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Utilization of Exotic Plant Genetic Resources in Wheat Registered Germplasm

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Abstract

Genetic Resources (PGRs) are material of plant origin which are of value for present and future generations of human kind. Since times immemorial these resources are being collected and conserved for further utilization in crop improvement programmes. Countries are highly interdependent on these genetic resources including the diversity rich nations where the major food production is dependent on crops which have actually originated in other countries. Thus, PGRs are continually exchanged for use in developing better crop varieties, resistant to various pests and diseases and to improve quality, quantity and other valuable or desirable traits. This unique germplasm is provided soft protection and registered at ICAR-National Bureau of Plant Genetic Resources since 1996 through the Plant Germplam Registration Committee. An analysis on the extent of utilization of exotic germplasm in for developing trait specific unique germplasm was done. To start with the data was analysed for wheat germplasm registered from year 1996-2014, and it was found that 75% of the exotic germplasm was used as parents for the lines which were registered at ICAR-NBPGR.

Keywords

Exotic; Germplasm; NBPGR; Registered; Traits

Introduction

The exotic germplasm offered enormous opportunity for addressing the needs of the breeders/ researchers for developing varieties resistant to various pests and diseases and to improve quality, quantity and other value addition traits. It was the exotic germplasm that enabled wheat, maize, chilli, potato, tomato, cabbage, cauliflower, soybean, sunflower and many other crops to become major field crops in India. Introductions therefore, have played pivotal role in the establishment of large number of crops and development of improved varieties [1]. In the last decade of the 20th century, most obviously due to the trends of globalization and privatization, a paradigm policy shift was witnessed in the international policy environment and plant genetic resources regarded as "common heritage of humankind" became the "sovereign rights of a nation". This major shift was due to adoption of Convention on Biological Diversity (CBD) which came into force in 1993, during the Rio Earth Summit of the United Nations. The CBD reaffirmed national sovereignty over genetic resources and stressed that the authority to determine access to genetic resources rests with the national governments and is subject to national legislations. It provides for a bilateral approach to access/ exchange between countries on prior informed consent (PIC) and mutually agreed terms (MAT).

This regulation for access to germplasm under CBD was recognized by the parties to the CBD. With the objective of giving due credit to the scientists/developers of the unique/ promising research/experimental material including parents of inbred lines and to facilitate flow of germplasm among the scientists working in the crop improvement programmes, ICAR constituted Plant Germplasm Registration Committee (PGRC) in 1996. Deputy Director General (DDG), Crop Science is the Chairman of PGRC which is being held at regular intervals. Through PGRC, promising/ unique germplasm are reviewed/scrutinized for registration through an established procedures for which Guidelines have already been posted at NBPGR website. During the process of research and experimentation to develop improved varieties for specific or multiple traits, many useful materials are developed which may not qualify for notification and release as variety. Such material having resistance/tolerance to biotic and abiotic stresses, and other unique traits with academic, scientific and applied values may be registered through National Bureau of Plant Genetic Resources. Through this process the contributions of researchers who had developed/identified the trait-specific germplasm are recognized (NBPGR, 2014). The information on such registered germplasm is disseminated through publications in Journals, Technical bulletins/ Inventories or Newsletters from time to time.

In the current scenario the focus of national and international policies is on conservation and utilization of germplasm in order to meet future challenges. The aim of the present study was to analyse to what extent the exotic germplasm is being utilized for developing the unique / promising genotypes and it was observed that both all type of exotic introductions recent or old were used to develop these elite germplasm. Wheat is one of the most important food crop is providing one-fifth of the total calories for the world's populations. More than 560, 000 wheat accessions are maintained in nearly 40 genebanks globally, however wheat breeding is currently restricted to limited sampling of the diversity [2].

Materials and Methods

To undertake the study on this aspect, the data available in the form of published inventories, technical bulletins were referred [1,3,4]. The data from year 1996 to year 2015 was considered only for wheat genotypes registered. Since 1996, XXXII meetings of PGRC have been held and a total of 1219 accessions have been registered in various crops.

The extent of use of exotic germplasm and derived benefits vary from crop to crop. Accurate information regarding the degree of usage of exotic germplasm in breeding programmes or in commercially released varieties of cultivated crops is difficult to obtain. Such estimates could be based upon pedigree information. Hence, the pedigree of the registered wheat germplasm was studied and the information on the national identity of the exotic accession that is exotic collection number (EC number) utilized in developing these genotypes were searched from the NBPGR website [5] accessible to all users.

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For some genotypes, the EC numbers could not be traced but from philology [6], their exotic origin is confirmed. Few lines were registered as EC numbers itself [7].

The identity of the registered germplasm and the exotic genotype used in the pedigree of the registered genotype with the national identity number is given in Table 1 [8]. The data revealed that majority of the germplasm registered have utilized exotic lines as can be inferred from the pedigree provided in the Technical bulletins published by ICAR-NBPGR [9].

Results and Conclusion

From 1996-2014 a total of 156 accessions were registered in wheat, of which 110 (75%) accessions have exotic germplasm in their pedigree. This infers the impact of exotic germplasm utilization in developing promising genotypes in wheat. Similar type of study in other crop groups may be further taken to see the impact of the exotic germplasm utilization in crop improvement programmes.

A survey of pedigrees of trait specific wheat germplasm registered with NBPGR yield two conclusions one is that the trait specific germplasm are quite interrelated since a few lines like WL 711, C306 and Sonalika appear repeatedly. Only a few exotic germplasm accessions with extreme phenotypes for target traits tend to be chosen as parents in breeding programmes. The other is that exotic germplasm has played a prominent role in development of trait specific germplasm against the notion that exotic germplasm has not been utilized. Incorporation of exotic germplasm is the best means to enhance the genetic base of agriculturally important crops. The study thus depicts that introduced diverse germplasm is much used for crop improvement programmes and the lines which are used many a

Table 1: Details of the genotypes utilized in registered germplasm at ICAR-NBPGR.

Genotype	EC No.	Source Country	Registered identity/INGR No.	Traits for which registered
414148	EC414148	CIMMYT, Mexico	PWR4101, EC414148, INGR05013	New source for restoration of fertility. Registered as EC number
414149	EC414149	CIMMYT, Mexico	PWR4099, EC414149, INGR 05013	New source for restoration of fertility. Registered as EC number
Blue bird	EC291925, EC291931	USA	ISD 215, IC296779 (1NGR 00019)	Amber grained 2% superior over Sonalika (check) and protein content at par with Pusa 5
Blue boy	EC67269, EC672209		FLW2, IC296488 (INGR03014)	Resistance to brown, black and yellow rust in different genetic background
BOW	EC295745	ICARDA, Syria	Giant 3, IC296529 (INGR03028)	High grains/spike (97) and spikelets/ spike (22) with long (15 cm) spike length and extended grain filing period (51 days)
BUC's/PVN's	EC266196	CIMMYT, Mexico	GS HS431 , INGR 08007,	Registered SELECTION FROM CIMMYT Breeding material, seedling resistance against stem and leaf rust pathotype
BUC's/PVN's	EC266196	CIMMYT, Mexico	UAS334, IC599612, INGR14027	Resistance to foot rot
C306	EC233313	CIMMYT, Mexico	DI-9, INGR99002, IC296736	Registered as dwarf isogenic line having Rht1 gene
C306	EC233313	CIMMYT, Mexico	C306 m10, IC296740 (INGR99018)	Non-carrier of necrotic allele Nel (ne1ne1ne2ne2)
C306	EC233313	CIMMYT, Mexico	Selection T2600, IC524018, INGR 05015	Diverse source of resistance for leaf and stem rust
C306	EC233313	CIMMYT, Mexico	WCF8-BL 10, IC443618, INGR 05032	Cellular tolerance and early phenology
C306	EC233313	CIMMYT, Mexico	WCF8-W12, IC443619, INGR05033	Heat and cellular tolerance and bold grains
C306	EC233313	CIMMYT, Mexico	WCF8-HT13, IC443622, INGR05034	Drought and lodging resistance, and water use efficiency
C306	EC233313	CIMMYT, Mexico	HW2004, IC524292, INGR06033	Brown rust genes in good agronomic background
C306	EC233313	CIMMYT, Mexico	HW3601, IC598203, INGR13051	Resistant to brown black rust, it carries gene for leaf rust resistant, Lr 19 and stem rust resistant Sr 36
C306	EC233313	CIMMYT, Mexico	DI717, IC546939, INGR06008	Semi-dwarf isogenic line with Rht-3 gene conferring lodging resistance
C591	EC270505	Australia	DI-105,INGR99001, IC 296725	registered as dwarf isogenic line having *Rht3* gene
Cappele Desprez	EC176085, 216604	UK	FLW29, IC553914, INGR08002	Resistance to brown, black and yellow rust
CENTUR K	EC598402	USA	FLW1, IC296487 (INGR03013)	Brown and black rust resistance in different genetic background
China 84.40022	EC226912	USA	FLW 3, IC296489 (INGR03015)	Resistance to yellow and black rust in different genetic background
China 84.40022	EC226912	USA	FKW 1, IC546933, INGR06004	Resistance to yellow and black rust in different genetic background
Chirya 3	EC407563	CIMMYT, Mexico	LBRL-1, IC549914, INGR08058	Leaf blight resistance
Chirya 7	EC407567	CIMMYT, Mexico	LBRL-6, IC549913, INGR08057	Late blight resistance

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Chirya 7	EC407567	CIMMYT, Mexico	LBR11, IC566637, INGR09010	Resistance to leaf blight (*Bipolaris sorokiniana*)
Compare	EC390323	Australia		Winter wheat lines resistant to prevalent yellow rust race 46S119
CPAN 3004 (KTDH54 X)	EC398011	UK	GS HS424, INGR 08006 d	Dveloped from a cross CPAN 3004/HPW (DL) 30/HS 286
CPAN 3004 (KTDH54 X)	EC398011	UK	VL 798, IC296431 (INGR 03007)	Immune to hill bunt disease
CPAN 3004 (KTDH54 X)	EC398011	UK	HD219, IC546938, INGR07047	Resistant to leaf and stripe rust, karnal bunt, loose smut, root aphids with high protein content
Dove/BUC	EC221726	CIMMYT, Mexico	AKW2692-1, IC296767, INGR04022	Heat tolerant
Hobbit	EC176083	UK	FLW11, IC470825, 05003	Multiple rust resistance
K134(60)/VEE	EC221672	CIMMYT, Mexico	PHR1011, IC566636, INGR09009	High protein content (13.8%)
Kalyansona	EC315270, 202617, 303806	UK	hw2002,IC408333, INGR04014	Resistant to brown and black rusts (Lr 24 and Sr 24 genes)
Kalyansona	EC315270, 202617, 303806	UK	WR95, IC563970,INGR08070	Source for apd1 gene for apical lethality
Kalyansona	EC315270	UK	HW 2002, IC408333 (INGR04014)	Resistant to brown and black rusts (Lr24 and Sr 24 genes)
KAUZ	EC653359	CIMMYT, Mexico	VL 858, IC546940, INGR07002	Registered a genetic stock for excellent chapati quality developed through selection from a cross OPATA/RAYON/ KAUZ, very good yield potential
Kavkaz	EC167652	USA	W5634, IC 296603, INGR04021	Resistant to loose smut, karnal bunt, stripe and leaf rust in different genetic background
KS91WGRC11	EC598382	USA	FLW26, IC549928, INGR07007	Resistance to brown and black rusts and predominant pathotypes of yellow rust, carries Lr42 from exotic winter wheat
M3	EC493710	USA	Harit-1 (M3), IC427810 (04023)	New source of leaf blight resistance)
Mega	EC176081	UK	FLW12, IC470826, 05004	Multiple rust resistance
MEMO'S	EC214753		DL 482, IC296426 (INGR 03003)	Resistant to karnal bunt in different genetic background
MILAN	EC30264	USA	DBW 51 (IC0589135, INGR11011)	Registered as developed out of cross site/MILAN high yielding and resistance to pests and leaf blight, high biscuit spread factor (7.87 cm), protein content (12.84%) very high iron content (50.4ppm)
MILAN	EC30264	USA	LBRL 13, IC566638, INGR09011	Resistance to leaf blight (*Bipolaris sorokiniana*)
MILAN/SHA 7	EC531242	Bangladesh	WBM 1587 , INGR 07009	Registered Genetic stock , selection from CIMMYT, seedling resistance against most virulent pathotype of stripe rust 46S119
Opata	EC610397	CIMMYT, Mexico	VL 858, IC546940, INGR07002	Registered a genetic stock for excellent chapati quality developed through selection from a cross OPATA/RAYON/ KAUZ, very good yield potential
Opata	EC326765	CIMMYT, Mexico	VL 858, IC546940, INGR07002	Registered a genetic stock for excellent chapati quality developed through selection from a cross OPATA/RAYON/ KAUZ, very good yield potential
PBW343	EC597853	USA	DBW 46 (IC0589134, INGR11010)	Registered as , high level of resistance to prevalent races of yellow rust, brown rust and leaf blight
Rascon 3	EC610449	CIMMYT, Mexico	DDW 12, IC0589133, INGR11009,	Registered, DURUM GERMPLASM HIGHEST IRON (45.9 PPM), ZINC (47.9 PPM), Manganese (941.6ppm) resistant to rust and karnal bunt developed from the progeny of cross Rascon 3 and Raj 1555. Rascon is a high yielding genotype
Rayon F89	EC597848	USA	VL 858, IC546940, INGR07002	Registered V a genetic stock for excellent chapati quality developed through selection from a cross OPATA/RAYON/ KAUZ, very good yield potential
Regent	EC202	USA	INGR 11037-11039	Registered at NBPGR i RILs drought tolerant can be used as genetic material for transferring the desirable drought tolerance acquired from C306, derived from WL I11 and C308 (Derived from Regent)
Regent	EC10715	USA	INGR 11037-11039	Registered at NBPGR i RILs drought tolerant can be used as genetic material for transferring the desirable drought tolerance acquired from C306, derived from WL 711 (Derived from Regent)
Rudy (Acc. 4873)	EC3473	USA	PAU HMW GluA/1, IC296452 (INGR03024)	HMW glutenin subunits from Glu-Al with high SDS sedimentation value
Sefed Lerma (200048)	EC378793	Japan	DBQ W1, INGR 3072, IC 0595583,	Registered as Germplasm for good biscuit Quality used EC 378793 as donor for soft grain characteristics, has wild allele of Pina, wild alleles of puroindolines

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SITE/MO MILAN CMSS93BOO5795/4Y/10M-10Y-10M-6Y-OM-2KBY-OKBY-OM	EC531242	Bangladesh	BW 51 (IC0589135, INGR11011)	Registered as developed out of cross site/MILAN, high yielding and resistance to pests and leaf blight, high biscuit spread factor (7.87 cm), protein content (12.84%) very high iron content (50.4ppm)
Sonalika	EC378799	CIMMYT, Mexico	RL 4, IC296923 (INGR 03001)	Cytogenetic stock
Sonalika	EC378799	CIMMYT, Mexico	RL 83, IC296924 (INGR 03002)	Cytogenetic stock
Sonalika	EC378799	CIMMYT, Mexico	Sel 111IC296469 (INGR 03008)	High grain weight and protein content
Sonalika	EC378799	CIMMYT, Mexico	Sel 212, IC296470 (INGR03009)	Leaf and stem resistance gene on same chromosome
Sonalika	EC378799	CIMMYT, Mexico	HW2031, IC408334 (04015)	Resistant to brown rust (Lr 28)
Sonalika	EC378799	CIMMYT, Mexico	HW2001, IC524288, INGR06032	Brown rust genes in good agronomic background
Sonalika	EC378799	CIMMYT, Mexico	WR95, IC563970,INGR08070	Source for apd1 gene for apical lethality
Sonalika	EC378799	CIMMYT, Mexico	HS491, IC566222, INGR10097	Very good biscuit quality; spread factor (9.82), grain hardness (36)
Sonora	EC37990	USA	W 3203, IC296784, INGR04019	Resistant to loose smut, karnal bunt, stripe and leaf rust in different genetic background
Topdy 6	EC626192	CIMMYT, Mexico	DW1001, IC445070 (04081)	Gamma Gliadin 45 band (pasta quality), high yield and karnal bunt (race 77-2 and 77-7) resistant
Turaco	EC482998	CIMMYT, Mexico	VL824, IC549923, INGR07003	Powdery mildew resistance
V81623	EC218950	CIMMYT, Mexico	GS HS431 , INGR 08007,	Registered selection from CIMMYT breeding material, seedling resistance against stem and leaf rust pathotype
VEE'S/PVN'S	EC296296	Syria	Giant 3, IC296529 (INGR03028)	High grains/spike (97) and spikelets/ spike (22) with long (15 cm) spike length and extended grain filing period (51 days)
VPM/6 Cook /5 Brookton	EC693154	Australia	INGR 13052	Registered as resistance to stem and leaf rust
WH157,Pno. 275	EC462371	CIMMYT, Mexico	SG 15, INGR99003, IC296727	DUOSPICULUM SPIKE (double spikelet on one rachis node) type
WH157,Pno. 275	EC462371	CIMMYT, Mexico	SG-22, IC296728 (INGR 99004)	Branched spike (Supernumerary spikelets) type
WH157,Pno. 275	EC462371	CIMMYT, Mexico	SG 8809, IC296729 (INGR 99005)	Normal gigas spike having RM-Ts gene complex
WH542	EC634300	CIMMYT, Mexico	FLW28, IC553913, INGR08001	Resistance to brown and yellow rust
WH542	EC634300	CIMMYT, Mexico	PHSL5, IC566633, INGR09006	Bold seed (67.9gTGW)
WH542	EC634300	CIMMYT, Mexico	PHSL10, IC566634, INGR09007	High 1000 grain weight (65.6g)
WH542	EC634300	CIMMYT, Mexico	PHSL11, IC566635, INGR09008	High 1000 grain weight (65.4g)
WH542/kbr 2	EC634300	CIMMYT, Mexico	FLW13, IC470827, 05005	Multiple rust resistance
WH542/kbr2	EC634300	CIMMYT, Mexico	FLW11, IC470825, 05003	Multiple rust resistance
WL711	EC158297	UK	WCF12-7, IC59436,INGR 11037	Registered at NBPGR RILs drought tolerant can be used as genetic material for transferring the desirable drought tolerance acquired from C306, derived from WL I11 and C306 (Derived from Regent)
WL711	EC202499	UK	WCF12-61, IC594377INGR 11038	Registered at NBPGR i RILs drought tolerant can be used as genetic material for transferring the desirable drought tolerance acquired from C306, derived from WL I11 and C307 (Derived from Regent)
WL711	EC202499	UK	WCF12-19, IC594378, INGR11039	Drought tolerance
WL711	EC202499	UK	WCF12-208, IC594379, INGR11040	Drought tolerance
WL711	EC202499	UK	PAU wheat genicualata 1, IC296432 (INGR03018)	Cytogenetic stock
WL711	EC202499	UK	PAU wheat triuncialis 1, IC296436 (INGR03019)	5u-5a substitution genes providing resistance to powdery mildew, cereal cyst nematode and slow rusting
WL711	EC202499	UK	PAU wheat triunicalis 4IC296439 (INGR03020)	Addition line of acrocentric chromosome of *A. triuncialis* with Karnal bunt and leaf rust resistance
WL711	EC202499	UK	MBL-2, IC405230 (INGR03050)	High protein content (14.1%)

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WL711	EC202499	UK	WCF8-BL 10, IC443618, INGR 05032	Cellular tolerance and early phenology
WL711	EC202499	UK	WCF8-W12, IC443619, INGR05033	Heat and cellular tolerance and bold grains
WL711	EC202499	UK	WCF8-HT13, IC443622, INGR05034	Drought and lodging resistance, and water use efficiency

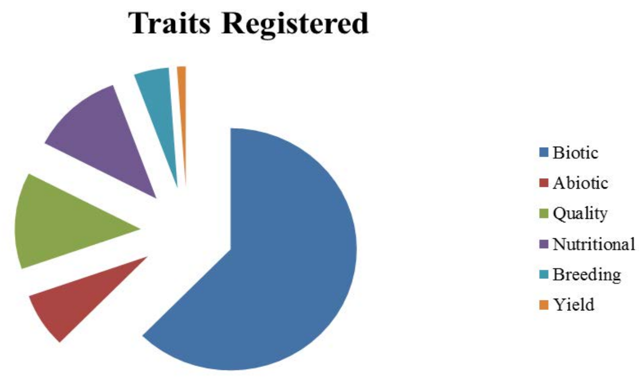

Figure 1: An estimate of various traits in registered germplasm.

time in developing the trait specific germplasm and this information will help breeders/ researchers in identifying the germplasm of their choice (Figure 1). Indigenous lines developing these exotic germplasm as one of the parents in their pedigree need to be identified and published for the use of breeders/researchers through published literature and other reports. However repeated use of only few exotic germplasm lines can have serious consequences, narrow genetic base, slow response to selection reduced genetic variation and thus are vulnerable to abiotic and biotic stresses.

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