



# NBPGR



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QUARTERLY

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## WHOLE GENOME SEQUENCING OF SESAME BY NBPGR

NBPGR completed whole genome sequencing of Swetha variety of sesame (*Sesamum indicum* L.), an indigenous oilseed plant of importance to marginal farmers and international trade. This is the result of a fully indigenous effort with funding from the National Agricultural Innovation Project (NAIP/ICAR). The sequence assembled has total genome coverage of 85% compared to the 80% coverage reported in January 2013 by the yet-to-complete effort of Henan Sesame Research Center, Zhengzhou, China. The Indian sesame sequences have been submitted to NCBI database as Bioproject no. PRJNA219369 and Submission no. SUB345070.



A field view of *Sesamum indicum*; inset shows diversity for capsules per node

This Indian effort has succeeded in deciphering the sesame genome using the next generation sequencing procedures by combining the random genomic sequence information with over 50X coverage and transcriptome sequences. The 385 Mb sequence assembled represents the full sesame nuclear genome with a somatic chromosome complement of  $2n=26$ . The contigs assembled were helpful in identifying the high-utility microsatellite markers in large numbers (over 52,000 SSRs) and the valuable genes that confer heat and moisture stress tolerance to the sesame plant. From the 52,000 SSR sequences identified; about 2,500 pairs of primers were synthesized. Analyses of such primer pairs led to identification of polymorphic SSRs which were subsequently employed for genotyping the core collection. These polymorphic SSRs were also used for genotyping the sesame mapping population comprising the two parental lines and 206 RILs (Recombinant inbred lines). The markers identified are being mapped to ensure their ready use in marker assisted crop improvement programmes. The annotated transcriptome sequences contain information on genes controlling the flowering and stress tolerance pathways which are expected to provide the much needed impetus to application of latest tools of biotechnology in sesame improvement programmes to make the crop more competitive and beneficial to the farmers.

This work was carried out by the team from NBPGR comprising Dr K.V. Bhat, Dr Ramya Kurien, Ms Niti Pathak, Ms Ratna Kumari, Ms Nirupama Bindhani and Dr Nupur Mondal in collaboration with Dr S.K. Sen from BREF-Biotek, Indian Institute of Technology (IIT), Kharagpur.



## Plant Exploration and Germplasm Collection

### Exploration and Germplasm Collections from North-Eastern Hill Region



**Variability collected in foxtail millet from Mon district, Nagaland**

A multi-crop exploration and collection trip was conducted in Mon district, an unexplored remote area of North-East Nagaland by staff of NBPGR, New Delhi. This area is inhabited by the Konyak tribe. A total of 138 samples comprising mainly rice, maize, foxtail millet, chenopod, soybean, chilli, cowpea, pumpkin, perilla and crop wild relatives were collected from 25 sites. In eastern and southern parts bordering Myanmar, interesting germplasm of *Chenopodium album*, pigeonpea, velvet bean, cowpea, white seeded type of *Perilla frutescens* was collected.

Another exploration tour by staff of NBPGR, New Delhi was undertaken for the collection of citrus germplasm from Siang Valley of Arunachal Pradesh. Indian Wild Orange (*Citrus indica*, believed to be the progenitor of present day mandarin) plants were observed in large numbers in the forest areas of East Siang and Upper Siang districts, which differed from the population earlier reported from Garo hills of Meghalaya. Natural wild populations of *C. medica* in Siang hills were observed. Several other *Citrus* species were also collected.



***Gossypium barbadense* collected from Manipur. Flower corolla without purple spot at centre**

Staff of NBPGR Regional Station (RS), Cuttack and Central Institute of Cotton Research (CICR), Nagpur carried out exploration for cotton germplasm from Manipur. A total of 17 samples belonging to *Gossypium barbadense* var. *barbadense*, and *G. barbadense* var. *brasiliensis* besides *Ocimum basilicum* and *O. citriodorum*



**Indian Wild Orange (*C. indica*, above) and Citron (*C. medica*, below) in Siang Valley, Arunachal Pradesh**



**Collection of *Oryza rufipogon* from Loktak Lake, Manipur**



were also collected from 15 sites of six districts (Senapati, Imphal East, Imphal West, Bishnupur, Thoubal and Temenglong).

NBPGR RS, Shillong, in collaboration with Central Rice Research Institute (CRRI), Cuttack undertook exploration for wild germplasm of rice from Manipur (districts of Imphal West, Imphal

East, Bishnupur and Thoubal). A total of 30 rice germplasm comprising landraces with wild characteristics (presence of awns, large glumes and shattering habits) and two wild relatives of rice, *Oryza rufipogon* and *Zizania latifolia* were collected.

### Crop Specific Collections

Several crop-specific collaborative explorations were conducted by staff of NBPGR during this period, which are summarized below.

Explorers	Areas explored	Crops collected (samples)	Remarks
NBPGR RS, Cuttack and Orissa University of Agriculture and Technology, Bhubaneswar	Kandhamal districts of Odisha, 25 sites	Millets (39)	Barnyard millet ( <i>Echinochloa crus-galli</i> ), finger millet ( <i>Eleusine coracana</i> ), foxtail ( <i>Panicum sumatrense</i> ), Sorghum ( <i>Sorghum bicolor</i> ), maize ( <i>Zea mays</i> ), and rice ( <i>Oryza sativa</i> )
NBPGR RS, Shimla	Jammu & Kashmir, Himachal Pradesh and Uttarakhand	Common bean ( <i>Phaseolus vulgaris</i> ) (66)	Farmers grow several landraces as mixture, which helps in on-farm conservation of a large genepool
NBPGR RS, Srinagar and Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir	Remote and hilly areas of Jammu & Kashmir (districts Ramban, Doda, Kishtwar, Budgam, Kupwara, Shopian and Kulgam)	Pulses (91)	Common bean ('rajma'), cowpea, horse gram and green gram collected. Significant collection was of 'Keshwan rajma' from a remote village, Thakraie in Keshwan hills, district Kishtwar, which is reported to cause low or no flatulence on consumption
NBPGR RS, Jodhpur and Directorate of Oilseed Research, Hyderabad	Districts of West Rajasthan (Jodhpur, Barmer, Jaisalmer, Bikaner, Hanumangarh Churu and Nagaur)	Castor (118)	Variability was observed for plant type, growth habit, number of capsules per plant, capsule size and shape, and seed size
NBPGR RS, Hyderabad and Tamil Nadu Agricultural University, Coimbatore	Dindugal district, Tamil Nadu covering the protected areas of Western Ghats (Palani Hill Range)	Cereals, millets, pulses and oilseeds (118)	Landraces of paddy, sorghum, finger millet, kodomillet, foxtail millet, little millet, barnyard millet; pigeonpea, french beans, lima bean; sesame, castor; <i>Solanum</i> sp. and wild species of <i>Vigna</i>
NBPGR RS, Hyderabad and Indian Institute of Pulses Research, Kanpur	Kurnool and Kadapa districts of Andhra Pradesh covering the protected areas of Eastern Ghats (Nallamalai hills, Seshachalam hills, Guvvalacheruvu and Balapalle ranges)	Urd bean, mung bean, horsegram (56)	Diversity was observed for seed size and colour in urdbean, mungbean, horsegram and cowpea; in leaf lobing for pillipesara, and pod pubescence in wild pigeonpea ( <i>Cajanus scarabaeoides</i> )





**'Keshwan rajma'** collected from Kishtwar, Kashmir



**Perennial castor** in West Rajasthan



***Solanum pseudocapsicum***, a wild relative of brinjal collected from Palani hills, Western Ghats

## Germplasm Introduced

A total of 24,626 accessions (8,054 germplasm and 16,572 trials) of different crops were introduced from 26 countries. Promising introductions were:

***Arabidopsis* (EC790603-790619; 796207-796233; 796234-796246) USA:** Transgenic lines transformed with different gene sequences, pBCYellow vector, pBROK2.

**Durum Wheat (EC786580) USA:** Alien disomic substitution 1E (1B) line.

**Onion (EC794410-794416) Taiwan:** Lines for high yield, storability, early maturing etc.

**Paddy (EC791930-791970) USA:** Tolerance to shattering, disease and lodging.

**Paddy (EC791971-792103) China:** Tolerance to shattering, disease and lodging.

**Paddy (EC792106-792118; 792176-796599) Philippines:** Wild MAGIC parents; heat and cold tolerant.

## Plant Quarantine

A total of 69,308 imported samples of germplasm and trial material (including 59 transgenics) of various crops and their wild relatives were processed for quarantine clearance. Of these,

315 samples were found infested/infected. A total of 269 infested/infected/contaminated samples were salvaged through physico-chemical methods. Twenty-seven samples were rejected: 14 samples of *Oryza sativa* from Brazil, China and USA due to *Tilletia barclayana*; three samples of *Capsicum annuum* from Taiwan; two samples of *Solanum* spp. from Taiwan and one sample of *Momordica charantia lycopersicum* from Thailand due to *Fusarium solani*; and 10 samples of *Glycine max* from Canada due to *Peronospora manshurica* which is not yet reported from India.

At NBPGR RS, Hyderabad, a total of 13,960 samples of import (2,238) and export (11,722) germplasm were processed for quarantine. Import germplasm (1,658 samples) was released to the consignees after necessary mandatory treatments. During quarantine processing, *Alternaria brassicicola* was intercepted on mustard from Australia; *Stemphylium* sp., *Rhizoctonia solani* and *Ascochyta pinodes* on sunflower from France; *Colletotrichum lindemuthianum* on sunflower from USA; *R. solani* on mustard and rapeseed from Australia were intercepted.



## Germplasm Characterized and Evaluated

Crop (accessions)	Traits	Superior accessions identified/range of values
<b>NBPGR RS, Shimla</b>		
Field crops (1,772)	Multiple traits	Grain amaranth (IC17926, IC17935)
	Multiple traits	Buckwheat (IC49668, IC42427, EC272177)
	Multiple traits	Common bean (IC258378, IC382206, IC271530)
	Multiple traits	Rice bean (IC524549, IC524085)
Temperate fruits (87)	Nut weight	Walnut (IC538532, IC020070)
	Kernel recovery	Walnut (IC020070, EC026894)
	Kernel colour	Walnut (EC036744, EC038653, IC020070)
	Multiple traits	Pecan nut (cv. 'Mahan' and 'Desirable')
<b>NBPGR RS, Hyderabad</b>		
Tomato (70)	Total soluble sugar (TSS)	2.9 - 11.0 °Brix
Black gram (36)	Total protein	19.44% - 28.9%
Cowpea (54 )	Total protein	18.8% to 29.9%
Chilli (21)	Total soluble sugar (TSS)	4-10 °Brix
	Total chlorophyll content	42 - 79
<b>NBPGR RS, Thrissur</b>		
Rice (114)	Early flowering (38 days)	IC537480, IC537492, IC537497, IC324739, IC537466 and IC539470
Deep water rice (71)	No. of effective tillers/plant	4.0 - 24.3
	Days for 80% maturity	84 - 93
	Grain length; width; thickness	7.3 - 9.3; 2.3 - 3.9; 1.6 - 2.3 mm, respectively
	100 seed weight	1.6 - 2.7 g
	Yield	0.8 - 35.6 g
Cluster bean	High pod weight/plant	NKD52 (450 g) NKD54 (353 g), PNB (220.88 g), IC040021 (212.70 g)
	Multiple traits	NKD52 -High pod length (13.5 cm), width (1.3 cm) and weight (6.512 g)
<i>Garcinia cambogia</i> (36)	Number of fruits/tree	IC244109-1 and IC244115
	Fruit yield/tree	5071 (522.3 kg) and 5158 (557.4 kg)
	Single fresh fruit weight	IC244093-1 (188.3 g)



Variability in grain amaranth at NBPGR RS, Shimla



Pod size variability in cluster bean (vegetable type) at NBPGR RS, Thrissur



Variability for nut shape and size in pecan nut at NBPGR RS, Shimla



## Patent Granted

NBPGR, along with Department of Biotechnology (DBT) was granted an Indian patent (#258165) for '**Diagnostic kit based on polymerase chain reaction for detection of cry1Ac gene in Bt Cotton Bollgard-I**'. The invention is a process enabling detection of transgene i.e. cry1Ac gene responsible for production of cry1Ac protein for insert resistance in Bt Cotton Bollgard-1 using combination of novel primer pair of sequence ID 1 in polymerase chain reaction (PCR). The process comprises designing of primer sequence for cry1Ac gene, preparation of PCR mixture, amplification of target sequence using PCR with three temperatures regime and conversion of the technology in the form of a kit. The inventors of the patent are Dr G.J. Randhawa, Principal Scientist, Division of Genomic Resources and Mr Prashant K. Firke.



*Sterculia parviflora* in fruiting stage

It can be promoted as a beautiful ornamental by virtue of its bright red, star shaped and velvety fruits.

## Development and release of varieties from germplasm at NBPGR RS, Shimla

A variety of rice bean (*Vigna umbellata*) '**Him Shakti (VRB-3)**' developed by NBPGR RS, Shimla along with VPKAS Almora, was released by the Central Variety Release Committee for cultivation North-West and North-Eastern Hill Region of India. It exhibits high yield (17.05 q/ha), light green seed colour and mid maturity (133 days).

One variety each of adzuki bean (*Vigna angularis*) namely '**HPU-51**' for high yield (13.20 q/ha) and red seed colour and '**Him Bathua**' of chenopod (*Chenopodium album*) for high yield (10.34 q/ha) and early maturing (110 days) developed by NBPGR RS, Shimla were released by the State Variety Release Committee for general cultivation in the Indian Himalayan region.

## *Sterculia parviflora* - A potential ornamental tree

*Sterculia parviflora* Roxb. (IC553746) collected from Nicobar Islands and established in the Field Genebank (FGB) at NBPGR, RS, Thrissur as grafted scions on locally adapted *Sterculia urens* came to flowering and fruiting in its third year.

## Rice Core Collection Identified from National Genebank Collection

A **rice core collection** consisting of **1,548** accessions has been developed from 15,000 accessions drawn from the National Genebank at NBPGR. These were characterized for three consecutive seasons ((2009-2010, 2010-2011, 2011-2012) at five centres namely Central Rice Research Institute (CRRI), Cuttack, Banaras Hindu University (BHU), Varanasi, Directorate of Rice Research (DRR), Hyderabad, Central Soil Salinity Research Institute (CSSRI), Karnal and Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur under a DBT funded project entitled '**Establishment of National Rice Resource Database**'. The accessions were characterized using 30 standard agro-morphological descriptors comprising 19 qualitative and 11 quantitative traits. A portal has been developed for this project and a database created for integrating the data on characterization of these 15,000 accessions.

The project team at NBPGR comprises Dr K.C. Bansal (Coordinator), Dr Kalyani Srinivasan (PI), Dr Sunil Archak (Co-PI), Dr Rakesh Singh (Co-PI), Ms Reshma Shaheen, Dr Pummy Kumari and Mr Vikas Kumar. For more details see <http://www.nbpgr.ernet.in/nrrd>



## TRAININGS AND FIELD DAYS ORGANIZED

### Regional Training Workshop on GIS and Climate Analogue Tools



Dr S.K. Datta, DDG (CS) giving the completion certificate to Dr N. Sivaraj in the presence of Dr P.N. Mathur, Bioversity International and Dr K.C. Bansal, Director, NBPGR

A 'Regional Training Workshop on GIS and Climate Analogue Tools for PGR Management and Enhanced Use' was organized at NBPGR, New Delhi, from December 2-6, 2013. The workshop was organized by NBPGR in collaboration with Bioversity International, New Delhi, under the aegis of a Consultative Group on International Agricultural Research (CGIAR) funded research project on 'Climate Change and Food Security (CCAFS)'. The aim of the workshop was to impart contemporary knowledge on geographical information systems (GIS), climate data, climate analogues and their applications in PGR management and utilization, along with hands-on experience on various software, databases, clustering and analyses. The participants included eight persons from ICAR, one each from SAU and CSIR, and four from neighboring countries of the South East Asia (Vietnam, Laos and Cambodia) engaged in PGR management. Topics covered included role of GIS in PGR management and use; GIS and climate databases, geo-referencing data and importing data to a GIS platform; applications of remote sensing technologies in climate change studies; climate analogues; PGR data analysis in DIVA-GIS; use of geo-spatial tools for mapping of biodiversity etc. The Workshop was inaugurated by Dr J.S. Chauhan, ADG (Seed), ICAR and certificates were distributed by Dr S.K. Datta, DDG (CS), ICAR during the valedictory function on December 5, 2013. The workshop was coordinated by Dr Sunil Archak, PI, CCAFS project.

### Germplasm Field Day on Vegetable Crops at Issapur



Vegetable Crops Field Day at NBPGR Experimental Farm, Issapur

During *kharif* season, 2013 a **Germplasm Field Day on Vegetable Crops** (brinjal and bottle gourd) was organized at NBPGR Experimental Farm, Issapur, New Delhi on 30 October. A total of 780 accessions of vegetable crops comprising brinjal (700) and bottle gourd (80) were grown for characterization and evaluation. Evaluation for brinjal fruit and shoot borer was undertaken. The bottle gourd accessions included mostly those collected from North eastern part of the country. More than 25 participants from ICAR institutes and SAUs attended this important event. The vegetable crop breeders/researchers selected lines for utilization in the crop improvement programme.

### Germplasm Field Day on Crops at Jodhpur

A field day was organized at NBPGR RS, Jodhpur for crops like guar, mothbean, mungbean, cowpea, bajra and sesame on September 28, 2013. Some 150 scientists, farmers, students and persons from state agricultural department participated.



Dr R.K. Tyagi, Head, Division of Germplasm Conservation, addressing the participants during Germplasm Field Day at NBPGR RS, Jodhpur



## Awards and Recognition

**Wheat characterization and evaluation experiment conducted by NBPGR (2011-12) enters the Limca Book of Records 2013**



**Dr J.C. Rana**, Principal Scientist and Officer-In-Charge, NBPGR RS, Shimla elected as **Fellow, National Academy of Agricultural Sciences, Delhi** (FNAAS, 2014).

**Dr S.K. Yadav**, Senior Scientist, Germplasm Exchange Unit received '**Young Scientist Award 2013**' for his outstanding contribution in the field of Agricultural Science, during National Conference on 'Energy, Environment and Biotechnology Research (NCEEER-2013)', at Mewar Institute of Management, Vasundhara, October 6, 2013.

**Dr K. Rameash**, Senior Scientist, NBPGR RS, Hyderabad, awarded with '**Young Scientist Award**' and '**Life Fellow of the International Consortium of Contemporary Biologists**' conferred by MSET- International Consortium of Contemporary Biologists, at National Conference on 'Recent Advances in Modern Biology and Sericulture', Bangalore, October 24, 2013.

## Deputations Abroad

**Dr Jyoti Kumari**, Senior Scientist, Division of Germplasm Evaluation, deputed for training under NAIP-HRD Component (Crop Science) in the area of Allele Mining at **Department of Agronomy, Kansas State University, Manhattan, KS, USA** from September 16 to December 14, 2013.

**Dr Veena Gupta**, Principal Scientist, Division of Germplasm Conservation, NBPGR, New Delhi, attended the **International Training on Genetic Resources and Intellectual Property Rights**, Phase 1, at Swedish University of Agricultural Sciences, Uppsala, Sweden from September 23 to October 11, 2013.

**Dr Kavita Gupta** Principal Scientist, Division of Plant Quarantine, NBPGR, New Delhi participated in the **2<sup>nd</sup> International Congress on Biological Invasions** from October 22-26, 2013 and **11<sup>th</sup> International Forestry Quarantine Research Group Meeting**, Qingdao, China, from October 28 - November 1, 2013.

**Dr Gurinderjit Randhawa**, Principal Scientist, Division of Genomic Resources, NBPGR, New Delhi, participated in the **Workshop of the Network of Laboratories for the Detection and Identification of Living Modified Organisms** organized by Secretariat of the Convention on Biological Diversity (SCBD), United Nations Environment Programme, Montreal, held at Ispra, Italy from November 25-27, 2013.

## Retirements

**Dr J.B. Tomar**, Principal Scientist, Officer-in-Charge, NBPGR RS, Ranchi took voluntary retirement w.e.f. November 8, 2013.



**Sh Hari Ram**, Skilled Support Staff Experimental Station Issapur, New Delhi, superannuated on October 31, 2013.

## Transfer

**Dr R.S. Rathi**, Senior Scientist, transferred from NBPGR, RS, Shillong to NBPGR, RS, Ranchi (October 7, 2013) and became Officer-In-Charge w.e.f. November 11, 2013.

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