

Criterion - 7

Institutional Values and Best Practices

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Advanced studies on breeding and molecular mapping



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**MOLECULAR MAPPING AND BREEDING FOR
HIGH POPPING VOLUME IN HIGH YIELDING
MAIZE LINES**

THESIS

SUBMITTED TO ETERNAL UNIVERSITY, BARU SAHIB IN THE PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

BIOTECHNOLOGY

BY

**SHIVANI THAKUR
(BS15PSBT007)**



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ETERNAL UNIVERSITY

BARU SAHIB

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OCTOBER-2020



CERTIFICATE-I

This is to certify that the thesis entitled "**Molecular Mapping and Breeding for High Popping Volume in High Yielding Maize Lines**" submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Biotechnology in the Department of Genetics-Plant Breeding and Biotechnology, Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib, Himachal Pradesh is a record of bonafide research carried out by **Ms. Shivani Thakur Reg. No. (BS15PSBT007)** under the supervision of Dr. H. S. Dhaliwal, Professor of Biotechnology and no part of the thesis has been submitted for any other degree. The assistance and help received during the course of this investigation have been acknowledged.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

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(Shivani Thakur)

This is to certify that the above statement made by Ms. Shivani Thakur (BS15PSBT007) is correct to the best of my knowledge.

Date: 14.10.2020
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CERTIFICATE-II

We, the undersigned, member of Research Degree Committee of Ms. Shivani Thakur Reg. No. (BS15PSBT007) a candidate for the degree of Doctor of Philosophy in Biotechnology agree that the thesis entitled "Molecular Mapping and Breeding for High Popping Volume in High Yielding Maize Lines" may be submitted in partial fulfilment of the requirement for the degree.

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ABSTRACT

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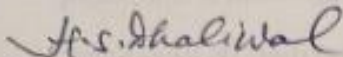
Degree: Doctor of Philosophy

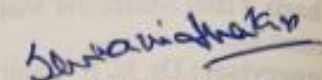
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Popcorn (*Zea mays* L.) is a special type of maize that pops up when heated leading to high flake volume. It is being used as popular fiber rich and nutritious snack all over the world. The genetic control of popping rate and flake volume are not understood properly. Most of the popcorn cultivars have low yield and are highly susceptible to various diseases. Southern corn leaf blight (SCLB) caused by *Bipolaris maydis* and banded leaf sheath blight (BLSB) caused by *Rhizoctonia solani* cause significant yield losses in maize throughout the world. The present genetics study was carried out to establish the genetic control of popping volume/flake volume using a F_2 mapping population. Limited available maize germplasm was screened for resistance against SCLB and BLSB under artificial inoculation field conditions. A teosinte (*Zea mexicana* L.) race grown for fodder was found to be highly resistant to banded leaf sheath blight under artificial inoculation conditions while most of the maize cultivars were highly susceptible. A commercially used high popping volume (HPV) inbred line with low yield and high susceptibility to SCLB and BLSB was crossed with a low popping volume (LPV) composite, and resistance to SCLB to develop the mapping population. The F_1 HPV x LPV showed low popping volume indicating that the high popping volume is governed by recessive genes. The F_2 population of 505 plants showed continuous variation for popping volume indicating that the popping volume is a quantitative trait governed by multiple genes. Bulk segregant analysis (BSA) was carried out for popping volume QTL using 66 maize SSR markers showing polymorphism between HPV and LPV. Genotyping of both positive and negative debulks using the associated markers confirmed the association of four SSR markers with QTL for popping volume. The Single marker analysis (SMA) of the F_2 plants showed that the 3 SSR markers bnlgl1331, bnlgl1520 and bnlgl1836 on chromosome 1, 2 and 5 respectively, accounting were closely associated with the QTL for popping volume covering 78% of total phenotypic variance. The QTL for popping volume mapped on chromosome 1, 2 and 5 have been designated as *qPVEU-1*, *qPVEU-2* and *qPVEU-5*, respectively. As expected using BSA all the three QTLs for popping volume had additive gene action with the positive alleles for popping volume contributed by HPV. The homozygous plants of F_4 and BC_2F_3 backcross population for the three QTL *qPVEU-1*, *qPVEU-2* and *qPVEU-5* had high popping volume validating their contribution to popping volume and their utilization for MAS for enhancing popping volume. A number of F_4 and BC_2F_3 progenies homozygous for three QTL of high popping volume with resistance to SCLB, have been identified. Only 7 out of 33 BC_2F_3 progenies involving teosinte as the donor for BLSB, were uniformly resistant to BLSB strongly indicating that the BLSB resistance introgressed from teosinte is controlled by a major gene in addition to other minor genes. Selection for high popping volume was done among the BC_2F_3 progenies homozygous for QTL *qPVEU-1*, *qPVEU-2* and *qPVEU-5* and uniformly resistant to BLSB which could be used for

mapping the genes for BLSB resistant for MAS of the popping volume in maize lines. The F_4 and BC_2F_3 progenies resistant to SCLB and BLSB diseases, homozygous for high popping volume QTL $qPVEU-1$, $qPVEU-2$ and $qPVEU-5$ with high yield and yield components can be further tested for the traits and used to develop the high yielding and disease resistant popcorn cultivars.


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