Journal of Scientific Research and Reports

Volume 30, Issue 12, Page 1-7, 2024; Article no.JSRR.126736
ISSN: 2320-0227

Agro-morphological Characterization of Maize (*Zea mays* L.) Landraces from Tribal Regions of Kashmir

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jsrr/2024/v30i122645

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/126736

Original Research Article

Received: 19/09/2024
Accepted: 27/11/2024
Published: 29/11/2024

ABSTRACT

Twenty one maize landraces were collected from tribal areas of Kupwara, Budgam and Anantnag districts and were evaluated for agro morphological characteristics**.** A field experiment with 18 maize landraces was conducted at the station during Kharif 2021-2022 and the data was recorded for various quantitative and qualitative characters related to growth and yield performance. Most of the landraces showed distinct variation with regard to different growth parameters. A wide range in the quantitative characters exhibited by the landraces showed the diversity in the germplasm. Analysis of the variance showed that all the characters were highly significant among the landraces.

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Cite as: *Nasseer, Sabina, Zahida Rashid, Shabina Majeed, Faisal Rasool, Munazah Rashid, Adil Gul, Shahida Iqbal, A.A. Lone, and Z. A. Dar. 2024. "Agro-Morphological Characterization of Maize (Zea Mays L.) Landraces from Tribal Regions of Kashmir". Journal of Scientific Research and Reports 30 (12):1-7. https://doi.org/10.9734/jsrr/2024/v30i122645.*

Keywords: Characterisation; germplasm; landraces; crop varieties.

1. INTRODUCTION

Maize (*Zea mays* L., Family -*Poaceae*) is one of the most important crops in many countries being utilized as grains and fodder. Maize is emerging as third most important crop after rice and wheat, and contributes 2.5 billion dollar to Indian agriculture GDP. As maize is being cultivated in diverse agro-climatic conditions, it is characterized by a number of landraces which are adapted to local climate (Prasanna,2010). Crop landraces are the cultivated crop types with the highest genetic variation as well as with the best adaptation to the natural and anthropological environment where they have evolved (Maxted *et al*.1997). They contain locally adapted alleles and represent irreplaceable bank of highly co-adapted genotypes. Information on both qualitative and quantitative morphological traits of existing maize landraces may be useful in maintaining their genetic variability and preserving them from genetic erosion (Lucchin,2003). The characterisation and evaluation of the available maize germplasm is a necessary first step to facilitate breeding efforts (Doriana *et al*.2012).

There is an important role of morphological data in respect to identification, characterization as well as management of germplasm collection (Smith and Smith,1989). Many tools are now available to study relationships among cultivars, including various types of molecular markers; however, morphological characterization is the first step in the description and classification of germplasm. The characterization of morphological variability is useful tool to identify accessions with desirable characteristics such as earliness, disease resistance, or improved ear trait (Shrestha,2013). The aim of this study was to discover possible genetic diversity in maize accessions from different tribal areas of Kupwara, Budgam and Anantnag districts of Jammu and Kashmir using morphological characters so that the information can further be used for the planning conservation, and the utilization of these resources for future use in breeding programs for development of climate resilient crop varieties.

2. MATERIALS AND METHODS

Twenty one landraces of maize have been collected from native farmers in the different tribal districts of Kashmir. The geographical location of the experiment site was 34.0073833 N latitude; 74.7936748 E longitude and at an altitude of 1,660 m above sea level. The average rainfall is 600 mm. The experimental soil was medium type with normal pH; nitrogen and potash. Total of twenty one landraces were sown in a plot size of 5 m x 4m each replicated three times in a randomized block design. The landraces were sown during the month of May 2021 and 2022 at a row spacing of 60 cm and plant to plant spacing of 20 cm. The recommended agronomic package of practices was followed during the crop growth period. The visual observations were recorded on 11 qualitative traits (leaf colour, stem colour, attitude of leaf blade, anthocyanin colouration of silk, ear placement, ear shape, type of grain, colour of grain, kernel row arrangement and angle between leaf blade and stem) Eleven quantitative traits viz. days to 50 % tassel anthesis, plant height, leaf width and length (leaf below upper ear), stem diameter, ear height, tassel length, as well as other traits like, maturity days, cob weight, kernel rows per cob and kernels per row were also recorded. Analysis of variance was performed on each morphological data to test the significance of variation between accessions by using OPSTAT software.

3. RESULTS AND DISCUSSION

The importance of maize germplasm characterization has been highlighted by number of studies (Kumar *et al*. 2014, Mushtaq *et al*.2016, Salami,2015). In the present study, the morphological diversity pattern of 18 maize landraces, with their agro-morphological traits were analyzed. The existing diversity was evaluated based on 22 morphological traits in 21 maize landraces. I) Qualitative traits: The observations on qualitative traits revealed that about 90 % landraces had dark green coloured leaves and 44% landraces had brownish tinge on stem at ground level. Though 22% landraces had purple colored stem while as the rest had green colored stem. Most of landraces (72 %) showed straight attitude of leaf blade. Majority of landraces (62%) exhibited purple colored silk whileas the rest 38% had green colored silk. In most cases the ear (cob) was placed on plant either at middle or at low height (27%). These different landraces showed conico-cylindrical (22%) and cylindrical (55%) as well as conical type(22%) of ear shape. Grain colour is the most variable character observed; about 16%

Table 1. Mean values of quantitative traits of maize landraces

Land Races	Days to 50% taselling	Plant height (cm)	leaf length (cm)	Stem Diameter (cm)	Leaf width (cm)	Ear height (cm)	Tassel length (cm)	Maturity days	Cob wt. (g)	Rows/cob	Kernels/row
KDM--101	72	168	9.5	2.8	3.6	71.3	23.5	124	4.4	14	35
KDM--102	74	182	7.3	3.5	3.9	68.4	12.4	123	5.2	12	38
KDM--103	76	184	8.5	3.6	5.8	64.3	24.2	120	3.8	14	44
KDM--104	77	155	7.6	2.8	5.4	73.1	21.3	112	3.6	16	47
KDM--105	79	128	8.6	2.6	6.2	74.3	18.3	124	4.9	12	36
KDM--106	76	163	9.4	3.7	4.1	69.4	14.6	122	5.4	16	32
KDM--107	74	176	8.5	3.2	7.4	79.3	19.6	125	4.7	12	28
KDM--108	76	174	9.2	2.6	5.9	8.3	21.5	124	3.8	14	36
KDM--109	77	167	7.8	3.8	6.4	82.4	18.7	95	4.9	16	34
KDM--110	72	168	6.8	2.7	6.4	62.5	19.5	122	4.5	12	29
KDM--111	74	145	7.6	3.7	4.5	61.7	21.6	124	5.4	10	36
KDM--112	73	164	8.4	3.6	6.2	64.9	17.6	116	3.2	14	34
KDM--113	72	178	6.4	2.8	5.8	73.5	16.9	121	5.1	12	38
KDM--114	71	174	8.9	3.4	6.7	61.8	17.5	124	5.2	16	42
KDM--115	70	184	5.7	3.6	7.9	64.9	23.8	116	4.3	14	48
KDM--116	75	138	7.9	4.2	8.1	62.8	25.2	123	4.9	16	46
KDM--117	77	128	8.7	3.8	7.5	45.3	24.3	115	3.5	12	24
KDM--118	75	169	7.4	4.7	5.3	58.6	21.3	123	4.8	14	26
KDM--119	76	154	8.3	4.9	6.4	68.7	24.6	98	4.6	18	32
KDM--120	73	165	6.8	5.1	6.8	67.3	20.6	109	5.2	20	39
KDM--121	75	178	7.2	4.6	7.4	74.5	18.5	106	4.9	16	42
SE (m)	**0.5**	**3.69**	**0.22**	**0.16**	**0.27**	**3.3**	**0.54**	**0.43**	**0.14**	**0.52**	**1.47**
CV %	**16.34**	**11.21**	**12.12**	**18.41**	**16.42**	**14.36**	**11.94**	**10.62**	**14.31**	**16.04**	**18.14**

Landrace No.	Leaf color	Stem color	Attitude of leaf blade	Anthocyanin color of silk	Ear placement	Ear shape	Type of grain	Color of grain	Kernel row arrangement	Angle between leaf blade and stem
KDM-101	Dark green	Brown	Straight	Purple	Middle	Conical	Flint	Yellow	Straight	Narrow
KDM-102	Dark green	Green	Straight	Green	Low	Conico cylindrical	Dent	Yellow	Straight	Narrow
KDM-103	Dark green	Purple	Straight	Green	Middle	Conico cylindricall	Flint	Orange	Straight	Wide
KDM-104	Dark green	Green	Straight	Purple	Middle	Conical	Flint	Orange	Curved	Wide
KDM-105	Light green	Brown	Straight	Purple	Middle	Cylindrical	Flint	Red	Curved	Wide
KDM-106	Dark green	Green	Curved	Purple	Middle	Cylindrical	Dent	Red	Curved	Wide
Landrace No.	**Leaf color**	**Stem**	**Attitude of**	**Anthocyanin**	**Ear**	**Ear shape**	**Type of**	**Color of**	**Kernel row**	**Angle between leaf**

		color	leaf blade	color of silk	placement		grain	grain	arrangement	blade and stem
KDM-107	Dark green	Brown	Curved	Purple	Low	Conical	Dent	Brownish red	Straight	Wide
KDM-108	Dark green	Purple	Curved	Purple	Low	Conico cylindrical	Round	Red	Straight	Narrow
KDM-109	Dark green	Brown	Curved	Purple	Low	Conical	Round	Red	Irregular	Narrow
KDM-110	Light green	Brown	Curved	Purple	Low	Cylindrical	Round	Orange	Irregular	Narrow
KDM-111	Dark green	Green	Straight	Purple	Middle	Cylindrical	Round	Yellow	Straight	Wide
KDM-112	Dark green	Brown	Straight	Purple	Middle	Conico cylindrical	Round	Blackish red	Irregular	Wide
KDM-113	Dark green	Green	Straight	Green	Middle	Cylindrical	Flint	Dark brown	Irregular	Wide
KDM-114	Dark green	Purple	Straight	Purple	Middle	Cylindrical	Flint	Dark brown	Irregular	Wide
KDM-115	Dark green	Brown	Straight	Green	Middle	Cylindrical	Flint	Orange	Straight	Wide
KDM-116	Dark green	Green	Straight	Green	Middle	Cylindrical	Dent	White	Curved	Narrow
KDM-117	Dark green	Brown	Straight	Green	Middle	Cylindrical	Flint	White	Curved	Narrow
KDM-118	Dark green	Purple	Straight	Green	Middle	cylindrical	Flint	White	Straight	Narrow
KDM-119	Light green	Purple	curved	Green	Low	conical	Flint	Orange	curved	wide
KDM-120	Dark green	Green	curved	green	Low	cylindrical	dent	Dark brown	straight	narrow

Table 2. Qualitative character description of landraces of maize (*Zea mays* L.)

Land Races	Days to 50% taselling	Plant height (cm)	leaf length (cm)	Stem Diameter (cm)	Leaf width (cm)	ear height (cm)	Tassel length (cm)	Maturity days	Cob wt. (g)	Rows/cob	Kernels/row
KDM--101	72	168	9.5	2.8	3.6	71.3	23.5	124	4.4	14	35
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CV %	**16.34**	**11.21**	**12.12**	**18.41**	**16.42**	**14.36**	**11.94**	**10.62**	**14.31**	**16.04**	**18.14**

landraces had yellow colour grains and other landraces with grain colour like white (16%), red (22%), or (22%) and dark brown (11%) were also observed. Straight kernel row arrangement was found abundant trait with about 44% which was followed by curved and irregular kernel row arrangement in equal proportions. These results revealed that the landraces possessed higher degree of variability

3.1 Quantitative Traits

The mean values of quantitative traits revealed traits are presented in Table 1. The evaluation of 11 quantitative traits for 18 maize landraces, showed the variation in plant height (128-184 cm), crop maturity days (91 to 123 days), days to tasseling (71-77 days). The findings of the present study in Table 1 showed that stem diameter was most varied trait (18.44%), followed by kernels per row (18.14 %) and leaf width (16.42 %). Among the studied traits, days for maturity days showed the lowest variation (10.62%). The leaf width and leaf length ranged between 3.6 to 8.1 cm and 5.7 to 9.4 cm respectively. The days required for 50% tassel anthesis was highest (79 days) in KDM- 105 and lowest (70 days) in M- 115. Tassel length was lowest (14.6 cm) in KDM-106 and highest (25.2 cm) in KDM-116. The yield attributing characters like number of kernel rows per ear, number of kernels per row and cob weight were evaluated. The kernels per row had a wide range of 28-48 whereas 12-20 kernel rows per ear were also recorded. Among the morphological characteristics plant height, stem diameter, leaf length and width, ear length and diameter, number of rows per ear and grain colour, contributed most in overall variability among maize landraces. Wasala et al. (2013) studied morphological characters in multi-location trial for 48 landrace accessions of maize. They also observed that grain yield, ear diameter and kernel weight showed significant differences among accessions. Crop maturity days are important trait (Shrestha, 2013) in breeder's point of view as landraces with minimum maturity can be explored in development of early variety. Some traits are directly contributing in grain yield (Kumar et al. 2014) like ear length, ear diameter, rows per ear etc. Grain colour is one of the diverse traits which may facilitate for discrimination of germplasm. Among the studied maize landraces some of the landraces exhibit some of these desirable traits which have more importance in breeding new varieties. Galarreta and Alvarez (2001) also suggested that the traits like days to flowering, plant height and ear placement height, ear length, ear diameter, no. of rows per ear are more suitable for characterization and classification of maize landraces. Takawale et al. (2009) suggested that the unexploited maize germplasm from tribal areas of the country can be tapped and utilized for further breeding programme.

4. CONCLUSION

Present work highlights the vast agro morphological diversity between studied landraces. The findings of the present study may provide a source of data related to variation required for future breeding programs. By studying morphological traits in maize landraces, the information for planning the conservation and utilization of these resources can be generated for future breeding programs. These landraces will be subjected to stress tolerance and molecular studies to ensure their inclusion in future breeding programmes for developing varieties that are best suited to climate smart agriculture.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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https://www.sdiarticle5.com/review-history/126736