वार्षिक प्रतिवेदन
annual report
2006-07

मक्का अनुसंधान निदेशालय
Directorate of Maize Research
(Indian Council of Agricultural Research • भारतीय कृषि अनुसंधान परिषद)
Pusa Campus, New Delhi-110 012 (India) • पूसा कैम्पस, नई दिल्ली–110 012 (भारत)

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ANNUAL REPORT

2006-07

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DIRECTORATE OF MAIZE RESEARCH

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Pusa Campus, New Delhi-110 012 (INDIA)

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ANNUAL REPORT 2006-07

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PREFACE

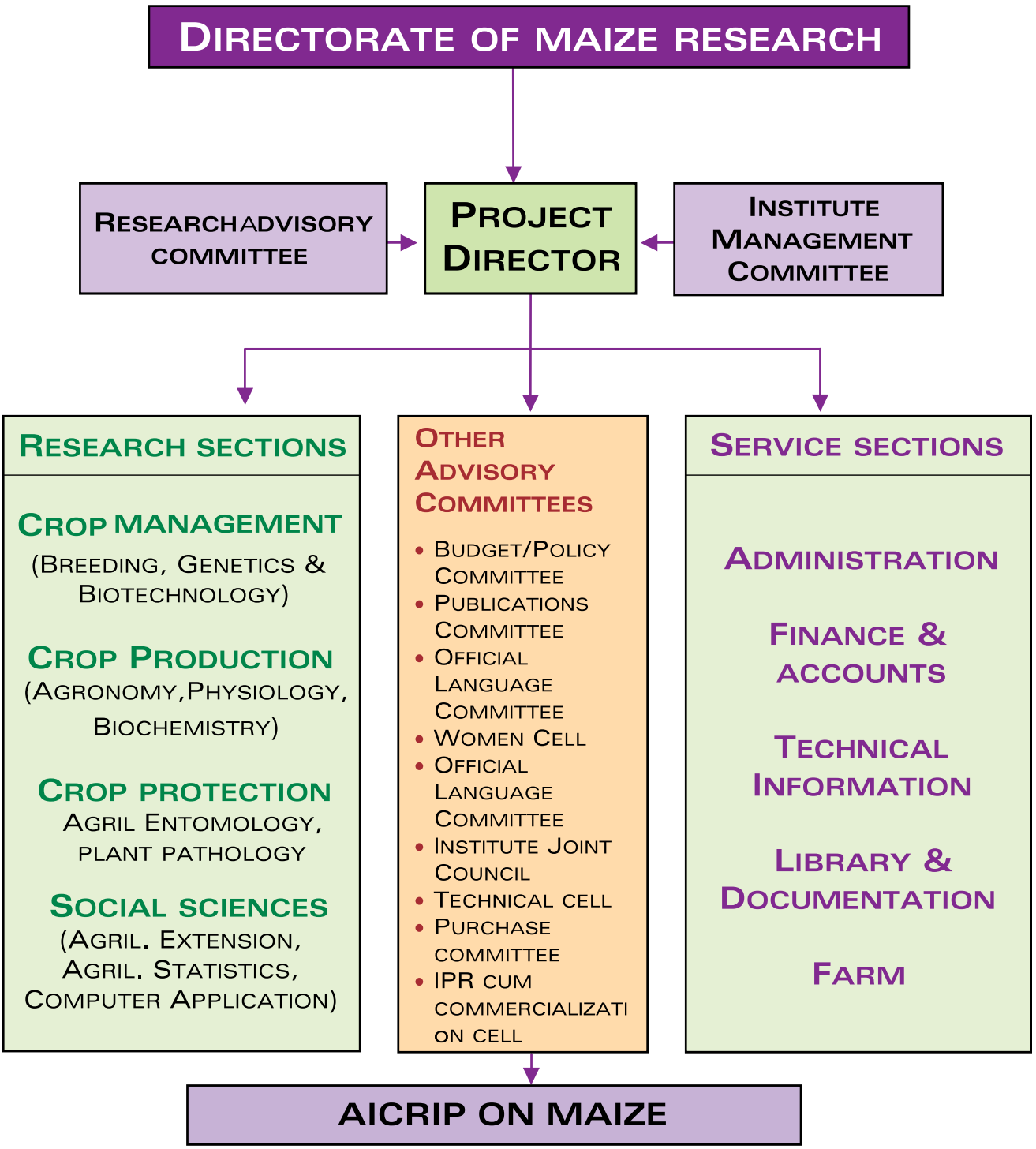
With the improving economy of the country, the demand for poultry, piggery, dairy and other cattle products is on the increase. The area under maize cultivation has registered a continuous increase over the years since 2001-02. Maize contributes significantly for supporting these farm sectors specially the QPM hybrids which have become popular with farmers. Specialty corns such as sweet corn, baby corn and their products, etc., are catching the fancy of the urban semi-urban and rural sections of society. Besides, the significance of maize is increasing the world over due to its increasing application in diverse user sectors. Maize holds promise for ethanol production as one of the supplements to share some of the burden of petroleum on foreign exchange. The collective impact of the emerging scenario calls for the increase in the productivity and production of maize of these different kinds.

The major thrust area is to develop single cross hybrids for *rabi*, *kharif* and *spring*. To meet this end, elite lines from All India Coordinated centres have been pooled and are being evaluated for various traits by breeders, agronomists, entomologists and plant pathologists. Promising inbreds have been characterized for getting them registered. To reduce the crop losses caused by insect pests and diseases, integrated pest management strategy has been developed and validated at several locations in four states. The package of practices for boosting the production of baby corn and quality protein maize has been developed. The production technologies have also been transferred to farmers through frontline demonstrations and training to the farmers.

We take this opportunity to express our gratitude to Dr. Mangala Rai, Secretary, DARE and Director General, ICAR, Dr. G. Kallu, DDG, Crop Science, Dr. S.P. Tiwari, Deputy Director General (Education and Crop Science), and Dr. S. N. Shukla, Assistant Director General (Food and Fodder Crops) for their unflinching support and constructive suggestions in pursuing these mandated activities of the Directorate. I would like to place on record my sincere appreciation and thanks for the excellent performance given by the scientists of this Directorate in successfully carrying out the research programmes and coordination activities. The concerted efforts made by technical, supporting and administrative staff to provide assistance to the scientists in various ways to enable them carrying out their research so efficiently are also praiseworthy.

January 30, 2008

(SAIN DASS)
Project Director


DIRECTORATE OF MAIZE RESEARCH
RESEARCH ADVISORY COMMITTEE
PROJECT DIRECTOR
INSTITUTE MANAGEMENT COMMITTEE
RESEARCH SECTIONS
CROP MANAGEMENT
(BREEDING, GENETICS & BIOTECHNOLOGY)
CROP PRODUCTION
(AGRONOMY, PHYSIOLOGY, BIOCHEMISTRY)
CROP PROTECTION
AGRIL ENTOMOLOGY, PLANT PATHOLOGY
SOCIAL SCIENCES
(AGRIL. EXTENSION, AGRIL. STATISTICS, COMPUTER APPLICATION)
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SERVICE SECTIONS
ADMINISTRATION
FINANCE & ACCOUNTS
TECHNICAL INFORMATION
LIBRARY & DOCUMENTATION
FARM
AICRIP ON MAIZE

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संस्थान में चलाए जा रहे अनुसंधान कार्यक्रम के अन्तर्गत मुख्यतः मक्का से सम्बंधित जटिल समस्याओं के समाधान पर बल दिया जाता है। संस्थान का लक्ष्य है कि बहु–विषयी अनुसंधान जैसे पौधप्रजनन, सस्य विज्ञान, कीट विज्ञान, पादप रोगविज्ञान पादप कार्यिकी, जैव रसायन शास्त्र व सामाजिक विज्ञान आदि कार्यक्रमों के माध्यम से मक्का की उत्पादकता तथा उत्पादन में वृद्धि कर भारतीय किसानों को आर्थिक रूप से समृद्ध किया जा सके तथा देश में भुखमरी तथा कुपोषण जैसी व्याधियों से राहत दिलाई जा सके।

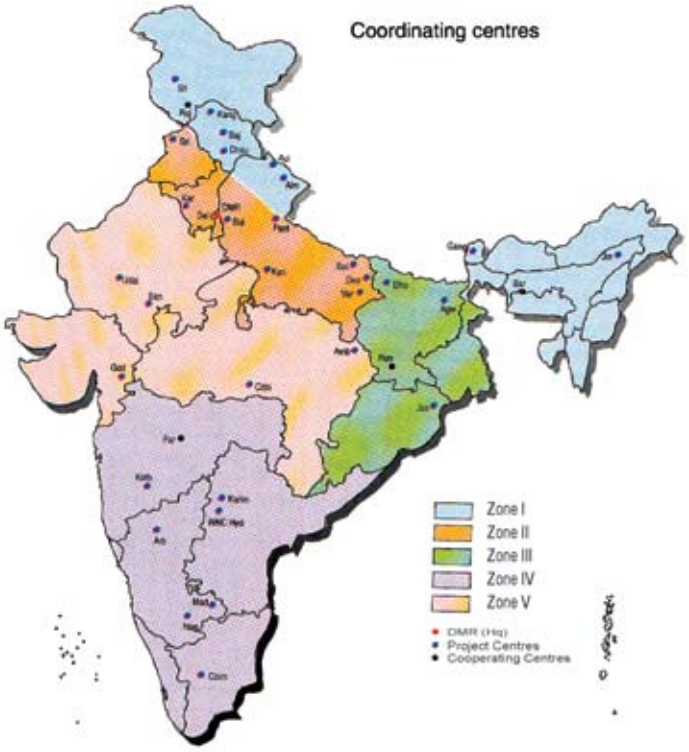
- मक्का अनुसंधान नें हमारे देश में 50 वर्ष सफलता पूर्वक पूरे कर लिए हैं। इस निदेशालय ने अप्रैल 2007 को अपनी स्वर्णजयंती कार्यशाला का आयोजन किया ।
- पाँच संकर प्रजातियाँ अर्धसरकारी तथा सरकारी निजिक्षेत्र Central Subcommittee for Notification of Varaities के द्वारा जारी की गई।
- एक QPM संकर प्रजाती HQPM-5 को समस्त भारत के लिए अच्छी पैदावार के लिये चुना गया ।
- QPM संकर प्रजाती के जनक (Parents Inbred) के बीज का उत्पादन किया गया।
- इस अवधि के दौरान 1560 अन्तर्जात (Inbred) लाइनों का मूल्यांकन उत्तम लाइनों व Acclimatization के लिये किया गया जिसमें पीली, श्वेत, QPM, स्वीट कार्न, शिशु मक्का, पॉप कॉर्न, Highoil (अधिक तेलवाली मक्का) व मोमीया मक्का प्रमुख है।
- चुनी गई 638 अन्तर्जात लाईनों को खरीफ के दौरान हैदराबाद में उगाया गया व उनको सरकारी व अर्धसरकारी तथा निजी क्षेत्र के वैज्ञानिकों के समक्ष चयन के लिये रखा गया।
- प्रयोगशाला में कीटों के उत्पादन के दौरान उनको पकड़ने व विविध प्रकार के डिब्बों में एकत्रित करने के लिये Insect Handling Device का अविष्कार किया गया है। इस तकनीकी को पेटेंट के लिये नांमकित किया गया है जिसका नामांकन नम्बर 0224/DEL/ 2007 है।
- Turcicum Leaf Blight के लिये 4 लाइनें व Polusora Rust की 3 लाइनें प्रतिरोधकता के लिये चुनी गयी है।
- Post Flowering Stalk Rot के प्रति प्रतिरोधकता के लिए 4 लाइनों को पंजीकरण किया गया है।
- Mycotoxin के प्रति दूषित होने की क्षमता सबसे कम (0.3 ppb) शाक्तिमान–4 में पाई गई है।
- निदेशालय ने 10,500 अग्रपंक्ति प्रदर्शनों (FLD's) का आयोजन, मॉनिटरिंग, तकनीकियों का प्रसार व उनमें भाग लेकर पूरे देश में मक्का की उन्नत उत्पादन प्रौघोगिकियों का प्रचार प्रसार किया गया है।
- डा साँई दास ने 10 जून 2006 को मक्का अनुसंधान निदेशालय के परियोजना निदेशक का कार्यभार सभांला।

EXECUTIVE SUMMARY

The research programme is planned and executed keeping the mandate of the Directorate in view in the multidisciplinary mode envisaging plant breeding, agronomy, entomology, plant pathology, plant physiology, biochemistry, and social sciences. The salient features of the work are given below:

- The crop improvement research of maize has successfully completed 50 years. The Directorate celebrated it's Golden Jubilee Workshop in April 2007.
- Five hybrids three from public sector and two from private sector were released by central sub committee on crop standards and notification of varieties.
- Ten hybrids, seven from public sector and three from private sector were identified by variety identification committee.
- One QPM hybrid, HQPM-5 was identified for it's cultivation across the country.
- Parents of QPM hybrids seeds were produced.
- During the period under report 1560 inbred lines including exotic and indigenous which consists of yellow, QPM, sweet corn, baby corn, pop corn, high oil and waxy maize were evaluated for acclimatization and superior lines were maintained.
- A set of 638 inbreds selected during kharif were sown at Hyderabad and were exposed to public and private breeders for selection of superior inbred lines.
- An 'Insect Handling Device' has been develolped and filed for patent vide application number 224/DEL/2007. It is a versatile device for handling large number of insects with great ease and useful for the mass production of biological control agents.
- Four lines for Turcicum Leaf Blight and three for *Polysora rust* were identified.
- Four lines with resistance against post flowering stalk rot have been registered.
- The most promising genotype, shaktiman-4 (0.30 ppb) was identified resistant to mycotoxin contamination.
- Directorate organized, conducted and monitored 10500 FLD's all over the country on production.
- Dr. Sain Dass joined the Directorate of Maize Research as Project Director w.e.f. June 10, 2006

THE DIRECTORATE



- *Mandate*
- *Thrust Area*
- *Staff Position*
- *Financial Statement*
- *Resource Generation*
- *Funds received from externally funded projects*

The Directorate of Maize Research has mandate to organize conduct and coordinate the research activities for the improvement and enhancement of maize productivity vis-a-vis production with an ultimate objective of meeting the ever increasing demand especially for animal feed and industrial utilization. The Directorate has the responsibility to generate and popularize appropriate and suitable technologies to be adopted by the maize growers. To begin with major emphasis was laid on the development of double and double top cross hybrids as also for the development of composite/open-pollinated varieties. Today the major emphasis is being laid on the adoption of single cross hybrid technology which is perhaps the only mean for sharp increase in the production. Also, emphasis is being laid on the development of quality protein maize to ameliorate the nutritional quality for weaker section of the society whose staple food is maize.

MANDATE

(a) To undertake basic and strategic research activities with respect to germplasm enhancement like tolerance to abiotic and biotic stresses, quality improvement, specialized uses, etc.

(b) To coordinate interdisciplinary research activities as follows:

  (i) strategic and applied researches for genetic improvement in yield, quality and resistance to biotic and abiotic stresses.

  (ii) development of efficient package of practices for increasing productivity.

  (iii) tailoring maize for diversified uses for industry and other sectors.

(c) To organize activities related to overall development of maize, for example: training programmes, on-farm research, frontline demonstrations, etc.

(d) To render and undertake consultancy services and programmes on maize research and development for needy agencies/institutions in India or abroad.

To develop effective collaborative programme in maize research and development with national and international institutions.

THRUST AREA

- Development of maize varieties with single cross hybrids
- Development of specialty corns
- Development of quality protein maize
- Development of IPM strategy and its promotion
- Value addition in specialty corns

STAFF POSITION

STAFF POSITION AS ON MARCH 31, 2007

Category	Sanc-tioned	filled	Vacant
RMP	1	1	-
Scientific	21	16	5
Technical	11	3	8
Administrative	9	8	1
Supporting	4	1	3
Total	**45**	**29**	**17**

FINANCIAL STATEMENT (2006-07)

Head of Account	Plan D.M.R. AICRP on maize	Non Plan AICRP on maize	Total Plan D.M.R.	Non Plan	Total
Establishment	117.97	135.40	117.87	124.82	242.69
Charges overtime					
allowance wages					
Traveling allowance	34.97	2.00	33.38	1.97	35.35
Other charges	209.00	155.00	204.40	154.98	362.38
(Incl. NRC)					
(a)works					
(b)minor works	118.00	15.00	117.22	14.89	132.11
©Maintenance of office buildings					
Other items/HRD	5.00	-	3.91	-	3.91
Need-based research					
Total	**484.94**	**303.00**	**476.78**	**296.66**	**773.44**

RESOURCE GENERATION

Particulars	Amount (Rs. Lakh)
Sale of farm produce	2.18
Sale of publications and tender forma	0.46
Rent	—
Standard License Fee	0.14
Interest earned on loans and advancest	0.37
Analytical testing charges	0.90
TrainingMiscellaneous receipts	7.10
Total	**11.15**

FUNDS RECEIVED FROM EXTERNALLY FUNDED PROJECTS

Particulars		Amount (Rs. Lakh)
A.P. Cess fund scheme	24.54	33.09
F.L.D.	299.92	287.92
DUS Testing	8.90	8.90
Transgenic Project	96.98	77.92

QUINQUENNIAL REVIEW TEAM RECOMMENDATIONS

The Directorate's work was reviewed by QRT under the chairmanship of Dr. SK Vasal, distinguished maize Scientist of CIMMYT. The team concluded the review of the project from 1997-2005. The recommendations of the report are as given below.

Comments on Recommendations of Quinquennial Review Team of DMR (1997-2005)	
Recommendation of QRT	**DMR / Council's comments**
BREEDING	
1. QRT feels that hybrid research in the maize program needs to be revolutionized. Single cross hybrid technology as is being emphasized is a step in the right direction. The QRT fully support this initiative organized around Inbred-hybrid strategy as this will prompt breeders to develop agronomically superior lines with respectable yield and other traits preferred in such lines.	Agreed. This work will be continued.
2. Heterotic groupings and patterns of source germplasm and inbreds will need to be established and placed in an appropriate multi-functional heterotic model. Research on maize testers will have to be expanded and a strategy will have to be developed to prevent narrowing down of maize germplasm..	Agreed This work will be expanded.
3. There is a need to develop a strong resource inbred base germplasm from diverse backgrounds with special traits and with known heterotic groupings and patterns. A database of such lines should eventually be developed for effective and efficient use by researchers of all disciplines.	Agreed. The database will be developed.
4. The QRT encourages procurement of new maize germplasm from institutions like CIMMYT, IITA, and other sources.	Agreed. The present collaboration with CIMMYT AND IITA will be continued.
5. Good collaboration should be established with NBPGR as lots of maize accessions received in the y are stored there. A system could be set up to evaluate and characterize 200—300 accessions periodically. Seed of better performing entries can be requested for use in the breeding program.	Agreed. This collaborative program will be further developed.
6. Identifying and documenting sources of resistance is important for biotic and abiotic stresses. Some sources are already documented in special bulletins. QRT strongly feels that research on abiotic stresses need to be intensified. The QRT proposes that one or two sites be selected for each stress for proper screening. In addition, other facilities be developed.	Agreed. The DMR will identify suitable sites under AICRP for this work and provision will be made to provide necessarty facilities during the XIth 5-year plan.

7. There is a need to target maize research to specific maize growing environments especially in unfavorable and marginal areas prone to drought and biotic stress (es). Early maturing public bred materials should find a place in such environments.	Agreed. Work on these lines will be continued
8. It would be preferable to produce general and special trait synthetics using lines for specific areas where hybrid reach is low like in north-east. Maize research and technology development for NEH areas needs to be prioritized. It is suggested that composite effort be replaced by synthetic development. This will call for resource allocation to develop requisite infrastructure for seed production and encouraging consumer preference,	Agreed. In respect of geog-raphies, where introduc-tion of hybrids is still difficult, synthetics will be preferred over composites.
9. Conscious efforts are also needed to develop more germplasm locally by recycling QPM lines through pedigree breeding. The QPM effort is exemplary in showing use of exotic germplasm by slightly modifying and adapting these lines under Indian conditions.	Agreed. This work is already being done and will be further strengthened.
10. Consumer preference and demand for other specialty corn types such as sweet corn, popcorn and baby corn is also growing at an accelerated pace. Systematic germplasm collection and developing new sources through conversion efforts should draw greater attention. Sources of genes and gene combinations for such special traits should also be obtained from neighbouring countries and other institutions.	Agreed. Work on specialty corn has been given considerable thrust and this will continue in future also.
11. As work on specialty corn is gaining momentum, the QRT feels that active collaboration with some reputed processing industries will be useful Visits to neighboring countries like Thailand and to other relevant countries including USA will be helpful to learn about research aspects emphasized in specialty corn types in public and private institutions.	Agreed. Provision for collaborative work with other countries will be made under relevant protocol during XIth plan.
12. ICAR partly supports CIMMYT's research work on QPM. It is thus imperative that one or two researches from Indian maize program visit CIMMYT every season or every year. The visits should coincide with harvesting time so that good performing materials can be requested for possible use in the breeding program. QPM and stress traits will be good candidates for conversion activities.	Agreed. The present collaborative arrangement with CIMMYT will be continued as per provisions.
14. Use of high density planting in breeding program must be encouraged. It ought to be recognized as an important tool for increasing yield, reducing lodging and building tolerance to biotic and abiotic stresses. High density plantings can be used during inbred line development and for realizing full potential of short and medium plant type.	Agreed. This will be implemented at DMR and under the ACRIP program.

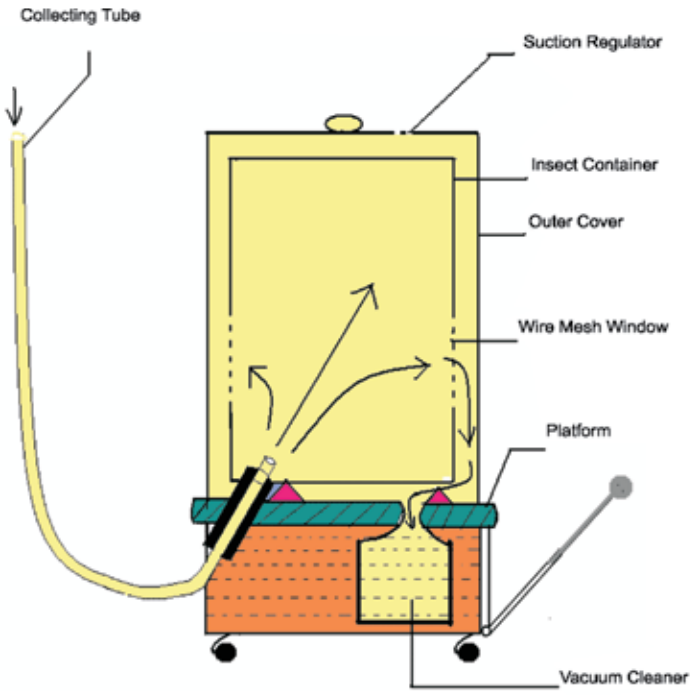
15. Use of modern tools requires like DMR and Biotechnology is needed for more difficult problems especially conversion activities can be greatly facilitated using marker assisted selection. Initially such traits be emphasized which have yielded little or no progress through conventional approaches.	Agreed. This work will receive renewed impetus in future.
16. Promotion of public bred hybrids suffers from seed production constraints. The QRT would like to see and support mechanism(s) that can help promotion of public bred hybrids preferably with private-public common program, if found feasible.	Agreed. The policy of seed production by private seed industry is already in place. Prospects for public-private participation will be further explored.
17. Work on abiotic stresses is important and is slowly gaining momentum. Systemic breeding efforts are needed along with good field execution and management skills. The QRT strongly recommends choosing at least two sites having excellent soil conditions for proper screening of materials against abiotic stresses.	Agreed. Suitable sites will be selected and due facilities will be proposed under the XI th 5-year plan.
19. Guarding and saving seed is important for current and future use To prevent loss of valuable lines. DMR and zonal centres are in urgent need of good seed storage cold room facilities.. These facilities assume greater importance with increasing emphasis on hybrid technology, The QRT strongly recommends providing such facilities at least at six of the 28 centres in the country in the first phase where most of the research is being carried out. These centres are Delhi, Karnal, Ludhiana, Pantnagar, Hyderabad and Udaipur.	Agreed. This is very important for saving valuable genetic stocks and seeds. Provision will be made in XIth 5-year plan for providing deep cold stores at recommended locations.
19. The QRT strongly recommends organizing training programs in hybrid technology and QPM where the program is placing major thrust at the moment. Such courses will be particularly useful for younger scientists and for researchers at different stations with limited responsibility and access to maize literature.	Agreed. A renewed emphasis will be given to training programs particularly in relation to QPM and specialty maize.
20. Maize program has published some technical bulletins on sources of resistance to biotic and abiotic stresses, QPM and other specialty corn types. Scientific articles appearing in journals is however limited. Researchers should be encouraged to generate and publish more technical information in the future.	Agreed. Scientists will be encouraged to bring out more publications in scientific and popular journals.
AGRONOMY	
21. The QRT feels that in addition to routine agronomic activities, the agronomists should get deep involvement in stress physiology and researchable issues in seed production of parental lines and hybrids for target environments.	Agreed. The agronomists at selected locations shall be given additional responsibilities to test inbreds under varying agronomic conditions, population levels, environmental stress, etc.

SEED PRODUCTION	
26. In hybrid development, the breeders ought to have enough seed quantities of lines in active use. It is important that seed requirements should always stay ahead of the needs. We understand DMR is presently concentrating its seed production efforts at newly developed station at Begusarai. Sufficient manpower is a constraint at the moment. The QRT recommends additional funding for more positions at this site for better functioning of this station.	Agreed. ICAR will be approached to clear the posts already sanctioned under the IXth 5-year plan.
PATHOLOGY AND NEMATOLOGY	
27. Studies on on genetic variation in pathogens like Peronosclerospora sorghi and Exserohilum Turcicum using molecular markers may be undertaken first by collecting large number of isolates from different locations and then classifying them and using them to identify sources of resistance for wider areas.	Agreed. The work in progress will be further strengthened.
28. Reliable and authentic information on genetics of resistance to important disease of maize is very essential. Results can be interpreted with confidence only if the lines used in crosses are definitely resistant or susceptible. Further, availability of well defined isolates/races of the pathogen(s) is also necessary.	Agreed. This work will be given due importance and provision will be made in XIth 5-year plan for necessary facilities.
29. Two diseases, viz. Banded Leaf and Sheath Blight and Post-flowering stalk rots need special attention. Every effort be made to uncover resistance to these diseases. So also, Polysora rust is gaining importance in several pockets. There is a need to initiate work on epidemiological aspects of this rust.	Agreed. The work in progress will be further strengthened.
30. Work should be initiated on interaction of phytonematodes with soil-borne pathogens (involved in post-flowering stalk rot), in Rajasthan and parts of Gujarat.	Agreed. The work in progress will be further strengthened
ENTOMOLOGY	
31. Research on breeding for insect pest resistance needs strengthening as recommended by the previous QRT. Studies on biotypes of Chilo partellus, Atherigona spp. and Sesamia inferens should be carried out on priority basis. Efforts should be made to correlate occurrence of insect-pests (based on Survey) with various abiotic and biotic factors.	Agreed. The work in progress will be further strengthened.
32. Good work on IPM has been carried out and it should be continued in order to synthesize and develop highly effective IPM modules.	Agreed. T he work in progress will be further strengthened.

BIOCHEMISTRY & PROCESSING LAB	
33. At least one fully equipped functional biochemical laboratory should be established with enough manpower and resources to provide service to the breeders. The laboratory should have sufficient capacity to analyze samples from all the centres involved in QPM research. Assistance of some scientists who have expertise and experience in QPM research and are biochemists by training could be sought in developing such facility. Norms for type of samples to be analyzed should be agreed upon jointly by breeders and biochemists.	Agreed. This work will be given due importance and provision will be made in XIth 5-year plan for necessary facilities.
34. An Active collaboration with some reputed processing industries will be useful and countries like Thailand (baby corn) and USA (starch, oil, ethanol, starch convertibility) will be useful to learn, Scientists should be able to visit these countries for relevant areas and set up lab facilities in DMR.	Agreed. Provision will be made under the relevant protocol for this work.
POST HARVEST TECHNOLOGY	
35. Work on post harvest technology and value addition is important and perhaps be taken up at one or more centres where adequate laboratory facilities are available. In infrastructure for processing of baby corn, sweet corn, and pop corn be strengthen to help future growth of the industry some new interventions such as flavoured pop corn and sweet corn also deserves exploratory work. An infrastructure for processing of baby corn, sweet corn, and pop corn be strengthened to help future growth of the industry	Agreed. This work will be given due importance and provision will be made in XIth 5-year plan for necessary facilities.
ADMINISTRATIVE	
36. DMR to become a lead centre at Delhi will require additional scientific manpower ande space. The QRT feels that separate block(s) of land be allotted to DMR at IARI for germplasm development, enhancement and seed production. Since maize cropping season is fast approaching, an urgent action is needed to request and secure enough land for the coming season and to meet future needs.	Agreed The Director IARI will be approached to do the needful.
37. Shift in winter breeding location from Amberpet to Rajendra Nagar is very much welcome. The QRT strongly recommends providing funds for developing this facility rapidly so that breeders can get enough land in a timely fashion for planting.	Agreed. Provision will be made during XI 5-year program for needful.

38. The present system of zoning for testing of maize genotypes during kharif and rabi needs reconsideration. Instead of five zones, there may be only three zones viz. **Zone-1:-** J&K (hilly tract), Uttaranchal (hilly tract),H.P., North Eastern hill states, J&K plain area, Uttaranchal (Plains). **Zone-2:-**Punjab, Haryana, Delhi, U.P.,M.P. Bihar, Chhatisgarh, orissa, Rajasthan, Gujrat. **Zone-3:-** A.P, Karnataka, Maharashtra, Tamilnadu. This will help in increasing the number of locations while promoting the Material(s)	Agreed. The proposal will be discussed at the next workshop of AICRP and in consultation with ICAR, an appropriate decision will be taken.

RESEARCH ACHIEVEMENTS



INSECT HANDLING DEVICE

- *Breeding*
- *Entomology*
- *Pathology & Nematology*
- *Biochemistry & Quality*
- *Agronomy*
- *Abiotic Stress*
- *Statistics*

BREEDING

Release of hybrids/varieties under coordinated trial

During the period under report five hybrids were released by Central sub committee on crop standards and notification of varieties for agricultural crops. Out of these three hybrids were from public sector and two hybrids were from private sector. One QPM hybrid, HQPM-1 was release for cultivation across the country. Late maturing hybrid, PMH-1 was released for Punjab, Haryana and western U.P. and early maturity hybrid, Vivek Hybrid 21 was released for Uttaranchal, Himachal Pradesh and other hilly areas. Among the private sector hybrids, JKMH 1701, an early maturity hybrid, was released for Uttaranchal, North East Himalayan Region, West Bengal, Himachal Pradesh, Andhra Pradesh., Karnataka, Tamil Nadu and Maharashtra for *kharif* season. X1280, a late season hybrid was release for A.P, Karnataka, Maharashtra and Tamil Nadu for *rabi* season.

Table 1: List of the Varieties / hybrids of maize released in 2006

S. No.	Name of Varieties/ CompositesHybrid	Maturity	Year of Identification	Grain Colour	Area of Adaptation
1	HQPM-1	Late Season Kharif	2006	Yellow semi flint	Across the country Quality Protein Maize hybrid
2	PMH 10655)	Late Season Kharif	2006	Yellow semi flint	Delhi, Haryana, Punjab & West U.P.
3	JKMH-1701	Early Kharif	2006	Yellow semi flint	J&K, H.P., Uttranchal NEH region and A.P., Maharashtra, Tamil Nadu and Karnataka
4	Vivek Maize Hybrid-21 (FH3211)	Extra Early Kharif	2006	Yellow semi flint	J&K, H.P., Uttranchal, NEH region, Delhi, Haryana, Punjab and A.P., Maharashtra, Tamil Nadu and Karnataka
5	X1280	Late Season Rabi	2006	Orange semi flint	A.P., Maharashtra, Tamil Nadu and Karnataka

HQPM 1-A high quality portion maize hybrid released for across the country

HQPM 1 Released for across the country

Organization, analysis and compilation of coordinated trial

During kharif 2006, a total of 292 test entries comprising of hybrids and composites in different maturity groups and stages, were tested in coordinated trials across the country. Forty breeding, 15 agronomy, 10 pathology, 6 entomology and 8 each nematology and soil science trials were organized. Breeding trials were represented by 35 normal, 2 QPM and one each of baby corn, sweet corn and popcorn trials (Table 2). Table 3 gives the details of the trials organized. Under breeding programme 99 entries were tested in initial evaluation trial (IET) in 29-41 locations, while 104 entries were tested under advanced evaluation trial 1st year (AET I) in different zones. In AET II stage of evaluation 47 entries were tested in respective zones. In two QPM trials 11 and 13 entries were tested in QPM1 and QPM2, respectively trials. Under Baby corn 10 entries and 4 each in sweet corn and popcorn were tested. A total of 41 entries were tested under different maturity groups in agronomy, 207 in pathology, 107 in entomology, 183 in nematology and soil science (Table 3).

Table 2: Number of trials constituted and dispatched to different locations

Trail	Number
Normal corn	35
QPM	2
B corn	1
Sweet corn	1
Popcorn	1
Agronomy	15
Pathology	10
Nematology	8
Soil Science	8
Entomology	6

Table 3. Number of experiment organized for different discipline of Directorate of Maize Research in Kharif 2006

Sl. No.	Trial No.	No. of entries	No. of location
Breeding			
1.	61	41	41
2.	62	30	32
3.	63	17	31
4.	64	11	29
5.	65 Z2,3	5	14
6.	65 Z4	5	11
7.	65 Z5	10	5
8.	66 Z1	12	10
9.	66 Z2	2	5
10.	66 Z3	11	10
11.	66 Z4	13	10
12.	66 Z5	7	6
13.	67 Z1	5	7
14.	67 Z3	3	7
15.	67 Z4	10	10
16.	67 Z5	11	7
17.	68 Z1	4	7
18.	68 Z2	1	5
19.	68 Z3,5	2	11
20.	68 Z4	3	7
21.	69 Z2,4	3	21
22.	69 Z3	1	11
23.	69 Z5	2	9
24.	70 Z1	2	10
25.	70 Z3	4	11
26.	70 Z4	6	11
27.	70 Z5	2	10
28.	71 Z1	2	10
29.	71 Z2	1	10
30.	71 Z3	3	13
31.	71 Z4	1	11
32.	71 Z5	2	9
33.	72 Z1	6	10
34.	72 Z3	2	11
35.	72 Z4	10	11
36.	QPM1	11	10
37.	QPM2	13	10
38.	Baby 1	10	10
39.	Sweet	4	14
40.	Pop	4	14
	Total	**292**	**494**
Agronomy			
Late season maturity			
41.	Z2,4	3	8
42.	Z3	1	5
43.	Z5	2	4
Medium maturity			
44.	Z1	2	5
45.	Z3	4	4
46.	Z5	2	5
Early maturity			
47.	Z1	2	4
48.	Z2	1	3
49.	Z3	3	6
50.	Z4	1	4
51.	Z5	2	4
Extra early maturity			
52.	Z1	6	4
53.	Z3	2	6
54.	Z4	10	5
	Total	**41**	**71**
Pathology			
55.	61	41	15
56.	62	30	15
57.	63	17	14
58.	64	11	14
59.	75	17	15
60.	76	28	15
61.	77	18	15
62.	78	21	15

63.	QPM1	11	6
64.	QPM2	13	6
	Total	**207**	**130**
Entomology			
65.	75	17	6
66.	76	28	6
67.	77	18	6
68.	78	21	6
69.	QPM1	11	4
70.	QPM2	13	4
	Total	**107**	**32**

Nematology and Soil Science			
71.	61	41	1
72.	62	30	1
73.	63	17	1
74.	64	11	1
75.	75	17	1
76.	76	28	1
77.	77	18	1
78.	78	21	1
	Total	**183**	**8**

Germplasm development, evaluation, maintenance and distribution:

Directorate of Maize Research has given top priority on development of single cross hybrid for both normal and specialty corn. Various centres provided their inbred lines for inter-institutional hybrid development (Table

Table 4. Centre- wise contribution of lines/populations in inter- institutional hybrid development programme:

Name of the centre	Normal Yellow	Normal White	QPM	Temp	Specialty Corn				Stress Tolerant	Total
					Sweet	Pop	HOC	Ae & Waxy		
1. DMR	154	4	51	39	171	77	26	7	359	**888**
2. Uchani	59	21	70		4	6	13	1		**174**
3. Almora	21									**21**
4. Ludhiana	20									**20**
5. Bajaura	20									**20**
6. Delhi	18				4					**18**
7. Srinagar	15									**15**
8. Udaipur		16								**16**
9.Pantnagar	10									**10**
10.Varanasi	6									**6**
11.Arabhavi	5									**5**
12. Mandya	1									**1**
13. Dholi	1									**1**
14. Cimmy	37		49		5		23			**114**
Total	**367**	**41**	**170**	**39**	**184**	**83**	**62**	**8**	**359**	**1313**

4). One thousand two hundred ninety seven inbred lines developed and maintained by different centres were grown in Delhi during kharif season 2006. These were purified and subjected to cleaning and selection. Selected lines were further evaluated in Hyderabad during rabi 2006-07, along with sixteen additional white lines and two hundred forty seven introductions. The lines were further cleaned and seeds of selected lines were increased for distribution among SAU partners for their use in single cross hybrid development (Table 5).

HKI 288,
a promising
line

HKI 1105,
a promising
inbred line

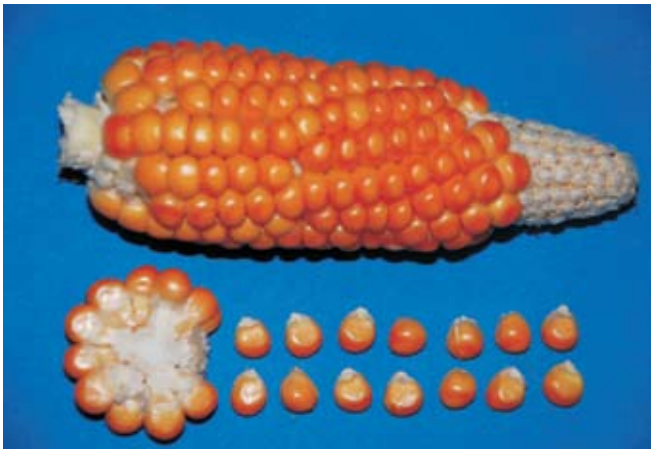
HKI 1126, a promising yellow inbred line

Normal Maize:

During Kharif 2006, 367 advanced lines of normal yellow and 41 normal white were evaluated and cleaned in Delhi. Based on their performance 124 yellow and 29 white lines were further evaluated in Hyderabad. Finally 65 normal yellow and 29 normal white lines were selected and distributed among various centers for location-specific evaluation. Seeds of selected lines will be also multiplied and utilized in combination breeding.

QPM:

During kharif 2006, 170 QPM lines and populations obtained from DMR QPM programme, Uchanni Centre and CIMMYT were evaluated. Based on agronomic performance and quality parameters 142 lines were selected and the lines were multiplied in Hyderabad. The same were distributed among the centres for development of QPM single cross hybrids.



HKI 161, a promising QPM inbred line

Specialty Corn:

One hundred eighty four sweet corn lines and populations were evaluated during kharif 2006. Based on agronomic performance and sugar content 140 lines were again evaluated in Hyderabad. Of these only 50 were selected for further evaluation and these lines were supplied to different centres of the country for using them in breeding programme. Similarly 83 popcorn lines were evaluated during kharif and 64 were selected. These were further evaluated in Hyderabad. Thirty three lines were selected in Hyderabad for distribution and utilization in popcorn single cross development programme. Sixty two high oil lines and populations were evaluated and 34 lines were further evaluated for their agronomic performance in Hyderabad. Ten high oil lines have been further advanced. Three high amylose and five waxy lines were also evaluated and seven have been retained in the programme.

Temperate Maize:

Thirty nine temperate lines maintained at DMR were evaluated and 27 were selected and advanced. Some of the promising lines are being used in single cross development programme.

Wide cross programme:

One hundred seventy lines for wide cross programme of DMR were evaluated and of these 42 advance lines were selected in Delhi for their further evaluation at Hyderabad. The lines will be screened against various stresses for identification of sources of resistance.

Table 5: Number of lines/populations evaluated and selected during 2006

Type	No. of lines/ populations evaluated	No. of lines/ populations selected
Normal yellow	367	65
Normal white	41	29
QPM	170	42
Sweet corn	184	50
Popcorn	83	33
High-oil	62	10
Ae & waxy	8	7
Temperate	39	27
Wide cross	170	42

Introductions:

Two hundred forty seven lines obtained from CIMMYT were evaluated for their acclimatization under Indian condition in Hyderabad during rabi 2006. Lines

Table 6. Number of lines distributed to different centres for inter-institutional hybrid development

S. No.	Name of Centers	Introd-uction	Nor-mal yellow	Normal white	Sweet corn	Pop corn	High-oil corn and ae lines	Sources of resistance				QPM	Total
								Insect	Disease	Abiotic	yellow	White	
1	Karnal	0	13	6	34	12	12	5	6	3	21	6	118
2	Bajura	8	37	15	31	12	12	5	5	3	32	7	167
3	Ludhiana	51	33	15	30	10		5	5	3	33	6	201
4	Hyderabad	0	34	14	29	10	8	4	5	2	30	7	143
5	Varanasi	0	34	14	27	9	8	4	5	2	26	9	138
6	Godhara	22	33	14	24	8	8	4	5	2	23	9	152
7	Almora	32	33	12	23	8	8	5	5	0	21	9	156
8	Pantnagar	15	33	9	23	6	6	4	4	0	22	5	154
9	Dholi	0	34	11	22	4	5	4	4	0	19	8	111
10	Kanpur	54	33	11	21	3	5	4	3	0	20	5	159
11	Jassipur	11	31	11	20	2	5	4	3	0	19	5	111
12	Udaipur	6	33	11	19	2	6	4	3	0	15	4	103
13	Coimbatore	4	33	10	16	1	5	4	3	0	15	5	96
14	Chhindwara	0	33	11	15	1	4	3	3	0	15	5	90
15	Ranchi	30	29	10	12	1	4	3	3	0	13	5	110
16	Ambikapur	0	28	10	11	1	2	2	1	0	15	5	75
17	Belipar	11	25	10	10	0	2	1	3	0	10	4	76
18	Nagenahalli	12	0	0	0	0	0	0	0	0	0	0	12
19	Karimnagar	22	0	0	0	0	0	0	0	0	0	0	22
20	Karimnagar	24	0	0	0	0	0	0	0	0	0	0	24
21	Jammu Tawi	57	0	0	0	0	0	0	0	0	0	0	57
22	Jorhat assam	13	0	0	0	0	0	0	0	0	0	0	13
23	Kangra	13	0	0	0	0	0	0	0	0	0	0	13
24	Srinagar	21	0	0	0	0	0	0	0	0	0	0	21

were maintained by self pollination and distributed among the breeders of both public and private sectors for their utilization in breeding programme (Table 6,7).

Germplasm exchange between centres

Field day was organized at ICRISAT on March 8-9, 2007 in which as many as 80 breeders from 20 different seed companies and 43 breeders from SAUs participated. Selection was made by them and seeds were supplied to 20 seed companies and 18 public sector centres. Advanced breeding lines were also supplied to 17 centres for location specific ada ptation and utilization in inter-institutional hybrid development programme. Number of lines supplied to various centres ranged from 75-201 (Table 6,7).

Table 7. Number of introductions supplied to private sector breeders

Sl. No.	Name of company	No.
1	Ganga Kaveri Seeds Pvt. Ltd.	24
2	Bioseed Research India	32
3	Advanta India Ltd.	51
4	New Town Yelhanka	12
5	Agri Science (P) Ltd.	24
6	Kaveri Seed Company	52
7	Vibha Agrotech Ltd.	37
8	Yaaganti Seed Pvt. Ltd.	44
9	Dharwad (Karnatak State Seeds)	64
10	Ajeet Seed Ltd.	31
11	ITPL Banglore	49
12	Krishidhan Seeds Ltd.	128
13	India Pvt. Ltd.	22
14	Star Agrotech Pvt. Ltd.	41
15	Nujiveedu Seeds Ltd.	29
16	Biotech Pvt. Ltd.	23
17	Basant Agrotech Akola	36
18	Nodia Seed India Pvt. Ltd.	29
19	Dawaladi, Jalna	15
20	Manisha Agri Biotech Pvt. Ltd.	33

Hybrid Evaluation Trial

A total of 180 hybrids of normal maize and specialty corn were evaluated in 13 yield trials during kharif 2006-07 at DMR, New Delhi. Thirty six normal maize hybrids in different yield trials were superior over the best check. Two QPM hybrids were also evaluated during the period under report. Fourteen QPM hybrids found superior to the best QPM check, HQPM 1. The detail of these trials are given below in the table I and each trial is discussed briefly as under.

Table 8. Summary of trial data conducted in Delhi

Sl. No.	Trial	Maturity	No of Entries	No of superior Genotype
1.	61 IET	Late maturity	45	11
2.	62 IET	Medium matu rity	32	15
3.	63 IET	Early maturity	21	6
4.	64 IET	Extra early maturity	13	-
5.	65 AET I year	Late maturity	9	5
6.	66 AET I Year	Medium Maturity	4	2
7.	71 AET II Year	Early	5	1
8.	QPM 1 IET	--	15	11

9.	QPM II Advanced Stage	--	19	3
10.	Sweet Corn	--	4	-
11.	Baby corn	--	10	-
12.	Pop Corn	--	4	-
13.	Stat Trial	Mtedium	9	1
		Total	**180**	**55**

Trial 61 IET Late Maturity: Forty five hybrids were evaluated in this late maturity initial evaluation yield trial. Eleven entries showed superiority over the checks, while only 4 recorded 10% superiority over the best check, Pro-311. Among superior genotypes 30-R-88 was the highest yielding entry with more than 40% higher yiel **ty:** Five out of 9 entries out performed the check but only two showed more than 10% superiority with NECH 3251 being the best followed by JH 11024 (Table 9).

Trial 66 AET I st-Year Medium Maturity: One hybrid, EH 1491 out of 4 tested under this trial gave more than 10% higher yield over the medium maturity best check, Bio-9637 (Table 9.

Trial 71 AET IInd-Year Early Maturity: Five early entries were evaluated in this trial. JH 3982 was the superior most entry with 8975 kg yield per hectare, registering more than 36% percent superiority over the check, Prakash (Table 9).

Quality Protein Maize Hybrid Trial I: Out of 15 QPM hybrids tested 11 out performed the best check, HQPM 1 with 8 registering 10% superiority. V-QPM-306 and HQPM 8 recorded more than 75% superiority, followed by HQPM 12 (54.35%), JH(QPM 193) (46.09%), EC 3152(Q) (46.09%) and others (Table 9).

Quality Protein Maize Hybrid Trial II: Nineteen hybrids were evaluated in this advanced yield trial. Two hybrids VQPMH 43 and HQPM 5 gave more than 10% yield over the best check, HQPM 1 (Table 9).

Table 9: Performance of best performing genotypes in different yield trials

Trial	Entry	Superiority 10%	Yield kg/ha
61 IET Late maturity	30 R 88	40.07	8731
	NAH 2049	27.51	7948
	JH 1116	24.19	7741
	BH 4070	22.04	7607
	Best Check	Pro 311	62.33
62 IET Medium maturity	JH 11180	73.74	9041
	BH 4062	61.95	84.42
	X-3904	52.57	7953
	JH 11137	40.37	73.17
	BH 4068	30.26	6790
	L-230	26.26	65.81
	BH 4069	25.18	6525
	Bisco 855	12.95	5888
	X-9452	12.33	5855
	BH 4067	10.94	57.83
	Best Check	Bio 9637	5213
63 IET Early Maturity	X-5313	48.74	8891
	R 20056	29.87	7763
	JH 3978	12.99	6533

	Best Check	Prakash	5977
65 AET Ist-Year Late Maturity	NECH 3251	32.51	8373
	JH 11024	16.55	7364
	Best check	Pro 311	6318
66 AET Ist-Year Medium Maturity	EH 1491	27.77	4265
	Best Check	Bio 9637	3338
71 AET IInd-Year Early Maturity	JH 3982	36.31	8975
	Best Check	Prakash	6584
Quality Protein Maize Hybrid Trial I	V.QPM-306	75.78	6428
	HQPM-8	75.74	6426
	HQPM-12	54.35	5644
	JH (QPM-193)	46.09	5342
	EC 3152 (Q)	46.09	5342
	HQPM-11	33.83	4894
	HQPM-10	31.91	4823
	HQPM-15	24.19	4541
	Best Check	HQPM 1	3657
Quality Protein Maize Hybrid Trial II	V Q P M H -43	30.35	7222
	HQPM-5	13.76	6303
	Best Check	HQPM-1	5540

The major activity of the Directorate may be research development of single corss hybrids under various types of maize. For this purpose 97 single crosses were successfully developed belonging to both normal and speciality group. These crosses will be evaluated in the common kharif season.

Transformation studies in maize:

Fifteen to 20 days old calli derived from immature embryos of CM124 and CM300 were bombarded with pCMBIA3301 with Basta and Gus as selective markers with various pressure regime and distances. Best Gus signal (Fig. 1) signal obtained at 900 and 1100 psi at 6 cm distance. Calli kept under selection media (Basta 2 mgl-1) has initiated to regenerate (Fig. 2). Efforts are being made to regenerate plants out of the same and confirm establishment of the gene construct in the genome.

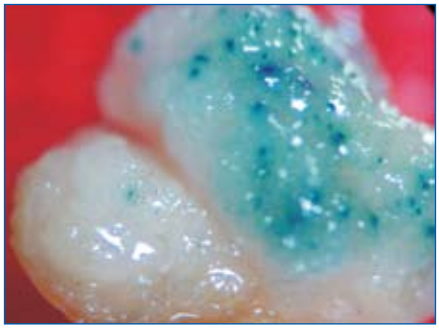


Fig. 1. Gus sopts in CM124 bombarded with pCAMBIA3301 at 1100 psi 6 cm distance

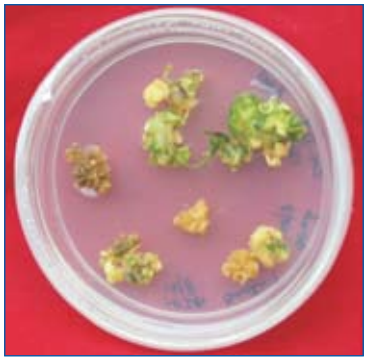


Fig. 2. Under selection (Basta 2mgl-1 shoot initiation in 19 days old bombarded calli of CM 124

Efforts are also being made toward Agrobacterium-mediated transformation of immature embryos using pCAMBIA3301 carrying CryIAb with Basta and Gus as selection marker.

DNA fingerprinting

Forty six elite inbred lines, viz. HKI 1015-WJ, HKI 1040-5, HKI 1094-WJ, HKI 209, HKI 335, HKI 470, HKI 1572, HKI 1025, LM 5, LM 6, NAI 105, CM 139, CM 104, CM 111, CM 208, HKI 1348-1, CM 300, CM 400, HKI 1342, HKI 1345, HKI 484, HKI 141(1+2+3), HKI 161-TR-5-6, HKI 164-7-7ER-4, HKI 17-2, HKI 193-2-1, HKI 33-5-2(1+2), HKI 163, HKI 5072-2-BT, CML175, CML176, HKI 164-7-2, HKI 27-3, HKI 188, SHD-1ER16, HKI 48-3-2, HKI Tall1-2-5, SHD-1ER10, SHD-1ER6, HKI PC4B, HKI PC8, HKI PC-BT-3, HKI 1827W-1, HKI 1831-3-5-6-7-87, HKI 536, CL-QRCYQ51 have been fingerprinted using 120 SSR markers (Fig. 3, 4). Eighty four out of 120 SSR markers attempted gave rise to reproducible banding pattern. Efforts are being made to identify core set of primers, which will be used to fingerprint more number of genotypes.

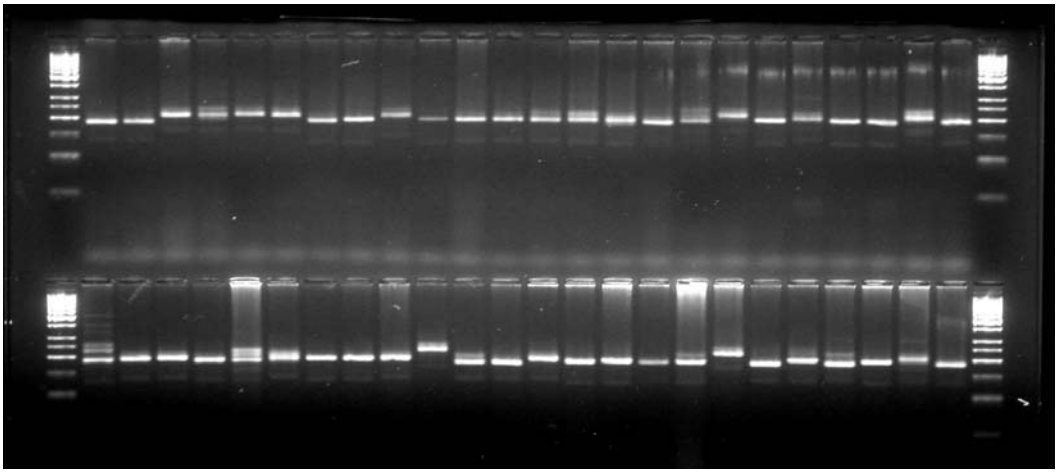


Fig. 3. Polymorphism pattern of 44 genotypes using bnlgz1866

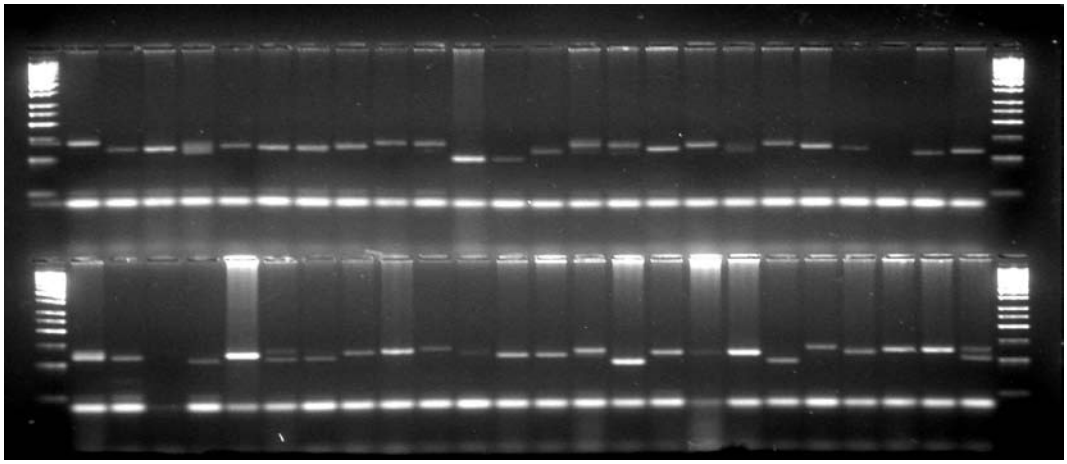


Fig. 4. Polymorphism pattern of 44 genotypes using bnlg1866

DUS Testing in maize

Three trials of maize comprising 14 hybrids, 41 inbred lines and 10 composites were conducted in Delhi, Almora, Dholi and Hyderabad during kharif 2006. Composites and hybrids were characterized as per DUS Testing Guidelines (Table 10, 11). Observation in inbred lines trial in Delhi could not be recorded primarily due to lack of plant stand. Due to poor germination, high

Table 10. Characters of the hybrids as per DUS guidelines in Delhi*

Sl. No.	Geno type	1. Leaf: angle bet blade & stem	2. Leaf: attitude of blade	3. Stem: antho col of br root	4. Tasl: Time of anthesis	5. Tasl: antho col at base of glume	6. Tasl: Anth col of glumes exc-luding base	7. Tasl: antho col of anthers	8. Tasl: density of spike-ets	9. Tasl: angle bet. Main axis & lateral brnches	10. Tasl: attitude of lateral branche	11. Ear: time of silk em-ergence	12. Ear: antho col of silks	13. Leaf: Antho col of sheath	14: Tasl: Length of main axis above lowest side branch	15 (2) Hy-zbrids only Plant: length
1	**HM 1**	Small	Drooping	Present	Early	Absent	Absent	Absent	Dense	Narrow	Straight	Very Early	Absent	Absent	Medium	Medium
2	**HM 2**	Small	Drooping	Present	Very early	Absent	Absent	Absent	Sparse	Narrow	Straight	Early	Absent	Absent	Long	Long
3	**HM 4**	Wide	Drooping	Present	Very early	Present	Absent	Absent	Sparse	Wide	Straight	Early	Absent	Absent	Long	Long
4	**HM 5**	Small	Drooping	Present	Medium	Absent	Absent	Absent	Sparse	Wide	Straight	Medium	Present	Absent	Long	Short
5	**HM 6**	Wide	Drooping	Present	Small	Absent	Present	Present	Sparse	Wide	Straight	Medium	Absent	Absent	Long	Short
6	**HQPM-1**	Small	Drooping	Absent	Small	Absent	Absent	Absent	Sparse	Wide	Straight	Early	Absent	Absent	Long	Medium
7	**Vivek H-4**	Small	Drooping	Absent	Early	Present	Present	Present	Sparse	Wide	Straight	Early	Absent	Atbsent	Short	Short
8	**Vivek H-5**	Wide	Drooping	Present	Early	Present	Present	Present	Sparse	Narrow	Straight	Very Early	Absent	Absent	Medium	Short
9	**Vivek H -9**	Wide	Drooping	Present	Early	Present	Present	Absent	Dense	Wide	Straight	Early	Absent	Absent	Medium	Medium
10	**Vivek H-15**	Wide	Drooping	Present	Early	Absent	Present	Absent	Dense	Wide	Curved	Very Early	Absent	Absent	Medium	Long
11	**Vivek H -17**	Wide	Drooping	Absent	Early	Absent	Present	Present	Dense	Wide	Straight	Very Early	Absent	Absent	Long	Short
12	**Pratap H M**	Wide	Drooping	Absent	Medium	Absent	Present	Present	Dense	Wide	Curved	Medium	Absent	Absent	Long	Short
13	**PHM 1**	Wide	Drooping	Present	Early	Absent	Absent	Absent	Dense	Wide	Curved	Early	Absent	Absent	Long	Long
14	**Paras**	Wide	Drooping	Present	Early	Present	Absent	Absent	Dense	Wide	Curved	Early	Absent	Absent	Long	Long

*Variability in the state of expression has not been depicted

Table 11. Characters of the composites as per DUS guidelines in Delhi*

1	**Suwan**	Wide	Drooping	Absent	Medium	Absent	Absent	Absent	Dense	Wide	Curved	Medium	Absent	Absent	Long	Medium
2	**JM-8**	Wide	Drooping	Present	Very early	Absent	Absent	Absent	Dense	Narrow	Curved	Very early	Absent	Absent	Long	Medium
3	**JM-216**	Wide	Drooping	Present	Early	Absent	Absent	Absent	Dense	Wide	Curved	Medium	Absent	Absent	Long	Long
4	**Vivek S M**	Wide	Drooping	Present	Very early	Absent	Present	Absent	Dense	Wide	Curved	Very early	Absent	Absent	Long	Short
5	**VL Amber Pop corn**	Wide	Drooping	Absent	Early	Absent	Absent	Absent	Dense	Narrow	3	Early	Absent	Absent	Medium	Medium
6	**VL baby corn**	Wide	Drooping	Present	Very early	Absent	Absent	Absent	Dense	Narrow	Straight	Very early	Absent	Absent	Long	Medium
7	**Tarun**	Wide	Drooping	Present	Early	Absent	Absent	Absent	Dense	Wide	Curved	Early	Absent	Absent	Long	Short
8	**Navin**	Wide	Drooping	Absent	Medium	Absent	Absent	Absent	Dense	Wide	Curved	Very early	Absent	Absent	Medium	Short
9	**D 765**	Wide	Drooping	Present	Very early	Absent	Absent	Absent	Dense	Wide	Straight	Very early	Absent	Absent	Long	Medium
10	**Surya**	Wide	Drooping	Absent	Early	Absent	Absent	Absent	Dense	Wide	2	Early	Absent	Absent	Medium	Medium

*Variability in the state of expression has not been depicted

temperature and low humidity at the time of flowering correct expression of various traits were not observed in the lines. Location specific expression of trait was recorded and variability in number of traits across location was also recorded both in case of hybrids and composites. Table 10 and 11 depict the maximum trait expression in Delhi. Traits Variation in expression of trait within the location has not been depicted in the tables.

16. Plant: Ear Place-tment	17. Leaf: Width of Blade	18. Ear: Length Without Husk	19. Ear: Diameter Without Huskz	20. Ear: Shape	21. Ear: No. of Rows of Grain	22. Ear: Type of Grain	23. Ear: Colour of Top of Grain	24. Ear: Antho Col of Glumes of Cob	25. Kernel: Row Arran-gement	26. Kernel: Popp-iness	27. Kernel: Swee-tness	28. Kernel: Waxiness	29. Kernel: Opaq-ueness	30. Kernel: Shape	31. Kernel: 1000 kernel Weight
High	Narrow	Long	Small	Conical	Many	Semi Dent	Yellow	Dark Purple	Straight	Absent	Absent	Absent	Absent	TooThed	Medium
Medium	Medium	Long	Small	Conical	Medium	Flint	White	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Medium	Medium	Long	Small	Conico-Cylindrical	Mediumt	Flint	Yellow	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Medium	Medium	Long	Medium	Cylindrical	Many	Dent	White With Cap	White	Straight	Absent	Absentz	Absent	Absent	Toothed	Medium
Medium	Medium	Long	Medium	Conico-Cylindrical	Manyz	Flint	Yellow With Cap	Light Purple	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Medium	NaRrow	Long	Small	Cylindrical	Many	Dent	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Indented	Medium
Medium	Narrow	Medium	Small	Conico-Cylindrical	Medium	Flint	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small
Medium	Narrow	Medium	Small	Cylindrical	Medium	Flint	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Medium	Narrow	Long	Medium	Cylindrical	Many	Flint	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Low	Narrow	Long	SmAll	Cylindrical	Many	Flint	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small
Medium	Narrow	Long	Small	Conico-Cylindrical	Many	Flint		White	Straighzt	Absent	Absent	Absent	Absent	Toothed	Medium
Low	Medium	Long	Small	Conico-Cylindrical	Many	Flint	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Indented	Large
Medium	Narrow	Long	Small	Conico-Cylindrical	Medium	Flint	White With Cap	White	Straight	Absent	Absent	Absent	Absent	Indented	Medium
Medium	Medium	Long	Small	Conico-CylindricAl	Medium	Semi Flint	Yellow With Cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Large

Medium	Medium	Long	Small	Conical	Medium	Flint	Orange	White	Straight	Absent	Absent	Absent	Absent	Indented	Medium
Medium	Medium	Long	Small	Conical	Many	Flint	White with cap	White	Straight	Absent	Absent	Absent	Absent	Indented	Medium
Medium	Medium	Long	Small	Cylindrical	Many	Flint	Yellow	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Low	Narrow	Long	Medium	Conical	Many	Flint	Yellow	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small
Medium	Narrow	Medium	Small	Conical	Many	Flint	Yellow	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Medium	Narrow	Medium	Small	Conical	Many	Flint	Yellow	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small
Medium	Narrow	Medium	Medium	Conical	Many	Flint	Yellow with cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small
Medium	Medium	Long	Small	Conico-cylindrical	Many	Flint	Orange	White	Straight	Absent	Absent	Absent	Absent	Toothed	Medium
Medium	Narrow	Long	Small	Conical	Many	Flint	Yellow	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small
Low	Medium	Long	Small	Conical	Many	Flint	Yellow with cap	White	Straight	Absent	Absent	Absent	Absent	Toothed	Small

Breeder Seed Production

During the period under report 83.1 quintals of breeder seed was indented including seed requirement from private sector. The total quantity of seed produced against the indent was 58.15 in Kharif. Some of the inbred lines and composite allocated to Udaipur, Banswara, Belipar, Dharwad, and Nagenhally centers are being produced during the Rabi 2006-07 and the final production figures will be available in May-June 2007. Details of the same in Table No.12.

Table 12. Centre-wise breeder seed production

S.No	Name of the Producing Centre/State	Name of the Variety	DAC Indent (Qtls)	Actual allocation as per BSP-1Target(QTls.)	Actual Production	Production surplus(+) Deficit(-) over BSP-1 Target
1	Almora	CM-212	0.08	0.08	1.00	0.92
		CM-141	0.04	0.04	0.04	0.00
		Pop-C4-5(CM 145)	0.04	0.04	0.25	0.21
		FH-3210 (Female)	0.07	0.07	0.25	0.18
		FH-3210 (Male)	0.05	0.05	0.25	0.20
2	DMR	NLD White	7.30	7.30	0.25	-7.05
		Shakti – 1	0.11	0.11	1.00	0.89
3	Dharwad /	CM-111	0.05	0.05	0.05	0.00
	Arbhavi	CM-500	0.07	0.07	0.50	0.43
		CM-501	0.05	0.05	0.50	0.45
		CM-202	0.10	0.10	0.50	0.40
		DMH-2(Female)	0.07	0.07	0.80	0.73
		DMH-2(Male)	0.05	0.05	0.50	0.45
4	Dholi	CML-142	0.10	0.10	0.20	0.10
		CML-150	0.25	0.25	0.45	0.20
		CML-186	0.65	0.65	0.70	0.05
		CML-176	1.32	1.32	1.50	0.18
		CML-161	0.07	0.07	2.20	2.13
		CML-163	0.05	0.05	1.07	1.02
		P- 7421	0.05	0.05	0.40	0.35
		Suwan Comp.	0.50	0.50	3.00	2.50

		Deoaki	0.07	0.07	0.85	0.78
		Laxmi	0.03	0.03	0.60	0.57
5	Hyderabad	CM-120	0.40	0.40	0.40	0.00
		CM-118	0.06	0.06	0.06	0.00
		CM-119	0.51	0.51	0.51	0.00
		CM-208	0.19	0.19	0.20	0.01
		CM-211	0.20	0.20	0.25	0.05
		CM-313	0.20	0.20	NR	-
		CM-132	0.05	0.05	0.05	0.00
		CM-133	0.05	0.05	0.05	0.00
		CM-148	0.36	0.36	0.45	0.09
		CM-149	0.25	0.25	0.25	0.00
		Priya Sweet Corn	0.57	0.57	R	-
6	Kanpur	Azad Uttam	0.20	0.20	1.05	0.85
		Azad Kamal	0.15	0.15	NR	-
7	Ludhiana	Navjot	4.54	4.54	6.00	1.46
		Ageti-76	0.22	0.22	1.10	0.88
		Vijay Composite	0.62	0.62	2.25	1.63
		CM-143	0.08	0.08	0.40	0.32
		CM-144	0.04	0.04	1.10	1.06
		Sheetal (Female)	0.07	0.07	1.00	0.93
		Sheetal (Male)	0.05	0.05	3.00	2.95
		JH-3851 (Female)	0.07	0.07	0.45	0.38
		Jh-3851 (Male)	0.05	0.05	0.50	0.45
8	Pantnagar	Gaurav	0.47	0.47	NR	-
		Sweta	0.33	0.33	1.96	1.63
		Pragati	0.15	0.15	4.58	4.43
		Kanchan	1.37	1.37	1.68	0.31
		Surya	1.27	1.27	3.22	1.95
		Amar(D-941)	1.60	1.60	1.26	-0.34

		CM-400	1.13	1.13	2.18	1.05
		CM-300	0.66	0.66	0.50	-0.16
		CM-600	0.80	0.80	0.49	-0.31
9	Udaipur	Pratap Makka-1(Female)	1.20	1.20	R	-
		Pratap Makka-1(Male)	0.60	0.60	R	-
		Pratap Makka-3	0.20	0.20	3.00	2.80
		Aravali Makka-1Composite	1.30	1.30	3.60	2.30
10	Banswara	Mahi Dhawal	0.22	0.22	3.30	3.08
		Mahi Kanchan	1.15	1.15	4.30	3.15
		CM 137	-	-	1.65	*
		CM 138	-	-	0.52	*
11	Godhra	Narmada Moti	0.60	0.60	R	-
12	Belipur	CML-142	0.10	0.10	R	-
		CML-150	0.25	0.25	R	-
		CML-186	0.65	0.65	R	-
13	Delhi	CM-136	0.10	0.10	NR	-
		CM-137	24.85	24.85	17.00	-7.85
		CM-135	0.21	0.21	NR	-
		CM-138	12.38	12.38	13.00	0.62
		CM-213	0.20	0.20	NR	-
		CM-142	0.70	0.70	NR	-
		Pusa Composite-3	1.00	1.00	NR	-
		CM-150	0.34	0.34	NR	-
		CM-150	0.20	0.20	NR	-

14	Uchani	HHM-1 (Female)	0.07	0.07	0.50	0.43
		HHM-1 (Male)	0.05	0.05	0.10	0.05
		HHM-4 (Female)	0.09	0.09	10.00	9.91
		HHM-4(Male)	0.04	0.04	0.50	0.46
		HQPM-1(Female)	0.11	0.11	10.00	9.89
		HQPM-1(Male)	0.07	0.07	10.00	9.93
15	Nagenhally	NAC-6004	0.07	0.07	R	-
		NAC-6002	0.07	0.07	R	-
16	Chhindwara	JM-8	1.20	1.20	R	-
		JM-216	3.00	3.00	R	-
		JM-13	1.50	1.50	R	-
		JM-12	2.70	2.70	R	-
		TOTAL	**83.1**	**83.1**	**129.27**	

R: Production being taken during rabi season
NR: Not reported
NP: No production

ENTOMOLOGY

Screening of Germplasm

Screening of germplasm in coordinated trails was conducted at seven locations in all the zones except zone-I during *kharif* 2006. The egg mass of *Chilo partellus* containing 15-20 eggs in black-headed stage were pinned close to the whorl. Eggs were released again where they were washed off by rain. Observations were taken 30 days after release of pests and leaf injury rating was recorded on 1-9 scale. All the lines screened were classified into three categories; least susceptible having rating ≤3; moderately susceptible, >3 but ≤6; highly susceptible, >6. The data of coordinated trails of all the four maturity groups and QPM-1 and QPM-2 is summarized in table.

The gremplasm which were found least susceptible to *C. partellus* in different maturity groups were:

Full season maturity- NECH 131 at Hyderabad; NECH-132, 30-R77, MCH-28, JH 11024, JH 11044 at Delhi in first year AET; MS POOL C7, TUXP.POOL C7, JC-1441 C3 at Karnal in 2nd year AET.

Medium maturity- R 2005-4, EH-1153, AH-48007, JKMH-462 in the first year and CHH-218, HKH-1188, SMH-3103 in the second year at Delhi; V-33 and HKH-1191 in the second year at Karnal; MH-05-2 in the 2nd year at Dholi.

Early maturity- BVM-10 and PAC-712 in 1st year AET at Delhi; R-2005-1 in 1st year AET at Kolhapur; BVM-9-1 and FH-3311 in the 1st year AET and EH-1389 in the second year AET at Karnal.

Extra early maturity- FH-3294, FH-3252, WC-236(Y) in 1st year AET and BVM-7, DEH-107, FH-3245, FH-3248, FH-3277, FH-3288 in the second year AET at Delhi; WC-236(Y) in 1st year AET at Kolhapur; FH-3294 in 1st year AET and DEH-105 in second year AET at Karnal.

QPM-1 V QPM-306, MH QPM-05-8, MH QPM 05-9, H QPM-9, H QPM-10, H QPM-12 at Delhi.

QPM-2 MH QPM-5-1, H QPM-5 at Delhi

Promising inbreed lines from all the centres were received and screened against *C. partellus*. Out of 253 lines, 33 were least susceptible. 150 moderately susceptible and 64 highly susceptible, out of which 99 have been selected for further screening in next kharif season.

IPM trails were conducted at Ludhiana, Dholi, Kolhapur, Hyderabad and Udaipur. The yield was enhanced in most places except at two places in Hyderabad. Kolhapur recorded maximum increased yield i.e. 44% in comparision to the farmers practice.

The pest scenario at different locations was observed by making regular observations in trap nursery. The *Chilo* infestation was worst at Godhra as observed during the monitoring of the centre. The crop was heavily damaged by the pest during maturity. Insect fauna was also monitored using aerial insect trap at Delhi. *Spodoptera* infestation in maize was quite high as evident from the pheromone trap data at Hyderabad. Oviposition studies of *C. partellus* were conducted at Delhi and Ludhiana.

An Insect-Handling Device has been developed which is versatile in nature; this device has been filed for patenting vide patent application no. 224/DEL/2007.

Table:1 Summary of germplasm evaluation against Chilo partellus in each maturity group at different places

Level of susceptibilitty	Extra-early maturity		Early maturity		Medium maturity		Full season maturity		QPM-1	QPM -2
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year		
Total Entry										
	8	**13**	**13**	**5**	**16**	**12**	**12**	**5**	**11**	**13**
Delhi										
Least susceptible	3	6	2	1	4	3	5	0	6	2
Moderately susceptible	5	7	10	5	9	9	7	5	5	11
Highly susceptible	0	0	0	0	0	0	0	0	0	0
Karnal										
Least susceptible	1	1	3	2	0	2	0	3		
Moderately susceptible	7	12	6	2	15	8	10	2		
Highly susceptible	0	0	4	2	1	2	2	0		
Ludhiana										
Least susceptible	0	0	0	0	0	0			0	0
Moderately susceptible	1	1	3	5	5	8			7	10
Highly susceptible	7	12	9	9	8	4			4	3
Kolhapur										
Least susceptible	1	0	1	0						
Moderately susceptible	7	10	11	5						
Highly susceptible	0	3	0	0						

Hyderabad										
Least susceptible	0	0	0	0	0	0	1	0	0	0
Moderately susceptible	8	12	10	5	13	12	8	2	11	13
Highly susceptible	0	0	2	0	0	0	3	3	0	0
Dholi										
Least susceptible	0	0	0	0	0	1	0	0		
Moderately susceptible	7	12	11	4	14	9	8	4		
Highly susceptible	1	1	2	1	2	2	4	1		
Udiapury										
Least susceptible	0	0	0	0	0	0	0	0	0	0
Moderately susceptible	7	8	6	5	12	8	0	1	9	3
Highly susceptible	1	5	6	0	1	0	11	4	2	9

During Kharif 2006, 253 lines were collected from different coordinated centres. These lines were screened against *C. partellus* under artificial infestation. Lines were selected and sown ear to row during rabi 2006-07 at Hyderabad. In this way 184 lines were screened during rabi 2006-07 out which 99 were selected based on their low level of susceptibility.

Egg masses pinned for infestation

Artificial Infestation

Table: 2 Entomology Programme at Delhi during Kharif 2007-253 lines

Plot No	Pedigree	Origin	LIR kharif 2006	LIR Rabi 2006-07
1001	CM 501	Hyd 2006R/47	2.4	6.2
1002	LM 6	Hyd 2006 R/74	4.4	4.0
1003	LM 11	Hyd 2006 R/77	3.8	5.0
1004	HKI-1352-5-8-9	Hyd 2006 R/128	3.3	-
1005	HKI-C322 -1	Hyd 2006 R/131	3.9	6.5
1006	HKI-C322-2	Hyd 2006 R/131	-	-
1007	HKI 586	Hyd 2006 R/154	4.6	5.3
1008	HKI-1040C2-1	Hyd 2006 R/164	3.9	-
1009	HKI-1040C2-2	Hyd 2006 R/164	-	-
1010	HKI-3-4-8-1	Hyd 2006 R/169	5.8	-
1011	HKI-3-4-8-2	Hyd 2006 R/169	-	-
1012	HKI-3-4-8-3	Hyd 2006 R/169	-	-
1013	HKI-3-4-8-4	Hyd 2006 R/169	-	-
1014	HKI-3-4-8-5	Hyd 2006 R/169	-	-
1015	HKI-3-4-8-6	Hyd 2006 R/169	-	-
1016	HKI-3-4-8-7	Hyd 2006 R/169	-	-
1017	HKI-3-4-8-6ER-1	Hyd 2006 R/171	7.0	4.1
1018	HKI-3-4-8-6ER-2	Hyd 2006 R/171	-	-
1019	HKI-3-4-8-6ER-3	Hyd 2006 R/171	-	-
1020	HKI 164-7-3-1	Hyd 2006 R/180	3.1	6.7
1021	HKI 164-7-3-2	Hyd 2006 R/180	-	-
1022	HKI 164-7-3-3	Hyd 2006 R/180	-	-
1023	HKI 164-7-4-1	Hyd 2006 R/181	3.9	4.8
1024	HKI 164-7-4-2	Hyd 2006 R/181	-	-
1025	CM 133	Hyd 2006 R/22	3.0	7.0
1026	CM 500	Hyd 2006 R/46	2.9	6.6
1027	V 354 -1	Hyd 2006 R/68	3.7	-
1028	V 354-2	Hyd 2006 R/68	-	-
1029	V 356	Hyd 2006 R/69	1.0	-

1030	LM 12	Hyd 2006 R/78	2.0	4.2
1031	LM 15 -1	Hyd 2006 R/81	2.9	6.4
1032	LM15-2	Hyd 2006 R/81	-	-
1033	KDM 300	Hyd 2006 R/91	3.2	5.0
1034	KDM 331	Hyd 2006 R/92	3.8	5.4
1035	KDM347	Hyd 2006 R/101	1.4	-
1036	HVZM253	Hyd 2006 R/103	3.0	-
1037	HVZM368	Hyd 2006 R/107	3.5	-
1038	HKI-1348(6-1-8)	Hyd 2006 R/122	3.1	5.8
1039	HKI- 1348-T-1	Hyd 2006 R/125	2.9	-
1040	HKI- 1348-T-2	Hyd 2006 R/125	-	-
1041	HKI -323-8-	Hyd 2006 R/144	2.0	6.3
1042	HKI-327T-1	Hyd 2006R/146	2.8	-
1043	HKI-327T-2	Hyd 2006 R/146	-	-
1044	HKI 577-1	Hyd 2006 R/153	2.8	5.1
1045	HKI 577-2	Hyd 2006 R/153	-	-
1046	HKI-323-8	Hyd 2006 R/179	3.9	-
1047	HKI-1015-6-1	Hyd 2006 R/157	2.0	-
1048	HKI-1015-6-2	Hyd 2006 R/157	-	-
1049	HVZM-343	Hyd 2006 R/105	2.7	6.9
1050	CM133	DL 2006K/22	3.0	7.0
1051	CM 500	DL 2006K/46	2.9	6.6
1052	CM 501	DL 2006K/47	2.4	6.2
1053	CM 502	DL 2006K/48	3.4	-
1054	LM 9-1	DL 2006K/75	1.9	5.7
1055	LM9 -2	DL 2006K/75	-	4.2
1056	LM 10-1	DL 2006K/76	3.6	5.0
1057	LM 10-2	DL 2006K/76	-	5.5
1058	LM 12-1	DL 2006K/78	2.0	4.2

1059	LM12-2	DL 2006K/78	-	6.4
1060	LM15	DL 2006K/81	2.9	6.4
1061	LM16-1	DL 2006K/82	2.8	6.2
1062	LM 16-2	DL 2006K/82	-	-
1063	KDM 330	DL 2006K/91	3.2	5.0
1064	KDM 331	DL 2006K/92	3.8	5.4
1065	KDM 332-1	DL 2006K/93	3.1	6.5
1066	KDM 332-2	DL 2006K/93	-	6.3
1067	KDM 345	DL 2006K/100	3.9	7.4
1068	KDM 349	DL 2006K/102	1.2	6.5
1069	HVZM 353	DL 2006K/103	3.0	4.3
1070	HVZM 329-1	DL 2006K/104	3.7	5.9
1071	HVZM 329-2	DL 2006K/104	-	5.9
1072	HVZM 343	DL 2006K/105	2.7	6.9
1073	HVZM 366	DL 2006K/106	3.7	6.2
1074	HVZM 368	DL 2006K/107	3.5	4.2
1075	HKI- 1348-(8-2)	DL 2006K/122	3.1	5.8
1076	HKI C 322	DL 2006K/131	3.9	6.5
1077	HKI-C 287-1	DL 2006K/132	3.3	4.6
1078	HKI-C 287-2	DL 2006K/132	-	5.3
1079	HKI 413	DL 2006K/134	2.7	6.2
1080	HI 1128-1	DL 2006K/136	2.7	6.8
1081	HKI 1128 -2	DL 2006K/136	-	7.1
1082	HKI -488 EARLY	DL 2006K/150	3.8	4.8
1083	HKI 577	DL 2006K/153	2.8	5.1
1084	HKI-1015-WJ-8-1	DL 2006K/158	2.3	7.3
1085	HKI-1015-WJ-8-2	DL 2006K/158	2.3	7.3
1085	HKI-1015-WJ-8-3	DL 2006K/158	-	5.4
1086	HKI-170 (H-2)	DL 2006K/195	3.9	4.4
1087	DMRQPM-03-121- ⊗-#	DL 2006K/207	3.8	4.9
1088	DMRQPM-03-124-⊗-#	DL 2006K/208	3.8	5.3
1089	DMRQPM-60-#- ⊗- #	DL 2006K/210	3.9	4.7

1090	DMRQPM-58- ⊗- ⊗ -#-2- ⊗- ⊗	DL 2006K/213	2.4	5.5
1091	DMRQPM-58- ⊗- ⊗ -#-3- ⊗- ⊗	DL 2006K/214	3.6	7.2
1092	DMRQPM-58- ⊗- ⊗ -#-12- ⊗- ⊗	DL 2006K/218	3.5	5.9
1093	DMRQPM-03-121- ⊗-#	DL 2006K/8-1	2.7	5.1
1094	DMRQPM-03-121- ⊗-#	DL 2006K/8-2		8.0
1095	DMRQPM-58- ⊗- ⊗ -#-23- ⊗- ⊗-1	DL 2006K/222-1	2.2	6.0
1096	DMRQPM-58- ⊗- ⊗ -#-23- ⊗- ⊗-2	DL 2006K/222-2		4.2
1097	DMRQPM-58- ⊗- ⊗ -#-32- ⊗- ⊗	DL 2006K/228	3.6	5.2
1098	DMRQPM-58- ⊗- ⊗ -#-36- ⊗- ⊗	DL 2006K/232	3.9	4.9
1099	DMRQPM-60-#-#-BULK- ⊗-9-#- ⊗	DL 2006K/236	3.3	4.4

During kharif 2006, 51 lines received from Hyderabad were screened against *C .partellus;* out of which 37 lines were selected based on their low level of susceptibility. These were further screened during rabi 2006-07 at Hyderabad from which 42 were selected.

Table: 3 Entomology Programme at Delhi during Kharif 2007-51 lines

Plot No	Pedigree	Origin	LIR kharif 2006	LIR Rabi 2006-07
1100	CM-104-1	Hyd 2006R/1	3.0	5.3
1101	CM-104-2	Hyd 2006 R/1	-	3.3
1102	CM-104-3	Hyd 2006 R/1	-	-
1103	CM-104-4	Hyd 2006 R/1	-	-
1104	CM-104-5	Hyd 2006 R/1	-	-
1105	CM-104-6	Hyd 2006 R/1	-	-
1106	HKI-586	Hyd 2006 R/10	4.1	6.7
1107	HKI-1040C2-1	Hyd 2006 R/10	-	7.3
1108	HKI-1040C2-2	Hyd 2006 R/10	-	4.9
1109	HKI-3-4-8-1	Hyd 2006 R/10	-	3.8
1110	HKI-3-4-8-2	Hyd 2006 R/10	2.5	6.4
1111	HKI-3-4-8-3	Hyd 2006 R/10	-	7.6
1112	HKI-3-4-8-4	Hyd 2006 R/12	-	-
1113	HKI-3-4-8-5	Hyd 2006 R/12	-	-
1114	HKI-3-4-8-6	Hyd 2006 R/12	-	-
1115	HKI-3-4-8-7	Hyd 2006 R/12	-	-

1116	HKI-3-4-8-6ER-1	Hyd 2006 R/13	3.7	5.0
1117	HKI-3-4-8-6ER-2	Hyd 2006 R/18	2.5	5.6
1118	HKI-3-4-8-6ER-3	Hyd 2006 R/18	-	-
1119	HKI 164-7-3-1	Hyd 2006 R/18	-	-
1120	HKI 164-7-3-2	Hyd 2006 R/18	-	-
1121	HKI 164-7-3-3	Hyd 2006 R/18	-	-
1122	HKI 164-7-4-1	Hyd 2006 R/18	-	-
1123	HKI 164-7-4-2	Hyd 2006 R/38	3.8	-
1124	CM 133	Hyd 2006 R/38	-	-
1125	CM 500	Hyd 2006 R/38	-	-
1126	V 354-1	Hyd 2006 R/209	4.4	5.4
1127	V 354-2	Hyd 2006 R/209	-	-
1128	V 356	Hyd 2006 R/209	-	-
1129	LM 12	Hyd 2006 R/229	4.6	4.9
1130	LM 15-1	Hyd 2006 R/230	4.3	5.2
1131	LM 15-2	Hyd 2006 R/230	-	-
1132	KDM 330	Hyd 2006 R/230	-	-
1133	KDM 331	Hyd 2006 R/230	-	-
1134	KDM 347	Hyd 2006 R/230	-	-
1135	HVZM 253h	Hyd 2006 R/230	-	-
1136	HVZM 368	Hyd 2006 R/230	-	-
1137	DMRQPM-58-⊗-⊗-#-34-⊗- ⊗	Hyd 2006 R/230	-	-
1138	DMRQPM-58-⊗-⊗-#-35-⊗- ⊗-1	Hyd 2006 R/231	4.3	5.9
1139	DMRQPM-58-⊗-⊗-#-34-⊗- ⊗-2	Hyd 2006 R/231	-	-
1140	DMRQPM-58-⊗-⊗-#-34-⊗- ⊗-3	Hyd 2006 R/231	-	-
1141	DMRQPM-58-⊗-⊗-#-36-⊗- ⊗	Hyd 2006 R/232	3.9	4.9

Of the 156 entries screened in Rabi (2005-06) and 154 in Kharif (2006) screened against *S. inferens* and *C. partellus* respectively. Only four were found least susceptible against *C. partellus* -

P591c4 ly2 GEN F67-1-2-1-B-B-B x CML486
(CML226 x CML295)-32-1-2-2-BBBB x CML486
Cuba/Guad C3 F46-1-3-2-B-B-B x CML486
[KlLlMA ST94A]-30/MSV-03-2-IO-B-I-B-B-2xP84cl F26-2-2-4-B-2-B] FI

Six were found moderately susceptible against pink stem borer-
[KlLlMA ST94A]-30/MSV-03-2-IO-B-I-B-B-2xP84cl F26-2-2-4-B-2-B] FI
(200-6 x GUATl89)(51-2-I)F1-B-xP84c1 F26-2-2-4-B-2-B] F1O2-1-3-1-2 x
Cuba/Guad C3 F46-1-3-2-B-B-B x CML486
P591c4 1y2 GEN F137-1-1-1-B-B-B x P33c3 F64-1-1-4-BB
Line recycle LLTtardAsiaxMIRT F65-2-1-2-1-B x CMlA86
(CML226 x CML295)-32-1-2-2-BBBB x P33c3 F64-1-1-4-BB

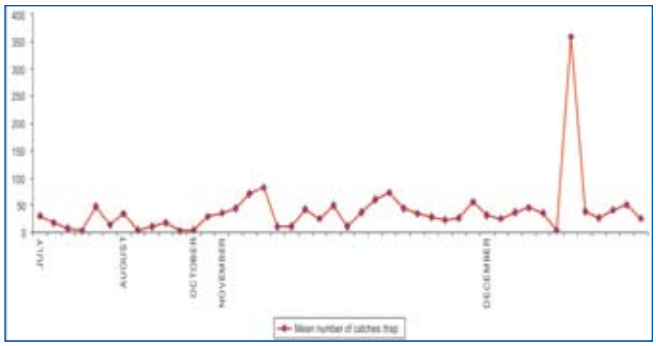
***Spodoptera* sp. Incidence was a major concern in A.P. Pheromon trap used shows the population intensity pattern during rabi 2006-07**

Table: 4 Screening against *Chilo partellus* during Kharif 2006 at Hyderabad Trial No Escy05-01

Entry no	Pedigree	MEAN LIR (1-9 Scale) Kharif 2006	MEAN LIR (1-9 Scale) Rabi 2006-07
100	P591c4 ly2 GEN F67-1-2-1-B-B-B x CML486	2.4	-
145	(CML226 x CML295)-32-1-2-2-BBBB x CML486	2.9	
74	Cuba/Guad C3 F46-1-3-2-B-B-B x CML486	2.7	
12	[KlLlMAST94A]-30/MSV-03-2-IO-B-I-B-B-2xP84cl F26-2-2-4-B-2-B] FI	2.7	4.2
15	[KlLlMA ST94A]-30/MSV-03-2-IO-B-I-B-B-2xP84cl F26-2-2-4-B-2-B] FI	5.4	4.5
53	(200-6 x GUATl89)(51-2-I)F1-B-xP84c1 F26-2-2-4-B-2-B] F1O2-1-3-1-2 x	6.9	4.1
107	P591c4 1y2 GEN F137-1-1-1-B-B-B x P33c3 F64-1-1-4-BB	6.5	4.2
134	Line recycle LLTtardAsiaxMIRT F65-2-1-2-1-B x CMlA86	7.1	4.3
146	(CML226 x CML295)-32-1-2-2-BBBB x P33c3 F64-1-1-4-BB	6.8	3.9

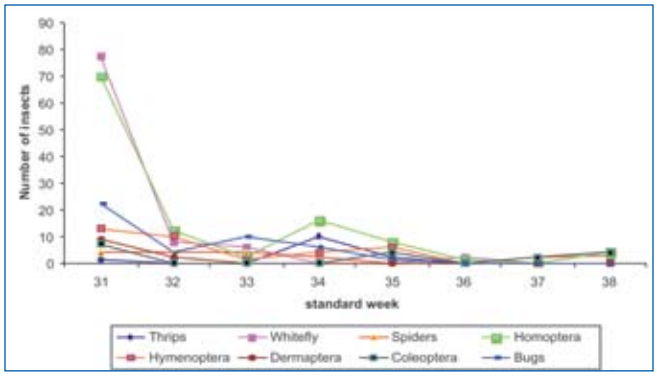
Spodoptera Adult

Graph showing Monitoring of Spodoptera incidence through pheromone traps in Maize at Hyderabad



In order to study the population dynamics of various aerial insects in maize ecosystem we used Aerial Insect Trap round the kharif 2006. The graph depicts the population pattern of different insect groups.

Graph showing Aerial Insect Trap Data during Kharif 2006 at Delhi



Technology developed for the mass production of biological control agents

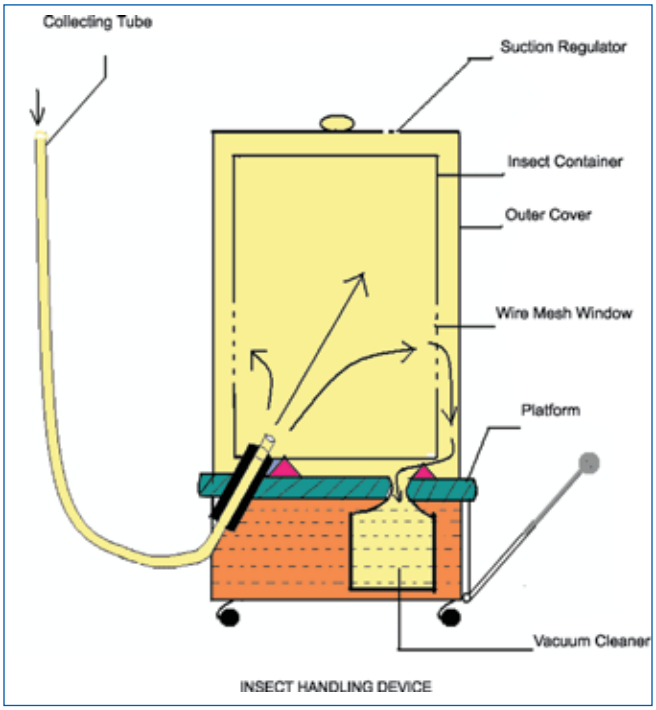
Insect Handling Device

Insects are reared in laboratories and insectaries for various purposes, such as biological control agents and for other useful purposes. Insect pests are also reared for screening the plant germplasm to study their level of resistance against them. Since insects walk, run and fly their handling is difficult when one has to handle large a number of them. An efficient mechanization have been achieved by developing a versatile type of insect handling device by which a large number of insects are collected in the insectaries in short time and without causing injury to the insects.

Patent filed-

Pradyumn Kumar and JC Sekhar-An Insect Handling Device

Patent Application no.0224/DEL/2007 dt. 5.02.2007



Identification of sources of resistance

Following resistant lines were developed

Table 5. Sources of Resistance

S. No.	Pedigree	Resistant against
1	WINPINKL4-2-YF	*Sesamia inferens and Chilo partellus*
2	WINPINKL5-3-PF	*S. inferens and C. partellus*
3	WINPINKL9-1-YF	*S. inferens*
4	WINPINKL37-1-YF	*S. inferens and C. partellus*
5	WINPINKL57-1-YF	*S. inferens*
6	WINPINKL62-1-YD	*S. inferens*
7	WINPINKL63-2-OF	*S. inferens*
8	WINSYNTHETIC	*C. partellus*

PLANT PATHOLOGY & NEMATOLOGY

Extensive surveys were conducted under survey and surveillance programme in maize growing areas of Bihar, Karnataka, Rajasthan, Tamil Nadu and Uttarakhand. In Bihar the disease observations were recorded in vegetative and reproductive phases of the crop. A total of 10 places covered in this region are; Muzaffarpur, Samastipur, Begusarai, Khagaria, Darbhanga, Madhubani, Sitamarhi, Motihari, Vaishali, and Chapra. The predominant diseases of the region were Mayelis leaf blight (MLB), BLSB and PFSR followed by Pythium stalk rot and Bacterial stalk.

In Rajasthan, 55 places were surveyed. Prevailing diseases of the area were MLB, RDM, Brown spot, Curvularia Leaf Spot, Post Flowering Stalk Rot (PFSR), Banded leaf and sheath blight (BLSB) and Head smut. The incidence of Rajasthan dowry mildew (RDM) was severe in village Kalaroi, MLB was severe in Nai, Godana, Kriti, Bassi, Madri, Ghasa, Kavita, Kumavton-ka-Guda Oda, Kakrwara and Bhatewar; Turcicum Leaf Blight (TLB) was severe in Amod, Bassi, Kumavton-ka-Guda and Bhatewar; Brown stripe downy mildew (BSDM) was severe in Peepalwas, Pawa, Bichchiwada, Kakarwa, etc. BLSB was severe at Magwas, Falasia, etc. CLS was severe Dabok,Holi, Thambla, Kavita, etc. and FSR was severe in Shaji – ka – Guda, Thambala, Ghasa, Khemli, Kavita, Kumavton-ka-Guda, Daroli, etc. Incidence of Head smut was severe in Pawa area. In experimental field of maize at Udaipur the incidence of Rajasthan dowry mildew (RDM) was up to 100% and Fusarium Stalk rot (FSR) rating was up to 8.0 in 1-9 rating scale under artificial inoculation conditions.

In Karnataka state, 5 places i.e. Arabhavi, Gokak, Dharwad, Bagalkot and Hubli comprising 79 fields, were covered (640-800 m.a.s.l.). Disease observations were taken at the grain filling stage. Prevalent disease of the region was TLB followed by Common rust (C. rust). The moderate incidence of Charcoal rot was observed. Mayelis leaf blight (MLB) was recorded in traces.

In Tamil Nadu, 10 places i.e. Saravanppatty, Pollachi, Palani, Madurai, Odumalaipattai, Palladam, Darapuram, Kangeyam, Avinashi, Thondamuthoor comprising 79 fields were covered (411.48 m.a.s.l.). Disease observations were taken at knee high and grain filling stages. The most prevalent disease of the area was Sorghum Downy Mildew followed by TLB. The intensity of SDM was recorded from traces to severe whereas TLB was recorded in traces. Some other disease like Rust and FSR were also observed in traces.

In Himanchal Pradesh, seven places i.e. Navada, Bahral, Sangarh, Singhpur, Danda Pagar, Amarkot and Dharu Chuleria were covered comprising 63 fields. The disease observations were taken at the time of grain filling stage. The prevalent diseases of this area were MLB, BLSB, and BSDM. The TLB, Brown spot and ESR were recorded from traces to moderate intensity.

In Uttarakhand, nine places i.e. Srikote, Talwari, Thala, Tharali, Lolit, Pipalkoti, Haleru, Kamandh, Chiniyalisaur, etc. were covered in two survey trips. Mixed cropping and scattered planting were prevalent in these areas and it was observed that due to mixed cropping the plants are robust and healthy. TLB was the major problem of this region and the losses in grain yield goes up to 50- 60% in favourable weather condition due to this disease. At research station Hawalbagh, the disease first appeared in the month of July which goes upto severe condition in the month of August. Incidence of MLB, BLSB *Physoderma maydis,* CLS and Physoderma leaf spot were observed in very low intensity. C. rust was observed in traces from one or two places.

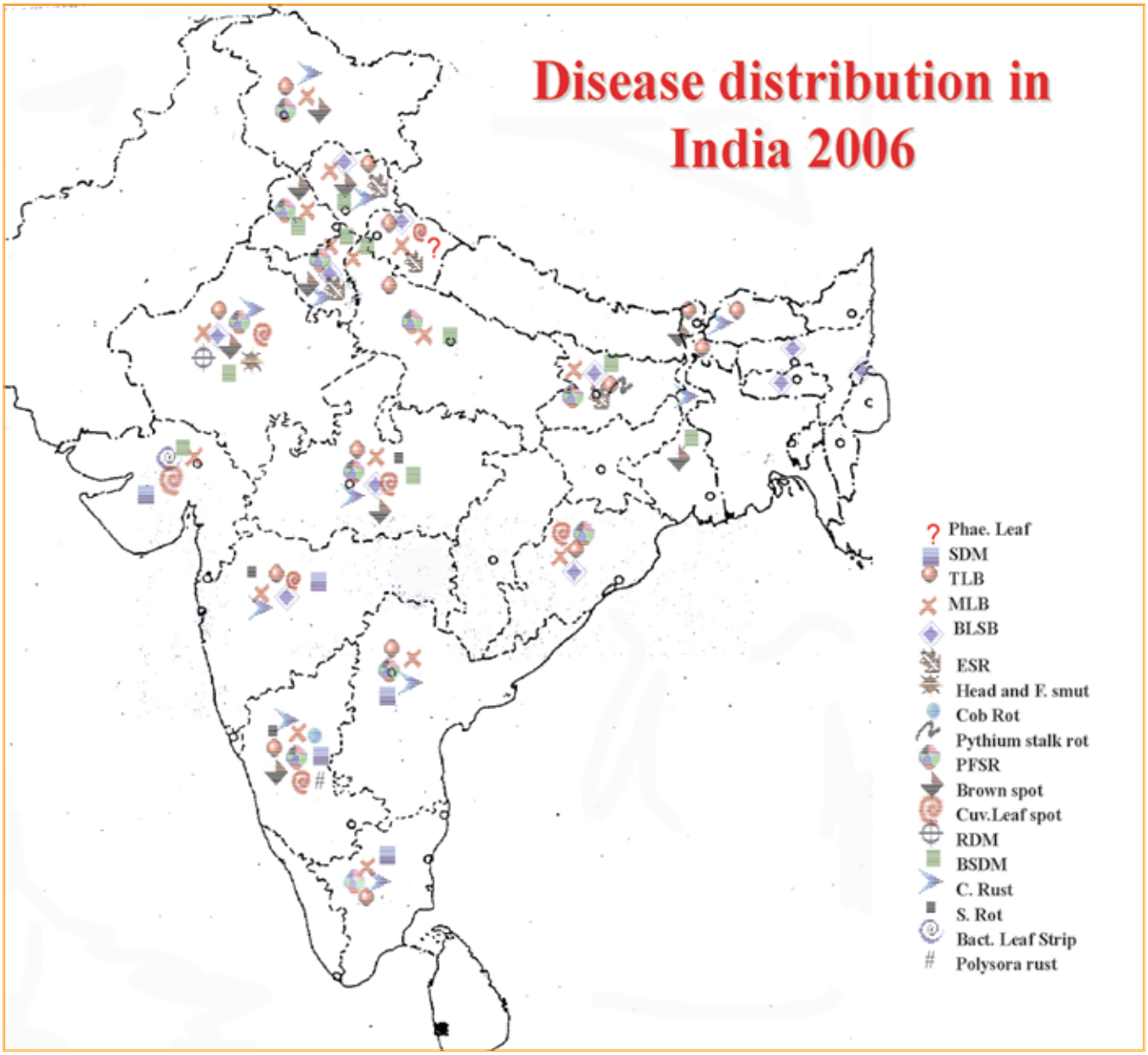


Fig.1 Disease distribution in India based on survey surveillance

Table : 1 Occurrence of Maize Diseases based on Survey and Surveillance 2006

States	TLB	MLB	BLSB	Brown spot	Cuv. Leaf spot	BSDM	RDM	SDM	Pythium Stalkrot	ESR	PFSR	Phae. Leaf spot	C. rust	Head smut and false smut
Rajasthan. Maize Local, PHEM-2, Myco	++	+++	++	++	+++		+++				+++			++
Bihar (Veg. And repro. Stage)		+++	+++						++	++				
Tamil Nadu (Knee high and grain filling stage)	+							+++			+		+	
Karnataka (Grain filling stage)	+++	+		+							++		+++	
H. P. (grain filling stage) Local, KH 9451	++	+++	+++	++		+++				++				
Uttarakhand	+++	++	++		++							++	+	

TLB=Turcicum leaf blight, MLB=Maydis leaf blight, BLSB=Banded leaf and sheath blight, Cuv. Leaf spot = Curvularia Leaf Spot, BSDM=Brown stripe downy mildew, RDM=Rajasthan downy mildew, ESR=Erwinia stalk rot, PFSR= Post Flowering stalk rots, Phae. Leaf spot = Phaeosporia Leaf Spot.

+ Mild, ++ Moderate, +++ Severe

Promising genotypes resistance to various diseases;

Kharif 2006-07

A total of 215 maize genotypes and 34 QPM genotypes of different trials comprising various maturity groups were evaluated against different maize diseases viz. MLB, TLB, BLSB, SDM, DM, BSDM, RDM, PFSR, C. rust, P. rust and ESR. The screenings of these genotypes were carried out against economically important maize diseases under artificially inoculated conditions in the various hot spots, identified for these diseases.

The most promising genotypes with combined resistance identified –

- NAH – 2049, KHH M – 102 - MLB, TLB and BSDM
- MCH-34 - TLB, ESR and Rust
- NAH 1137, 30-R – 88 - TLB, SDM, RDM, ESR and Rust
- BH – 4066 and POLO - TLB, PFSR and Rust
- JH – 10024 and FH – 3245 - MLB, TLB and Rust
- NAH – 2049 - SDM, RDM, BSDM, PFSR and Rust.

In IET Late-season maturity groups, the resistant genotypes identified

- JH-11117, HKH – 1603, NAH- 1144, SMH – 3904 Nah – 2049, PAC – 740 and BH – 4066, - TLB, BSDM
- BH – 4070 - Rust

In IET medium maturity, resistant genotypes identified

- BH – 4062, X- 3904; JH – 11137, JH – 11180 HKH – 1606, STAR – 9913 - TLB
- EH – 1810, BH – 4068, BISCO – 855 - PFSR
- L- 229, HKH – 1602 and BH – 4069 - RUST
- JH – 11180 - TLB and PFSR

In IET early maturity, resistant genotypes identified

- X – 5313, MCH – 35 - MLB
- JH – 31048, JH – 31053 - BSDM
- JH – 3155, and JH – 3978 - MLB and BSDM.

In IET extra-early maturity the resistant genotypes identified

- FH – 3358 - MLB and Rust
- FH – 3356 - PFSR

In AET Late-season maturity trials, promising resistant genotypes identified

- NAH – 2049 - SDM, RDM, BSDM, PFSR and rust
- JH – 11024 - MLB, TLB and rust
- MS Pool – C 7; X - 4010 - ESR
- Pro – 368 - C. rust and P. rust.

In AET medium maturity the promising resistant genotypes identified

- EH – 1561, EH – 1753, PH – 48007 - TLB, BSDM and rust
- R 2005 – 4, L – 173, and CHH – 227 - BSDM
- CHH – 219, HKH – 118 - PFSR
- X 9409, MCH – 30, HKH 119 - C. rust and P. rust.
- MH – 05 -2 was - MLB
- MH – 05 – 3 - TLB

In Early maturity resistant genotypes identified

- FH-3311 - C. rust and P. rust.
- X-11502 - ESR and C. rust and P. rust.

In Extra early maturity the resistant genotype identified

- FH-3245 - MLB, TLB and C & P. rust
- FH-3288 - MLB and BSDM
- FH-3294 - TLB, BSDM, C & P. rust
- JH-31050 - BSDM and PFSR
- WC-236 (Y) - BSDM and PFSR.

In QPM-1 promising genotypes identified

- EC-3152 (Q), MHQPM 05-9, HQPM-8 and HQPM-9 - TLB, C & P. rust
- HQPM 11 - TLB
- HQPM-12 - C. rust and P. rust.

In QPM-2 promising genotype identified

- JHQPM-41, HQPM-6, HQPM-7
  DQPM C 4 (W), JHQPM-41, JHQPM-159, HQPM-4 - MLB
- DMR QPM-03-102x0-## x DMR QPM-18-x0-x0 - ## - P. rust.

ICAR-CIMMYT Collaborative Programme

Eighty six maize genotypes were evaluated at 4 hot spot locations i.e. Hyderabad, Udaipur, Ludhiana and Delhi against PFSR in "Synthesis of gene pools and improvement of inbred lines resistant to PFSR" programme. Out of them five entries were found resistant PFSR at all the four locations. Seven resistant pools against PFSR are being maintained.

Rabi 2006-07

During Rabi 2006-07, various maize genotypes were screened and evaluated against TLB, SDM, C. rust and PFSR in various coordinated trials in different centers under artificial epiphytotic condition. In IET trials full season maturity, the genotypes JH 8223, JH-8266, JH-8323, JH-8456, PM-107 and K-50 were identified as resistant to TLB and C. rust Whereas JH-8280 was resistant to PFSR and C. rust.

In IET trial 2-3, medium maturity genotypes HKH-1602 showed resistant to TLB and C. rust, Whereas BH-40638 and BISCO-955 were resistant to C. rust. In IET trial 4 to TLB and C. rust Whereas X- 4A 146 was resistant PFSR. Genotypes JH-8099, JH-8185 and BULAND (C) were resistant to C. rust. In AET Ist year (Trial 5-6) genotypes BIO-9637 (C) and HKH-1237 were resistant to C. rust. Only genotype PHS-90 (w) SMH-4005 was resistant to TLB and PFSR.

In QPM evaluation programme HQPM-5 and HQPM-7 were showed resistant reaction to PFSR. In synthesis and development of maize lines to PFSR Hyderabad, 55 lines were found resistant for PFSR. In screening of maize inbred lines against TLB at Nagenahalli 59 lines were found resistant for TLB. In evaluation of three way cross maize hybrid against TLB at Nagenahalli, 52 hybrids were found resistant to TLB. In Sweet Corn evaluation programme, orange sweet corn, VL-15, ZA WIN Yellow Sweet Corn, JC-1 Sweet Corn and Mysore Sweet Corn were found resistant to TLB at Nagenahalli. In case of Baby Corn, Mahikanchan, FH-3161, HIM-129, NBC (White)-1, NBC (Yellow)-2, Nithya Shree showed resistant reaction against TLB at Nagenahalli.

Management of post-flowering stalk rots of maize through host resistance and other direct control methods

- **Management of post-flowering stalk rots of maize through host resistance and other direct control**

A field trial was conducted to study the efficacy of different level of potash for the management of PFSR in field and following results were obtained;

1. The higher dose of potash (80 kg/ha) showed 50.7 and 47.6 percent reduction in PFSR incidence; 23.1 and 38.1 percent increase in yield in Navjot and Pro 311, respectively over control when applied at knee high.
2. 62.2 And 76.1 percent reduction in PFSR incidence; 21.5 and 37.8 percent increase in yield when higher dose (80 kg/ha) applied in two split (½ dose at basal and ½ at knee high stage) in Navjot and pro 311 respectively over control.

Based on the work done, the integrated management modules for PFSR was developed

1. Avoid water stress condition
2. Crop rotation
3. Planting in row
4. Planting resistant cultivars
5. In stalk rot affected field, balance soil fertility specially increasing the potash level up to 80 kg/ha help in minimising the disease.
6. Use Trichoderma formulation in furrows after mixing with FYM @ 10g/kg FYM (1kg/100 kg FYM/acre) at least 10 days before its use in the field in moist condition.
7. Seed treatment with carbendazim 50WP @2.5g/kg seed can reduce disease

Table – 2 Efficacy of different level of potash for the management of PFSR

	Navjot					Pro 311		
Treatments	**Disease-rating (1-9)***	**%decrease disease**	**Yield q/ha***	**% increase in yield**	**Disease rating (1-9)***	**% decrease disease**	**Yield q/ha***	**% increase yield**
Potash - 0	6.5	-	2333.5	-	6.3	-	2420.0	-
Potash - 40	4.7	27.6	2798.0	19.9	3.7	41.2	2591.5	7.0
Potash - 80	3.2	50.7	2874.5	23.1	3.3	47.6	3342.5	38.1
Potash - 120	2.7	58.4	2898.7	24.2	2.5	60.3	3268.5	35.0
½ of total dose of Potash applied as basal + ½ of total dose applied at knee high stage								
Potash - 40	2.7	58.4	2662.0	14.0	2.5	60.3	2599.2	7.4
Potash - 80	2.0	69.2	2836.2	21.5	1.5	76.1	3297.5	37.8
Potash - 120	2.0	69.2	2852.7	22.2	2.6	58.7	3301.5	36.4
C.D. at 5 %	1.28		292.8		1.3		134.1	

- 62.2 And 76.1 percent reduction in PFSR incidence; 21.5 and 37.8 percent increase in yield when higher dose (80 kg/ha) applied at ½ dose at basal and ½ at knee high stage in Navjot and pro 311 respectively over control.

• Management of microbial spoilage of stored maize grains.

1. The fungal genera namely, *Fusarium* spp, *Aspergillus flavus*, A. *niger* were found associated predominantly with maize grains.
2. *A.niger* was found associated with only 11 genotypes, after 3 months storage period. After 6 months storage period, *A. flavus* was found associated with all genotypes. Whereas *Fusarium* spp, *A. niger* and *Penicillium* sp. were found associated with 12, 13 and 5, respectively.
3. Maximum microbial load was observed in genotypes KMH – 1701, Him – 129, pro 311, X- 3342, RP – 1, RP – 3 etc.
4. Minimum microbial load was observed in Shaktiman – 1, Shaktiman – 4, QPM – 2-136 KH – 510

Quality parameter of 14 healthy different maize genotypes under normal storage for different periodic intervals was studied.

1. Grain moisture percent exhibited a decreasing trend whereas 100 grain weight and starch percent were in increasing trends.
2. The protein percent was found in decreasing trends in the genotype with low microbial load and showed negative reaction for mycotoxin contamination whereas the genotypes having high microbial load and positive reaction mycotoxin contamination showed the increasing trend in protein percent
3. Tryptophan percent was observed in decreasing trends in all the genotypes.
4. Shaktiman – 1, Shaktiman – 4, and KMH – 1701 were found promising by showing negative reaction for mycotoxin production at 12.0 and 11.4 percent moisture level.
5. Genotypes Him – 129, RP – 3 and RP – 4 showed negative reactions for mycotoxin production only after 3 months and 6 months stored time.

Study of morphological resistance traits.

1. The vertical sections from grains of four maize genotypes i.e. Shaktiman 1, Pro 311(hybrid), Navjot and Priya Sweet (composits) were observed, seed coat and Aleurone layer were measured.
2. The thickness was maximum (90-100m) in Shaktiman 1 followed by Pro 311 (90-95m), Navjot (80- 90m) and Sweet corn (60-80m).
3. Shaktiman 1 was found promising one as showed the negative reaction for mycotoxin contamination and having maximum thickness.

Development of suitable management strategies to minimize the microbial spoilage in post-harvest stage in maize grains.

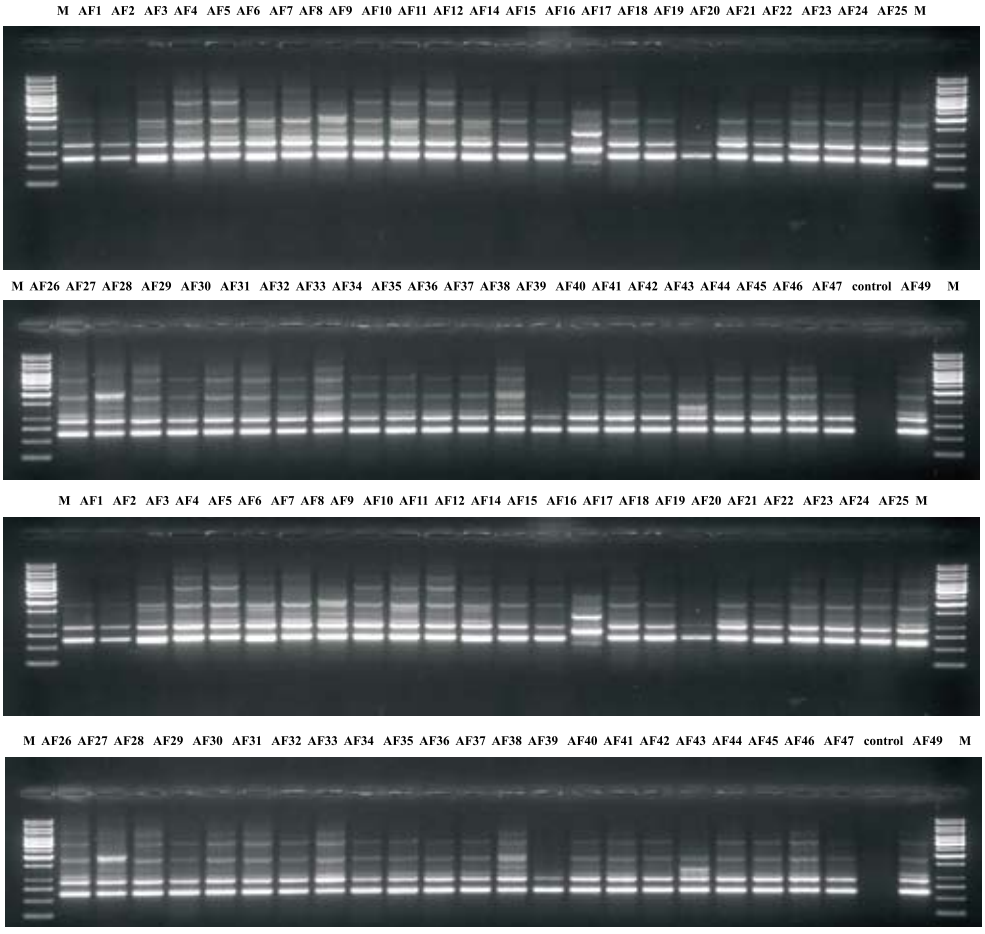
For management of aflatoxin a trial was planted on 27.08.2006. In this trial we take five varieties viz., salts -1, HM-4, 900M, bio9681 and BH-2187, four inorganic salts i.e., sodium carbonate, sodium bicarbonate, Potassium carbonate, Ammonium carbonate and three biocontrol agents namely one isolate of *Trichoderma harzianum* and two isolate of *Aspergillus niger*. The isolation of microflora and quality parameter study will be done at three months intervals for one year. Further studies are in progress.

Network project Prevention and management of Mycotoxin in Agriculturally important commodities

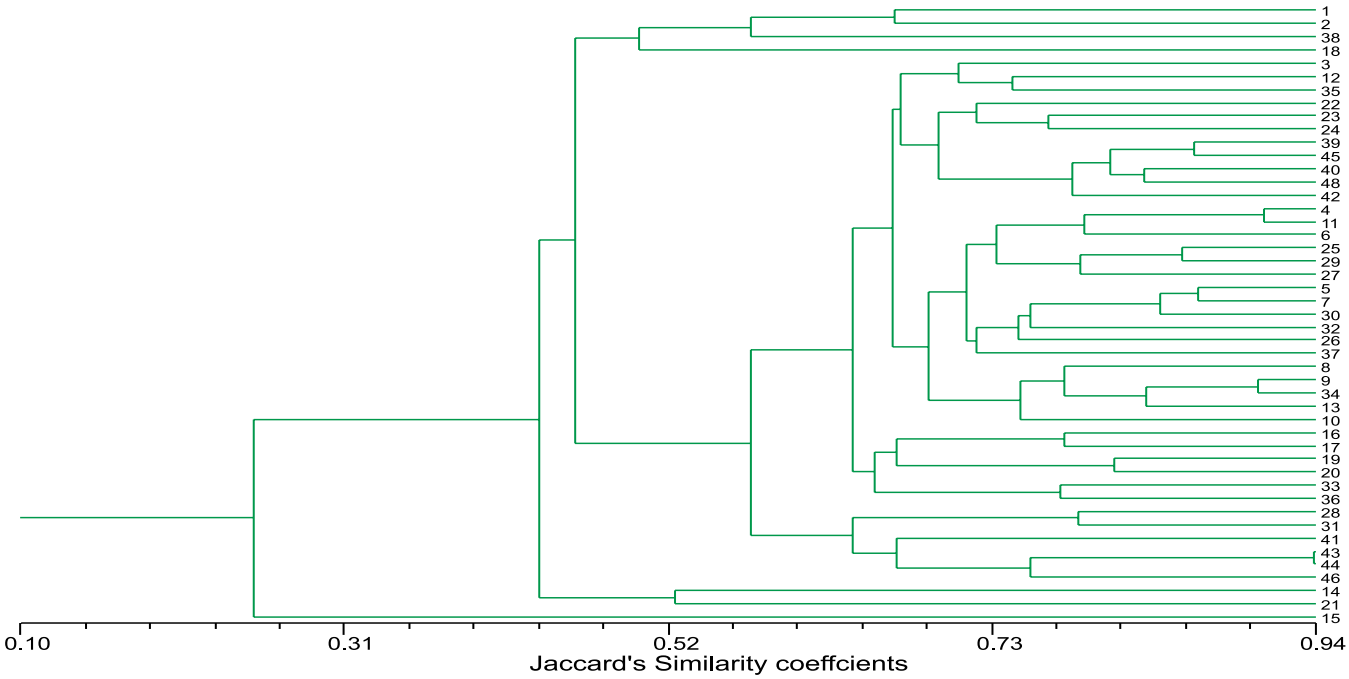
1. Pro-311 was found most suceptible whereas Priya sweet corn and Navjot showed some degree of tolerance to mycotoxin contamination.
2. The most promising genotypes identified on the basis of level of mycotoxin contamination were Shaktiman – 4 (0.30 ppb) followed by KMH – 1701 (0.40 ppb); HQPM – 1 (0.50 ppb); and QPM – 2 – 136 (0.60 ppb) whereas the highly toxic samples was Mon- 4 (62.42 ppb) at moisture % ranged from 12.6 to 11.1

Molecular characterization of Aspergillus flavus strains

Random Amplified Polymorphic DNA analysis of aflatoxin producing and non-producing strains was carried out for their polymorphism by RAPD markers thirty five OPERON random primers tested and only eleven gave reproducible amplification. Majority of strains fall into five major clusters, seventeen strains comprised of cluster 2, showed maximum similarity of 68 per cent among them and which was further sub divided into three sub clusters. Sub cluster 2.3was comprised of five strains including highly toxic strain AF-08, moderately toxic AF-09 and AF-10. Sub cluster 2.1 (includes six strains) also had moderately toxic strain AF-04. Cluster 1 was comprised of eleven strains which were further sub grouped into three sub clusters. Sub cluster 1.1 (includes three strains) had moderately toxic strain AF-12. All the strains in cluster 1 showed 67 per cent similarity among themselves, while that of cluster 3 was 65 per cent. Sub cluster 3.3 comprised of two strains included highly toxic AF-21. Five strains grouped to form cluster 4 with 63 per cent similarity among them, and further divided into three sub clusters. Cluster 5 had two highly toxic strains AF-15 and AF-22 with 53 per cent similarity between them. Strains AF-16 (highly toxic), AF-2 (less toxic), AF-19 (moderately toxic) and AF-39 were out grouped. Thus a fingerprinting profile of 47 strains had developed for their identification and further amplification with 65 primers is continuing with above strains of *A. flavus*.



Amplification of fifty strains of A. Flavus with RAPD primers ODS-12 (a) and OPP-2(b)



1-12 are strains AF-1 to AF-12, 13-46 are strains AF-14 to AF-47and 48 is AF-49

Fig. 3 Dendrogram showing genetic relationship of 50 strains of A. flavus

Screening of germplasms for resistance to aflatoxin contamination in field crop.

The maximum % of mean disease index i.e. 6.15 and 9.20 of *A. flavus* and *F. moniliforme* was recorded from Pro 311. How ever Shaktiman showed some degree of tolerance against both the pathogens and exhibited only 2.11 and 3.94 % mean disease index of A. flavus and F. moniliforme, respectively.

Table 3: Percent disease index of Pre-harvest mycotoxin trial during Kharif 2006

Variety (Treatment)	% disease index (Cob Rot)							
	Inoculated with *Aspergillus*	Inoculated with *Fusarium*	Inoculated with Aspergillus + *Fusarium*		Uninoculated		Mean	
Shaktiman-1	2.10	3.78	2.8	4.10	-	-	2.11	3.94
Madhuri	4.18	6.25	6.25	5.50	-	-	3.69	5.87
Navjot	2.90	1.85	1.85	5.0	-	-	3.02	3.42
Pro-311	8.10	9.85	9.85	8.55	-	-	6.15	9.20

F =Fusarium moniliforme

A = Aspergillus flavus

Study of morphological resistance traits.

Transverse sections of maize kernels of different maize genotypes were studied under compound microscope. Seed coat and Aleurone layers of these genotypes were measured to correlate the thickness of seed coat with aflatoxin accumulation. The transverse sections of grains of four maize genotypes i.e. Shaktiman 1(QPM), Pro 311(hybrid), Navjot and Priya Sweet (composites) were observed and seed coat and Aleurone layer were measured. The maximum thickness was (90-100m) in Shaktiman 1 followed by Pro 311 (90-95m), Navjot (80- 90m) and Sweet corn (60-80m). (Fig.3). In case of TLC analysis Shaktiman 1 showed the negative reaction also showed minimum concentration of AFB1 (0.30 ppb). The genotype Shaktiman 1 also showed minimum (0.46%) disease index of cob rot caused by A. flavus in artificial inoculation condition in field.

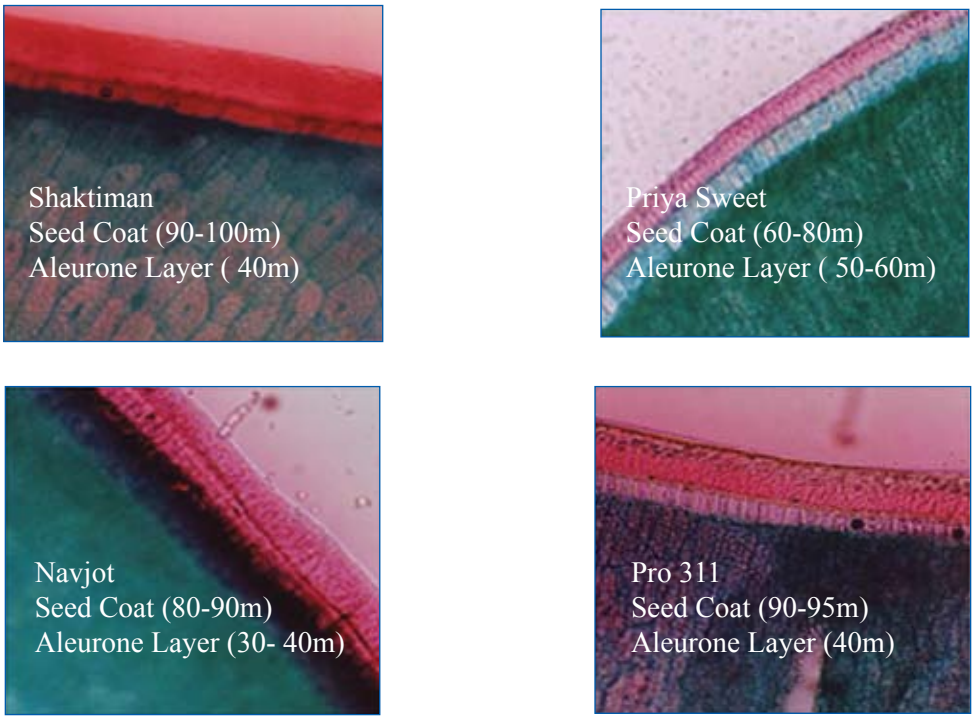


Fig. 4 T.S. of maize genotypes showing the thickness of Seed coat and Aleurone layer

Network Project on Gene Pyramiding; Pyramiding Genes for Resistance to Turcicum LeafBlight and Polysora Rust in Maize. (DMR, Genetics Div. IARI, VIPKAS Almora) & ARS, Nagenahalli.

- Donors for TLB resistance identified were V341, NAI 112, NAI 155 & NAI 127 and for P. Rust NAI 117, NAI 124, & NAI 167 were selected and are being used in crossing programme.
- Sixty-three experimental crosses were generated using nine resistant parents and seven susceptible elite parents. NAI112 identified as resistant donor to both the isolates of TLB and also to polysora rust. Out of these 63 crosses 18 crosses were selected after molecular marker assisted selection using SSR markers.
- DNA polymorphism of genotypes generated in BC1 F1 was carried out.

- **Assessment of vulnerability of crop yields to pest damage in global climate change. (Division of Environmental Science and DMR).**

➢ Four pathogenic isolates of R. solani causal organism of Banded leaf and sheath blight, viz. RS-1 (Barapani), RS-7 (Delhi), RS-47 (Udaipur) and RS-51 (Dholi) were pathogenic at temperature 8.8^{0}C (Min.) to 25^{0}C (Max.). The disease progress was restricted due to low temperature. None of the isolates produced sclerotia indicating poor epidemiological competence at low temperature. Among the four isolates, Udaipur and Dholi were more aggressive with larger lesion size (3.5 cm) at low temperature range (Max. 25^{0}C and Min. 8.8^{0}C) compared to Delhi and Barapani.

➢ Among the four pathogenic isolates, Barapani isolate was most prolific with regard to growth and sclerotial production at 25^{0}C and 90% RH, while Udaipur isolates exhibited least growth at temperatures 15^{0}C, 20^{0}C, 25^{0}C, 30^{0}C and 35^{0}C. Dholi isolate produced no sclerotia at all the temperature ranges tested.

Nematology

Two hundred thirty maize entries were screened against cyst nematode. *Heterodera zeae.* Maize entries viz. DMR-491, DMR-421, DMR-440, DMR-319, DMR-331, DMR-810, DMR-811, DMR-854, DMR-873 and DMR-907 exhibited moderately resistant reaction.

To study the distribution of maize cyst nematode, soil and root samples were collected from maize growing areas of Udaipur, Chittorgarh, Bhilwara and Rajsamand district of Rajasthan. Apart from these three samples received from Gujrat, and Uttarakhand. Survey results showed that maximum occurrence (81.25%) of H. zeae was observed from Rajsamand followed by Udaipur (72.00%) and Bhilwara (71.43%) district of Rajasthan. Maize cyst nematode was noticed in both the samples received from Godhra (Gujarat) whereas it was not observed from Almora (Uttarakhand) sample. Maximum average nematode population was recorded from Rajsamand samples i.e. 15.23 cyst/plant, 10.85 cysts and 850.80 larvae/100 cc soil.

BIOCHEMISTRY AND QUALITY

1. Value Addition in Quality Protein Maize (QPMt)

To increase the popularity of QPM as food it is essential to process it into different value added food products which may be nutritionally superior, commonly accepted and have better shelf life for house hold purpose. To this end, one QPM Shakti 1 and one normal maize varieties i.e. Navjot have been processed traditionally into their value added food products and evaluated for their nutritional quality.

2. Milling and Processing of QPM.

Both QPM and normal maize varieties produced maximum coarse dalia followed by grits and maida (Table-1) The recovery of fine dalia, processed flour and maida was more in QPM than normal maize. The recovery of coarse dalia was 19% more in normal maize. These differences may be due to hardness of normal maize than QPM.

3. Study of Zein and Non –Zein, Protein Components, in Different Milling Products.

Zein content was found less in all the milling products of QPM including whole kernels when compared with their respective normal maize version (Table – 2). This trend was just reverse in the case of non-zein in each of the above products/samples. Low value of non-zzein / zein ratio which represent vitreous ness and hardness was found higher in all products and whole kernels of QPM when compared with their respective normal maize version. These higher values of non-zein/ zein ratio in QPM than normal maize products/ samples clearly showed softness than their respective normal version.

Table 1: Percentage recovery upon processing of quality protein maize and normal maize (g)

Processed Products	Quality Protein Maize (Shakti-1)	Normal Maize (Navjot)
Grits	25.45	25.64
Coarse dalia	37.37	44.61
Fine dalia	7.51	3.24
Processed flour	8.21	6.63
Maida	17.88	14.26
Residue	3.58	5.82
Recovery	99.27	98.71

Table 2: Zein, Non - Zein and their ratio in different processed products in QPM and normal maize

Processed Product	Varieties	Zein (%)	Non - Zein (%)	Ratio Of Non Zein/Zein
Whole Kernel	QPM	44.44	55.56	1.25
	Normal	57.78	42.22	0.73
Grits	QPM	46.07	53.93	1.17
	Normal	78.88	21.12	0.27
Coarse Dalia	QPM	46.34	53.67	1.16
	Normal	79.27	20.73	0.26
Fine Dalia	QPM	24.88	75.12	3.02
	Normal	68.63	31.37	0.46
Processed Flour	QPM	27.98	72.02	2.57
	Normal	52.24	47.76	0.91
Maida	QPM	26.96	73.04	2.71
	Normal	46.30	53.70	1.16

4. Effects of Milling and Processing on Protein, Lysine and Tryptophan Contents in Different Milling Products.

Value of protein and its lysine and tryptophan content are set in Table –3. In general, protein content was observed slightly more in normal maize kernels and their milling products than QPM kernels and their products in both the treatments. Protein content was improved in maida and processed flour after milling. This improvement may be due to the presence of germ fraction. Similarly, lysine and tryptophan contents in both the treatments of QPM were found more in whole kernels and their products than their respective normal counterparts.

Table 3: Protein, Lysine and Tryptophan contents in different maize products of QPM and normal maize

Maize Products	Verities	Protein (%)		Lysine(G/16gn)		Tryptophan(G/16gn)	
		As such	Processed	As such	Processed	As such	Processed
Whole Kernel	QPM	9.87	9.85	3.05	3.18	0.68	0.89
	Normal	11.16	11.95	2.18	2.29	0.37	0.38
Grits	QPM	9.29	9.28	2.99	3.19	0.68	0.91
	Normal	11.14	10.68	1.98	2.77	0.39	0.40
Coarse Dalia	QPM	9.58	9.52	3.09	3.89	0.69	0.71
	Normal	11.30	11.24	2.17	2.38	0.38	0.41
Fine Dalia	QPM	10.06	10.98	3.07	3.76	0.66	0.78

	Normal	10.71	11.14	2.19	2.39	0.39	0.42
Processed flour	QPM	10.76	10.70	3.27	4.01	0.73	0.78
	Normal	12.07	12.42	2.00	2.31	0.49	0.51
Maida	QPM	11.28	11.05	4.17	4.43	0.80	0.83
	Normal	11.86	12.24	2.59	2.83	0.50	0.52

5. *In vitro* Tryptophan availability in different milling products

In both the varieties *in vitro* protein availability improve in all the milling products including whole kernels except **grits** and **coarse dalia** of both the verities and **maida** of QPM only (Table – 4) whereas *in vitro* tryptophan availability improved in all the milling products including whole kernels of QPM. No such improvement was seen in case of normal maize whole kernels and their milling products.

Table 4: In vitro protein and Tryptophan availability in different processed products of QPM and normal maize

Processed Product	Vareities	*In vitro* protein availability (%)		*In vitro* Tryptophan availability (%)	
		As such	Processed	As such	Processed
Whole Kernel	QPM	53.39	57.46	23.53	57.27
	Normal	59.16	63.47	23.08	23.91
Grits	QPM	58.02	58.60	43.00	58.00
	Normal	67.55	67.42	26.67	27.07
Coarse Dalia	QPM	67.85	67.88	34.85	72.06
	Normal	65.50	64.45	31.11	33.33
Fine Dalia	QPM	55.89	62.44	45.00	73.40
	Normal	58.54	65.75	32.50	33.45
Processed Flour	QPM	56.60	60.93	64.56	69.05
	Normal	61.48	65.50	33.65	34.89
Maida	QPM	67.38	65.75	52.22	66.30
	Normal	65.13	71.98	26.56	27.54

6. Sensory Evaluation of 'Dalia'

The sensory evaluation of QPM and wheat based dalia, cooked by traditional method, was carried out by a panel of 12 judges / tasters. Wheat based 'dalia' was used as standard. The change in colour, flavour, texture, taste, appearance and overall acceptability of both types are given in Table -5. Both QPM and wheat based 'dalia', which were overall rated 4.13 and 3.87 respectively, were liked moderately and well accepted. Slightly overall low rating of QPM based 'dalia' was due to the presence of pericarp fraction, which causes stickiness between teeth during chewing. The presence of pericarp fraction in QPM based 'dalia' is responsible for decrease rating in texture. This texture in QPM based 'dalia' may further improve by removing pericarp completely.

7. Evaluation of QPM germplasm for protein quality and a quantity parameters, received from DMR, Delhi center

Germplasm received from different programme of DMR, Delhi center were analyzed for protein & tryptophan. The protein ranged from 7.66% to 14.19% in SLW-HG888-CDHG-3-2-Z-Z-B-B-B-B-B-X CML-142-#-Ä-Ä-Ä and DMR QPM-28-5-Ä-Ä-#-#-# respectively. The quantity of trypotophan in protein were from 0.39 to 0.90% in DMR QPM-28-5-Ä-Ä-#-#-# and SLW–HG888-CDHG-3-2-2-2-B-B-B-B-BXCML-142-#-Ä-Ä-Ä respectively. The germplasm which have 0.7% or more than 0.7% tryptophan in protein have been selected for better quality purpose and those which have 9.0% or more than 9.0% protein have been selected for high protein purpose (Table-6).

Table 5: Sensory Characteristics (Organoleptic Test) of 'Dalia'

Characters	'Dalia' of QPM	'Dalia' of Wheat
Colour	3.83±0.297	4.00± 0.246
Texture	3.58±0.260	4.08±0.166
Flavour	3.67±0.188	4.08±0.235
Taste	4.00±0.123	4.50±0.230
Appearance	4.08±0.166	4.00±0.213
Overall Acceptability	3.83	4.13
Scoring:	Like Extremely-5	
	Like Moderately – 4	
	Neither Like Nor Dislike -3	
	Dislike Moderately- 2	
	Dislike Extremely -1	

Table 6: Evaluation of quality parameters in different QPM germplasm received from DMR, Delhi Centre.

1. Name of The Centre : DMR, Delhi
2. Total Number of Samples Analyzed : 86
3. No. of Selected Samples Reported : 27

S. No	Pedigree	% Protein	Try (g/16g N)
1.	CML-171-⊗-#-#-#	9.88	0.69
2.	DMR QPM-03-124-⊗-#-#	10.73	0.78
3.	DMR QPM-60-#-⊗-#-#	10.45	0.72
4.	DMR QPM-28-3-#-⊗-#-#	11.07	0.72
5.	DMR QPM-58-⊗-⊗-#-5-⊗-⊗-#	11.18	0.70
6.	DMR QPM-58-⊗-⊗-#-#-⊗-⊗-#	10.63	0.77
7.	DMR QPM-58-⊗-⊗-#-12-⊗-⊗-#	11.74	0.71
8.	DMR QPM-58-⊗-⊗-#-13-⊗-⊗-#	9.42	0.84
9.	DMR QPM-58-⊗-⊗-#-16-⊗-⊗-#	10.07	0.76
10.	DMR QPM-58-⊗-⊗-#-26-⊗-⊗-#	10.53	0.69
11.	DMR QPM-58-⊗-⊗-#-34-⊗-⊗-#	9.84	0.83
12.	DMR QPM-58-⊗-⊗-#-36-⊗-⊗-#	10.58	0.71
13.	DMR QPM-60-#-#-⊗-#-1-⊗-⊗-1	10.02	0.71
14.	DMR QPM-53-#-#-⊗-1-#-⊗-#	11.32	0.75
15.	DMR QPM-53-#-#-⊗-9-#-⊗-⊗-#	10.62	0.73
16.	DMR QPM-53-#-#-⊗-10-#-⊗-⊗-#	11.09	0.73
17.	DMR QPM-03-111-#-8-⊗-⊗-#	10.02	0.83
18.	DMR QPM-03-112-#-11-⊗-#	9.24	0.77
19.	DMR QPM-03-112-#-19-⊗-⊗-#	9.42	0.75
20.	DMR QPM-03-115-#-11-⊗-⊗-#	8.80	0.80
21.	DMR QPM-03-118-#-3-⊗-⊗-#	9.33	0.72
22.	DMR QPM-03-118-#-31-⊗-⊗-#	9.33	0.74
23.	DMR QPM-03-103-#-3-⊗-⊗-#	9.05	0.72
24.	CML-8-P-21-HC218-XCML-56624TSR-BBBBBXCML-142-#-⊗-⊗	9.88	0.74
25.	SO/SN Comp Bulk-#-SN3-cc bulk 75%-#-#-#-#-#-#-#	70.62	0.72
26.	Shakti	10.51	0.81
27.	DMR QPM-St-II inbred lines-#-#	10.58	0.70

8. Evaluation of QPM Germplasm for protein quality and quantity parameters, received from Uchani, Karnal Centre

Germplasm received from **Uchani, Karnal centre** of different programme, were analyzed for protein & tryptophan. The protein ranged from 8.12 to 12.98 in 164D-3-3 and SHAHA PALAN-Y-3. The trypotophan in proteins were 0.33 and 0.84% in 3-4-8-5 ER, and 164-7-2-1 respectively. The germplasm which have 0.7% or more than 0.7% tryptophan in protein have been selected for better quality purpose and those germplasm which have 9.0% or more than 9.0% protein have been selected for high protein purpose (Table-7).

Table 7: Evaluation of Quality Parameters In Different Qpm Germplasm Received From Uchani, Karnal Centre.

1. Name of The Centre : Uchani, Karnal
2. Total Number of Samples Analyzed : 98
3. No. of Selected Samples Reported : 34

S. No	Pedigree	% Protein	Try (G/16g N)
1.	139-3(1-3)x 35-1d-5	11.00	0.62
2.	139x35x35	10.49	0.69
3.	14-1(1+2+3)	9.74	0.64
4.	14-1(1+2+3+8+9+10)	11.14	0.64
5.	164-4-(1-3)	10.72	0.68
6.	164-4-(1-3)-1	9.51	0.61
7.	164-4-(1-3)-2	9.84	0.74
8.	164-7-2	9.46	0.82
9.	164-7-2-2	9.36	0.67
10.	164-7-3	9.51	0.64
11.	164-7-4	9.33	0.70
12.	164-7-6	10.39	0.67
13.	164-7-7	9.47	0.69
14.	164-d-3-3	10.48	0.75
15.	164-d-3-3-2	10.40	0.79
16.	164-tb-3-4-7	11.09	0.67
17.	170-(1+2)	10.58	0.76

18.	170 (1-1)	9.88	0.64
19.	193-2	10.16	0.67
20.	193-2-1	10.02	0.68
21.	193-2-2	10.63	0.68
22.	194-2	9.24	0.79
23.	194-2 Er 3	11.04	0.62
24.	194-6	9.10	0.62
25.	194-7	9.46	0.64
26.	27-3-1	11.46	0.63
27.	28 (3+4) 1a	10.17	0.72
28.	31-2	9.74	0.65
29.	33-5-2-(1+2)	10.35	0.67
30.	33-5-2 (1+2) Wg	9.19	0.76
31.	34-(1+2)-1	9.28	0.71
32.	368-3-1x36-2	12.14	0.63
33.	368-4-2-(1-6)	11.00	0.64
34.	1508 Er 2	10.86	0.60

9. Evaluation for high oil inbred lines

The oil content of 13 inbred lines received from **Uchani- Karnal** and 4 inbred lines received from DMR, were determined and given in Table-8. The % oil on dry weight basis ranged from 3.80 to 6.20 in Taller and Temp X Trop high oil QPM 14-#-⊗-4-#-⊗-⊗ respectively. The germplasm which have more than 6% oil content were recorded only in two lines of DMR and one line from **Uchani Karnal.**

Table 8: Evaluation of oil content in maize inbred lines

Centre	Total Number of Sample Analysed	Pedigree	Oil more than 6%
DMR Hydrabad R – 2005	13	Temp X Trop High Oil Qpm 14 -#-⊗-4-#-⊗-⊗	6.20
		Temp-⊗ Hoc 15 # # ⊗-⊗-⊗-#	6.11
Uchani Karnal - 2005	4	Tall-1-2-1g	6.05

10. Evaluation of Waxyness

Waxy germplasm should have nearly 100% amylopectin. Out of 5 germplasm, which were evaluated, only one germplasm (Waxy- corn –(x)-(x)-(x)-II) carries 93.17% amylopactin (Table-9).

Table 9: Evaluation of waxy lines on dry weight basis (%)

Centre	Pedigree	Starch (%db)	Amylose in starch	Amyloprotein in starch
Dmr Hydrabad – 2005	Kisan WAÄy WY 2 –1-6-B-B-A-⊗-47-#-⊗-⊗-⊗-⊗-#	65.89	23.25	76.75
	WAÄy Corn Composite -# -3-⊗-⊗-⊗-⊗-#	65.66	28.68	71.32
	Waxy Corn –⊗-⊗-⊗-#	68.49	6.83	93.17
	Sukhothai –1- Waxy-⊗-⊗-⊗-#	68.05	13.78	86.22
	Waxyness	63.63	40.99	59.01

11. Evaluation of sweet corn germplasm

Seventeen lines of sweet corn were evaluated for total sugar content. The % sugar ranged from 4.59 to 19.44 in Masmandu (sh2 sh2)-⊗-⊗-⊗ X (sh2 sh2)-⊗-⊗-⊗ and Nam Pung (Su. Su)-⊗-⊗-⊗ X POP A (S) CO (SH2 SH2)-⊗-⊗-⊗ respectively. More than 14% sugar content were observed only in four lines (Table 9).

Table 10 : Evaluation of Sweet Corn Germplasm for Total Sugar Content on Dry Weight Basis

PEDIGREE	SUGAR (%DB)
bt- gene C7 (bt1bt1)-⊗-⊗-⊗-X-MAISMADU (sh2sh2)-⊗-⊗-⊗	4.80
MAISMADU (sh2sh2) –⊗-⊗-⊗-X- MAISMADU (sh2sh2)-⊗-⊗-⊗	4.59
MAISMADU (sh2sh2) –⊗-⊗-⊗-X- PHIL SUPER SWEET (sh2sh2) –⊗-⊗-⊗	5.19
PHILSUPER SWEET (sh2sh2) -⊗-⊗-⊗-X- NSSW 8904 F4 (sh2sh2)-⊗-⊗-⊗	5.85
NSSW 8904 F4 (sh2sh2) –⊗-⊗-⊗-X- HSSW (HS) C1F3 (sh2sh2) -⊗-⊗-⊗	5.56
HSSW (HS) C1F3 (sh2sh2) –⊗-⊗-⊗ -X- DVLCE AMANILLO (SUSU) –⊗-⊗-⊗	7.50
DVLCE AMANILLO (SU SU) -⊗-⊗-⊗ -X-DVLCE BLANCO (SU SU) -⊗-⊗-⊗	14.18
DVLCE BLANCO (SU SU) –⊗-⊗-⊗-X-BULK MAIZE de PAKIA (SU SU) –⊗-⊗-⊗	15.74
BULK MAIZE de PAKIA (SU SU) –⊗-⊗-⊗ -X- SYNTHATIC SWEET CORN (sh2sh2) –⊗-⊗-⊗	15.98
SYNTHATIC SWEET CORN (sh2sh2) –⊗-⊗-⊗ -X- NAM PUNG (SU SU) –⊗-⊗-⊗	8.89

NAM PUNG (SU SU) –⊗-⊗-⊗ ⊗ POP A (S) CO (sh2sh2) –⊗-⊗-⊗	19.44
POP A – (S) CO (sh2sh2) –⊗-⊗-⊗ -X- NSS2W 9301 A (sh2sh2) –⊗-⊗-⊗	6.66
NSS2 /W 9301/A (sh2sh2) –⊗-⊗-⊗ ÄSWEET CORN	7.49
SWEET CORN –⊗-⊗-⊗-X-INSEC 1 (K4) –⊗-⊗-⊗	5.58
INSEC 1 (K4) -⊗-⊗-⊗ -X-INSEC 2(K4) –⊗-⊗-⊗	8.05
INSEC 2 (K4) -⊗-⊗-⊗ -X- INSEC (K4) –⊗-⊗-⊗-#	7.88
INSEC – (K4) –⊗-⊗-⊗-#-# -X- bt- gene C7 (bt1 bt1) –⊗-⊗-⊗	7.59

AGRONOMY

Research trials on agronomic management of maize genotypes were conducted both during kharif and rabi seasons under all five zones of the country. Results of multi- location trials on nitrogen x genotype, nitrogen x plant spacing, genotype x plant spacing, fertility management, maize based intercropping and agronomic management of specialty corn are described in this section.

Nitrogen × Genotype trials:

During Kharif, the NxG trials were conducted in all five zones on the entries of different maturity groups. In full season maturity group, NECH 129 was significantly superior over the best check at Karnal, Ludhiana and Pantnagar (Zone II), Baharaich, Jashipur and Varanasi (Zone III) and at Kolhapur, Karimnagar and Arbhavi (Zone IV), while NECH 128 was superior at Udaipur and Chhindwara (Zone IV). In medium maturity group, CHH 219 was significantly superior over best check at Bajaura (Zone I), V33 was superior over best check at Ambikapur and Varanasi and V32 at Varanasi (Zone III) and CHH 218 was best at Kolhapur and Karimnagar (Zone IV).

In early maturity group, the entry BVM 6 out-yielded the best check at Srinagar (Zone I) and X-11502 at Varanasi (Zone III). In extra-early maturity, entry FH 3248 was best at Almora and Bajura (Zone-I), FH 3245 at Baharaich and Jashipur (Zone III). In Zone IV the entry AH 23029 and FH 3288 were significantly superior over best check at Kolhapur and Karimnagar. At Kolhapur the entries BL 110, DEH-107 and BVM-7 also yielded significantly higher than the best check. At Karimnagar, the entries VL-103, VBM-7 and DEH-105 were the high yielding entries with significantly superior performance over best check.

During winter 2006-07, the NxG trials in medium and early season maturity group were conducted at Karnal, Bahraich, Dholi, Hyderabad, Kolhapur, Ludhiana and Banswara. Increasing levels of N had significantly higher grain yield across genotypes and locations with maximum yield under 240 kg N ha^{-1}. Among different genotypes, HKH-1200 was significantly superior over the best check at Dholi and Ludhiana, whereas at Bahraich and Hyderabad PHS-90 (W) SMH-4005, at Karnal AH-24010 and at Kohlapur and Banswara JKMH-702 were significantly superior over the best check.

NxG late season maturity QPM trials were conducted at Karnal, Bahraich, Dholi and Banswara wherein HQPM-4 was compared with Shaktiman-4 (QPM) and Seedtech-2324 (non-QPM). Yield performance of HQPM-4 was significantly superior over the best check (Shaktiman-1) at all the locations. However, the yield performance of non-QPM (Seedtec 2324) was superior than HQPM-4 at Bahriach and Banswara.

Nitrogen × Plant spacing:

During Kharif, the trial on NxS on QPM inbred lines conducted at Ludhiana showed that effect of increasing N was significant on plant height, number of cobs and grain yield per hectare. Spacing has significantly increased all the traits including grain yield but showed nominal effect on female flowering. Among the treatments, N 180 kg/ha at spacing 60×15cm was found the best treatment for all the entries. However, in hybrid trial on NxS, the effect of spacing was non-significant

on hybrid yield, while increasing level of N to 180 kg/ha significantly improved the yield of QPM hybrids, but the effect was non-significant on normal hybrids. At Karnal, the pre-released hybrids were experimented for NxS and the treatment N-200×S-88,888 was found the highest yielding treatment.

Genotype × Plant spacing:

During winter, the trial on GxS on inbreds was conducted at Karnal showed that closer plant spacing resulted in significantly higher grain yield and 70 × 15 cm row x plant spacing resulted in maximum grain yield. Among different inbred lines, HKI-161 had significantly higher yield over rest of the lines.

Fertility trial on hybrids:

Kharif: Pre-release QPM hybrids and normal were grown on different levels of N:P:K fertility at Karnal. The application of N-200: P-80: K-80 was found the best treatment with higher yield with all the entries. Among QPM entries, HQPM-4 was the best entries at all the level of N: P: K fertilization. In normal hybrids HKH-1138 was best at 100:40:40 and 150:60:60, while HKH-1191 was best at 200:80:80.

Winter: Pre-release QPM hybrid trials with varying fertility levels (N:P:K) was carried out at Karnal. Fertility levels brought significant variation in grain yield and though 180: 60: 60 and 210: 70:70 kg N: P_2O_5: K_2O were statistically remained on par with each other had significant yield improvement over 150: 50:50 kg N: P_2O_5: K_2O ha^{-1} irrespective of the entries. Among QPM entries, HQPM-5 and HQPM-3 were on par with each other but had significantly higher yield over rest of the entries (HQPM-1, 4, 6 and 7). In full season pre-release hybrids HKH-1203 was best at all the fertility levels and highest yield of 10.46 t ha^{-1} was recorded at 210:70:70.

Integrated nutrient management (INM) in maize based cropping systems:

During Kharif, the performance of the treatment ½ N + ½ P_2O_5 + ½ Cow dung + K (recommended dose) + Azotobacter + Azospirillum +PSB was found the best yield treatment at Jorhat. At Kangra, the application of 50% chemical fertilizers + 50% FYM was found good management with high yield of maize and *Gobhi* sarson.

During winter, the INM trial on maize based cropping systems conducted at Banswara (maize-wheat and maize-chickpea) and Chhindwara (QPM/sweet corn/baby corn-mustard crop sequences), the yield of winter crops after kharif corn was significantly increased with integrated nutrient management practices. At Banswara, maximum yield of both wheat and chickpea was recorded with INM package of 25 % FYM + 25 % vermicompost + Azotobacter + PSB + 50 % chemical fertilizers. At Chhindwara, the mustard yield under either of treatments of 150 % organic and inorganic was maximum.

Genotype × mulching trial:

The genotype x mulching trial was conducted at Jashipur during winter season. Both genotypes and mulching had significant effect on yield. Among different genotypes, highest yield of Navjot was recorded with straw mulch at 4 days, where as it was maximum with straw mulch at 8 days in Madhuri. Surya had better response to wet seeding wherein the grain yield was highest.

Maize based intercropping systems:

In the kharif, maize based intercropping trial at Banswara the paired row of maize + 3 rows of black gram was found the best yielding intercropping system.

At Udaipur, the intercropping of black gram with maize (2:2) was identified the best treatment with highest maize equivalent yield (48.2 q/ha), which was significantly higher than sole maize yield (30.5 q/ha).

The winter maize based high value intercropping trials were conducted in different zone at Jashipur, Jorhat, Chhindwara, and Bahraich. At Jashipur, sale maize was compared with maize intercropped with cabbage, cauliflower and tomato at varying levels of nitrogen. Increasing levels of N had significant yield advantage. The maize yield was significantly lower under intercrops compared to sole crop but among the intercrops cabbage and cauliflower had equally good compatibility compared to tomato. At Jorhat, among the different intercrops, coriander, amaranthus, fenugreek and peas had better compatibility over rest of the intercrops and highest maize equivalent yield (10.98 t ha^{-1}) was recorded with maize + coriander intercropping system. However, the maize

equivalent yield of all the intercropping systems was significantly higher than sole maize. At Chhindwara, sweet corn intercropped with different cut flowers did not show any significant yield penalty

on cob yield of sweet corn and resulted in additional benefit with cut flowers. Similarly at the same location, sweet corn intercropped with onion in different row geometry also resulted in comparable yield of sweet corn both under sole and intercropping. At Bahraich, maize intercropped with radish and spinach in different row ratio resulted in significant yield variation in maize and the intercrops. Among the intercrops, maize yield was significantly higher when it was intercropped with spinach than radish and for maize yield 1: 1 row ratio was better but for intercrops, 1: 2 ratio was superior.

Baby corn agronomy:

Among the various treatment combinations the higher dose of chemical fertilizer (150% of RF) + 100% of inorganic source was found the highest yielding treatment for baby corn at Ambikapur. In another trial at Arbhavi the 150% organic fertilization alone followed by 125% organic and 62.5% organic + 62.5% inorganic + bio-fertilizer were found the highest yield treatments for baby corn yield. At Chhindwara, again the higher dose of chemical fertilizer (150% of RF) + 100% of inorganic source was found the highest yielding treatment. At Udaipur, the population density of 166 thousand/ha was found the best population at all the level of fertilizer application,

and highest baby corn yield was obtained at recommended dose of N and P. In NxG trial on baby corn at Udaipur the entry Madhuri with 180 kg/ha N was found the highest yielder of baby corn. At Hyderabad, the 150% dose of recommended fertilizer (50% organic and 50% inorganic) was identified the best treatment for baby corn yield.

ABIOTIC STRESSES

In maize physiology program the main focus was on the identification of tolerant source germplasm, stress-adaptive secondary traits and their suitability for including in selection index for improving tolerance to abiotic stresses, including excessive moisture, drought and cold stresses. The experimental details, including germplasm, stress treatments, and salient findings of the experiments are as follows:

(A) EXCESSIVE MOISTURE STRESS:

i) Evaluation of elite maize inbred lines:

A total 175 inbred lines, including the lines from water logging physiology program, DMR, elite lines from Uchani, Pantnagar and Delhi center were planted in field and exposed to excessive moisture stress continuously for seven days at V7-stage (knee-high stage).

Analysis of variance showed that the genotypic variation were highly significant for all the characters under excessive moisture stress (Fig. 1). The stress condition resulted in stunted growth, which was apparent with reduced plant height under stress. Root biomass was another very important trait, which showed the root growth ability of genotype under excessive moisture conditions. The high root biomass in the tolerant genotypes protected the plants from logging, which was severe in the susceptible genotypes. Also, the tolerant entries were able to protect themselves from logging due to increased brace root development in under excessive moisture stress. Excessive moisture stress significantly delayed the ASI, which more pronounced in the susceptible group of genotypes. Apart from morphological effects, the stress condition severely affected biochemical traits, which was apparent

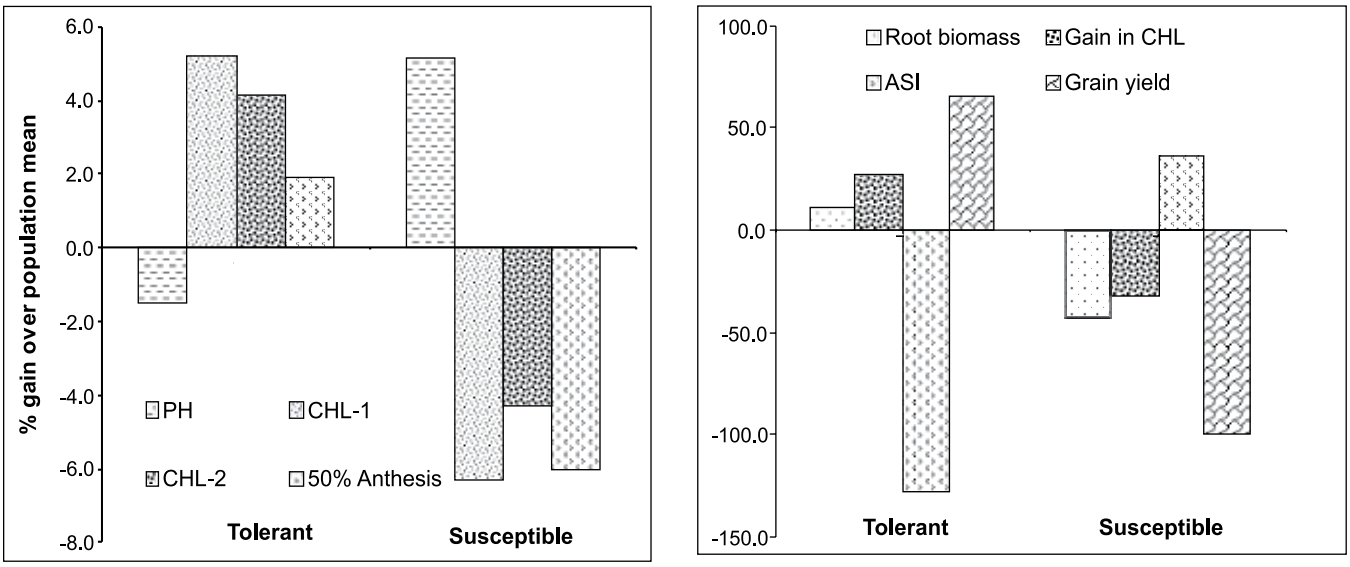


Fig. 1: Deviation (%) of the highly tolerant and susceptible lines from population means for different morpho-physiological traits & grain yield under excessive moisture stress.

with reduced leaf chlorophyll content under excessive moisture conditions. Practically, the leaf yellowing is among the first symptom of excessive moisture stress on maize plants. The overall impact of excessive moisture on various growth, physiological and biochemical traits eventually affected the final grain yield under stress. Stress conditions severely affected the grain yield; however, excellent genotypic variability was observed, which ranges from 2.24 - 0.00 t/ha, and the losses due to stress ranges from 16.5 - 100.0%.

ii) Performance of single cross hybrids:

A total 59 hybrids including the F1 progenies developed by crossing the water logging tolerant lines, drought tolerant lines, and single cross hybrids from CSS HAU, Karnal were evaluated under normal and excessive moisture stresses. Planting was done in one row plot in two sets with row length 3.0 m and two replicates using ALPHA-lattice design under waterlogging and one replication under normal moisture. One set was maintained under normal moisture and second set was exposed to excessive moisture stress continuously for 10 days at knee-high stage. Excessive moisture stress was applied by flooding the field (water depth 10 cm) continuously for 7 days, starting from 35 DAS (days after sowing *i.e.,* V_7 stage) to 44 DAS. Observations were recorded on various growths, physiological and yield component. The top ranking 15 hybrids with average yield 5.24 t/ha under excessive moisture and 7.51 t/ha under normal moisture were identified as the best hybrids across the moisture regimes. These selected hybrid possess all the stress-adaptive traits, such as brace root, minimum loss of chlorophyll, comparatively less depression in vertical growth, anthesis-silking interval <5.0 days etc. that eventually might have resulted in improved stable yield across moisture regimes. The two key issues, i.e.- loss of chlorophyll during waterlogging and recovery in chlorophyll content one week after release of stress were distinctly different between the tolerant and susceptible group of hybrids.

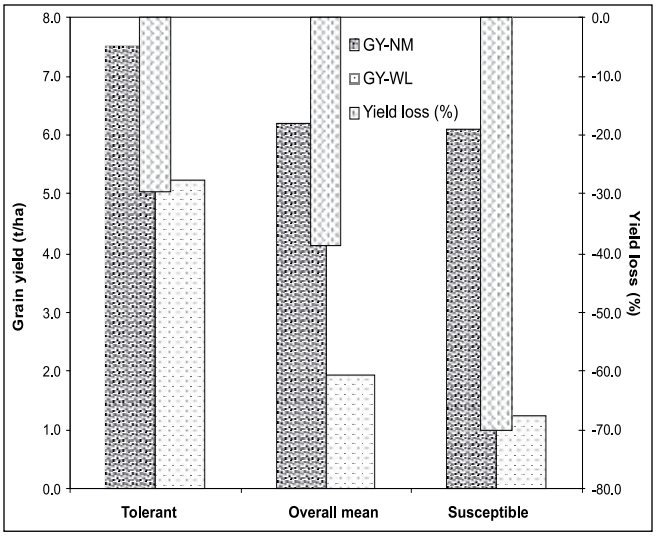


Fig. 2: Grain yield of the selected highly tolerant and susceptible hybrids & % loss in grain yield under excessive moisture stress.

The stress condition was relatively more pronounced on recovery ability, where the tolerant hybrids showed faster and higher recovery. Stress-induced reduction in plant and ear heights was also distinct between best and worst group of hybrids. At reproductive stage, the stress condition showed negative effects on both the time male and female flowering. However, the effect was comparatively more pronounced on female flowering, and that largely contributed towards prolonged anthesis-silking interval, particularly in susceptible group of entries. The overall effects of excessive moisture on various secondary traits eventually resulted in strong genotypic variability in yield attributes and finally on grain yield under stress.

iii) Relationship between line per se & hybrid performance:

A total of 12 elite maize inbred lines were selected from the line evaluation trials during past three years to identify the tolerant sources of germplasm for EM-stress. Out of total 12 inbred lines identified for the present study, 3 belong to highly susceptible, 3 moderately

tolerant and 6 lines were highly tolerant to EM-stress. The 12 lines were crossed in all possible combination (66 hybrid combinations). The F1 progenies and their parents were evaluated separately in trials under either normal or excessive moisture conditions using alpha (0, 1) lattice design. Data showed that under normal moisture the contribution of mid-parent heterosis was comparatively much higher (R^2 = 0.62**) than mid-parent yield (R^2 = 0.24*). However, under EM-stress the trend was just opposite, i.e. - correlation of hybrid yield was comparatively stronger with mid-parent yields (R^2 = 0.64**) than mid-parent heterosis (R^2 = 0.29*). Analysis of correlation between performance of genotypes under excessive moisture and normal condition (Fig.3) indicated that it was significant with hybrids (R^2 = 0.36*). However, the relationship between performance of mid-parents at the two level of moisture supply was poor (R^2 = 0.04). Large number of inbred progenies performed well under normal moisture regime but their performance under EM-stress was very poor with a yield level below the mean yield of the trial under EM-stress (1.19 t ha^{-1}).

Phenotypic correlation and linear regression analysis between hybrid and mid-parent yields (Fig.5)

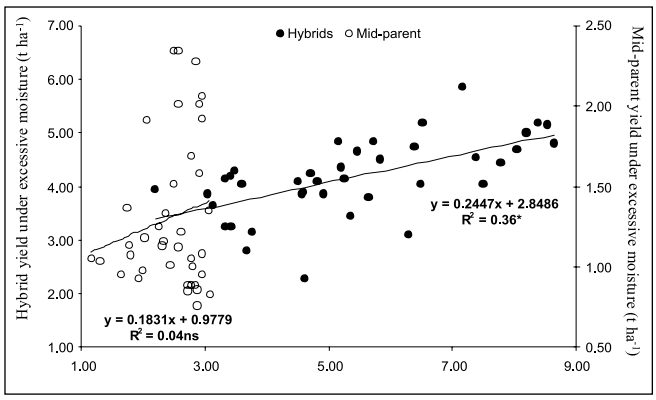
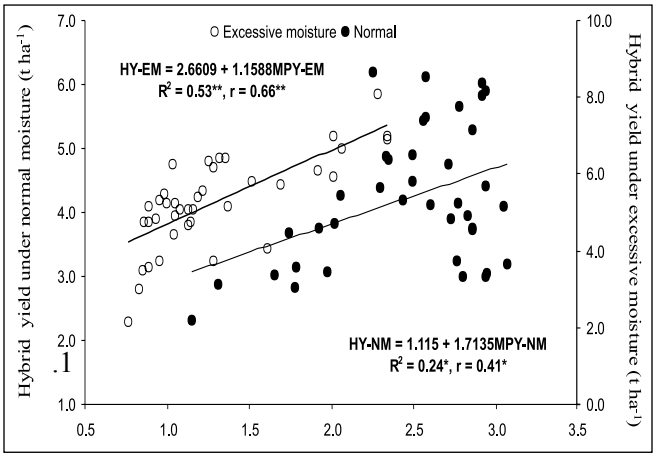


Fig. 3: Relationship between grain yield of hybrids and mid-parent under normal and excessive moisture conditions (* indicates significant differences at P<0.05; ns indicate non-significant)

showed strong and significant relationship under EM-stress (r = 0.66**, R^2 = 0.53**). Under normal moisture also the relationship was statistically significant, though it was comparatively weak (r = 0.41*, R^2 = 0.24*).



Mid-parent yield under normal and excessive moisture (t ha^{-1})

Fig. 4: Relationship between grain yield of hybrids and mid-parent under normal and excessive moisture conditions (* indicates significant differences at P<0.05; ns indicate non-significant)

Our findings suggest that advance generation elite inbred lines, systematically improved for EM-stress using stress-adaptive heritable traits, might be used to predict the performance of hybrid progenies under excessive moisture/water logging conditions. Selected elite lines for excessive moisture condition with favorable alleles for both normal and excessive moisture can be used to develop hybrids or open pollinated varieties with improved stable yields across the normal and high moisture conditions. However, it may be argued that breeder's major interest will be to know such kind of relationships at early generation of line development. Preliminary screening of early generation, but high performing lines under optimal conditions, derived from unimproved populations can be used to identify the lines with favorable allele for excessive moisture, and can be further improved simultaneously for both normal and excessive moisture using stress-adaptive heritable

traits. The promising mid- to advance generation lines with proven performance across the normal and excessive moisture conditions may hopefully be useful for development of hybrid or synthetic progenies with improved stable performance for the areas prone to face contingent and frequent excessive soil moisture conditions.

(B) DROUGHT TOLERANCE:

a) Screening of inbred lines for flowering stage drought tolerance:

Germplasm evaluation trials for drought tolerance, including 299 lines from early (120), medium (90), late maturity drought lines (64) and water logging lines (25) were planted in Alpha – lattice design at Maize Research Station Amberpet, Hyderabad, India. Planting was done on 29 November 2005 with three replication of each entry in a plot size of one row that was 3.0 meter long. Plants were 0.25 meter apart and rows were spaced at 0.75 meter. The target stage for imposing drought stress was whole reproductive phase, including flowering (both male and female), pollination, fertilization and early grain filling stage (lag phase, which is known to be completely dependent on current assimilate supply). To achieve this, the irrigation was withdrawn about 2 weeks before 50% male flowering till 2 weeks after completion of 50% female flowering.

(i) Early maturity lines:

Analysis of variance for the 120 early maturity lines for drought stress showed that the genotypic variation was statistically significant for all the characters, except for chlorophyll content and days to 50% anthesis. Ears per plant showed highest coefficient of variation followed by leaf senescence score. Performance of most of the lines was highly poor under drought stress. However, selected fraction of best lines was distinctly different from the worst fraction of entries. Comparison of the best and worst entries with mean of the population indicates that the deviation in chlorophyll content in the distinctly different genotypes was nominal from the population mean, i.e. tolerant (+7.5%) and susceptible (-2.7%). Similarly, in case of anthesis also the difference of tolerant and susceptible group of lines was small, i.e.- from -0.98 and +1.11%, respectively. However, in case of other traits the deviation of distinctly tolerant and susceptible genotypes from population mean was remarkable. The senescence was 45.6% less in tolerant lines, while it was 57.9% higher in susceptible lines in comparison to population mean. Similarly, deviation in leaf rolling score was +86.0% in susceptible and -33.6% in case of tolerant genotypes. Though, days to anthesis was least affected under drought stress, but deviation in anthesis-silking interval (ASI) from population mean was +112.7% in susceptible, while it was -77.7% with tolerant group of entries. This indicates that increased under drought stress was due to delayed silking. The distinct differences among various secondary traits eventually resulted in highly significant deviation in yield attributes and grain yield. The average ears per plant was 1.01 in selected tolerant entries, while it was zero in susceptible entries, which eventually resulted in average yield 1.39 t/ha in tolerant entries and the susceptible entries ended with zero yields.

(ii) Medium maturity lines:

A total 90 entries of S_5 lines from c9 of the new drought tolerant population (DTP-white and yellow) from CIMMYT, Mexico along with Indian materials of similar characteristics were screened for mid-season drought stress tolerance. Analysis of variance showed that the genotypic variation was statistically significant for all the characters, except for chlorophyll content and days to 50% anthesis. Ears per plant showed highest coefficient of variation followed by ASI. Performance of large number of lines was poor under drought stress. However, selected fraction of best lines was distinctly

different from the worst fraction of entries. Comparison of the best and worst entries with mean of the population indicates that the deviation in chlorophyll content in the distinctly different genotypes was slightly higher from the population mean, i.e. tolerant (+4.3%) and susceptible (+2.3%). Tolerant group of entries showed tendency of earliness because 50% anthesis was 0.55 and 1.2 days earlier in these entries in comparison to population mean and susceptible group of entries, respectively. However, in case of other traits the deviation of distinctly tolerant and susceptible genotypes from population mean was remarkable. The senescence was 167.9% less in tolerant lines, while it was 46.2% higher in susceptible lines in comparison to population mean. Similarly, deviation in leaf rolling score was +13.1% in susceptible and -24.6% in case of tolerant genotypes. Though, days to anthesis was least affected under drought stress, but deviation in anthesis-silking interval (ASI) from population mean was +59.2% in susceptible, while it was -225.5% with tolerant group of entries. This indicates that increased under drought stress was due to delayed silking. The distinct differences among various secondary traits eventually resulted in highly significant deviation in yield attributes and grain yield. The average ears per plant was 42.0% higher in selected tolerant entries, while it was 239.7% less in susceptible entries in comparison to population mean. Overall variation in genotypes was strongly expressed in terms of extreme variability in final grain yield under drought. Average yield of tolerant group of entries was 1.18 t/ha higher that population mean yield (0.80t/ha), while the susceptible entries ended with zero yield under stress.

(iii) Full-season maturity lines:

A total 64 lines derived from the population La Posta Sequa C7 and Tuxpeno Sequia C8 of CIMMYT, Mexico along with Indian materials of similar characteristics were screened for mid-season drought stress tolerance. Analysis of variance showed that the genotypic variation was statistically significant for all the characters, except for chlorophyll content and days to 50% anthesis. However, selected fraction of best lines was distinctly different from the worst fraction of entries. Ears per plant showed highest coefficient of variation (33.16%) followed by grain yield (23.4%). Comparison of the best and worst entries with mean of the population indicates that the deviation in chlorophyll content in the distinctly different genotypes was nominal. Tolerant group of entries showed tendency of earliness because 50% anthesis was 0.98 and 1.08 days earlier in these entries in comparison to population mean and susceptible group of entries, respectively. However, in case of other traits the deviation of distinctly tolerant and susceptible genotypes from population mean was remarkable. Plant senescence score was 39.1% less in tolerant lines, while it was 50.9% higher in susceptible lines in comparison to population mean. Similarly, deviation in leaf rolling score was +33.2% in susceptible and -64.2% in case of tolerant genotypes. Irrespective of reaction to drought stress, days to anthesis was least affected under drought stress in all the genotypes, but deviation in anthesis-silking interval (ASI) from population mean was +58.7% in susceptible (average ASI 22.8 days), while it was -200.0% with tolerant group of entries (average ASI 3.14 days). This indicates that increased under drought stress was largely due to delayed silking. The distinct variation among various secondary traits eventually resulted in highly significant deviation in yield attributes and grain yield. Average ears per plant were 1.03 in selected tolerant entries, while it was 0.04 in susceptible entries. Overall variation in genotypes was strongly expressed in terms of extreme variability in final grain yield under drought. Average yield of tolerant group of entries was 2.20 t/ha higher that population mean yield (0.91t/ha), while the susceptible entries ended with 30 kg/ha under stress.

(iv) Water-logging tolerant lines:

Analysis of variance for the 25 medium maturity water-logging tolerant lines for drought stress showed that the genotypic variation was statistically significant for all the characters, except for chlorophyll content and days to 50% anthesis (Table-4). Ears per plant showed highest coefficient of variation followed by grain yield under stress. Performance of most of the water logging tolerant lines was fairly good under drought stress (19 lines out of total 25). Comparison of the best and worst entries with mean of the population indicates that the deviation in chlorophyll content in the distinctly different genotypes was nominal from the population mean, i.e. tolerant (+1.56%) and susceptible (-5.24%). Similarly, in case of anthesis also the difference of tolerant and susceptible group of lines was small, i.e. -0.02 and +0.7%, respectively. However, in case of other traits the deviation of tolerant and susceptible genotypes from population mean was remarkable. The senescence was 15.7% less in tolerant lines, while it was 30.1% higher in susceptible lines in comparison to population mean. Similarly, deviation in leaf rolling score was +36.3% in susceptible and -21.9% in case of tolerant genotypes. Though, days to anthesis was least affected under drought stress, but deviation in anthesis-silking interval (ASI) from population mean was +43.7% in susceptible, while it was -32.5% with tolerant group of entries. This indicates that increased under drought stress was due to delayed silking.

ii) Relationship of various secondary traits with grain yield under drought:

Across the germplasm plant senescence score showed significant negative relationship with stress yield (Fig. 5). Enhanced leaf senescence under severe drought

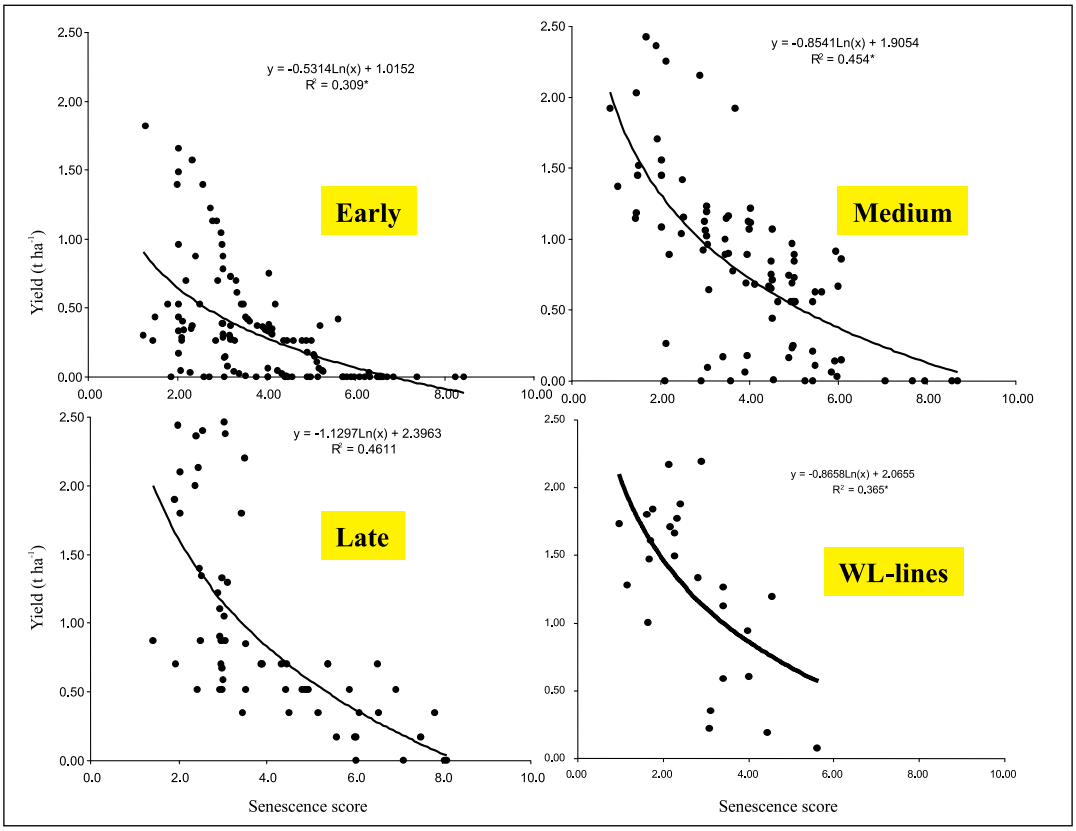


Fig.5: Grain yield as a function of senescence score (1-10) under drought in maize inbred lines exposed to reproductive stage drought stress under field conditions.

results early reduction in actively photosynthesizing leaf area and therefore reduced availability of photo-assimilate for kernel development and eventually reduced grain yield under drought. This finding suggests that stay-green trait is one of the desirable traits for improved yield in maize under drought stress. The relationship was relatively much stronger with medium and late maturity lines drought lines, which might be related to the relatively longer duration of crop cycles, which offer relatively more severe and prolonged stress in these germplasm. Since all the water-logging lines were already selected and improved for stay-green trait under excessive moisture stress, leaf senescence was delayed even in case of susceptible lines to drought, and probably therefore, the relationship was less important.

Leaf rolling score was also found to be negatively and significantly related with final grain yield under drought stress (Fig. 6). The relationship was relatively stronger with medium and late maturity drought lines. Leaf rolling is one the defense mechanisms related to water saving strategies under drought stress. However, being a C_4 crop maize already possess strong water efficient system and in case of extreme water deficit the leaf rolling helps in further saving of water by reducing the exposed leaf area to hot-dry condition and heat load on leaf.

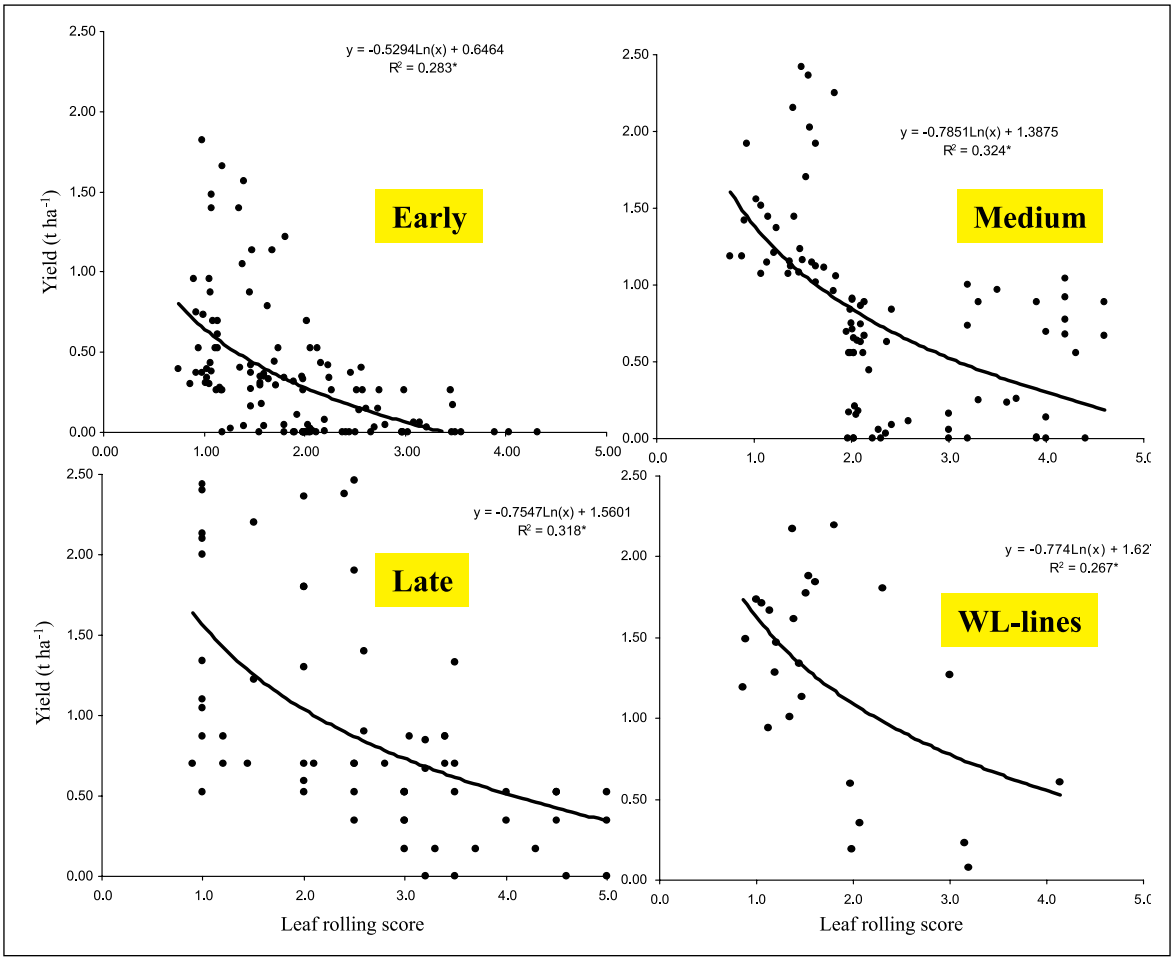


Fig. 6: Grain yield as a function of leaf rolling score (1-5) under drought in maize inbred lines exposed to reproductive stage drought stress under field conditions.

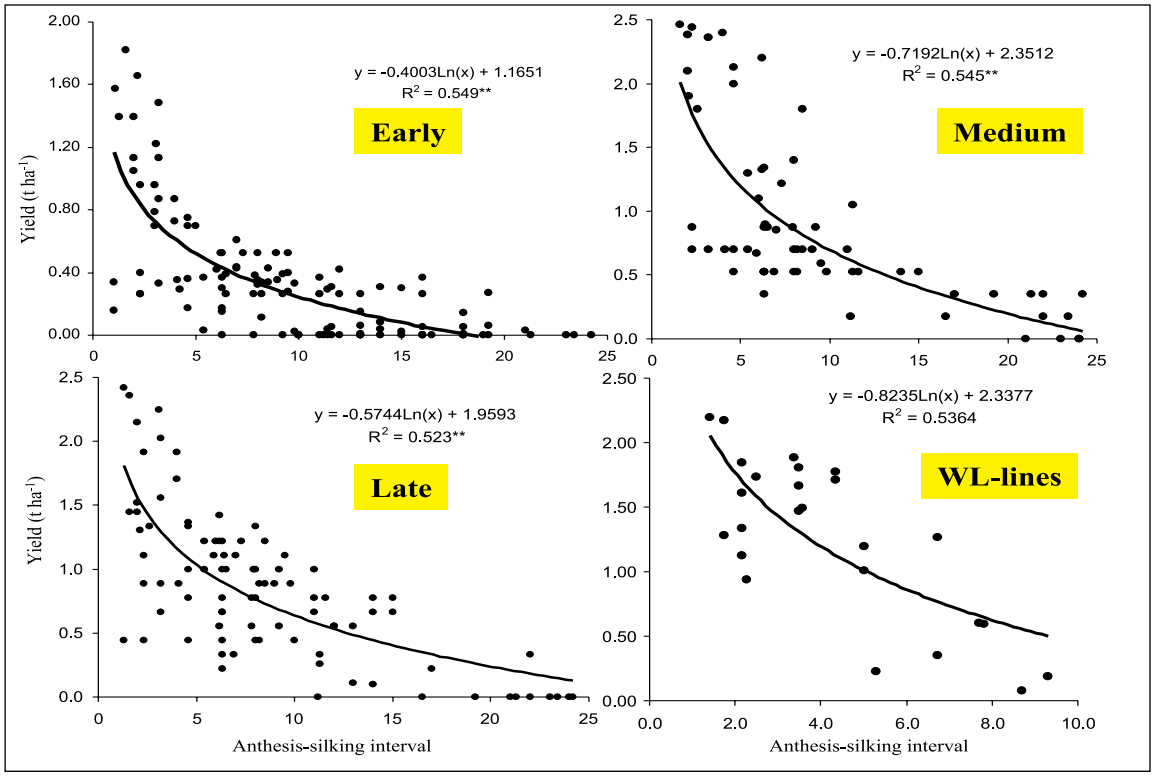


Fig. 7: Grain yield as a function of anthesis-silking interval (days) under drought in maize inbred lines exposed to reproductive stage drought stress under field conditions.

In general, days to 50% anthesis (male flowering) showed negative relationship with performance of genotypes under reproductive stage drought stress. This indicates a general tendency of maize genotypes to prefer earliness in case of water scarcity. Though, irrespective of type of germplasm, the relationship was weak and statistically non-significant. However, irrespective of type of germplasm the relationship of grain yield was highly significant with ASI (Fig. 7), and was largely dependent on days to 50% silking, not anthesis. In our previous study also, a general tendency of silk delay under drought has been observed across the germplasm and environment.

(C) COLD TOLERANCE:

In order to identify the contribution of introgression of temperate/highland tropical germplasm into tropical genotype and to further improve the level of cold tolerance the identified promising inbred lines (15) were crossed with four testers during *Rabi* 2004-2005.

Cold tolerant tropical lines: *WL7-*-*1, WL9-*-*-1, WL18-*-*-6, WL18-*-*-6, CML-327, CML-226-B-B, CML311, WL9-x-x-4, WL11-x-x-1, Pant -6, Pant -7, HKI-1025, HKI-1344, DL-15, DL-16 and (P87 F5-S7 x P44 F231-28)-B-B-B-2-3-B-B-B*

Testers: *Tropical*: CML-451 and CML-287, *Temperate*: S6 lines from heterotic group 'A' and 'B' from (B73xMo17).

Total 53 F1 seeds were harvested and evaluated for heterosis and hybrid vigor during *Kharif* 2005. A total 30 heterotic crosses (14 tropical and 16 temperate) along with 5 hybrid checks and all the lines and testers were

evaluated for cold tolerance during *Rabi* 2005-06 at Delhi, Salient finding of the experiment is as follows:

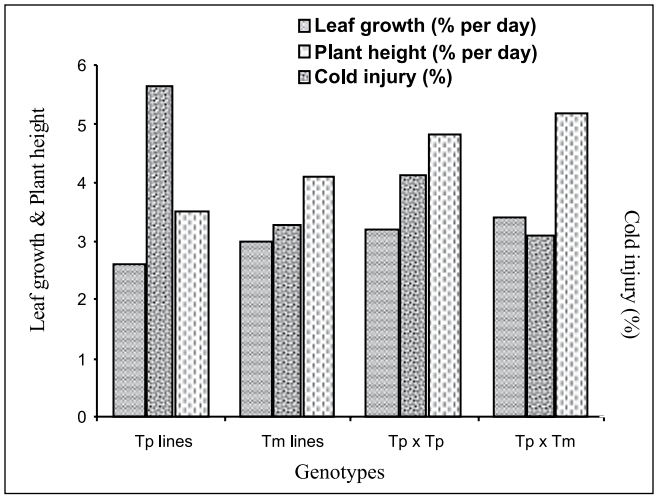


Fig 8: Performance of various type of germplasm under cold stress

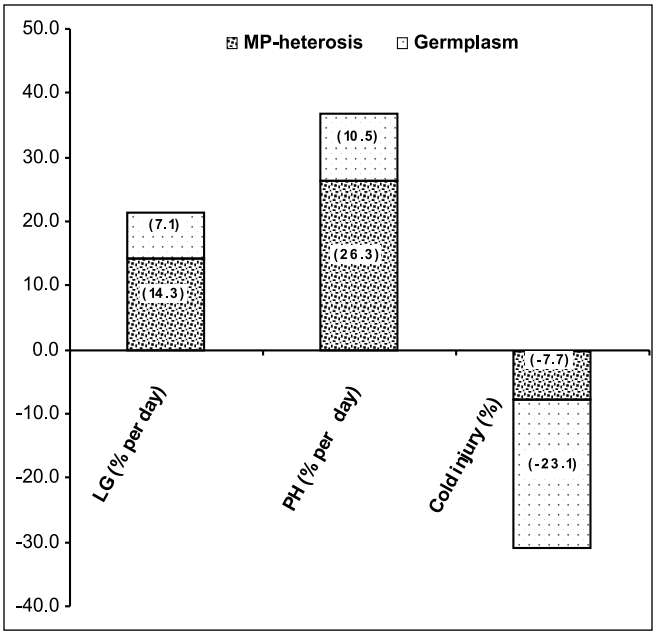


Fig 9: Relative contribution of mid-parent heterosis and genotype in improving cold tolerance.

Among the genotypes, tropical lines showed maximum cold injury, followed by tropical hybrids (Fig. 8). Temperate germplasm, both hybrids and inbreds showed least cold injuries. In terms of plant growth traits, leaf growth rate and increase in plant height was maximum in case of tropical x temperate hybrids and minimum in case of tropical lines. Data on relative contribution of mid-parent heterosis and germplasm indicate that contribution of heterosis was relatively higher in case of leaf growth and plant height, but germplasm has contributed more towards reducing the cold injuries (Fig. 9).

STATISTICS
SOFTWARE CUSTOMISED FOR ANALYSIS OF MAIZE EXPERIMENTS

A number of maize breeding experiments/trials are carried out every year mainly during Kharif and Rabi seasons. The coordinated trials are mostly multi-locational experiments. Each trial is carried out at upto 40 locations which include research cenzters of all five zones of Directorate of Maize Research spread over length and breadth of the country. It also includes trials carried out by the private sector seed companies. The data is recorded on 8 to 10 characters for each experiment/trial at all the locations. The data is analyzed and the annual report is prepared in a short span of time to help maize breeders in selection of germplasm and to enable them to draft the report for formulation of future research program and its presentation at the annual workshop. The accuracy and efficiency of the software is of paramount importance. Therefore, a new software, accurate and efficient in all respects, was needed to meet specific requirements of analysis of maize trials and preparation of annual report. Keeping this in view, a software, customized for maize trials and preparation of the annual report is written. A new proforma for data reporting was designed. The elements of ITC (Information Technology and Communication) are used to eliminate human bias and ensure accuracy and efficiency. The program is written in FORTRAN. RBD analysis of each trial is done and the program's output is in the form of tables which are produced directly in the annual report complete with means, ranks, zonal means, means over all locations, superiority over checks, agronomic data and statistical parameters for all characters. A part of the program is reproduced below:

```
Dimension x(8,6,45), RX(8,6),VX(8,45),SUM(8),T
SS(8),RSS(8),1VSS(8),ESS(8),CF(8),CD(8),VAR(8),V
E(8),VRR(8),VRV(8),NRL(12), 2VRE(8),FRV(8),FRR
(8),CV(8),vxm(45),rxm(6),am(8),avl(12,8),NVL(12),
3varl(12,8),cvl(12,8),Cdl(12,8),vxml(12,8,45),avm(45),
4 nzl(8),mzl(45),NAL(12),nPal(12),kal(12),NIRL(12),
yx(12),avs(45),
5jrank(45),Areal(45),ays(6,45),aym(6,45),xy
(2,12,45)
C Dimension Lrank(12,8,45), rxml(12,8,6)
CHARACTER *45 CHR(8), REPL, VARIETY, ERROR,
TOTAL
Character *5 Aloc,Bloc(12)
CHARACTER *8 FILEIN
Character *8 Filindx1,dsow,dharv,dsowl(12),Dharvl(12)
DATA CHR/'GRAIN YIELD (kg/ha) AT 15%
MOISTURE',
1'PLANT POPULATION (th/ha)','DAYS TO 50%
POLLEN SHED',
2'DAYS TO 50% SILK','DAYS TO 75% DRY
HUSK','PLANT HEIGHT (cms)',
3'EAR HEIGHT (cms)','SHELLING %'/
DATA REPL/'BET. REPLICATION'/
DATA VARIETY/'BET. VARIETIES'/
DATA ERROR/'BET ERROR'/
DATA TOTAL/'TOTAL'/
OPEN(3,FILE ='Filindx1',STATUS ='OLD')
C     NL=Total No. of Locations, NZL=NO.OF
      LOCATIONS IN EACH ZONE
C     MZL=LOCATION NO. IN EACH ZONE
C     NZ=NO.OF
      ZONES,ALOC,Bloc=LocationName,
```

```
C     NL=24, NR=04,NV=12,NC=09, NZ=05, NZL
      0504020706
C     240412090505050401570 6
C     MZL=0101010101020202020303040404040404
      04050505050505
C     NR>No. of RePlications, NV> No. of Varities or
      Treatments FOr
C     RePlication,  NC > No. of Characters
      READ(3,5)NL,NC,NZ,(NZL(I),I=1,NZ)
5     FORMAT(40I2)
      READ(3,5)(MZL(I),I=1,NL)
      write(*,1)NL,NC,NZ,(NZL(I),I=1,NZ),(MZL(I),
      I=1,NL)
      READ(3,9010)FILEIN
      write(6,901)fileIn
901   format(/'Data file name used =',a8/)
9010  FORMAT(A8)
      IF (FILEIN .EQ. 'QUIT') GO TO 9999
      OPEN(5,FILE =FILEIN,STATUS = 'OLD')
99    CONTINUE
      do 5555 kk=1,NL
C     parea=Plot Area F6.2,dsow=date of
      sowing,dharv= date of harvesing
C     NA=Nitrogen, PA=Phosphorous, KA=Pottassium
      Doses.NIR=No.of Irrigat
      Read(5,2)ALOC
      write(*,2)Aloc
      read(5,5)NR,NV
      write(*,1)NR,NV
      read(5,4)dsow
      read(5,4)dharv
      write(*,4)dsow
      write(*,4)dharv
      read(5,3)parea
      write(*,3)parea
      read(5,1)NA,nPA,KA,NIR
      write(*,1)na,npa,ka,nir
      NRL(kk)=NR
      NVL(kk)=NV
      Areal(kk)=parea
      bloc(kk)=aloc
      dsowl(kk)=dsow
      dharvl(kk)=dharv
      NAL(kk)=NA
      nPAL(kk)=nPA
      KAL(kk)=KA
      Nirl(kk)=Nir
WRITE(6,102)BLOC(KK),DSOWL(KK),DHARVL
(KK),NAL(KK),nPAL(KK),KAL(KK)
      1,NRl(kk),NVL(kk)
102   FORMAT(5X,A5,2(3X,A8),5I6)
2     FORMAT(A5)
3     Format(f5.2)
1     FORMAT(4I3)
4     format(A8)
      READ(5,5)NRS,NRM
      Read(5,6)Tval
6     format(f5.2)
C     NRS> NO. OF REPLICATION FOR
      SHELLING, NRM> NO. OF REPLICATIONS
C     FOR MOISTURE in I2 format
C     Rx >Sum over all Varieties for each Replication.
      When
C     divided by NV or FNV it is Mean for each
      Relication Over all
c     Varieties, Vx >Sum over all Replications for each
      Variety. When
C     divided by NR or FNR it is Mean for each
      Variety over all Repl.
      NT=NR*NV
      fnt=nt
```

```
      FNR=NR
      FNV=NV
      DFR=FNR-1.
      DFV=FNV-1.
      DFE=DFR*DFV
      DFT=NT-1.
      IDR=DFR
      IDV=DFV
      IDE=DFE
      IDT=DFT
      nc1=nc+1
      do 80 I=1,NV
      do 81 L=1,nrs
      81 ays(L,I)=0
      do 82 L=1,nrm
      82 aym(L,I)=0
      80 continue
      do 100 jj=1,NT
      read(5,11)ir,ip,iv,yld,ys,ym,(yx(i),i=2,nc)
      write(8,11)ir,ip,iv,yld,ys,ym,(yx(i),i=2,nc)
      x(1,ir,iv)=yld
      do 61 i=2,nc
      x(i,ir,iv)=yx(i)
      61 continue
      ays(ir,iv)=ys
      aym(ir,iv)=ym
      100 continue
C     11 format(i1,2x,i4,2x,i2,1x,f4.1,2x,f3.0,2x,f4.1,3
      (2x,f2.0),
C     13(2x,f3.0)
11    format(i1,1x,i4,1x,i2,3(1x,f5.2),6(1x,f5.1))
134   format(2i4,f12.4,8f6.1)
      do 63 i=1,nv
      avm(i)=0
      avs(i)=0
63    continue
      do 64 k=1,nv
      do 64 j=1,nr
      avm(k)=avm(k)+aym(j,k)
      avs(k)=avs(k)+ays(j,K)
64    continue
71    format(i5,2f7.2)
      do 66 k=1,nv
      write(8,71)k,avs(k),avm(k)
      avs(k)=avs(k)/nrs
      avm(k)=avm(k)/nrm
      xy(1,kk,k)=avs(k)
      xy(2,kk,k)=avm(k)
66    continue
      write(6,123)(k,avs(k),k=1,nv)
123   format(5x,'Shelling Means'/6(i4,f10.3))
      write(6,124)(k,avm(k),k=1,nv)
124   format(5x,'MOisture Means'/6(i4,f10.3))
      write(6,70)
70    format(1H1)
      do 65 j=1,nr
      do 65 k=1,nv
      x(1,j,k)=x(1,j,k)*avs(k)/100
      x(1,j,k)=x(1,j,k)*(100-avm(k))/100
65    continue
999   continue
      do 225 j=1,nr
      do 225 k=1,nv
225   write(8,135)j,k,(x(i,j,k),i=1,nc)
      135 format(2i4,8f9.2/(8x,8f9.2))
      DO 8 I=1,NC
      Am(i)=0
      DO 9 J=1,NR
      RX(I,J)=0.
```

```
      DO 9 K=1,NV
      Am(i)=am(i)+x(i,j,k)
9     RX(I,J)=RX(I,J)+X(I,J,K)
8     continue
      do 18 I=1,nc
      DO 10 K=1,NV
      VX(I,K)=0.
      DO 10 J=1,NR
10    VX(I,K)=VX(I,K)+X(I,J,K)
18    CONTINUE
      DO 12 I=1,NC
      SUM(I)=0
      DO 12 J=1,NR
12    SUM(I)=SUM(I)+RX(I,J)
      DO 15 I=1,NC
      AM(I)=AM(I)/FNT
      TSS(I)=0
      (I)=0
      VSS(I)=0
      DO 14 K=1,NR
      DO 14 L=1,NV
14    TSS(I)=TSS(I)+X(I,K,L)*X(I,K,L)
      16 K=1,NR
16    RSS(I)=RSS(I)+RX(I,K)*RX(I,K)
302   format(2i4,f16.4,f20.4,2f12.4)
303   format(2i4,2x,i4,f16.4/(10x,i4,f16.4))
304   format(2i4,2x,i4,f12.4/(10x,i4,f12.4))
305   format(i6,4x,i4,4x,f12.4/(i4,4x,f12.4))
222   continue
END
C     To arrange a series in Ascending and Descending
      Order
      subroutine skmasc(NN,y,irank)
      dimension X(45),Irank(45),y(45)
C     Read(5,2)NN,(y(i),i=1,nn)
2     format(i2/(10f3.1))
      N1=NN-1
      do 5 I=1,nn
      irank(i)=0
5     x(i)=y(i)
      Do 15 I=1,N1
      ii=I+1
      do 16 j=ii,nn
      IF(x(i).LE.x(j)) go to 16
      temp=x(i)
      x(i)=x(j)
      x(j)=temp
16    continue
15    continue
      do 20 i=1,NN
      do 21 j=1,Nn
      if(y(i).EQ.x(J)) Then
      Irank(I)=j
      go to 20
      Endif
21    continue
20    continue
      do 22 I=1,N1
      jj=i+1
      do 23 j=jj,nn
      If(Irank(i).eq.Irank(j)) then
      irank(j)=irank(j)+1
      endif
23    continue
22    continue
      do 25 i =1,NN
25    Irank(i)=NN+1-Irank(i)
101   format(5x,i4,2f6.1,i4)
      Return
      end
```

EXTENSION ACTIVITIES

- *Frontline Demonstrations in Maize*
- *Value addition in Baby Corn*
- *Kisan Melas & Exhibitions*

EXTENSION ACTIVITIES

Directorate of Maize Research provided extension services to the nation through organizing frontline demonstration in maize, training programmes and participation in Kisan Melas and exhibitions. A total of 2434 FLDs during Rabi 2005-06, 458 FLDs in Spring 2006 and 7143 FLDs during Kharif 2006 were organized in 16 states of India through 40 centres and NGOs. Summary of FLDs in maize conducted by various centres/agencies/ NGOs is presented in following Table:

Table 1. Summary of Frontline Demonstrations in Maize conducted by various centers of DMR and NGOs

S. No.	States	Varieties Used	Number of FLDs conducted	Avg. yield of FLDs (q/ha.) of Arg. Yield	State average yield (q/ ha)	Increase over state average yield (%)
RABI 2005-2006						
1	Bihar	Shaktiman-1 , Shaktiman-2 , Shaktiman-3, Shaktiman-4, HQPM-1, Sheetal, 900 M, Pro-Agro 4640	924	61.83	29.05	112.84
2	Gujarat	Gujarat Maize (GM) -3, GM-4, Narmada Moti, Madhuri	30	34.68	17.17	101.98
3	Punjab	HQPM-1, HM-4	314	49.05	40.0	22.7
4	Chhatisgarh	ProAgro-4212, 30V92,Sweet Cor. Mah2565,900M	85	41.59	13.83	231.50
5	West Bengal	HQPM-1	368	47.9	29.3	64.0
6	Uttar Pradesh	Shaktiman-1, Bio9681, Shaktiman-3, Madhuri, Alrounder,30G10, Pro-Agro 4640, C-1821, C1921, C1837,	363	61.2	20.44	199.44
4	Andhra Pradesh	900 M, HQPM-1 Shaktiman-4,	139	56.02	32.2	73.98

5	Maharashtra	Karvir (MPQ-13) Composite	111	38.52	18.63	106.78
6	Karnataka	DK-984,KHHM-101, JKH-203,Pro-Agro, Al1, HQPM-1, Rounder,900M	55	44.9	31.48	42.63)
7	Tamil Nadu	COH(M)4	45	44.81	15.67	186
	Total		**2434**	**54.85**	**30.76**	**78.32**
SPRING 2006						
1.	Uttar Pradesh	Pusa early Hybrid, Deoki (Comp.), Pro-Agro4212	287	38.15	14.11	170.37
2	Punjab	PMH 1, Paras	51	57.09		
3.	Orissa	Navjot, Madhuri (for green cob)	113	40.65	16.49	146
4.	Bihar	Shaktiman-3, Shaktiman-4	6.5	54.65	31.5	73.49
	Total		**457.5**	**41.11**	**30.76**	**33.65**
KHARIF 2006						
1	Andhra pradesh	CP-818, BioSeed, KH517, Navjot, Kanchan, Lakhmi4950, Polohybrid, Kaveri	850	62.87	31.42	100.12
2	Bihar	Shaktiman-1, Shaktiman-2, Shaktiman-3, Shaktiman-4, Kaveri, DHM-103, Pioneer 3342	2180	39.81	19.0	109.53

3	Chhattisgarh	Pro-Agro4640, 30V92, 900M, Bio 9681, PEHM-1, Pro-Agro4643	400	43.72	13.83	215.69
4	Himachal Pradesh	Grija, Comp Early Comp. Pro-4640 KH 9374, KH-2005, KH-9451, KH 101, Ganga Kaveri, PMZ-4, PSCL-4640, KH517,POLO, Bio-Seed9681, GK 3015, Hi-Shell	434	36.03	24.45	47.36
5	Jammu & Kashmir	C-6, C-15, PS-43,KG-2, KG-1, Madhuri, W3XW5, KH-612, KH-517, GS-2, KH-9451	948	35.63	15.9	124.09
6	Jharkhand	Bio 9681, Pro-311(4640)	50	22.97	14.44	59.05
7	Karnataka	DMH-2, Nithya Shree Com., NAC 6004, Pro-Agro, Bio-Seed, Kaveri, Swarna, All Round, DK990	300	55.42	29.79	86.03
8	M.P.	JM-216, Sweet corn, Hybrid	79	45.3	19.11	137.05
9	Maharashtra	Karveer Com. (MPQ-13), Super 900M	100	37.03	18.26	102.79
10	Orissa	Navjot, Madhuri, DHM-107, MR 3765, Bio9681	295	34.09	13.05	161
11	Punjab	PMH-1, JH 3459, Paras, Double, HQPM-1	177	40.99	29.1	40.85

12	Rajasthan	PEHM-2,Pratap Makka-3,Arravalli Makka-1, Navjot,PEHM-1,Pratap makka-5, HQPM-1,Pratap Hybrid Makka-1, Shaktiman-1, Bio-9681, PAC-701,Shakti 3758	731	20.5	14.55	86.73
13	Tamilnadu	COH (M) –5	350	67.44	15.60	332
14	Uttarnchal	Him-129,Vivek Maize Hybrid-9, Vivek Maize Makka15,Vivek Sankul makka-11,VLAmberpopcorn, DEH-10103, Pragati, DEH-11303D-131, DEH-10503, D-995,	106	36.92	14.17	160.55
15	UP	Shaktiman-1, Shaktiman-2, Shaktiman-3, Shaktiman-4, PEMH-3, Bio-9637, ProAgro-4640, X-3342, Pragati, Madhuri, Bio-9636,Bio-9220, 30 R 77, C-1415 & Pro-Agro-4212, K-2020, Advanta, K-218, Hi-Shell, Monsanto, GK 3015, RMH 4212, GK 3344	1848	47.06	17.95	162.17
16	West Bengal	HQPM-1	678	41.75	28.1	49.05
		Total	**7143**	**44.17**	**17.99**	**145.53**

Cultivation of *rabi, spring and kharif* maize, quality protein maize, intercrop, baby corn, seed production, etc .were successfully demonstrated at farmers field through frontline demonstrations. In QPM hybrids, Shaktiman-1, Shaktiman-2, Shaktiman-3, Shaktiman-4 and HQPM-1 were used during rabi and kharif 2006. In intercropping, onion, coriander, potato, pea, etc. were intercropped into maize.

Training on "Value addition in Baby Corn"

Kisan Melas & Exhibitions

The training programme on "Value addition in Baby Corn" was organized in the Directorate of Maize Research, Pusa Campus, New Delhi from July 27-28, 2006 under Intergrated Scheme on Oilseed, Pulses, Oil plan and Maize (ISOPOM). The participants were the officials of State Department of Agriculture of Delhi and progressive farmers. Several women farmers also participated in the programme. Preparation of various recipies was demonstrated to the participants.

In order to create awareness about maize cultivation, we participated actively by putting up stalls in the following Kisan Mela and Exhibitions during 2006-07.

1. National Farmers Conclave pre-budget discussion 2007-08 from Dec 2-3,2006 at Mela ground, IARI, Pusa Campus, New Delhi-110012.

2. Exhibitions at CGO complex, Lodhi road, New Delhi-110003 on 16/01/2007 on the occasion of inspection by Parliamentary Committee on Official Language.

3. Krishi Expo 2007 at Pragati Maidan, New Delhi from Feb 21-25,2007.

4. Pusa Krishi Vigyan Mela from February 24-26, 2007 at Mela ground, IARI, Pusa Campus, New Delhi-12.

Posters and Technical Bulletins on *Kharif* maize, Rabi maize, quality protein maize, sweet corn, pop corn, baby Corn, maize products, etc. were distributed among farmers, entrepreneurs and development agencies.

ANNUAL WORKSHOP MEETING

PROCEEDINGS OF THE 49TH ANNUAL WORKSHOP AT B.A.U., RANCHI FROM APRIL 4-6, 2006

The inaugural session was chaired by Dr. N.N. Singh, Vice Chancellor, RAU. The chief guest of the function was Dr. G. Kalloo, DDG Crop Science & Horticulture, ICAR and Dr. S.K. Vasal, Distinguished Scientist; CIMMYT, Mexico was the guest of honor. Dr. B.N. Singh, Director of Research, BAU while welcoming the dignitaries and the delegates emphasized on the importance of maize in the state of Jharkhand. Dr. R.P. Singh, Project Director, DMR, presented the PD's report for the year 2005-06. He informed the house that during 2003-04, the total area in the country under the maize cultivation was 7.32 million ha. against 6.64 million ha. during 2002-03. The total production during the year was 14.93 million tones with an increase of about 3.78 million tones over the previous years. During the year under report, 2 full-season maturing hybrids HM-4 and HM-5 for Haryana, 1 hybrid COH M 4 for Tamil Nadu and 1 QPM hybrid HQPM-1 were notified for cultivation during Kharif season. Besides this, 4 composites Birsa Makka-2 and Birsa Vikas Makka-2 were notified for cultivation in Jharkhand and Shalimar KG-1 and Shalimar KG-2 for Jammu & Kashmir. During the previous years 4 hybrids were identified by the workshop. This consist of 2 hybrids from private and 2 from public sector in different maturity groups. Early maturing hybrids JH 3851 were identified for AP, Maharashtra, Karnataka, Tamil Nadu, Rajasthan, MP, Gujrat, Eastern UP, Bihar, Assam, Orissa, Jharkhand and Chhatisgarh. FH-3210 as an extra early maturing hybrid was identified for eastern UP, Bihar, Assam, Orissa, Jharkhand and Chhatisgarh. Besides these, the Project Director presented the progress made by the Project in the area of crop improvement, fodder maize, breeders seed production, crop production and crop protection technology, biochemistry and quality.

Dr. D.K. Ganguly, the ex-Maize Breeder from BAU, Ranchi was felicitated by the Chief Guest for his outstanding contribution in popularizing maize cultivation in the state of Jharkhand. The Chief Guest also released two publications of DMR namely, Stresses in Maize and Maize Phenology and Physiology by P.H. Zaidi and N.N. Singh. Dr. S.N. Shukla, ADG (FFC), ICAR apprised the chairman and the chief guest about the deliberations during the pre-workshop sessions held on April 4-5, 2006. He also informed that the yield of 9 tonnes/ha achieved in the Frontline Demonstrations (FLDs) indicates the potential of this crop. Dr. S.K. Vasal, Distinguished Scientist from CIMMYT and the Guest of Honour in his remarks emphasized the need of right utilization of the available germplasm in the country and to adopt the correct breeding strategy to derive maximum benefit. Dr. N.N. Singh, Vice Chancellor, BAU, Ranchi in his Chairman's remarks stressed the need to have a 3-pronged strategy for hybrid development programme. He also suggested that scientists from Ranchi, Jammu and Ambikapur should be trained at Almora and Karnal. He also mentioned that to develop hybrids within the shortest time, there is a need to utilize the available germplasm as well as evaluate and utilize some of the heterotic germplasm. He further desired that the Project Directorate should organize Refresher Courses for the scientists in crop improvement and management of biotic and abiotic stresses. The potential area which needs attention in a state like Jharkhand are specialty corn in periurban agriculture, intercrop with vegetables, suitable post-harvest technology and dual purpose maize which has good possibility in the state.

Thereafter, Dr. (Mrs.) V. Kerketta, Professor, Plant Breeding, BAU, facilitated Drs. G. Kalloo, S.K. Vasal and N.N. Singh.

Dr. G. Kalloo, DDG (CS & Horticulture), the Chief Guest of the Session in his remarks mentioned

that the growth rate have been set at a high pace in the agricultural sector. Crop efficiency, genetic synchrony, conversion of maize to high value products are important areas in the maize programme which should be addressed on priority. He also emphasized the need of reducing the cost of cultivation and to generate exact information on nutrient use efficiency under different plant populations. The genetics of nutrient uptake like nitrogen, phosphorus, zinc, sulphar, boron etc. should be worked out. He also suggested to convene a meeting for developing a project on specialty corn viz. sweet corn, baby corn and pop corn. There is also a need for development multiple disease resistance against downy mildew, TLB and BLSB in maize through Gene Pyramiding. Dr. Kalloo emphasized the need for a massive drive for development of full-season hybrids and promised support of the Council in this endeavour. He informed that the AICRP system is under review to reorient the AICRPs in the mode of basic and strategic research.

Dr. M.G. Chakravorty, BAU, Ranchi offered a vote of thanks to the chair and all the delegates of the workshop.

RECOMMENDATIONS OF THE WORKSHOP

Breeding

1. In full season maturity material promotion of entries will be on the basis of 5% yield superiority compared to the best check, however, for long term strategy 10% superiority will continue.
2. Dr. Vasal highlighted that good lines in full season maturity are available, which may be used by this group.
3. For using as check entries newly best-released hybrids should be used in the trial.
4. Early maturity material should be developed in the high plant density. In this context it was decided that Dholi, Pantnagar and Udaipur Centre will initiate work in this programme.
5. It was also decided that trial for NEH region trial will be formulated by DMR and Vice-Chancellor, CAU, Imphal will be requested to help in testing of the material at various centres of NEH region.

Entomology

1. *Chilo partellus*, the major pests of kharif maize can be successfully managed by making two releases of *Trichogramma chilonis* @ 8 cards (1,60,000 wasps) per hectare at 12 and 22 days after sowing.
2. To have uniformity in understanding the level of susceptibility of maize germplasm for *Chilo partellus* and *Sesamia inferens* following rating and terminology will be followed in 1-9 leaf injury rating scale

   ≤ 3 Less susceptible

   >3-6 Moderately susceptible

   >6 Highly susceptible

   At the end, a joint meeting of the Entomology, Pathology and Nematology was held to discuss the strategy for developing various treatments of IPM module. It was decided that these treatments should be adopted as per need.

Pathology & Nematology

1. The problems of implementation of IPM Trials should be addressed on priority and the Chairman was of strong view that we must dedicate ourselves to the concept of IPM.
2. Pathologists from all the centres to collect and send suspected Nematode sample of Maize to Dr. Baheti who will provide the Proforma for passport information of the sample.
3. PI Pathology suggested in house that, Nagenahalli as a hot spot location for Polysora rust for screening of maize materials.

4. Revalidation and further confirmation BLSB resistant materials JH- 10704 (IET full season), EH-1389 (AET early maturity), DEH- 11 (AET extra early maturity) identified at Delhi and Pantnagar in this kharif season. Seeds of these hybrids and the parents are to be procured for further confirmation and their utilization in development of source germplasm.
5. Chairman suggested that work on gene pyramiding should be extended to other locations covering more diseases.
6. Maize genotypes of specialty corn should be screened against various maize diseases.
7. Methods should be adopted to prevent the spread of disease inoculums from sick plots to other experimental fields.
8. The maize materials included in various coordinated trials for screening against diseases must be untreated and private sectors should submit the seed with a declaration that seeds are untreated.
9. The chairman suggested that *A. niger* identified for control of Guava wilt at Lucknow should be tried for management of microbial spoilage of maize grains.
10. Good sources of resistance identified in the different centers should be maintained even if they are not promoted in the coordinated trials.

    Weather data on soil microenvironment should be recorded which will give useful information for soil pathogens.

Administrative recommendations:

1. Funds to conduct IPM trials should be made available on time.
2. Coordinated centers entrusted with additional collaborative programme should be provided with financial assistance for hiring technical help.
3. Additional funds should be provided for carrying out disease survey and surveillance in the different centers.

OTHER ACTIVITES/FOREIGN VISITS/RETIREMENTS

- *Training imparted to students*
- *Training conducted by institute*
- *Research Programmes & Projects*
- *Resource Generation*
- *Distinguished Visitors*

TRAINING IMPARTED TO STUDENTS

This Directorate offered 2-5 months training to M.Sc. & B.Tech. students from several colleges of Haryana, Rajasthan and other states as a project work for the partial fulfillment of degree course. The projects completed under the guidance of Institute scientists are listed below.

Table 1. Details of the Training Imparted to Students

S.No.	Name of the candidate	Degree & University	Title of dissertation	Supervisor
1	Ashish	M.Sc., Rajasthan Univ.	Mass production technology of Cotesia flavipes and Trichogramma spp.	Dr. Pradyumn Kumar
2	Ms. Neha Pabreja	B.E , CITM,Faridabad	Study of strains of Beauveria bassiana and Metarhizium anisopliae as biocontrol agents against maize pests	Dr. Pradyumn Kumar
3	Ms.Rashmi Sharma	B.E. , CITM,Faridabad	Study of strains of Beauveria bassiana and Metarhizium anisopliae as biocontrol agents against maize pests	Dr. Pradyumn Kumar
4	Vidit Yadav	B.Tech.,CITM,Faridabad	Mass production technology of Cotesia flavipes and Trichogramma spp.	Dr. Pradyumn Kumar
5	Devan Gopal	B.Tech.,CITM,Faridabad	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
6	Smriti Sangwan	B.Tech.,CITM,Faridabad	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
7	Pavneet Kaur	B.Tech.,Rai University, Gurgoan	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
8	Neha Gera	M.Sc.,Seedling College,Jaipur	Tissue Culture	Dr. Sujay Rakshit
9	Monica Saxena	B. Tech.,Ishan College, Greater Noida	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
10	Somya Sinha	B. Tech.,Ishan College, Greater Noida	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
11	Abhilasha	M.Sc.,Amity, Instt. Of Biotech., Noida	Tissue Culture	Dr. Sujay Rakshit
12	Manisha	M.Sc.,Amity, Instt. Of Biotech., Noida	Tissue Culture	Dr. Sujay Rakshit

13	Prateek	B.Tech.,SEC,SIKAR	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
14	Mohit	M.Tech.,Instt. of Tech., Bundelkhand	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
15	Sarita	Vanasthali Vidhyapeth, Jaipur	DNA Finger printing of maize inbreed lines by SSR markers	Dr. Sujay Rakshit
16	Anwar Alam	Jamia Milia, Delhi	Studies on stress-adaptive mechanism of water logging induced anaerobiosis in maize	Dr. P.H.Zaidi
17	Usha Chopra	Vanasthali Vidhyapeth, Jaipur	Physiology of cold stress tolerance in tropical maize.	Dr. P.H.Zaidi

Table 2. Training conducted by institute-

S.No.	Name of training	Date of training	Paid/free of cost
1	Maize Entomology	4-8 Sep. 2006	Sponsored by DMR
2	Value addition in Baby Corn	27- 28 July, 2006	

Table 3. Research Programmes & Projects-

S.No.	Funded Agency	Project Title	Project Leader
1	ICAR AP-CESS	Development of stem borer resistant- transgenic maize	Dr. Pradyumn Kumar
2	ICAR AP-CESS	Net work project Prevention and management of Mycotoxin in Agriculturally important commodities	Dr. Sangit Kumar
3	ICAR AP-CESS	Network Project on Gene Pyramiding; Pyramiding Genes for Resistance to Turcicum LeafBlight and Polysora Rust in Maize	Dr. Sangit Kumar
4	ICAR AP-CESS	Assessment of vulnerability of crop yields to pest damage in global climate change.	Dr. Sangit Kumar
5	ICAR AP-CESS	Development of technologies for improved and stable productivity of winter maize under cold stress in north India.	Dr. P.H.Zaidi
6.	ICAR-NPTC	Functional genomics of drought tolerance in maize	Dr. P.H.Zaidi
7	ICAR AP-CESS	Technological transformation for improved and stable productivity of Kharif maize under multiple abiotic stresses.	Dr. R.P.Singh
8	ICAR	DUS Testing	Dr. S.B.Singh

Table 4. **Resource Generation**

Project Title	Source	Total outlay	Project Investigator
"Development of technology for the commercial production of Cotesia sp- a potential parasitoid of Lepidopteran pests"	DST	Rs. 6,79,400/-	Dr. Meenu Agarwal

Table 5. Distinguished Visitors

S.No.	Visitor	Institute/Place
1	Dr. Mahmoud Mounier MA Ragheb	Egypt
2	Dr. Kevin Pixley	CIMMYT
3	Dr. G.Kalloo	DDG(Hort. & CS), ICAR, New Delhi
4	Dr. SK Vasal	Distingished Scientist, CMMYT/SSA, Mexico
5	Dr. Basant Ram	Vice-chancellor, RAU, Samastipur
6	Dr. NN Singh	Vice-chancellor, BAU,Ranchi
7	Dr. HS Gupta	Director, VPKAS, Almora
8	Dr. RB Deshmukh	Vice-chancellor, Mahatma Phule Krishi Vidyapeeth, Rahuri
9	Dr. DJ Patel	Nematologist, Anand (Gujrat)

FOREIGN VISIT

Dr. Sain Dass- Participated in 14th Regional Technical Co-ordination Committee (RTCC) Meeting of Rice-Wheat consortium-CIMMYT at Kathmandu, Nepal, Feb 14-15, 2007

Dr. P.H.Zaidi - Deputation

1. Department of Crop & Soil Sciences, Cornell University, USA to attend the advance training course during 10-31 July, 2006
2. ASA meeting at Indianapolis, USA, 12 – 16 November, 2006

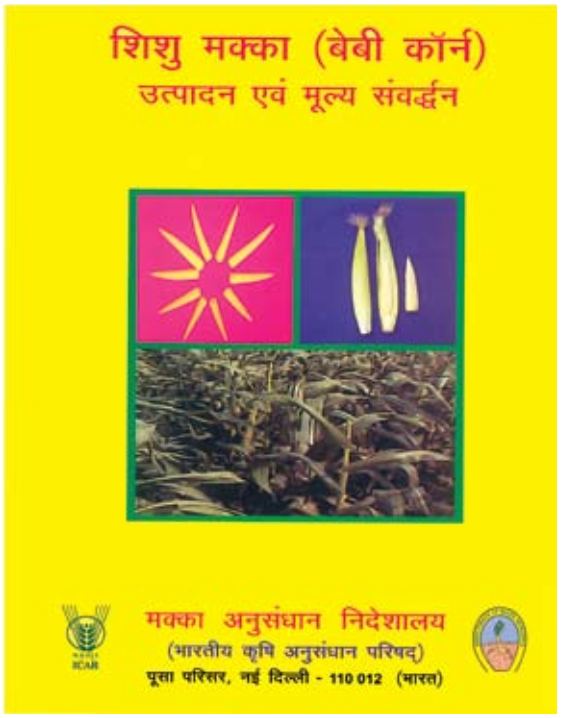
Personnel retired during 2006-2007

Dr. Iqbal Singh	Principal Scientist
Mrs.Sarita Gera	Assistant Administrative Officer
Mr. N.L.Manchanda	Tech. Assistant T-I-3

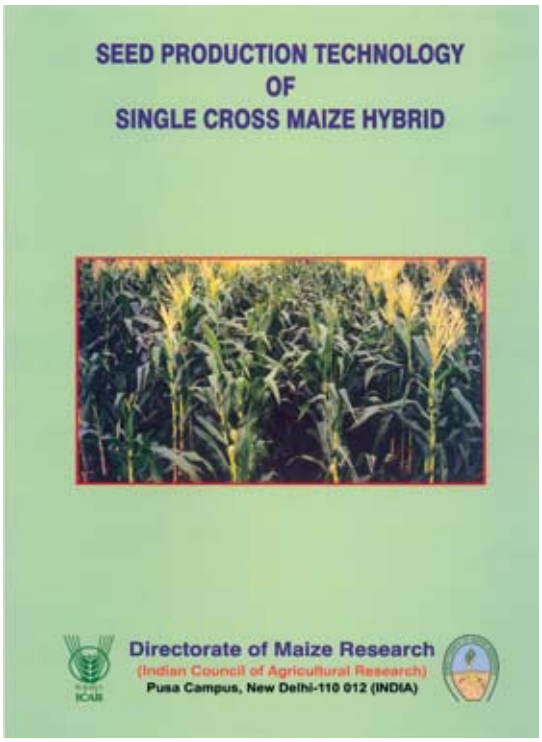
Personnel Promoted during 2006-2007

Dr. P.H. Zaidi	Sr.Scientist (Plant Physiology)
Mr. V.K. Yadav	Scientist Sr. Scale (Ext)
Mr. K.P. Singh	Scientist Sr. Scale (Computer Application)
Mrs. Sarita Gera	Assistant Administrative Officer
Mr. Ajay Kumar Singh	Tech. Assit, T-I-1

PUBLICATIONS/ HONOURS/AWARDS



- *List of Publications*
- *Honours/Awards*



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AWARD & HONOR

- Ms. Rafat Sultana, Senior Research Fellow, Physiology Lab, Directorate of Maize Research was awarded with the prestigious "ISPA fellowship" by International Society for Plant Anaerobiosis (ISPA), UK. The decision was announced at ISPA meeting at Japan and Ms. Rafat is one of the six awardees of this fellowship. The fellowship is awarded on the basis of her strong academic achievements and publications in reputed International journals on waterlogging tolerance in maize.
- Dr. Meenu Agarwal selected as DST Women Scientist under WOS-B scheme and awarded a project entitled **"Development of technology for the commercial production of Cotesia sp- a potential parasitoid of Lepidopteran pests"** in the Entomology unit of Directorate of Maize Research, New Delhi-110012. The budget outlay of the project is Rs. 6,79,400/- (Rupees six lakhs seventy-nine thousand and four hundred only) for a period of two years.

RESEARCH STAFF

RESEARCH STAFF OF THE DIRECTORATE OF MAIZE RESEARCH

DIRECTORATE OFFICE

Dr. Sain Dass	Project Director (Maize)
Dr. Rajendra P. Singh	Principal Scientist & Principal Investigator (Agronomy)
Dr. Sangit Kumar	Principal Scientist & Principal Investigator (Pathology)
Dr. Pradyumn Kumar	Principal Scientist & Principal Investigator (Entomology)
Dr. S.B. Singh	Principal Scientist (Plant Breeding)
Sh. N.P. Gupta	Principal Scientist (Plant Breeding)
Dr. Iqbal Singh Superannuated on	Principal Scientist (Plant Breeding) 31/10/06
Dr. A.S. Sethi	Principal Scientist (Statistics)
Dr. H.O. Gupta	Principal Scientist (Biochemistry)
Dr. Rajpal Singh	Principal Scientist (Plant Breeding)
Dr. Om Prakash Sharma	Senior Scientist (Biochemistry)
Dr. P.H. Zaidi	Scientist Sr. Scale (Plant Physiology)
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Mrs.Meena Shekhar	Senior Scientist (Pathology)
Mr. Virendra Kumar Yadav	Scientist (Ext.)
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Mr. Satish Rai	Technical Assistant
Mr. Sameer Kumar Rai	Technical Assistant
Mr. Kamal Vats	Technical Assistant
Mr. Rahul Singh	Technical Assistant
Mr. Vinod Paswan	Technical Assistant

Administrative staff of DMR

Mr. R.P. Chamola	AA& FO	
Mr. K.S.Mishra	Joined on	07/02/07
Mrs.Sarita Gera	Superannuated on	31/10/06
Mr. M.N.V.Rao	UDC	23/01/07
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