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ORIGINAL ARTICLE

DUS Characterization of Early Maturing Quality Protein Maize Inbreds under Temperate Conditions

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ABSTRACT
Morphological characterization of forty early maturing QPM inbreds (KDQL1, KDQL2, KDQL3, KDQL4 to KDQL40)was carried out using DUS characters. The study was conducted at Dry land Agricultural Research Station Budgam (SKUAST-K) during Kharif, 2017. The altitude of the location is 1587 m above MSL with coordinates of 34.08^{0}N of latitude and 74.83^{0}E of longitude. Visual observations were recorded on single plant basis on five randomly selected plants in each inbreds at appropriate growth stages as per descriptor of IIMR, Ludhiana. Data on stem length, ear placement, width of leaf blade, ear length without husk, ear diameter and grain rows per ear were recorded on five randomly selected plants in each plot, while the kernel traits were also recorded as per the standard procedures.
Keywords: QPM inbreds, Glutamines, Maize

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INTRODUCTION

As a product of conventional plant breeding, Quality Protein Maize (QPM) is an example of biofortification. The maize carrying the o2 gene in homozygous condition characterized by the hard modified endosperm with vitreous kernels is known as QPM. Using marker assisted selection, *opaque*-2 gene was transferred gene into two early maturing inbreds which were further crossed to develop Vivek QPM 9, an early duration QPM hybrid. The presence of the o2 allele in a homozygous state results in decrease in the production of Alpha zein protein enzymes that are responsible for degradation of free lysine. In turn, there is a corresponding increase in non-zein proteins such as glutamines. Glutamines confer higher lysine and tryptophan levels [1] and seed contains 2 g/100 g or more of lysine.As far as the utility of QPM is concerned several studies were carried out related to the biological value of protein which is estimated on the average proportion of absorbed protein that is successfully retained by the body for growth and maintenance. In addition, QPM has other nutritional advantages over normal maize comprising of higher concentration of niacin (Vitamin B3) due to higher tryptophan levels and better absorption of potassium and carotene by body [2]. QPM is also found to reduce the cost of purchasing protein supplements to non-ruminants and can be used as a new animal feeds by providing balanced feed [3, 4].

In developing countries where many farmers are accustomed to growing of hard flints and dents, the kernel phenotype or appearance of the opaque's was also a major barrier to their acceptance. Other problems with the opaque-2 materials included slower drying after physiological maturity of the grain, a thicker pericarp, greater susceptibility to ear rot and stored grain pests, problems with germination and field emergence .As these problems were found in original o2 materials and there was no definite solution or strategy, thus many breeders identified to develop QPM germplasm that is competitive in agronomic performance and free of problems. In order to address the issue of genetic vulnerability of QPM inbreds, accelerated development of improved QPM hybrids/ composites/ lines is required and to improve the current QPM production in cultivars that are adapted to temperate agro-ecologies. Further to resolve such issues "Protection of Plant Varieties and Farmers Rights (PPV & FR) act was passed by Indian government in 2001, which provides the registration of new variety of plant if it confirms to the criteria of Distinctness, Uniformity and Stability (DUS). In terms of this act DUS generates a description of the variety, using its relevant characteristics by which it can be described as a variety. The variety is deemed to be "Distinct" if it is clearly distinguishable by one or more essential characteristics from any other variety. The variety is deemed to be "Uniform", if subjected to variation that may be expected from particular features of its propagation, it should be sufficiently uniform. The variety is deemed to be "Stable", if relevant characteristics remain unchanged after repeated propagation. In present study a set of 40 inbred lines was evaluated and characterized through phenotypic studies. The characterization of germplasm provides a baseline information regarding the morphological and agronomic traits [5]. Moreover potential adaptability of the lines to varied agro-ecologies was studied to distinguish lines for grain yield/other traits under field conditions.

MATERIAL AND METHODS

The basic plant materials in the present study comprised of 40 QPM inbred lines belonging to early maturity group designated from KDQL1 to KDQL40.The seed material was sown out in Randomized Complete Block Design with three replications at Dry land Agricultural Research Station Budgam, during *Kharif*, 2017. The altitude of the location is 1587 m above MSL with coordinates of 34.08^{0}N of latitude and 74.83^{0}E of longitude. Row to row and plant to plant spacing was maintained at 70cm and 20cm, respectively. Recommended agronomic practices were followed to ensure healthy plant stand and to provide optimum level of management crop growth. The characterization was carried out using thirty one DUS characters.The DUS traits and the state of expression which were recorded are as:

Table 1:

S. No.	Character	State of expression
1	Leaf: angle between blade and stem	Small
		Wide
2	Leaf attitude of blade	Straight
		Drooping
3	Anthocyanin colouration of brace roots	Absent
		Present
4	Time of anthesis	Very early
		Early
		Medium
		Late
5	Anthocyanin colouration of base of glumes	Absent
		Present
6	Anthocyanin colouration of glumes excluding base	Absent
		Present
7	Anthocyanin colouration of anthers	Absent
		Present
8	Density of spikelets	Sparse
		Dense
9	Angle between main axis and lateral branches	Narrow
		Wide
10	Tassel attitude of lateral branches	Straight
		Curved
11	Time of silk emergence	Very early
		Early
		Medium
		Late
12	Anthocyanin colouration of silks	Absent
		Present
13	Anthocyanin colouration of sheath	Absent
		Present
14	Tassel length of main axisabove lowest side branch	Short
		Medium
		Long
15	Plant length	Short
		Medium
		Long
		Very long
16	Ear placement	Low
		Medium
		High
17	Width of leaf blade	Narrow
		Medium
		Broad
18	Ear length without husk	Short
		Medium
		Long

19	Ear diameter	Small
		Medium
		Large
20	Ear shape	Conical
		Conico-cylindrical
		Cylindrical
21	Number of rows of grain	Few
		Medium
		Many
22	Type of grain	Flint
		Semi flint/ semi dent
		Dent
23	Colour of top of grain	White
		White with cap
		Yellow
		Yellow with cap
		Orange
		Red
		Other
24	Anthocyanin colouration of glumes of cob	White
		Light purple
		Dark purple
25	Kernel row arrangement	Straight
		Spiral
		Irregular
26	Kernel poppiness	Absent
		Present
27	Kernel sweetness	Absent
		Present
28	Kernel waxyness	Absent
		Present
29	Kernel opaqueness	Absent
		Present
30	Kernel shape	Shrunken
		Round
		Indented
		Toothed
		Pointed
31	1000 kernel weight	Very small
		Small
		Medium
		Large

RESULTS AND DISCUSSION

The frequency distribution of these Inbreds for various DUS characters is given below in Table 2.

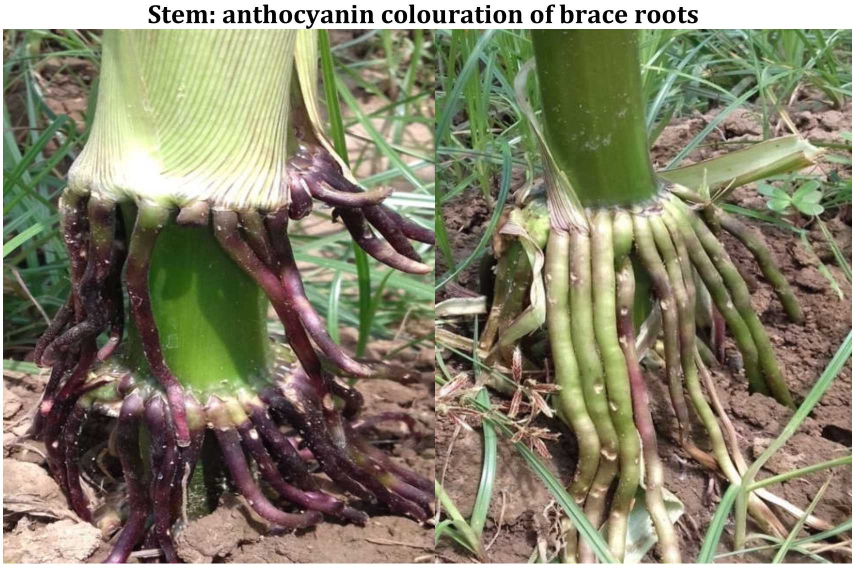
Table 2: Frequency distribution of Quality Protein Maize Inbreds for various DUS characters

S. No.	Character	State of expression	No.of inbreds	Frequency distribution (%)
1	Leaf: angle between blade and stem	Small	26	65
		Wide	14	35
2	Leaf attitude of blade	Straight	18	45
		Drooping	22	55
3	Anthocyanin colouration of brace roots	Absent	23	57.5
		Present	17	42.5
4	Time of anthesis	Very early	22	55
		Early	17	42.5
		Medium	1	2.5
		Late	None	0
5	Anthocyanin colouration of base of glumes	Absent	16	40
		Present	24	60
6	Anthocyanin colouration of glumes excluding base	Absent	17	42.5
		Present	23	57.5
7	Anthocyanin colouration of anthers	Absent	17	42.5
		Present	23	57.5
8	Density of spikelets	Sparse	27	67.5
		Dense	13	32.5
9	Angle between main axis and lateral	Narrow	26	65

	branches	Wide	14	35
10	Tassel attitude of lateral branches	Straight	26	65
		Curved	14	35
11	Time of silk emergence	Very early	12	30
		Early	21	52.5
		Medium	7	17.5
		Late	None	0
12	Anthocyanin colouration of silks	Absent	19	47.5
		Present	21	52.5
13	Anthocyanin colouration of sheath	Absent	40	100
		Present	None	0
14	Tassel length of main axis above lowest side branch	Short	1	2.5
		Medium	14	35
		Long	25	62.5
15	Plant length	Short	40	100
		Medium	None	0
		Long	None	0
		Very long	None	0
16	Ear placement	Low	1	2.5
		Medium	19	47.5
		High	20	50
17	Width of leaf blade	Narrow	7	17.5
		Medium	12	30
		Broad	21	52.5
18	Ear length without husk	Short	None	0
		Medium	23	57.5
		Long	17	42.5
19	Ear diameter	Small	40	100
		Medium	None	0
		Large	None	0
20	Ear shape	Conical	14	35
		Conico-cylindrical	7	17.5
		Cylindrical	19	47.5
21	Number of rows of grain	Few	1	2.5
		Medium	22	55
		Many	17	42.5
22	Type of grain	Flint	29	72.5
		Semi flint/ semi dent	3	7.5
		Dent	8	20
23	Colour of top of grain	White	2	5
		White with cap	None	0
		Yellow	13	32.5
		Yellow with cap	4	10
		Orange	20	50
		Red	1	2.5
		Other	None	0
24	Anthocyanin colouration of glumes of cob	White	36	90
		Light purple	2	5
		Dark purple	2	5
25	Kernel row arrangement	Straight	25	62.5
		Spiral	5	12.5
		Irregular	10	25
26	Kernel poppiness	Absent	None	0
		Present	40	100
27	Kernel sweetness	Absent	40	100
		Present	None	0
28	Kernel waxyness	Absent	40	100
		Present	None	0
29	Kernel opaqueness	Absent	40	100
		Present	None	0
30	Kernel shape	Shrunken	2	5
		Round	29	72.5
		Indented	1	2.5
		Toothed	8	20
		Pointed	None	0
31	1000 kernel weight	Very small	None	0
		Small	4	10
		Medium	36	90
		Large	None	0

A wide spectrum of variation was found in the frequency distribution of inbreds for various characters. For leaf characters angle between blade and stem, maximum frequency of (65%) as found for "small" state of expression while the rest percentage was for "wide" character. Maximum percentage of inbreds (55%) were found to be "drooping" for leaf attitude of blade. The Anthocyanin colouration of brace roots was mostly found to be absent (57.5%). Majority of the inbreds were early in there anthesis and silking period and none was found to be late. Anthocyanin colouration of base of glumes, glumes excluding base and colouration of anthers were mostly present with frequency of 60%, 57.5% and 57.5% respectively. Majority of spikelets were "sparse" with narrow angle between main axis and lateral branches. The Tassel attitude of lateral was mostly found to be "straight"(65%). The Anthocyanin colouration of sheath was found totally lacking while the colouration of silks contributed almost (52.5%) . Height was mostly short while the ear placement was found to be "high". Ear length without husk and no. of rows of grains (flint state of expression of grains) was found to be "medium" with frequency of 57.5% and 55% respectively while the ear diameter attributed 100% to the "small" state of expression. The ear shape was found to be cylindrical (47.5%). About Kernel characters , the kernel arrangement in majority of inbreds was found to be straight (62.5%), poppiness present while sweetness ,waxiness and opaqueness were found lacking with "medium"kernel weight.

Stem: anthocyanin colouration of brace roots

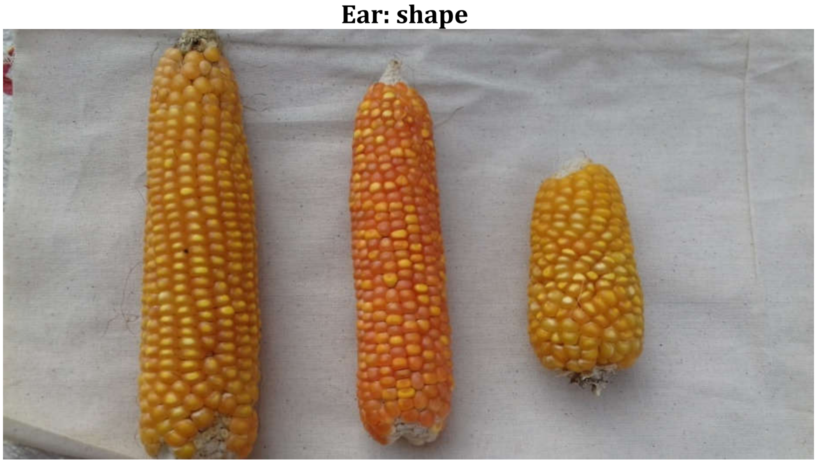


Tassel: anthocyanin colouration of glumes excluding base

Tassel: density of spikelets

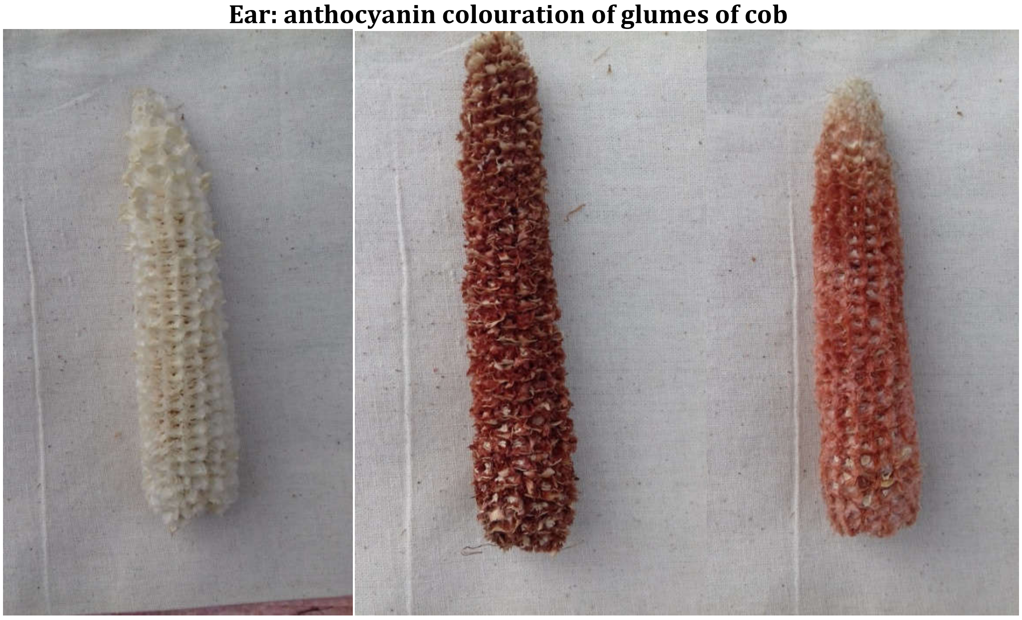
Ear: anthocyanin colouration of silks

Ear: shape

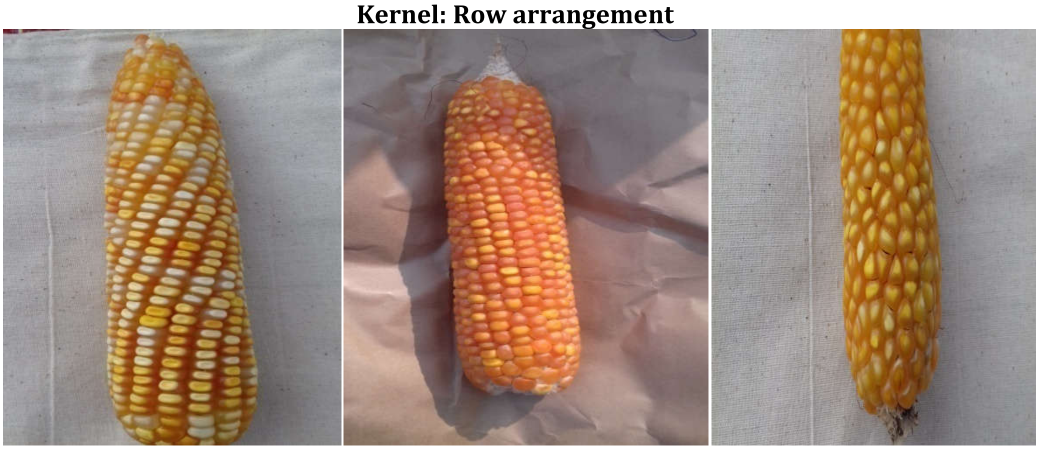


Ear: number of rows of grains

Ear: anthocyanin colouration of glumes of cob



Kernel: Row arrangement



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