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# CHARACTERIZATION OF MAIZE (*ZEA MAYS*) GENOTYPES ON THE BASIS OF KNOB COMPOSITION

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## ABSTRACT

**The present investigation was initiated with an objective for characterization of local maize genotypes on the basis of heterochromatic knobs through pachytene analysis. Pachytene analysis revealed a total of 9 knobs forming positions in three maize genotypes The number of knobs in these genotypes varied from 2($G_7$) to 5 ($G_2$, $G_4$, $G_5$). The most common knob forming positions were 6S(100%), 2L(90%) and 6La(50%). The knob at 4L position was present in $G_2$ and $G_4$ only, whereas 5L knob was present in $G_1$ and $G_{10}$ only. Chromosome numbers 1,3 and 10 were completely knobless. The knobs present on short arm only were 6S, 7ST and 9ST, while the knobs on long arm were 2L, 4L, 5L, 6La, 8La and 9L.**

***Key words : Maize, knob composition.***

Maize is third important cereal grown in India. It was introduced into India from America in the beginning of the seventeenth century. It is grown in all countries of the world and occupies about 130 million hectares. Maize occupies the largest area in U.P, Bihar, Rajasthan, M.P and Punjab. It has the highest average national productivity about 1.7-1.8 t/ha. The area under maize cultivation is about 6.2-6.5 mha. Bihar is an important maize growing state in the country, which accounts for 6.9 lakh hectare area and 1.27 million tonne production. In Bihar the average yield per hectare Rabi maize and kharif maize is 25.54 quintal and 17.15 quintal respectively. In North Bihar, Begusarai, Samastipur, Bhagalpur, Khagaria, Madhepura and Siwan are the leading districts growing maize on large scale.

Maize has been extensively studied at morphological, cytogenetical, genetical as well as molecular level providing significants tools in understanding several biological phenomena that are of practical interest to the plant breeders.

Knobs are more clearly visible during pachytene stage. It appears as an electron dense made up of compact fibrillar material, with small electron luscent patches (Sharma and Sarma, 1988). The knobs are structural components of chromosome organization and inherited in the same way as the genes (Rhoades and McClintock, 1935, Rhoades, 1955). These heterochromatic knobs are not random in their distribution, rather occupy fixed position on chromosomes (Longley, 1939).

The amount of knob heterochromatin has been attributed to the adaptation of maize to its environment. Chughtai *et.al.* (1995) have suggested that depending on environment, the number of homozygous or heterozygous knobs determine the hybrid performance. Thus knob composition of hybrids (as well as landraces and varieties of maize) apparently plays important role in adaptation to their environmental condition. Consideration of this factor in maize breeding for various target environments and purposes may ensure more success than random crossing and selection. Thus the present investigation was an attempt to Characterization of maize genotypes/land races on the basis of knob composition at pachytene stage of meiosis.

## MATERIALS AND METHODS

Disease free healthy seeds of maize land races were collected from different areas of Bihar and Jharkhand. Initially several genotypes were tested but finally, on the basis of their suitability for experiments, ten genotypes were selected (Table-1).

The field experiment was carrid out at the research field of Department of Genetics , Rajendra Agricultural University, Pusa, Samastipur, Bihar during the Kharif 2002. Pusa in August, 2002 in the research field of R.A.U., Pusa in 60cm x 30cm spacing in plot of approximately 5m to 10m size. The seeds germinated

**Table-1 :** Maize genotypes.

| Sl. No. | Genotypes code | I.C. No. | Site of collection | | | |
|---|---|---|---|---|---|---|
| | | | Village | Block | District | State |
| 1. | $G_1$ | 331544 | Khedarpma | Vaishali | Vaishali | Bihar |
| 2. | $G_2$ | 331551 | Pahlijaghat | Sonpur | Chapra | Bihar |
| 3. | $G_3$ | 331553 | Dumri | Chapra Sadar | Chapra | Bihar |
| 4. | $G_4$ | 331558 | Dumri | Chapra Sadar | Chapra | Bihar |
| 5. | $G_5$ | 331593 | Sohonla | Kuchaycott | Gopalganj | Bihar |
| 6. | $G_6$ | 331599 | Kusahar | Sidhawalia | Gopalganj | Bihar |
| 7. | $G_7$ | 347131 | Babupur | Sabour | Bhagalpur | Bihar |
| 8. | $G_8$ | 347133 | Masaru | Sabour | Bhagalpur | Bihar |
| 9. | $G_9$ | 347134 | Jamni Paharpur | Godda | Godda | Jharkhand |
| 10. | $G_{10}$ | 347138 | Sanjhotari | Bannsi | Banka | Bihar |

**Table-2 :** Knob polymorphism in maize genotypes.

| Genotypes | I.C. No. | Total knob number | Knob Position | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2L | 4L | 5L | 6S | 6La | 7ST | 8La | 9ST | 9L |
| $G_1$ | 331544 | 4 | + | - | + | + | - | + | - | - | - |
| $G_2$ | 331551 | 5 | + | + | - | + | + | - | + | - | - |
| $G_3$ | 331553 | 4 | + | - | - | + | + | - | - | - | + |
| $G_4$ | 331558 | 5 | + | + | - | + | + | - | - | + | - |
| $G_5$ | 331593 | 5 | + | - | - | + | + | - | + | - | + |
| $G_6$ | 331599 | 4 | + | - | - | + | - | - | - | + | + |
| $G_7$ | 347131 | 2 | - | - | - | + | - | - | + | - | - |
| $G_8$ | 347133 | 4 | + | - | - | + | + | - | + | - | - |
| $G_9$ | 347134 | 3 | + | - | - | + | - | - | - | + | - |
| $G_{10}$ | 347138 | 3 | + | - | + | + | - | - | - | - | - |

+ = Present, - = Absent

in 4-5 days after sowing. All the recommended agronomic practices were followed and doses of fertilizers were applied.

Pachytene analysis of ten selected genotypes of maize were done in tassel. Tassel collected at healthy boot stage tassels were harvested at random at 8-9 A.M. during flowering stages after about 45 days of sowing. The tassel were fixed in aceticacid-alcohol fixative which consisted of glacial acetic acid and absolute ethanol in a 1:3 proportion. The fixed tassels were kept at room temperature for 24 hr. The freshly fixed florets were either used immediately for cytological preparation or stored for later use. The fixed tassels were, as and when necessary, stored in 70 percent ethanol at $14\pm2^0$C in a refrigerator.As and when required the stored tassels were refixed in 1:1 acetic-alcohol for 1-3 hrs. before using than for chromosome preparation.

The boot stage buds were dissected on a clean slide and anthers of appropriate sizes were selected. The anthers were then placed in a 2 percent aceto-carmine stain solution in homeopathic phials or covered watch glasses and allowed to be stained for 20 minutes at room temperature. At the time of slide preparation, the stained anther was teased with rusted needles on a clean microslide in a drop of 2 percent aceto-carmine stain to liberate the pollen mother cells. The anther wall and other debris were removed. The suspension of pollen grains in the staining solution was then covered with a cover glass, slightly warmed and gently squased for proper spreading of pollen mothers cells and chromosomes. Over stained preparations were suitably destained with 45 percent aceticacid.

Alternatively, fresh (unfixed) pollen grains were squeezed out in 2 percent aceto-carmine solution on a clean slide and warmed until properly stained preparation were obtained. The rest of the procedure remained as above. Mordanting with $Fe^{++}$ was

accomplished either by dissolving a pinch of $FeCl_3$ powder in the fixative. So as to make the later slightly brownish or by touching the warm staining solution with a rusted needle as the occasion required. The slides were temporarily sealed with molten paraffin wax using a spear needle.

The slides were observed under a trinocular Olympus research microscope using an objective 100 x with a drop of immersion oil on the cover glass. For most observations, the day light was utilized as the source of illumination. Whenever necessary, artificial tungsten light and blue filters were also used.

Camera lucida drawings were made using a prism type camera lucida. In the camera lucida drawings, chromosome were measured in micron by drawing a scale of the stage micrometer.

For microphotography of pollen mother cells, dividing cells and chromosomes, Kodak colour films (100 ASA) were used on Olympus trinocular research microscope with microphotographic attachment. For light source, the in- built tungsten bulb attachment was used alongwith a blue filter. The drawings of pachytene chromosome were drawn on the basis of these microphotographs.

## RESULTS AND DISCUSSION

Pachytene analysis of all ten maize genotypes included in present investigation revealed variability in the number, position and size of the knobs present on different chromosomes. Altogether nine knobs were observed in these maize genotypes which included 2L, 4L, 5L, 6S, 6La, 7ST, 8La, 9ST and 9L (Table-4). Chromosome 1,3 and 10 were completely knobless in these genotypes. Among these genotypes, $G_2$, $G_4$ and $G_5$ possessed maximum number of knobs (5 each) followed by $G_1$, $G_3$ , $G_6$, $G_8$ (4 knob each), $G_9$, $G_{10}$ (3 knob each) and $G_7$ (2 knob). The minimum number of knobs (2) was present in genotypes $G_7$ (Table-2).

Knobs on 6S was present in all the genotypes studied whereas large 2L knob was present in all except $G_7$. A large size 4L knob was observed in $G_2$ and $G_4$ only, but a large size 5L knob was observed in $G_1$ and $G_{10}$ only. Knob at 6S position, just close to nucleolar organizing region (NOR) on short arm of chromosome 6 was present in all the genotypes, although its size was variable ranging from small to medium. Knobs on the long arm of chromosome 6 present at 6La position was observed in $G_2$, $G_3$, $G_4$, $G_5$ and $G_8$. A medium size 7ST knob was recorded in genotype $G_1$. A large knob at 8La position on the long arm of chromosome number 8 was present in genotype $G_2$, $G_5$, $G_7$ and $G_8$ only. Large spear shaped terminal knob at 9ST position was observed on the short arm of chromosome 9 of three genotypes, *viz* $G_4$, $G_6$ and $G_9$ only, however, it was absent in genotypes $G_1$, $G_2$, $G_3$, $G_5$ , $G_7$ $G_8$ and $G_{10}$. A medium sized knob at 9L position on the long arm of chromosome 9 was present in genotypes $G_3$, $G_5$ and $G_6$ among the ten selected genotypes.

Thus genotype $G_1$ possessed total 4 knobs on 2L, 5L, 6S and 7ST positions while chromosome 1,3,4,8,9 and 10 were completely knobless. Genotype $G_2$ possessed total 5 knobs at 2L, 4L, 6S, 6La and 8La positions, while the chromosomes 1,3,5,7,9 and 10 were knobless.

Genotype $G_3$ possessed total 4 knobs at 2L, 6S, 6La and 9L positions whereas chromosome number 1,3,4,5,7,8 and 10 were completely knobless. In genotype $G_4$ total five knobs at 2L, 4L, 6S, 6La and 9ST positions were present whereas chromosome number 1,3,5,7,8 and 10 were completely knobless. Genotype $G_5$ possessed five knobs at 2L, 6S, 6La, 8La and 9L positions whereas chromosome number 1,3,4,5,7 and 10 were completely knobless. Genotype $G_6$ possessed four knobs at 2L, 6S, 9ST & 9L positions only, whereas chromosome number 1,3,4,5,7,8 and 10 were completely knobless. Genotype $G_7$ possessed two knobs only at 6S and 8La positions whereas chromosome number 1,2,3,4,5,7,9 and 10 were completely knobless. Genotype $G_8$ possessed four knobs at 2L, 6S, 6La and 8La positions whereas chromosomes number 1,3,4,5,7,9 and 10 were completely knobless.

Genotype $G_9$ possessed three knobs only at 2L, 6S and 9ST positions whereas chromosome number 1,3,4,5,7,8 and 10 were completely knobless. Genotype $G_{10}$ possessed three knobs at 2L, 5L and 6S positions only whereas chromosome number 1,3,4,7,8,9 and 10 were completely knobless

## CONCLUSION

The present investigation was initiated with an objective for characterization of local maize genotypes on the basis of heterochromatic knobs through pachytene analysis. Knobs are more clearly visible during pachytene stage in maize. Pachytene analysis

revealed a total of 9 knobs forming positions in three maize genotypes The number of knobs in these genotypes varied from 2($G_7$) to 5 ($G_2$, $G_4$, $G_5$). The most common knob forming positions were 6S(100%), 2L(90%) and 6La(50%). The knob at 4L position was present in $G_2$ and $G_4$ only, whereas 5L knob was present in $G_1$ and $G_{10}$ only. Chromosome numbers 1,3 and 10 were completely knobless. The knobs present on short arm only were 6S, 7ST and 9ST, while the knobs on long arm were 2L, 4L, 5L, 6La, 8La and 9L.

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