peas. The two types of peas are generally cultivated, i.e., one in the field pea (*Pisum sativum* (L.) var*. arvense*), and the other is garden pea (*Pisum sativum* (L.) var *hortens*). Garden pea is generally used for table purposes and is harvested in green pod conditions. In India, the major field pea-producing states are UP, MP, Bihar, Assam, and Orissa, contributing about 95% of the pea's total area and yield.

The morphological characteristics of plants are a result of the intricate interplay between environment and genetics, including regulatory and structural genes. The variants of these genes reveal their unique genetic regulations, and any change in phenotypic characteristics is a sign of genetic expression [1]. The morphological description has proven to be a valuable tool in plant germplasm identification and classification, breeding material selection, and genetic diversity identification. The present study, therefore, aims to assess the level of morphological diversity within this collection of pea lines, with the ultimate goal of aiding in the selection and more efficient utilization of this germplasm in breeding programs.

2. MATERIALS AND METHODS

Experimental material consisting of fifty-two pea genotypes was received from Field Pea Improvement Project, Department of Plant Breeding and Genetics, COA, Jabalpur, and AICRP on MULLaRP, IIPR Kanpur. The material was grown in a complete randomized block design with three replications in *Rabi* season 2020. Each entry was sown at 30 cm and 10 cm between rows and plants, respectively, with two rows of 2 m length. These lines were characterized as per National Test Guidelines for the DUS test of Pea (Table 1), which PPV and F.R. Authority, GOI, New Delhi. The Phenotypic frequencies calculated were further used to estimate Shannon's Diversity Index (H) to assess the present

diversity [2]. H= -∑ [pi × log pi] Where, pi is the portion of the total number of entries belonging to the i^{th} class.

Table 1: Essential characters along with descriptor

S. No.	Characteristics	Strategies				
1.	Stem anthocyanin coloration	Absent (1)			Present (9)	
2.	Foliage colour	Light Green (3)	Green (5)		Dark Green (7)	
3.	Foliage waxy bloom	Absent (1)	Present (9)			
4.	Leaflets	Absent (1)	Present (9)			
5.	Leaf axil colour	Green (1)	Purple (2)			
6.	Stipule rabbit eared	Absent (1)	Present (9)			
7	Stipule type	Normal (1)	Vestigial (9)			
8.	Flower opening (days)	Extra early (1)	Early (2)	Medium (3)	Late (4)	
9	Flower standard petal colour	White (1)	Blue (2)	Pink (3)	Red (4)	Purple (5)
10.	Number of pod/axils	Single (1)	Double (2)	Multiple (3)		
11.	Pod curvature	Absent (1)	Weak (3)	Medium (5)	Strong (7)	
12.	Pod shape of distal part	Pointed (1)	Blunt (9)			
13.	Pod intensity of green colour	Light Green (3)	Green (5)	Dark Green (7)		
14.	Plant height	Short (3)	Medium (5)	Long (7)		
15.	Seed shape	Spherical (1)	Cylindrical (2)	Dimpled (3)		
16.	Seed surface	Smooth (1)	Wrinkled (2)			
17.	Seed cotyledon colour	Cream (3)	Green (5)	Yellow (7)		
18.	Weight of 1000 seeds	Small (3)	Medium (5)	Large (7)		
19.	Seed Testa mottling	Absent (1)	Present (9)			

3. RESULT AND DISCUSSION

A. Morphological Characterization

In the investigation, significant variation was observed in coloration, seed, plant, pod, and stipule, which are important traits for identifying, characterization, and grouping genotypes (table 2). All fifty-two genotypes have foliage waxy bloom and normal stipule types, and there was no variation recorded for these traits. Stem anthocyanin colouration was present only in the B-22 genotype. Purple leaf axial colour was present only in four genotypes viz., DDR 54, JP 885, B22, Gol Batra tedua rest of the genotype has green leaf axial colour. The flower's standard petal colour was also purple in these four genotypes. The remaining genotypes have white standard petal colour. Seed testa mottling is present only in 2 genotypes, B22 and DDR54. The purple colour of the pea can also be attributed to the accumulation of anthocyanins, whereas the white pea flowers lack these pigments [3, 4, 5]. Variation was found higher for foliage colour i.e., light green in 11 genotypes, green in 20 genotypes and dark green in 21 genotypes. This finding was in consonance with the findings of [3,6]. Pod intensity of green colour was found to be light green, green, and dark green in 16, 25, and 11 genotypes, respectively. Similarly, the high variation found in flower opening (days) were two extra early (Safed Batra Gudda and Gol Batra Tendua), 13 early, 35 medium, and two late lines. A similar finding was reported by [7, 8].

Pod curvature was absent in 22 genotypes, while 27 had weak and three genotypes had medium pod curvature. The plant height of 27 germplasm lines falls in long, 17 have medium while eight lines have short plant height category. The weight of 1000 seeds also showed a high degree of variation in genotypes 28 have medium seed size, 17 large seed size while seven lines showed small seed size. Investigated pea lines show three types of seed shapes: spherical in 36 genotypes, cylindrical in 5 lines, and dimpled in 11 pea lines. Similarly, seed cotyledon colour was also categorized as creamy in 21 lines, green in 9, and yellow in 22 genotypes. These findings were in agreement with [3, 6, 7, and 10].

Table 2 : Characterization of field pea genotypes according to DUS guidelines

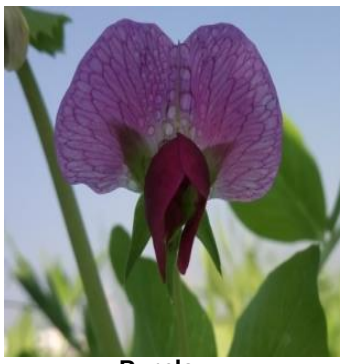
Germplasm	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
DDR 52	1	7	9	1	1	1	1	2	1	2	3	9	5	5	1	1	3	7	1
P 3	1	5	9	1	1	1	1	3	1	2	1	9	7	5	1	1	7	7	1
FP 14-56	1	7	9	9	1	9	1	3	1	2	1	9	3	7	1	1	5	5	1
HFP 94-13	1	5	9	1	1	1	1	3	1	2	3	9	5	5	1	1	7	5	1
FP 14-46	1	7	9	9	1	9	1	3	1	2	1	9	3	5	3	2	3	5	1
KPMR 30	1	5	9	9	1	1	1	3	1	2	1	9	5	7	1	1	7	3	1
FP 9-539	1	5	9	1	1	1	1	3	1	2	3	9	5	5	1	1	3	3	1
PP 155	1	7	9	9	1	9	1	3	1	2	1	9	7	7	1	2	3	3	1
DDR 54	1	3	9	9	2	9	1	2	5	1	3	9	5	7	1	1	3	7	9
JP 885	1	7	9	9	2	1	1	2	5	2	1	9	3	3	3	2	5	5	1
HVP 2	1	5	9	1	1	9	1	3	1	2	3	9	5	7	2	1	7	5	1
IPF 99-25	1	7	9	9	1	1	1	3	1	2	1	9	7	7	1	1	7	5	1
FP 1482	1	7	9	9	1	1	1	3	1	2	3	9	3	5	2	2	3	5	1
RP 3	1	3	9	9	1	9	1	3	1	1	1	9	7	5	1	1	5	3	1
KPMR 402	1	3	9	9	1	1	1	3	1	2	1	9	5	7	1	1	3	5	1
FP 14-27	1	3	9	1	1	1	1	3	1	2	1	9	3	7	1	1	7	5	1
FP 14-21	1	3	9	1	1	9	1	3	1	2	1	9	3	7	1	1	7	7	1
KPMR 402	1	3	9	9	1	1	1	3	1	2	1	9	5	3	1	1	3	5	1
DDR 55	1	7	9	9	1	1	1	3	1	2	1	9	7	7	2	2	7	5	1
KPMR 327	1	5	9	9	1	1	1	3	1	2	3	9	5	5	1	1	3	5	1
NDVP 4	1	3	9	9	1	1	1	3	1	2	1	9	7	5	1	1	7	5	1
KPMR 502	1	5	9	9	1	9	1	3	1	2	1	9	5	5	1	1	7	5	1
VL 3	1	3	9	9	1	9	1	3	1	2	3	9	3	7	2	2	3	3	1
FP 14-13	1	7	9	9	1	1	1	3	1	2	3	9	3	7	1	1	7	5	1
Jayanti	1	5	9	9	1	1	1	3	1	2	1	9	5	7	1	1	7	5	1
B 22	9	3	9	9	2	1	1	2	5	2	1	9	5	7	3	1	3	3	9
Rachna	1	5	9	1	1	9	1	3	1	2	5	1	3	3	1	1	7	5	1
FP 75-96	1	7	9	9	1	9	1	2	1	2	3	9	7	5	1	1	7	5	1
Choti Safed (Anju)	1	5	9	1	1	1	1	3	1	2	3	9	5	7	1	1	3	7	1
FP 18-30	1	5	9	9	1	1	1	3	1	2	3	9	3	7	1	1	7	7	1
FP 14-8	1	3	9	1	1	1	1	3	1	2	3	9	5	5	1	1	3	7	1
Matar Rangpur	1	5	9	1	1	1	1	3	1	2	3	1	7	7	1	1	3	5	1

FP 94-12	1	7	9	9	1	9	1	4	1	2	3	9	5	7	1	1	7	5	1	1
JP 180	1	7	9	9	1	9	1	2	1	2	1	9	5	7	3	2	5	3	1	1
FP14-33	1	7	9	9	1	9	1	4	1	1	3	9	5	7	1	1	7	7	1	1
VRP 5	1	3	9	9	1	9	1	3	1	2	5	1	3	3	3	2	5	7	1	1
PSM 3	1	7	9	9	1	9	1	3	1	1	3	1	5	3	3	2	5	5	1	1
Safed Batara Gudda	1	5	9	9	1	1	1	1	1	1	1	9	3	7	1	1	3	7	1	9
FP 7562	1	5	9	9	1	1	1	2	1	1	3	9	3	3	3	1	3	7	1	1
FP 1330	1	5	9	1	1	1	1	3	1	2	3	9	5	5	2	1	3	5	1	9
Gol Batra Teduaa	1	5	9	9	2	1	1	1	5	1	3	9	3	7	1	1	7	7	1	9
GS 10	1	7	9	9	1	9	1	2	1	1	3	1	7	3	3	2	5	5	1	1
Aman	1	5	9	9	1	1	1	3	1	2	1	9	7	7	1	1	7	7	1	1
FP 14 86	1	7	9	1	1	9	1	3	1	1	3	9	5	7	3	1	3	5	1	9
Arka Sampurna	1	7	9	9	1	9	1	2	1	2	3	1	5	5	1	1	7	7	1	9
Arkel	1	5	9	9	1	1	1	2	1	2	5	1	5	3	3	2	5	7	1	1
FP 14-17	1	7	9	9	1	9	1	3	1	2	3	1	5	7	1	1	7	5	1	1
JM 6	1	5	9	9	1	1	1	2	1	2	1	9	3	7	1	1	3	5	1	1
DDR 27	1	7	9	9	1	9	1	2	1	2	3	9	3	5	1	1	3	7	1	1
KPMR 585	1	5	9	9	1	1	1	3	1	2	3	9	7	7	1	1	7	7	1	1
FP 14-15	1	7	9	9	1	9	1	2	1	1	1	9	5	5	1	1	3	5	1	1
Pusa Pragati	1	7	9	9	1	1	1	3	1	2	3	1	5	5	3	2	5	5	1	1

Whereas, 1**=** Stem anthocyanin coloration, 2=Foliage colour, 3=Foliage waxy bloom, 4=Leaflets, 5=Leaf axial colour, 6=Stipule rabbit eared, 7=Stipule type, 8=Flower opening (days), 9=Flower standard petal colour, 10=Number of pods per axil, 11=Pod curvature, 12=Pod shape of distal part, 13=Pod intensity of green colour, 14=Plant height, 15=Seed shape, 16=Seed surface, 17=Seed cotyledon colour, 18=Weight of 1000 seeds, 19=Seed testa mottling.

Pictures of different morphological characteristics of different pea genotypes

FLOWER STANDARD PETAL COLOUR



Purple

White

LEAF AXIL COLOUR

Present

Absent

LEAF LEAFLETS

Absent

Present

POD CURVATURE

Commented [MS1]: It is preferable to place a ruler, angle meter, or chlorophyll meter (SPAD) beside to some pictures to show the difference between them.

Absent

Weak

Medium

Strong

POD: SHAPE OF DISTAL PART

Pointed

Blunt

STEM ANTHOCYANIN COLOURATION

Present **Absent**

SEED SHAPE

Spherical **Dimpled** **Cylindrical**

SEED: SURFACE

Smooth Wrinkled

Wrinkled

B. Shannon's diversity indices.

The shannon's diversity indices estimated for 20 morphological traits (Table 3) ranged from 0 to 1.062 with a mean value of 0.612. The highest value of diversity index 1.062 was obtained for foliage colour whereas, the lowest value of diversity index of 0 were obtained for foliage waxy bloom and stipule type as genotypes exhibited no variability for these traits. The values of indices unveiled the presence of high diversity in the morphological characters studied, particularly for the foliage colour followed by pod intensity of green colour, seed cotyledon colour and plant height [11].

Table 3: Frequency distribution of morphological traits

Trait	Classes	Number of Genotypes	Percentage (%)	Shannon Weaver Diversity Index (H)
Stem anthocyanin coloration	**Present**	1	1.92	0.095
	Absent	51	98.08	
Foliage colour	**Light green**	11	21.15	1.062
	Green	20	38.46	
	Dark green	21	40.38	
Foliage waxy bloom	**Present**	52	100	0.000
	Absent	0	0.00	
Leaflets	**Present**	39	75.00	0.561
	Absent	13	25.00	
Leaf axial colour	**Green**	48	92.40	0.271
	Purple	4	7.60	
Stipule rabbit eared	**Present**	22	42.31	0.681
	Absent	30	57.69	
Stipule type	**Normal**	52	100.00	0.000
	Vestigial	0	0.00	
Flower opening (days)	**Extra early**	2	3.85	0.864
	Early	13	25.00	
	Medium	35	67.30	
	Late	2	3.85	
Flower standard petal colour	**White**	48	92.30	0.271
	Purple	4	7.69	

Number of pods per axil	**Single**	10	19.23	0.490
	Double	42	80.77	
Pod curvature	**Absent**	22	42.31	0.869
	Weak	27	51.92	
	Medium	3	5.76	
Pod shape of distal part	**Pointed**	9	17.30	0.461
	Blunt	43	82.70	
Pod intensity of green colour	**Light green**	16	30.76	1.043
	Green	25	48.07	
	Dark green	11	21.15	
Plant height	**Short**	8	15.38	0.994
	Medium	17	32.69	
	Long	27	51.92	
Seed shape	**Spherical**	36	69.23	0.808
	Cylindrical	5	9.61	
	Dimpled	11	21.15	
Seed surface	**Smooth**	40	76.92	0.540
	Wrinkled	12	23.07	
Seed cotyledon colour	**Creamy**	21	40.38	1.034
	Green	9	17.31	
	Yellow	22	42.31	
Weight of 1000 seeds	**Small**	7	13.46	0.969
	Medium	28	53.84	
	Large	17	32.69	
Seed testa mottling	**Present**	2	3.84	0.163
	Absent	50	96.15	

Conclusion:

Based on this study, a high amount of diversity is present in the germplasm for traits such as foliage colour, pod intensity of green colour, seed cotyledon colour, plant height and weight of 1000 seeds. Foliage colour (dark green) for high photosynthetic ability and semi leaflets type for standing plant suture, drought resistance, and foliage waxy bloom can be selected for abiotic resistance [9]. Some unique traits were reported only in a few of the genotypes, i.e. stem anthocyanin colouration, leaf axial colouration, flower standard petal colour, and seed testa mottling. These unique traits must be selected in field pea

breeding programmes for the development of specific varieties with distinct identification and as indicators to determine an unstable expression of the phenotype of the candidate variety. The results may offer scope for pea breeding programs aimed to generate new and improved cultivars with specific genetic identities.

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