Plant Germplasm Registration Notice*

The Plant Germplasm Registration Committee of ICAR in its XXVII[th] meeting held on July 31, 2013 at the National Bureau of Plant Genetic Resources, New Delhi approved the registration of following 25 germplasm lines out of 123 proposals considered. The information on registered germplasm is published with the purpose to disseminate the information to respective breeders for utilization of these genetic stocks in their crop improvement programmes. Upon request, the developer(s)/author(s) is/are obliged to distribute the material for crop improvement programme of National Agricultural Research System.

1. HW 3601 (IC0598203; INGR13051), a Wheat (*Triticum aestivum*) Germplasm with Resistance to Brown Black Rust, it Carries Gene for Leaf Rust Resistant, *Lr* 19 and Stem Rust Resistant *Sr* 36

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HW 3631 (IC0598414; INGR13052), a Wheat (*Triticum aestivum*) Germplasm with Resistance to Stem and Leaf Rust, it Carries Gene for Leaf Rust Resistance *Lr*19 and Stem Rust Resistance *Sr*36

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The stem and leaf rusts of wheat respectively caused by *Puccinia graminis* Pers. f.sp. *tritici* Eriks. & E. Henn. (*Pgt*) and *P. triticina* Eriks. (*Pt*) are of countrywide importance in India. Both the diseases survive and spread from the source of their primary inocula available all-the-year-around in Nilgiri / Palni hills of South Hill Zone and Himalayas of North Hill Zone (Nagarajan and Joshi, 1985). From epidemiological point of view, the Pgt urediospore dispersal in India is unidirectional from the southern hills only (Nagarajan *et al*., 2006). On the other hand, primary inoculum of *Pt* originates both from Nilgiri/Palni hills and Nepal Himalayas, establish initial disease foci respectively in Peninsular/ Central India and adjoining Himalayan tarai areas and spread further to other parts of the country (Nagarajan and Joshi, 1985).

Central zone (CZ) is the migratory route of stem and leaf rust urediospores originating from Nilgiri/Palni hills. Rust inocula disseminate through CZ with the help of wind systems (as defined in Indian Stem Rust Rules) to main wheat growing areas in Northern plains of India (Nagarajan and Joshi, 1985). Rust inoculum built up on any susceptible variety in CZ will be of serious threat to the wheat crop in the Indian wheat bowl of NWPZ. Hence, the development and release of rust resistant high yielding wheat varieties and their cultivation in CZ is the envisaged strategy of wheat rust control which rests on diversifying the genetic basis of rust resistance for curtailing build up of rust inoculum in CZ.

Keeping in mind the objective of rust free production of wheat in CZ and to check the northwards spread of leaf and stem rust inoculum originating from south Indian hills, stem rust (*Sr*) and leaf rust (*Lr*) resistant genetic stocks were developed at Indian Agricultural Research Institute, Regional Station, Wellington-643 231, The Nilgiris, Tamilnadu, by the introgression of two independent segments of linked genes, *Sr*25/*Lr*19 (from *Agropyron elongatum*) and *Sr*36/*Pm*6 (from *Triticum timopheevi*) into the genetic background of

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Table 1. Seedling reactions of parents and genetic stocks to selected pathotypes of stem and leaf rusts

Sl. No.	Parents/Genetic stocks	Reaction to pathotypes							
		Stem rust			Leaf rust				
		40A	40-1	117-6	12-3	77-5	77-7	77-8	104-2
1	Cook*6/C 80-1	; 1	; 1	; 1	; 1+	0 ;	; 1	3C	;
2	C 306	4	4	4	3+	3+	2C	3C	3+
3	HW 3601	; 1	; 1	; 1	; 1	; 1	;	3	; 1
4	WH 147	4	4	4	3+	3+	3+	3+	3+
5	HW 3631	; 1	; 1	; 1	; 1	; 1	; 1	3+	; 1

high yielding, well adapted and rust susceptible wheat cultivars, C306 and WH147 of CZ.

Australian line, Cook*6/C 80-1, carrying stem/leaf rust resistance genes, *Sr*25/*Lr*19 and *Sr*36/*Pm6* used as donor parent and rust susceptible well adapted cultivars, C306 and WH147 were used as recurrent/recipient parents. Three cycles of back crossing were performed and final constitution made at BC_3-F_5 generation. Evaluation of the BC_3-F_5 lines along with their recurrent parents and controls carrying specific *Sr* and *Lr* genes under natural and artificial conditions indicated that the newly constituted lines confer resistance to most of the leaf and stem rust pathotypes at seedling (Table 1) and adult plant stages. Presence of *Sr*25/*Lr*19 and *Sr*36/*Pm6* were validated by applying the SCAR markers SCS 265, SCS 253 and Gb for *Lr*19 and SSR marker Stm 773 for *Sr*36 (Sivasamy *et al.,* 2009).

Thus, the newly constituted lines would serve as donor for leaf and stem rust resistance genes and the availability of combination of major and genetically diverse resistance genes in well adapted wheat cultivars would facilitate the strategic deployment to achieve enhanced resistance.

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2. UP 2672 (IC0597682; INGR13053), a Wheat (*Triticum aestivum*) Germplasm with High Protein Content (14.1%)

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UP 2672 possesses high protein content i.e.>14%. It was continuously tested for 5 years at many locations and has given consistently high protein content (>14%). In addition to high protein content it also possesses high thousand grain weight (46.6 g) and was found good for flour recovery. It is being used as check in Quality Component Screening Nursery (QCSN) for protein content.

3. MCM-11/01 (IC0524594; INGR13054), a Maize (*Zea mays*) Germplasm with 3-4 Cobs per Plant and Early Maturing

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Maize (*Zea mays* L.) is one of the important crops of Nagaland state in NEH region of India. The production of maize in the state is 0.13 mT with an average yield of ~2.0 tonnes/ha. Maize yield is determined by a number of traits including cobs/plant. Generally, 1-2 cobs/plant are observed in the present cultivars. A maize line (MCM-11/01) with multiple cobs (3-5) was selected from trial plot of an indigenous collection (IC0524594) in 2009. This accession was collected from Zubza village (latitude 25.7ºN, longitude 94.03ºE, altitude 983 m) of Kohima (Nagaland). Selected plants were grown in isolation for two consecutive years (2010 and 2011) at NBPGR Regional Station, Umiam (Meghalaya). Data were recorded on a number of agro-morphological traits. Mean data for some of the traits along with three check varieties are presented in Table 1. The MCM-11/01 had higher (3.4) number of cobs/plant, while all checks recorded single cob per plant. This is a unique trait as it has not been observed in the existing germplasm of NEH region. Although the selection had a higher number of cobs/plant, the grain yield/plant was not significantly higher than the checks, mainly due to its small grain size. The MCM-11/01 had dark brown coloured husk and cream coloured kernel. Breeding approaches can be initiated to incorporate this multi-cob trait into improved maize varieties.

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Table 1. Agro-morphological characteristics of selection (MCM-11/01), parent (IC524594) and checks

Trait	MCM-11/01	IC524594	RCM-1-3	Delhi check	Local red
No. of cobs/plant	3.4	1.0	1.0	1.0	1.0
Cob length (cm)	20.0	20.4	23.0	24.8	27.0
Cob width (cm)	4.8	4.4	5.2	3.4	5.8
Cob height (cm)	93.3	188	174.0	134.0	160.0
Plant height (cm)	200	348	307	268	262
Days to maturity	114	115	112	118	115
100-seed weight (g)	18.3	24.2	24.9	25.3	30.0
Grain yield/plant (g)	128.4	113.4	106.2	130.5	125.4
Husk cover	Good	Intermediate	Intermediate	Intermediate	Good
Husk colour at maturity	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
Kernel row arrangement	Regular	Straight	Straight	Straight	Straight
Kernel colour	Dull yellow	Yellow	Yellow	Yellow	Yellow
Grain shape	Indented	Indented	Indented	Indented	Indented
Grain size	Medium	Medium	Medium	Bold	Bold

4. SSG 226 (IC0597771; INGR13055), a Sorghum (*Sorghum bicolor*) Germplasm with Low Hydrocyanic Acid (HCN) (66.6 ppm), High Digestibility and High Leaf-Stem Ratio

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SSG 226 was the mutagenic derivative of the forage sorghum variety, SSG 59-3 which was released in 1974. To date, it has been used as a check variety in All India Coordinated Sorghum Improvement Project forage sorghum trials, since a multi-cut variety that could perform better than SSG 59-3 was not available at the National level. The line, SSG 226 was the outcome of the efforts made to create variability in SSG 59-3 and to identify lines with improved quality. Leaf parameters such as leaf length, leaf breadth are also important in forage sorghum as these increase the intake by the animal. Among the quality traits, low Hydrocyanic acid (HCN), high protein and high digestibility are important as far as forage sorghum is concerned. HCN is an anti-nutritional factor in forage sorghum which is potentially toxic to the animal when fed on 30-35 days old sorghum crop. Digestibility of fodder is the most important forage quality parameter which helps in better absorption of the feed taken in by the animal and studies show that small changes of IVDMD of 3-4% units would result in improvements of 17-24% in daily gains and production per hectare. SSG 226 had the lowest level of HCN (66.6 ppm vs 82.9 ppm of SSG 59-3) among all the lines tested with high IVDMD values compared to SSG 59-3. Its leaf-stem ratio was more compared to SSG 59-3. SSG 226 had the lowest level of HCN (66.6 ppm vs 82.9 ppm of SSG 59-3) among all the lines tested with high IVDMD values compared to SSG 59-3 (Table 1). Its leaf-stem ratio was more compared to SSG 59-3. This line with a combination of improved traits may be of interest to forage sorghum breeder aiming towards improving multi-cut forage sorghum for earliness and fodder quality.

Table 1. Performance of SSG 226 over two years

Line	HCN			IVDMD %			Leaf: Stem ratio		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pool
SSG 226	64.05	69.2	66.6	51.57	54.63	53.10	0.44	0.34	0.39
SSG 59-3	90.05	75.7	82.9	46.06	48.18	47.12	0.23	0.35	0.29
lsd 5%	19.20	14.0	15.6	03.10	04.28	04.0	0.02	0.14	0.10

5. NSS-7809 (IC0283734; INGR13056), a Sorghum (*Sorghum bicolor*) Germplasm with Popping Traits

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an annual, diploid, highly allogamous cereal crop. It is cultivated in a vast range of environmental conditions including frequent drought events and poor soil fertility. Popping trait is a potential area to be studied in the case of pearl millet as these grains can also be popped like corn, sorghum and rice (Murugeshan, 1986; Murty *et al.,* 1988); but its popping yields are usually low (<40%). Therefore, the present study was aimed to evaluate and search the unique germplasm/genetic stock for popping

trait, so that the identified germplasm can be used for genetics study as well as trait introgression into elite cultivars through appropriate breeding tools.

Morpho-agronomic Characteristics: The accession IC 283734 (INGR 13056) was identified with unique popping traits. This acc. had high popping yield (76.23±2.6%), puffing index (10.31±0.58), pop size (8.84±0.68mm) and expansion ratio around 3.07 %. It was having early maturity (82±2 days) and tall plant height (230±5 cm). The spike length, spike girth and seed weight of this accession were found to be 23.7±1.2 cm, 2.51±0.24 cm and 13.2±1.1 g respectively. Apart from this it has nodal tillers, nodal pubescence and short bristle length.

Associated Characters and Cultivated Practices: This accession is moderately resistant for blast and rust and resistant for downy mildew disease based on field screening. It can be grown for dual purpose to be used as fodder as well as food. Its early maturity property has the added advantage for fitting into multiple cropping systems. This accession belongs to related species *P. squamulatum* and was collected from Nandhikotkur district of Andhra Pradesh. It can also be used for identification of causal gene, inheritance of the trait and mapping and tagging of underlying genes by making crosses between contrast parents.

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6. BAR-062 (IC426765; INGR13057), a Blackgram (*Vigna mungo*) Germplasm as a Photosensitive Line (Flowers only in Post Rainy/*Rabi* season)

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Black gram *(Vigna mungo* (L) Hepper) also known as *urdbean*, *minumulu* (Telugu), *mash*, *black mapte* etc. is an important short duration pulse crop grown in many parts of India. Blackgram is of very ancient cultivation and believed to have originated in India (Purseglove, 1974). Breeding efforts to develop improved, high yielding varieties in black gram have resulted in release of 107 varieties in India catering to the diverse agro ecological regions of the country and local preferences. Most of the varieties released are photo-insensitive and therefore can be grown during any time of the year. A perusal of NORV database indicated the availability of only one photosensitive line (LBG-17) is known to exist in this crop, which flowers in short-day conditions (www.nbpgr.ernet.in). However, there is a need to identify more photosensitive lines in order to have parental diversity for varietal development, keeping the location specific requirements. One such accession was identified during evaluation and characterisation of germplasm collected from Andhra Pradesh.

Morpho-agronomic Characteristics: One hundred and sixty accessions of black gram germplasm lines were grown at the NBPGR RS experimental farm, Hyderabad, India, during Rainy 2005, 2006 and Post-rainy 2005-06, 2006-07 seasons for evaluation. The days to 50% flowering of the germplasm lines ranged from 34 to 52 days in rainy seasons and 46 days to 60 days in post rainy seasons. An accession *viz.* IC426765 (Collector No: BAR-62), did not flower in both the rainy seasons. However the above mentioned accession produced productive pods during the successive post-rainy seasons and recorded 49 days to 50% flowering indicating its photosensitive nature (Babu Abraham *et al.,* 2013). Morpho-agronomic traits of the blackgram germplasm accession are given below:

Morpho-agronomic traits of blackgram accession – IC426765

Descriptor	Descriptor state
Plant habit	Indeterminate
Primary leaf shape	Ovate lanceolate
Leaf colour	Dark green
Leaf pubescence	Dense
Pod pubescence	Dense
Seed colour	Black
Mean of two seasons (post rainy2005-06 & 2006-07)	
Days to 50% flowering (no.)	49
Plant height (cm)	20.51
Primary branches/plant (no.)	2.8
Clusters/plant (no.)	15
Pods/cluster (no.)	3.6
Seeds/pod (no.)	4.77
100-seed weight (g)	4.8
Pod length (cm)	3.75
Peduncle length (cm)	5.8
Pods/plant (no.)	17.4

The performance of this photosensitive line was analyzed in comparison to released check varieties in the post rainy 2005-06 and 2006-07. In post rainy 2005-06, accession IC426765 performed better than LBG-20 in plant height and 100-seed weight (CD 0.05).The superior performance of these accession in some of the quantitative traits *viz.,* plant height and 100-seed weight over released checks indicate its potential in the breeding programmes for black gram crop improvement.

IC426765 had indeterminate growth habit and dense pod pubescence. These qualitative characters indicate that it is a primitive landrace. In addition, the qualitative characteristics of this photosensitive accession were compared with Krishnayya (LBG 17), a photosensitive variety released by Acharya NG Ranga Agricultural University, Andhra Pradesh. It differed from the released variety (LBG-17) in leaf colour, primary leaf shape and seed colour indicating the different genetic background.

This accession IC426765 (BAR-62) is a new report of photosensitive black gram germplasm line. The dominance of photoperiod insensitivity over photoperiod sensitivity has already been reported (Verma, 1971). It is well documented that, the photosensitive trait in any plant is a primitive character as loss of photoperiodic response is considered as a sign of domestication (Paroda *et al.*, 1988). Further, the alternate use of the accession such as forage, cover crop and green manure crop can also be exploited during the rainy season by detailed studies on the biomass yield and nitrogen fixation in the field in view of the prolonged nodulation in the absence of reproductive phase. Disintegration of the nodules has been correlated with the onset of pod formation stage (Singh, 1974). Therefore, this line can be utilized in the pulses breeding programmes to develop multipurpose varieties of blackgram suitable for different agro-climatic zones of Andhra Pradesh.

The passport data details show that, IC426765 was collected from Killoyi village, Mandasa mandal in Srikakulam district of Andhra Pradesh.

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7. IC0486088 (IC0486088; INGR13058), an Upright Podding Chickpea Genotype Suitable for Mechanical Harvesting

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Cultivated chickpea (*Cicer arientinum* L.) has two distinct forms, *i.e. Desi* (small seeded, angular shaped and colored seeds with high percentage of fibre) and *Kabuli* types (large seeded, owl shaped, beige colored seeds with a low percentage of fibre). The average yield of chickpea is still low in India and further genetic improvement is constrained by the non-availability of appropriate germplasm. Further, there is a scope for widening the genetic base of cultivated varieties through pre-breeding. Plant genetic resources are the reservoir of useful gene/allele sources and provide basic raw materials for further genetic improvement.

The National Bureau of Plant Genetic Resources, New Delhi, undertook a large scale characterization and evaluation programme of the entire gene bank chickpea germplasm at Mahatma Phule Krishi Vidyapeeth (MPKV) Rahuri, Maharashtra, in a collaborative mode to enhance their proper utilization during *rabi* 2011-12. The experiment was conducted at the Pulse Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri in which a total of 18,873 germplasm accessions were grown under Augmented Block Design with three improved check varieties, *viz*., *Vijay, Digvijay* and *Vishal.*

The observations were recorded on twenty agro-morphological traits in the entire chickpea germplasm. While recording these various traits in the chickpea germplasm, one accession namely, IC486088 was found to bear upright peduncle and podding behaviour. This unique trait was further validated in the off-season Himalayan nursery at Chaudhary Sarwan Kumar, Himachal Pradesh Agricultural University, Research Station, Sangla during summer 2012 and the upright podding behaviour was found to be true to its type. The upright podding trait has a special significance for its possible utility in mechanical harvesting of chickpea which is becoming increasingly important in view of huge labour requirement for manual harvesting of crop and the associated drudgery involved with it. This unique accession bearing special trait of interest can be further investigated to understand its inheritance pattern and can be suitably incorporated in future chickpea breeding programme for developing varieties suitable for mechanical harvesting.

8. IND 001 – Kappadam Tall (IC0430667; INGR13059), a Coconut (*Cocos nucifera*) Germplasm with Low Husk (33 to 36%) and High Copra Content (215 to 280 g)

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Kappadam Tall coconut – a selection from the west coast populations (WCT) coconut population has scientific and commercial value as it has potential to be used in breeding programmes for increased fruit size and lower husk content. The accession also known as 'Chappadan' in some parts of Kerala, is a robust palm from the South-west coast of India. The accession was collected and planted at CPCRI, Kasaragod during 1935. An *inter se* mated population of this collection is conserved in the National Gene Bank at CPCRI.

Morpho-agronomic Traits: Compared to the other Indian varieties from WCT, this accession gives heaviest fruits with thinner husk. The fruits of this selection are predominantly green, oblong to round in shape. The palms of this selection are tall statured with clear bole on the stem and about 25 leaf scars over the stem between 1 and 2 m from the ground. The leaves are longer (3.7 m) with broader and longer leaflets. The palms are strictly cross pollinating as there is no overlapping of male and female phases within and between inflorescences. The palm starts flowering after 6 to 7 years of age yielding heavier nuts. The average fruit weight is around 1200 g with dehusked fruit weight of about 800 g. The kernel weight ranged from 400 to 550 g which gives 215 to 280 g of copra.

Cultivation Practices: The palms of Kappdam Tall selection can be grown with the regular recommended package of practices with summer irrigation for sustained yield of nuts. It can be grown in all coconut growing regions for conservation and further utilization. It has good potential for use in breeding programmes aiming for increasing the nut size and copra yield.

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9. IND 030-Laccadive Micro Tall (IC0430669; INGR13060), a Coconut (*Cocos nucifera*) Germplasm with Cluster Bearing Heavy Bunches of Micro Nuts

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The accession was first introduced from Lakshadweep islands to mainland India in 1940, Conserved in field gene banks and evaluated in replicated trials. The Laccadive Micro Tall is a selection from the tall coconut populations of Lakshadweep Islands known for cluster bearing, heavy bunches of micro nuts with high oil content. The accession is unique for its heavy bunches with large number of micro nuts and has scientific and commercial value as it has recorded highest copra oil content (75%) among the conserved coconut accessions. The accession is also found suitable for ball copra production as the very slow rate of germination, small

nuts with less nut water aiding in very low spoilage during storage for making ball copra.

Morpho-agronomic Traits: The palms of this selection are tall statured with clear bole on the stem. The palms start flowering after 6 to 7 years of age but profuse fruit production generally observed after 9 to 10 years of planting. The mean annual bunch production is 11 with a range of 8 to 12. The average yield varies from 100 to 320 fruits per annum in Kasaragod whereas still higher in selected palms in few years. The palms are mostly alternate bearers, nuts are small, kernel is thick with average copra content of about 90 g. The copra oil content is 75%, the highest recorded among the germplasm evaluated so far. The nuts of Laccadive Micro tall are suitable for production of ball copra mainly due to the slow rate of germination resulting in lowest damage during storage which is required for ball copra production. The inflorescences are longer with strong peduncle with partial overlapping of male and female phases in alternate years during successive inflorescence production making the palms self pollinated to some extent. The fruits are green or greenish brown, oval to round shaped. The dehusked nuts are also oval or round shaped with a pointed tip.

Cultivation Practices: The palms of Laccadive Micro Tall selection can be grown with the regular recommended package of practices with irrigation for sustained yield of nuts. It can be grown in all coconut growing regions for conservation and further utilization. It has good potential for use in breeding programmes aiming for increasing the nut yield, oil content and more copra out turn.

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10. IND 092 - Cameroon Red Dwarf (IC0598219; INGR13061), a Dwarf Coconut (*Cocos nucifera*) Germplasm with Distinct Bright Orange Colored Nuts. Higher Content of Tender Nut Water and High Copra Content

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The said type of CRD selection was made from the originally introduced orange dwarf population from Cote d'Ivoire and conserved during 1977 in the field gene bank at CPCRI. Palms developed from the seed nuts through *inter se* mating of selected mother palms have been conserved at National Genebank at CPCRI. After evaluation for decades, the present selection was made having higher copra among the dwarf accessions with bright orange coloured fruits among the germplasm with dwarf plant stature. The nuts produced from the selected palms were used to establish progeny blocks at CPCRI. The selection has both scientific and commercial value owing to the dwarfness coupled with attractive orange fruits with good quantity of tender nut water and high copra content.

Morpho-agronomic Traits: The palms of this dwarf selection are dwarf statured attaining a height of 4.4 m at 18 years of planting. The palm does not possess bole but the stem is not very slender with a girth of about 76 cm. The internodal length is very short and the length of 10 internodes is about 25 cm. The palms start flowering after 6 years of age. The inflorescences are short with

strong peduncle with complete overlapping of male and female phases making the palms autogamous. The fruits are attractive orange red in colour, medium sized, oval shaped with a pointed apical end. The dehusked nuts are also oval, medium sized with strong shell and thick kernel. The palms tend to bear in alternate years with an average bunch production of 10 per year. The average nut yield is 80 fruits per palm per year. The fruit weighs about 945 g, with a smaller percentage of husk to whole fruit weight (27.8%). The nut without the husk weighs about 657 g and produces nearly 220 g of copra per nut which is highest among the conserved orange dwarf accessions in the genebank.

Cultivation Practices: The palms of Cameroon Red Dwarf selection can be grown with the regular recommended package of practices with irrigation for sustained yield of nuts. It can be grown in all coconut growing regions for conservation and further utilization. It has good potential for use as apparent in breeding programmes aiming for earliness, tender nut yield, copra yield and attractive coloured fruits.

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11. IND 414 – Chowghat Yellow Dwarf (IC0598220; INGR13062), Distinct Dwarf Coconut (*Cocos nucifera*) Germplasm with Yellow Coloured Nuts and Erect Leaves

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Chowghat Yellow Dwarf is a unique indigenous yellow dwarf coconut line developed through selection from the original population of Chowghat Orange Dwarf conserved at National Gene Bank at CPCRI. The palms in the gene bank were developed through the *inter se* mated original mother palms available at CPCRI followed by progeny selection at CPCRI for nut colour. After evaluation of the progenies for inheritance of the trait, the selection was made for the unique trait of yellow fruits, rachis, flowers and petiole. As there are no indigenous yellow dwarf population exists in the mainland India, the selection is considered unique. Useful variety as a parent for crossing with selected talls to produce hybrids and hence of commercial value.

Morpho-agronomic Traits: Most yellow dwarf populations of the coconut growing regions of the world has been related to Malayan dwarfs which are characterized with drooping leaves and straight spindle. The Chowghat Yellow Dwarf is observed as having erect leaves, large sized nuts with higher tender nut water, higher nut yields has excellent adaptability to the coconut growing environment in the country as it is a selection from the Chowghat Orange dwarf. The inheritance of the yellow colour traits is also confirmed as the *inter se* mated seedling progenies exhibited mostly seedlings with yellow coloured petiole and few with orange colour. The typical palms of this type could be selected based on the petiole colour.

The number of fruits per bunch was observed to range from 12 to 20. The palms belong to dwarf type of coconut with a stem girth of 55 cm at 1 m height and an average leaf length of 3.45 m at the age of 30. The bunch production in the selected palms are regular and ranged from 9 to 13 bunches per year after

commencement of flowering. The colour of the fruit is yellow, oval shape with a fruit length of 37cm and fruit breadth of 16.5cm. The tender nuts contained more sweet water ranging from 250 to 340ml per nut (Average 290ml) with average TSS of about 6.7º brix.

Cultivation Practices: The palms of Chowghat Yellow Dwarf can be grown with the regular recommended package of practices with summer irrigation for sustained yield. It can be grow in all coconut growing regions for conservation and further utilization.

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12. IND 221 – Andaman Horned Cocos (IC0598221; INGR13063), a Coconut (*Cocos nucifera*) Germplasm with Distinct Character of Horny Nuts

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Horned cocos is a unique coconut type developed through selection from the original population collected from Andaman islands during 1999 and conserved at National Gene Bank at CPCRI research centre, Karnataka. The palms in the gene bank were developed through the nuts collected from the original mother palms available at natural coconut populations of South Andaman district followed by seedling selection at CPCRI. After evaluation of the said accession for inheritance of the trait, the selection was made for the unique trait of presence of multiple ovaries female flowers which results in horn like structures over the matured coconut fruits. The trait is unique and not present in any other accession in the gene bank. The extent of genetic diversity in the accession was evaluated using 14 highly polymorphic microsatellite markers. The observed heterozygosity was 0.19, while the observed heterozygosity was 0.25. This indicated a tendency towards inbreeding within the population. It had a fixation index (FST) of 0.25 indicating a high level of genetic differentiation. It come handy as a marker in breeding programmes.

Morpho-agronomic Traits: Coconut produces female flowers with one ovary without any appendages over the set fruits. The candidate accession *viz*., Horned cocos produces female flowers with three or more divided part of ovary (multiple ovaries) which result in the horn like appendages over the fruits making it unique. The inheritance of the traits is also confirmed as the second generation palms at the field genebank of CPCRI also exhibited the trait. The original mother palms are identified with this unique trait among the natural coconut populations at South Andaman district collected during 1999. Subsequently the seedling progenies were planted and evaluated at National Field Gene Bank of coconut under CPCRI Research Centre, Kidu, Karnataka. Hence the performance is known at two locations i.e. Andaman and Karnataka

The number of fruits per bunch ranged from 10 to 21 in the initial years of flowering fruiting from 2009 to 2011. The palms belong to tall type of coconut with a stem girth of 85 cm at 1 m height and an average leaf length of 3.6 m at the age of nine. The bunch production is regular and ranged from 7 to 10 bunches per year after commencement of flowering. The setting percentage of fruit is about 30 percent. The colour of the fruit is green with oval shape. The husked fruit is round with a hard shell measuring an average of 4 mm thick. The cavity volume ranged from 120 to 140 ml.

Cultivation Practices: The palms of Horned cocos are normal in all other morphological traits similar to other coconut accessions. They can be grown with the regular recommended package of practices with summer irrigation for sustained yield. It can grow in all coconut growing regions.

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13. IND 331-Laccadive Mini Micro Tall (IC0598222; INGR13064), a Coconut (*Cocos nucifera*) Germplasm with Distinct Character of Extremely Small Nuts with Very Low Copra Content, not found in any other Coconut Variety

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Mini Micro Tall is a unique coconut type present in Minicoy Island of Lakshadweep, known for its smallest fruits. This unique type was collected through selection from the original coconut population of Minicoy Islands and conserved at National Gene Bank at CPCRI research centre, Karnataka. The palms in the gene bank were developed through embryo culture of nuts collected from the original mother palms available at CPCRI Regional station, Minicoy. The trait of smallest nuts in all bunches of the palms is unique and not present in any other accession in the gene bank. The nuts of this type do not germinate under natural conditions. The germplasm has academic and scientific value besides the potential for ornamental planting. This could be of interest to breeders trying to increase the number of nuts per bunch.

Morpho-agronomic Traits: This type is a tall coconut type with morphological traits similar to other coconut accessions but differing in the nut component traits. The female flowers develop into small fruits recording lower values for most nut component traits. The average fruit weight was about 31 g with copra content of 5 g. The accession was observed with lowest husk content also. The colour of the fruits in this accession is green or greenish brown with round shape. The kernel sometimes fills the entire cavity with the embryo completely embedded in the kernel. The cavity has very less water of about 1.1 ml and the copra has 73% oil.

Cultivation Practices: As the Mini Micro nuts do not germinate under natural conditions owing to the less nut water and quick drying of nuts, they need to be multiplied through embryo culture. The vegetative growth of Mini Micro Tall palms is normal with similar morphological traits compared to other coconut accessions. They can be grown with the regular recommended package of practices with summer irrigation.

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14. IND 099 – Niu Leka Green Dwarf (EC0415218; INGR13065), a Coconut (*Cocos nucifera*) Germplasm of Short Statured Palm but Possessing the Advantageous Characters of Talls

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Niu Leka Dwarf selection is a unique coconut type selected from the original population collected from Fiji islands during 1983, conserved and evaluated at World Coconut Germplasm Centre, CARI, Sipighat over 25 years. The palms of this selection planted in the National Gene Bank at CPCRI, were developed through *inter se* mating of selected original mother palms available at Andaman followed by seedling selection. The present selection was made having higher copra among the dwarf accessions in the germplasm with dwarf plant stature, allogamous trait and robust growth. The selection has both scientific and commercial value owing to its dwarfness coupled with higher copra content and attractive green nuts. This variety has good commercial potential since it combines commercially favorable traits of tall and dwarf varieties

Morpho-agronomic Traits: This accession is a Green Dwarf with higher copra content among the dwarf populations in the gene bank. The palms are very dwarf with nuts and pollination behaviour similar to talls. The average weight of dehusked fruit is about 800 g with kernel weight of about 450 g yielding about 260 g of copra. Generally, dwarf accessions of coconut are highly self pollinated due to the overlapping of male and female phases in the inflorescences. However, this Niu Leka Dwarf selection is observed with a greater degree of cross pollination owing to its non-overlapping phases. The palms are dwarf characterized with higher number of leaf scars (over 33 in 1 m) on the stem making the selection is exhibiting the higher level of dwarfness. The stem of the palms are robust with girth at 1 m over 100 cm which is unlikely in other dwarf accessions. The stem is intermittently constricted which is a unique trait of this selection whereas the stem is smooth in other tall and dwarf accessions. The palms come to flowering in about 4 to 5 years; the leaves are shorter and stiff, leaflets closely arranged (nearly plicate) allowing less light below the crown. The fruits are green in colour, oblong to round in shape, with a cavity volume of over 300 ml in mature nuts. The tender nuts are large with a fresh weight of about 2 kg having on an average of 470ml of sweet tender nut water. Biometric clustering revealed that the grouping of this accession with talls due to the allogamous nature and higher copra.

Cultivation Practices: The palms of Niu Leka dwarf selection has to be established with careful selection of mother palms followed by *inter se* mating among them and seedling selection to maintain the dwarfness and other desirable traits. They can be grown with the regular recommended package of practices with summer irrigation for sustained yield. It can grow in all coconut growing regions for further utilization. It has tremendous potential to be used in the coconut improvement programme for breeding for dwarfness coupled with higher copra out turn and tender nut yield.

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15. Ole-9-P2-P1-P22 (IC0597598; INGR13066), a Safflower (*Carthamus tinctorius*) Germplasm as a High Oleic Acid (18.63%) and High Oil (34%) Content Line

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Safflower (*Carthamus tinctorius* L.) is an important oilseed crop, its oil demand is increasing world over because of its potential for multi-purpose uses. Oleic content in safflower oil is generally around 17-20% making it unsuitable for deep frying (Gecgel *et al*. 2007). High oleic safflower oil is stable at high temperatures and makes it superior for frying. High oleic oil is also suitable as a biodiesel fuel additive (Bergman and Flynn, 2001).

The high oleic safflower line, Ole-9-P2-P1-P22, having 81% oleic content was developed from a cross, EC523367-9 x EC548816-14, through back-crossing followed by sib-crossing and simultaneous selection for high oleic and high oil content at the Directorate of Oilseeds Research, Hyderabad, India (Praduman and Anjani, 2012). The parent, EC-523367-9 is a high oleic selection and the parent, EC-548816-14 is a lenoleic selection possessing high seed weight.

Ole-9-P2-P1-P22 possesses high oil content (34%). It is spiny in nature with profuse branching habit, serrate obvate upper leaves and green stem. It matures in 70-75 days and matures in 120 to 125 days after planting. It also exhibited resistance to wilt (*Fusarium oxysporum* f.sp *carthami)* in wilt sick plot over three years at the Directorate of Oilseeds Research, Hyderabad.

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16. TCH 1728 (IC0597400; INGR13067), a Cotton (*Gossypium hirsutum*) Germplasm with Leaf Hopper (*Amrasca bigutulla*) Resistance, More Leaf Thickness, Higher Number of Trichomes

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The proposed breeding line TCH 1728 is an assured source for leaf hopper resistance. It has unique characteristic features of more leaf thickness and higher number of leaf trichomes. The breeding line was developed at Department of Cotton, Tamil Nadu Agricultural University, Coimbatore during 2004-05 from the parental hybridization of H 26 X H 56-9-6-4-1 followed by pedigree selection breeding.

Morpho Agronomic Characteristics: The breeding line TCH 1728 recorded a boll weight of 4.6 g and with about 32 numbers of bolls per plant. Boll shape of the entry is oval with pointed tip and had medium size boll. Under All India Co-ordinated Varietal Trial, the breeding line TCH 1728 was recorded 1,811 kg/ha and ranked 2nd place in South zone during 2010-11 in Br.02a Initial Evaluation trial of *G. hirsutum*. This was 18.9% and 16.8% increase yield over the local check MCU 13 (1,523 kg/ha) and zonal check surabhi (1,550 kg/ha) respectively. In respect of fibre quality parameters, the breeding line TCH 1728 possessed a ginning outturn of 31.1%. It is registered as long staple

cotton with 30.9mm span length and fibre strength of 21.9 mm. It matures in 160 days.

Associated Characters and Cultivated Practices: The entry TCH 1728 performed well against leaf hopper in North zone locations and recorded grade 1 for jassid injury in 1-3 scale during 2010-11 in preliminary screening (Br.02a) to sucking pests. Under epizotic screening at Rahuri during 2011-12, the entry TCH 1728 recorded grade 2 for jassid injury. In South zone, the entry TCH 1728 was tested under Br.03a PVT of *G.hirsutum* in AICCIP during 2011-12. The result showed that the entry TCH 1728 recorded moderate resistance to leaf hopper. The same result was also obtained in advanced screening of promising entries for leaf hopper resistance. Based on the study the culture is highly suitable and adaptable for all the three zones *viz*., Northern, Central and south.

Variations in leaf anatomical structures contributing for resistance against leaf hopper are given hereunder.

Characters	Entries	
	TCH 1728	Check DCH 32
Leaf thickness (µ)	111.31	96.57
Trichomes / sq.cm	165.6	17.0
Distance of phloem from lower epidermis (µ)	222.78	214.76
Palisade cell structure compact / semi-compact	Compact	Semi-compact
Palisade cell height (µ)	57.33	36.98
Thickness of phloem (µ)	79.01	59.13

The culture TCH 1728 registered higher number of leaf trichomes of 165.6/sq. cm and leaf thickness recorded was 111.31 µ which was higher as compared to the check DCH 32. This showed that the entry has the ability to disrupt the setting behaviors of the leaf hopper in leaves. Higher leaf thickness associated with a thick epidermis and with high percentage of straight trichomes on leaves resulted in difficulty for leaf hopper to pierce the leaf surface. The entry TCH 1728 recorded compact palisade cell structure and higher palisade cell height of 57.33 µ which showed that leaf hopper was unable to puncture the leaf at right angle to the long axis of its body and it could not reach the tissue directly above the point of puncture. This leads to resistance against leafhopper in TCH 1728. The other character such as thickness of phloem and distance of phloem from lower epidermis was also higher in TCH 1728. From this study it is concluded that the breeding line TCH 1728 is superior against leaf hopper. Hence, this breeding line can be used as resistant source for leaf hopper.

17. IC 553688 (IC0553688; INGR13068), a Chilli (*Capsicum chinense*) Germplasm as a Unique Material for High Capsaicin Adapted to the Tropical Humid Climate

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During the last few decades, there has been substantial increase in area under crops with high nutraceutical values and accordingly there lies a constant scope for identification of genotypes with higher content of any active principle. *Capsicum chinense* is well known for its exceptional heat (Scoville score) and the extracts have a huge national and international market owing to their diverse use. Hence, hot chillies and peppers have huge potential in nutraceutical industry. The capsaicinoids content of the chilli fruits greatly vary among the species, cultivars, and the growing conditions. The native chilli variety '*Bhut Jolokia*' found in northeastern regions of India was recently reported to be the hottest chilli pepper in the world (Mathur *et al*., 2000). IC 553688,

a locally grown chilli landrace, was collected from a place known as '47 Kilometre Point', south of Indira Point (6.75° N, 93.83° E) of Andaman & Nicobar Islands and evaluated at Central Horticultural Experiment Station, a regional research station of Indian Institute of Horticultural Research, Bengaluru.

The leaf surface of the genotype IC 553688 had the characteristic crinkled pattern between the veins, had greenish-white petals, blue anthers, flowers borne in clusters of 2-4, fruits had constriction between calyx and pedicel. It also has distinct traits like crinkle leaf surface between the veins, presence of a calyx constriction, multiple flowers per node, greenish corolla, and blue anthers and the fruits had distinct aroma. The fruit had undulating surface and distinct aroma resembling clarified butter. The length of fruits ranged from 4.0-6.0 cm and weighed about 4.98-7.40 g. IC 553688 was analysed using HPLC against the pungency of a '*bhut jolokia*' strain which revealed a rating of 1,147,384 and 508,623 SHU respectively. The '*bhut jolokia*' hitherto known to be the hottest chilli variety of India because of its higher pungency recorded as have 855,000 SHU and 1,041,427 SHU in 2000 and 2004 respectively. However, the present comparison has revealed that (IC 553688) has more heat unit than '*bhut jolokia*' reported in every occasion.

IC 553688 has become well adapted to hot and humid climate during the long course of cultivation in Andaman and Nicobar Islands and therefore, it can be successfully cultivated in hot humid climatic zones with better recovery of pungent principles. Under the climatic condition of Bhubaneswar, a single plant produces around 150 fruits weighing 800 g/plant. Hence, it enjoys good chances of commercial exploitation of the genotype in areas having similar environmental conditions. Thus, *C. chinense* accession IC 553688 rich in capsaicin content can be exploited for use in pharmaceutical industry.

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18. NKO-24 (IC0573223; INGR13069), a Spiked Ginger Lily (*Hedychium spicatum*) Germplasm with Bold Seed, Early Emergence and Late Senescence

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Spiked Ginger Lily (*Hedychium spicatum* Buch.-Ham. ex J.E. Smith) a genus of Zingiberaceae, is found abundantly in the wild state in the forest land of Uttarakhand. It is known locally as *van-haldu, siura, bagaldu, kachoor, kapur-kachari, kapur-kachali* and *gandh sathi.* In the Greek language *Hedychium* (*hedys,* sweet; *chion,* snow) refers to the fragrant white flowers of some species. World-wide, it has 50 species reported from Madagascar, South-west China, Nepal and Indo-Malaysia, whereas, 35 species are available from the hills of east, south and central India, Jammu and Kashmir, Himachal Pradesh, Arunanchal Pradesh and Uttarakhand. It is widely available in moist, damp-shady and evergreen forests of oak-rhododendron and oak-deodar at an altitude of 800 to 2,800 m above mean sea-level. It has several ethnobotanical notes and much popular in traditional systems for the treatment of diarrhoea, piles, bronchial asthma, semen disorders, skin diseases and stomach ailments (Gaur, 1999).

During the project period (April, 2008 - June, 2012) entitled "Studies on relationship between ecogeography of the chemotypic variation of nine important but highly threatened medicinal plant species and prospects of their cultivation" financed by NAIP-IV, a total of 34 accessions of Spiked Ginger Lily were collected from North-west Himalayas and Central Himalayan Region of India and identified a superior genotype *i.e.*, bold seeded, early emergence and late senescence. The Spiked Ginger Lily germplasm (NKO-24/IC573223) was collected and identified from Kausani, District - Bageshwar at an altitude of 1600 m asl of Uttarakhand. It was successfully raised and thrives well with luxuriant

growth in Field Gene Bank/ Herbal Garden, NBPGR, R/S Bhowali, Nainital, Uttarakhand. The present genetic stock of *Hedychium spicatum* Buch.-Ham. ex J.E. Smith germplasm collection NKO-24/IC573223 showed bold seeded, early emergence and late senescence as compared to other accessions including local check collected from Central Himalayan region (Koranga *et al.,* 2011).

Morpho-agronomic Characteristics: It is aromatic, branched, perennial, 100-120 cm. high. Leaves broadly ovate–lanceolate, 35.0-45.0 X 5.0-6.0 cm, acuminate, glabrous above, sparsely pubescent beneath; flowers fragrant, white, orange–red base, in dense, terminal, 12.0-15.5 cm long spike; capsules globose, 3-valved with an orange–red lining; seeds black with red aril (Tables 1 and 2).

Table 1. Qualitative and quantitative characters studied in different accessions of *Hedychium spicatum*

S.No.	Plant character	IC 573203 (Local check)±SE	IC 573223 (Bold seeded genotype) ±SE	Genotypes* (32 accessions) ±SE
1.	Plant habit	Perennial	Perennial	Perennial
2.	Mode of reproduction	Asexual & sexual	Asexual & sexual	Asexual & sexual
3.	Plant growth habit	Semi-erect/erect	Semi-erect/erect	Semi-erect/erect
4.	Rhizome length (cm)	37.0±8.4	42.0±13.3	35.2±13.2
5.	Rhizome thickness (cm)	36.9±6.3	24.6±9.7	30.2±13.6
6.	No of primary branches/rhizome	1.2±0.4	2.2±0.7	1.30±0.4
7.	Month to 50% sprouting	May	April	May
8.	Aerial stem length (cm)	60.6±9.5	116.3±8.21	64.2±12.14
9.	Number of leaves/clum	8.7±1.4	9.8±1.8	7.9±1.4
10.	Lamina attachment (angle on clum)	Acute	Acute	Acute
11.	Lamina length (cm)	29.2±4.8	42.5±3.7	29.8±5.8
12.	Lamina width (cm)	8.5±1.4	5.9±0.4	7.5±1.5
13.	Lamina shape	Oblanceolate	Oblanceolate	Oblanceolate
14.	Month to flower initiation	July	June	July
15.	Number of spike/plant	01	01	01
16.	Spike length (cm)	10.6±3.7	15.2±5.7	14.7±5.5
17.	No. of flowers/spike	25.7±2.6	17.9±4.8	16.5±3.2
18.	Flower colour	White, orange-red base	White, orange-red base	White, orange-red base
19.	Corolla tube length (cm)	7.9±0.4	7.5±0.3	7.9±0.4
20.	Floral bract length (cm)	3.1±0.37	3.0±0.39	2.9±0.30
21.	Floral bract colour	Green	Green	Green
22.	Floral bract shape	Oblong	Oblong	Oblong
23.	Month to capsule maturity	August	July	August
24.	No. of capsule/spike	2.4±2.23	1.7±2.79	2.8±3.02
25.	Capsule shape	Globose	Globose	Globose
26.	Seed yield/plant (g)	84.5±82.1	67.0±114.2	101.5±107
27.	Seed colour	Brown	Brown	Brown
28.	Aril type	Lacerated	Lacerated	Lacerated
29.	Aril colour	Red	Red	Red
30.	100-seed weight (g)	0.76±0.02	2.57±0.15	0.81±0.03
31.	Month of senescence	September-October	October-November	September-October

* Mean value of 32 accessions

Table 2. 100-seed weight of *Hedychium spicatum* accessions

S. No.	Collector No.	IC Number	100 seeds weight ± SD	Area of Collection	State	Alt m asl
1.	MMBO-3043	IC589078	0.80±0.040	Dhakuri, Bageshwar	UK	2876
2.	MMBO-3057	IC589081	0.80±0.021	Shama, Bageshwar	UK	1967
3.	NBH-01	IC574525	0.82±0.029	Mandal, Gopeshwar	UK	2200
4.	NBH-02	IC574524	0.82±0.067	Shimla, Shimla	HP	2200
5.	***NKO-24**	**IC573223**	**2.57±0.153**	**Kausani, Bageshwar**	**UK**	**1603**
6.	NKO-27	IC573226	0.80±0.036	Meckludganj, Kangra	HP	1831
7.	NKO-29	IC573228	0.81±0.035	Harabagh, Mandi	HP	1450
8.	****NKO-2965**	**IC573203**	**0.76±0.017**	**Niglat, Nainital**	**UK**	**1480**
9.	NKO-37	IC573233	0.79±0.050	Kandi, Kullu	HP	2066
10.	NKO-43	IC574506	0.85±0.026	Bara Pathar, Nainital	UK	1556
11.	NKO-46	IC574509	0.83±0.017	Sigadi, Nainital	UK	2202
12.	NKO-53	IC574515	0.80±0.012	Dhanachuli, Nainital	UK	2234
13.	NKO-55	IC574517	0.82±0.060	Momaulla, Champawat	UK	2149
14.	NKO-59	IC574521	0.82±0.012	Shillong Peak, Shillong	MG	1888
15.	NKO-67	IC589086	0.80±0.026	Gorikund, Rudraprayag	UK	1931
16.	NKO-71	IC589089	0.79±0.035	Sunil gaon, Chamoli	UK	2075
17.	NKSK-01	IC573205	0.82±0.025	Ramgarh, Nainital	UK	1702
18.	NKSK-06	IC573207	0.80±0.023	Kasyalekh, Nainital	UK	2290
19.	NKSK-07	IC573208	0.78±0.015	Dudkani dhar, Nainital	UK	2104
20.	NMB-2874	IC566778	0.81±0.030	Almora	UK	1700
21.	NMB-2882	IC566786	0.76±0.021	Deedihat, Pithoragrah	UK	1710
22.	NMB-2886	IC566790	0.76±0.015	Selapani,Pithoragrah	UK	1740
23.	NMB-2938	IC566842	0.84±0.006	Lohaghat, Champawat	UK	1580
24.	NMB-2939	IC566843	0.81±0.006	Lohaghat, Champawat	UK	1800
25.	NMB-2940	IC566844	0.77±0.015	Munch, Champawat	UK	1785
26.	NMB-2941	IC566845	0.84±0.006	Chatrabhot, Champawat	UK	2130
27.	NMJO-2985	IC582502	0.81±0.030	Dhanpur, Champawat	UK	1860
28.	NMJO-3000	IC582517	0.81±0.044	Radi, Uttarkashi	UK	2040
29.	NMJO-3005	IC582522	0.84±0.006	Shi Ram chatty, Uttarkashi	UK	1960
30.	NMJO-3090	IC589094	0.79±0.021	Pharsari, Tehri	UK	1520
31.	NMJO-3105	IC589095	0.81±0.044	Mussorie, Dehradun	UK	1782
32.	NMO-2971	IC582488	0.84±0.035	Jundana, Tehri	UK	1400
33.	NMVMKO-12	IC573211	0.82±0.052	Dunagiri, Almora	UK	2000
34.	NKO-74	IC589097	0.81±0.042	Deewakhal, Pauri	UK	2011

*NKO-24/ IC573223 Bold seeded, Early emergence and late senescence type; **NKO-2965/ IC573203 Local check UK: Uttarakhand; HP: Himachal and MG: Meghalaya

Associated Characters and Cultivated Practices: Rhizomes and seeds, both may be used for propagation but vegetative propagation of rhizomes is faster and easy method to get healthy produces. Vegetative propagation (rhizomes and cut-eyes) is the most reliable method for successful establishment and early flowering in plants. Active parts of rhizome with vegetative buds (eye) (2-3 cm) planted during April-May gave 100% rooting and sprouting. Rhizome pieces with apical buds are buried in soil at 15 cm depth containing soil, litter and FYM (farmyard manure) in equal amounts. Nursery is raised in April or early May when the rhizomes sprouts out. Propagules sprout within a month.

It can be cultivated between 1000-3000 m altitude in the sub-tropical and temperate zones but rich porous soil, moist and shady places with rich forest humus are highly suitable for the growth and productivity of the species. Fields with gentle slopes are suitable for cultivation.

Rooting in old rhizomes and vegetative buds can be increased by the treatment of IAA (500 ppm) or IBA (500 ppm). Approximately 70-85 thousand seedlings are required for cultivation in one-hectare land. Raised beds are suitable for optimum growth of the plants. The market price of dry rhizomes is Rs. 15/- – 25/- per kg and essential oil extracted from roots cost around Rs. 3000/- – Rs. 3500/- per kg.

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19. SES 159 (IC0561900; INGR13070), a Wild Sugarcane (*Erianthus arundinaceus*) Germplasm Possessing High Biomass, High Yield, High NMC and C.O.D., Amenability for *in vitro*

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So far, genetc improvement in sugarcane has been focused on high sugar, high yield and disease resistant. In the present scenario of fuel and energy crisis, international attention has shifted to biofuel and Biotechnology and new terms such as bioethanol, biodiesel, energy-cane, etc. have come into picture. Research is being directed on high biomass/energy crops and germplasm is searched for potential sources. Attention has turned to C4 perennial grasses like sugarcane and its wild relatives such as *Erianthus, Miscanthus* as potential candidates. SES 159 was found to be superior among all evaluated clones *viz.* SES 159, SES 3, Mythan A, EA Cuttack, IMP 1536 and CR 1. Next to SES 159, SES 3 (35 t/acre) gave the highest cane yield followed by Mythan (32 t/acre), EA Cuttack (25.5 t/acre), IMP 1536 (23.3 t/acre) and CRI 1 (22.7 t/acre). The COD values, of juice especially the SES 159 (93,974 mg/l), indicates that theoretically one litre of juice can produce 40 L of biomas and one tonne of cane, by simply crushing without any milling can produce roughly about 250 liter of juice and 10 m^3 biomas with a calorific value of 5,400 kcal/Nm^3. Therefore, juice from one tonne of wildcane would save 6.0 L of furnace oil. The high yielding SES 159 gave the bagasse yield of 53% with fibre pith ratio of 2.2:1. All the colnes studied have given more than 50% bagasses yield which is much more than the commercial sugarcane where the bagasses yield would be around 28-30%. This wild sugarcane has a good potential as a renewable and sustainable source of fibre or fuel and alcohol as a substitute.

20. SBI 1148-11-13-2-225 (IC0598218; INGR13071), a Sugarcane (*Saccharum.* spp. Hybrid) Germplasm Possessing High Sucrose and Red Rot Resistance in Addition to the other Agronomic Traits of Co 1148

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SBI 1148-11-13-2-255 is a fourth generation self of Co 1148, a promising sub-tropical commercial variety which was under cultivation for over 50 years. Co 1148 is high yielding with drought tolerant but has medium sucrose content and susceptibility to red rot disease. SBI 1148-11-13-2-255 was developed through repeated selfing of Co 1148, followed by selection for sucrose content and red rot resistance keeping the yield potential of Co 1148 at Sugarcane Breeding Institute (ICAR), Coimbatore. The characters for which the self is registered are a rare self at fourth generation developed from the popular subtropical variety of sugarcane *viz.* Co 1148. Possessing high sucrose and red rot resistance in addition to the other agronomic traits of Co 1148– improved by repeated selfing of the medium sucrose and red rot susceptible Co 1148.

Morph-agronomic Characters: This self is identified for registration as a genetic stock based on its *per se* and progeny performances. *Per se* performance: Performance of this self in clonal trials showed significant improvement in sucrose content (19.44 %) over Co 1148 (17.14 %) and was moderately resistant reaction to red rot, while was on par with Co 1148 for other yield parameters.

Progeny Performance: Among eight crosses involving the inbred derivatives as parents evaluated in plant and ratoon crops, the cross involving 1148-13-11-2-255 as female was the most promising with improvement in Brix, number of millable canes, cane diameter and cane length (SBI Annual report, 2004-05). Subsequent evaluation of the progeny in the clonal trials led to the identification of two Co canes *viz.* Co 2010-11 and Co 2010-20 from the cross 1148-13-11-2-255 x Co 775 (SBI Annual report, 2010-11), thus demonstrating its value as a donor parent for important agronomic traits of sugarcane.The genotype has attained high level of homozygosity after four generations of selfing as proved using molecular markers. Sugarcane, being a complex polyploid, parents like this self are needed to improve precision of breeding programmes.

The genotype flowers during the first fortnight of November and has low pollen fertility of 30% unlike the original parent (>60%), hence can be used as a female parent. The clone is characterized by erect, medium thick canes with long internodes and long bud grooves, small flat buds, nearly closed green canopy with light green leaf sheath, lanceolateligular process and yellow wax band.

This genetic stock improved over a proven parent through selfing is probably the first of its kind developed in sugarcane and owes promise in breeding varieties for the subtropical India to develop varieties as good as Co 1148 with stability in yield and wide adaptability across the subtropical states with the additional benefits of red rot resistance and high sucrose.

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21. DBQW 1 (IC0595583; INGR13072), a Wheat (*Triticum aestivum*) Germplasm for Good Biscuit Making Quality

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Our previous study demonstrated that most of the wheat varieties developed in India are hard in grain texture have poor biscuit making quality. The primary requirements of good biscuit making quality are soft grain and weak gluten. Therefore, soft wheat germplasm lines were identified in wheat germplasm collection at DWR, Karnal. However, soft wheat germplasm showed low yield and susceptible to lodging, and hence used as the donor for soft grain characteristics. Detailed molecular analysis showed that null mutation in *Pina* is primarily responsible for harder grain texture in Indian wheats. Back cross populations were developed using high yielding and widely adapted variety HD 2687 as recurrent parent and germplasm line EC 378793 as donor for soft grain characteristics that has wild allele of *Pina*. Foreground selection was made using markers for *Pina* and selecting wild alleles of puroindoline a present in EC 378793. Plants with BC_2F_2 and subsequent generations were evaluated for puroindoline profiles and SKCS hardness Index. Microlevel test utilizing 1 gram of whole meal flour was used in identifying superior segregants in recombinant lines of breeding.

Some of the lines in BC_2F_4 generation showed transgressive segregants towards softer grain characteristics and higher biscuit spread factor. The material was advanced to BC_2F_7 generation and evaluated for two years (2011-12 and 2012-13) for biscuit making quality and yield determining traits. Superior lines with higher spread factor were identified and then evaluated for grain weight and yield subsequently. DBQW 1 showed higher yield potential and 60% enhancement in biscuit spread factor (The ratio between cookie diameter and thickness: W/T)) as compared to HD 2687. Therefore, it can be used as the genetic stock for these unique characteristics in future breeding programs to improve the biscuit making quality in wheat.

Morpho-Agronomic characteristics of **DBQW 1** (Data based on two crop seasons; 2011-12 and 2012-13).

Characteristic / morpho-agronomic description	Remark / Observation
Average plant height	102 cm
Days to maturity	118 days
1000-grain weight	38.1g
Grain hardness Index	30.2
Biscuit spread factor	11.80
Grain protein content	11.80% (14% mb)

22. RPMRE 6 (IC0594593; INGR13073), a Paddy (*Oryza sativa*) Germplasm with Broad Spectrum Gall Midge Resistance, Multiple Resistance to GM+BPH+WBPH

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The breeding line RPMRE-6 (Rice Project Multiple Resistance Entomology-RP4680-1-2-23) was developed at DRR by making a cross between ARC15831 X RP2068-18-3-5 and subsequently following pedigree selection method. RPMRE-6 showed resistance to rice Gall midge, Brown plant hopper and White backed plant hopper consistently for the last 2 years in All India Coordinated Rice Improvement Programme (AICRP) trials (DRR 2008, DRR2009). The morpho agronomic characters are given in the Table 1.

Table 1. Morpho-agronomic characters of RPMRE6

Character	Details
Time of heading	105 Days (Medium Duration)
Basal leaf sheath colour	Purple
Stem length	60 Cms (Very Short)
Decorticated grain type	Short bold
Decorticated grain colour	Light brown
Decorticated grain aroma	Absent
Resistance to gall midge biotypes	Resistant to biotypes1,2,4,& 4M
Resistance to brown plant hopper (BPH)	Resistant at Raipur & DRR
Resistance to white backed plant hopper (WBPH)	Resistant at Coimbatore

Amplification of genomic DNA with gene specific markers confirmed presence of Gm3, Gm4 and Gm8 genes in the line conferring resistance to gall midge biotypes 1, 2, 4 & 4M. Genetics of BPH and WBPH resistance in this line needs to be studied.

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23. DMR QPM 102 (IC0594369; INGR13074), a Maize (*Zea mays*) Germplasm with Medium Maturity, Low ASI, High Tryptophan, High Protein

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DMR QPM 102 (IC 0594369, INGR 13074), a Medium Maturing Quality Protein Maize Inbred Line

Maize is a major cereal crop for both livestock feed and human nutrition, worldwide. With its high content of carbohydrates, fats, proteins, some of the important vitamins and minerals, it has acquired a well-deserved reputation as a 'poor man's nutricerea'. However, conventional maize is a poor quality food as it lacks the full range of amino acids especially lysine and tryptophan. With the discovery of *opaque-2* (*o-2*) gene and its modifiers, and elucidation of role of hard endosperm (*He*) gene, it became possible to modify the contents and profile of amino acids of proteins in maize. As a consequence, Quality Protein Maize (QPM) germplasm was developed and released in different parts of the world including India. Directorate of Maize Research (DMR) is actively involved in QPM research. It has developed QPM inbred lines with high tryptophan (≥0.6%) and lysine (>2.4%) in protein. In this communication, information on unique traits in respect of DMR QPM 102 (IC 0594369 and INGR 13074) is reported. This inbred line has been derived from exotic germplasm CLQ-RCYQ 30 after evaluating, selecting and selfing for 5-7 generations. Each time the kernels were assayed biochemically for tryptophan content and screened on white board for opaqueness. The semi-opaque/semi normal kernels with tryptophan >0.6% were retained and line developed thereof. The proposed line is a medium maturing QPM line with low anthesis silking interval (ASI) of one day, high tryptophan (0.65%) and high protein content (13.02%). It also exhibited moderate resistance against Maydis Leaf Blight (MLB).

Morpho-agronomic Characteristics: In the present study, data were recorded on agro-morphological, phenological and quality traits especially tryptophan (%) and protein (%). Based on the average data of two years (2010 and 2011), the line displayed mean male flowering i.e. anthesis (50%) in 53 days and mean female flowering i.e. silking (50%) in 54 days thereby indicating low anthesis silking (ASI) interval of only one day which is a potential indicator of the line being tolerant to moisture deficit situations. It also showed sparse tassel density of spikelets with wider angle (>45^0) between main axis and lateral branches which are strongly curved. The line is of short stature (93 cm) with median ear placement. A field view of the DMR QPM 102 at flowering and milky-dough stages showed it as genetically uniform and productive line. A scrutiny of post-harvest data revealed its conical ear shape with 10-12 numbers of rows of yellow, flint, toothed grains. It possessed straight kernel row arrangement and 1000 kernel weight of 192 g. The biochemical analysis displayed that it contains

0.65% tryptophan in protein which is more than double than the normal inbred line *viz.,* HKI 1105 (0.33%) with high protein content of 13.02% protein (Kaul *et. al*., 2012).

DMR QPM 102 along with a set of elite lines and checks was screened for Maydis Leaf Blight (*Cochliobolus heterostrophus* (Drechs.) Drechs. [anamorph = *Bipolaris maydis (Nisikado*) Shoemaker] in the years 2009, 2010, 2011 and 2012 under artificial conditions at identified hot spots i.e. Delhi, Ludhiana and Karnal. The lines were rated as Resistant (0-2), Moderately Resistant (2.1-3.0), Susceptible (3.1-4.0) and Highly Susceptible (4.1-5.0) as per the rating scale of 1-5 (Guidelines of All India Co-ordinated Research Project on Maize Pathology). Most of the lines displayed moderate resistance with mean rating of 2.7 with susceptible and resistant checks showing 3.9 and 2.0 average score, respectively. On the basis of four years data, DMR QPM 102 displayed reaction rating in the range of 1.5 to 2.5 with a mean rating of 2.1. At all the hot spots, the mean rating of the line was found 2.5, 2.2, 1.7 and 2.3 over the period of study, respectively. Hence, it could be deduced that the proposed line is a stable source of resistance to MLB.

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24. NKG 134 (IC0218988; INGR13075), a Pea (*Pisum sativum*) Germplasm as a Resistant Against Four Isolates *viz. rangway, trilokinath, stingri, kangra* of Powdery Mildew (*Erysiphe pisi*) in Pea

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Pea (*Pisum sativum* L.) belongs to family Fabaceae is an important multipurpose crop grown for green pods and grains in the cool temperate zones and tropical highlands of the world (Ali *et al.,* 1994; Azmat *et al.,* 2010). Generally, pea is grown in winter season in the Indian plains but it is an important summer (off-season) crop in the high hills (Rana *et al.,* 2010; Bala *et al.,* 2011). Powdery mildew of pea caused by *Erysiphe pisi* DC is one of the most serious diseases resulting 25–50 % losses in yield and quality worldwide (Katoch *et al*., 2010).

In order to identify the resistant germplasm we screened 701 germplasm lines which were grown in Augmented Block Design along with six check varieties *viz.* Lincoln and Azad pea as susceptible and HFP4, DMR11, DMR7 and Rachna as moderately resistant to resistant for *E. pisi* in the winter season of 2008-2010. Infector row of two susceptible checks i.e. Lincoln and Azad pea were grown in each block to have uniform speared and infection of the disease to avoid escapes. Under laboratory condition, 64 accessions which were found resistance under field screening along with six check varieties were screened against four isolates of *E. pisi* using detached leaf technique. The four isolates *viz*., *rangway, trilokinath, stingri* had been collected from temperate region while and *kangra* from sub-tropical region where powdery mildew is a major disease on pea crop. The infection types 0, 1 and 2 were scored as resistant reaction whereas 3 and 4 as susceptible reaction.

INGR13075 showed resistant reaction with 0 score under field conditions while 1 against *rangway, trilokinath,* and *kangra* isolates and 2 against *stingri* isolate of powdery mildew. It has been observed that plant breeders invariably have resistant germplasm in their breeding stocks but majority of them have poor agronomic background carrying several undesirable gene. This makes gene transfer more cumbersome. Therefore, it is good to obtain additional information on the extent of genetic diversity and agronomic performance of resistant germplasm accessions (Singh *et al.,* 2011). The additional horticultural attributes of

INGR13075 were no of primary branches (4.0), no of pods clusters/plant (11.50), pod length (5.80cm), no. of pods/plant (21.0), no. of seeds/pod (6.0), and 100-seed wt. (15.46). The seed colour was white and round. The overall performance of the INGR13075 showed that it has high level of resistance to powdery mildew along with sufficient amount genetic diversity and agronomic superiority, which can be used for breeding pea varieties with resistance to powdery mildew and high yield.

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