

Wild relatives of crop plants in India: identification and diversity

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Wild relatives of crop plants in India- Documentation

Search for new genes (BP Pal, 1937 Agriculture and Livestock in India, 7: 573-578)

Wild relatives of crop plants in India (Arora and Nayar, 1984, NBPGR, New Delhi)

Wild relatives of cultivated plants in India (Pradheep, Bhandari and Bansal, 2014, NBPGR, New Delhi)

WILD RELATIVES OF CULTIVATED PLANTS

(1) *Solanum melongena* L.

S. melongena - A bushy perennial plant with white flowers.

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Others- *Luffa*, *Crotalaria*

Search for YMV-resistant material- ***Abelmoschus tuberculatus*** along fields, Saharanpur (IW 130, Plant Introduction Plots, HS5277, 15/12/1946, HB Singh); morphology, pollen and seed characters, cytology, crossability with crop and other wild species (Pal, Singh and Swarup, 1952; Joshi & Hardas, 1953, 1956, 1976; Gadwal *et al.*, 1968, Joshi *et al.*, 1974); [collection & evaluation under NBPGR-IBPGR project \(Bisht *et al.*, 1995\).](#)

Solanum melongena* var. *insanum, var. 'potangi', var. 'Travancore' (Bhaduri 1951, Mital, 1950); 'potangi' pollen parent, crosses with *S. melongena*= fully fertile hybrids (Pal & Singh, 1943, '46); inversion in var. *insanum* as compared to *S. melongena* (Anon., [Bose Institute], 1955; Magoon *et al.*, 1962).

[Geneflow studies in Nilgiris in Indo-US collaborative project \(2011\).](#)

Sesamum prostratum* and *S. laciniatum, chromosome numbers and cytogenetical studies. Ramanujam, 1941, '42; Ramanujam & Joshi, 1947; Ragavan & Krishnamurti, 1945, '47.

Collection of ***Vigna sublobata***, progenitor species of mung, *silvestris* related to urid from Western Ghats: Arora & Singh, 1974

Indian centre of diversity-

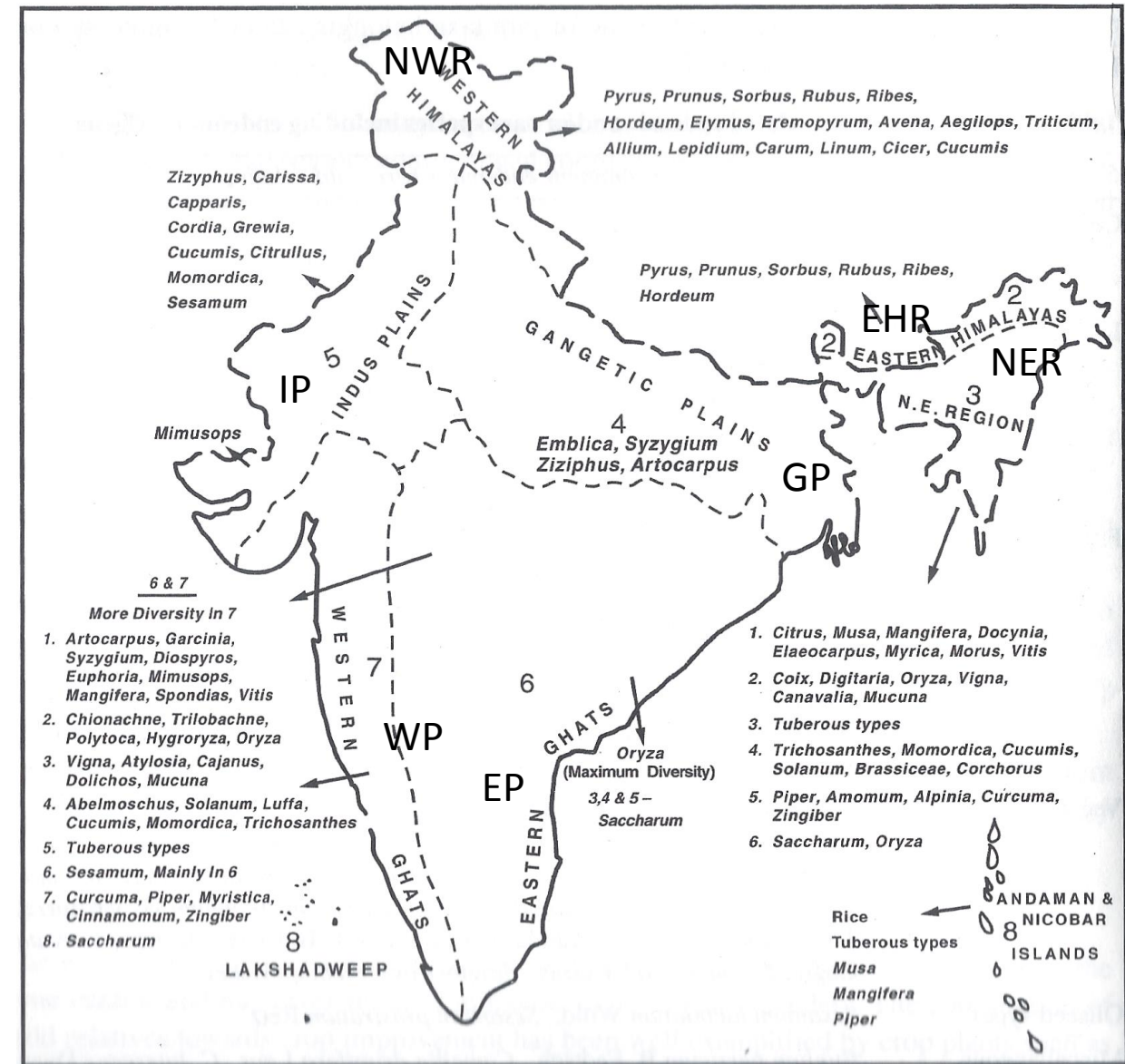
>166 crop plants with native diversity

>326 wild relatives of crops- WP 145> NEI
132> NWR 125> EP 91> EHR 82> GP 66> IP
45

Western Himalayas: Cold/ & drought tolerance. Barley, bluish/black grain types (>3300 m) like local Tibetan types. Wheat, Lahaul and Spiti- resistance/tolerance to rust.

North-eastern region/ Eastern Himalayas: Tribal dominated belts- legumes; *Brassica*, *Perilla*; tree cotton; taro/yam and tuberous/ rhizomatous/bulbous types; *Citrus*, *Musa* and bamboos.

Western peninsular region/ Eastern peninsular region: tuber crops/ rhizomatous types- *Curcuma* & ginger, pepper. East- tribal-dominated tract of Orissa and the Chotanagpur plateau; *Central tribal region*: Madhya Pradesh and adjoining tracts of Maharashtra



Arora, 1997; Arora et al., 2006; Arora & Nayar, 1984; Arora & Pandey, 1996

WRCP (in major crop categories) in India- distribution & habitat features; phytogeographic regions with high diversity; species relationships between crop and wild	Arora & Nayar, 1983a & b; 1984	<u>WRCP in India</u> WRCP as per crop categories Relationships between crop and wild <u>Taxonomic indices</u> Size of genus, species/ genus Widespread vs, rare and endemics <u>Diversity distribution and importance in PGR</u> Distribution in phytogeographic regions vis-à-vis agro-ecological/ ecogeographic zones zones Collection, conservation and utilization strategies
Rare and endemic species; size of genus; collection/ conservation measures- ex situ/ in situ Phytogeographic regions vis-à-vis agro- ecological zones Additional categories- MAP, forest trees, forages, ornamentals Differences between domesticated & wild species Utilisation aspects	Arora et al., 1983; Arora & Pandey, 1996; Arora, 1997; Arora & Nayar, 1999	
Spp. richness within Indian region (1- >40)	Arora, 2000	
Ecogeographic zones of diversity in relation to habitat	Arora, 2000; Nayar, 2006	

Wild relatives of crops: Issues

- **Wild relatives account for 7% of total wild species diversity**
- **Priority given for diversity collection and conservation of species of wild related species of crop plants at the NBPGR**

Diversity collected by NBPGR: 2409 accessions of wild relatives out of 23243 accessions of wild species collected (10.47%)

Diversity conserved by NBPGR: 1125 accessions of wild relatives out of 13583 accessions of wild species conserved (8.25%)

83 species of wild relatives out of 580 wild species conserved at the NBPGR (14.26%):

Genebank (GB): 564 accessions (43 species)

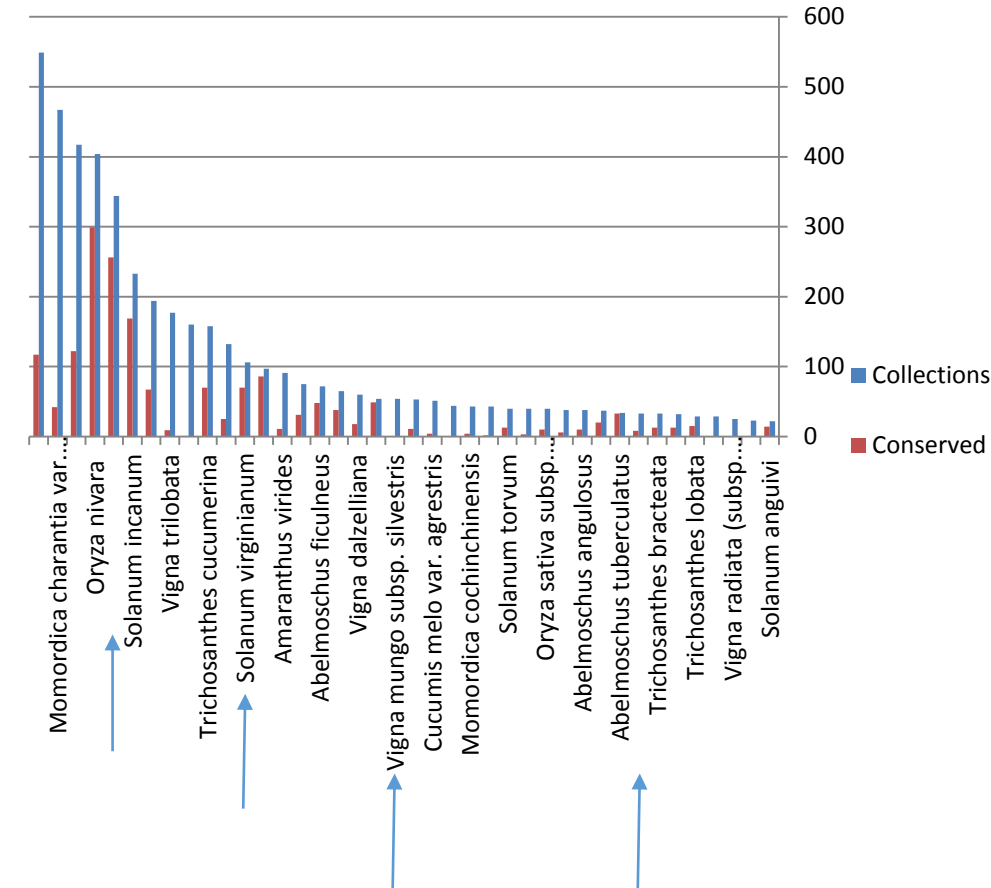
Cryobank (CB): 504 accessions (69 species)

In vitro (IV): 48 accessions (16 species)

140 species represented as herbarium specimens in NHCP

AKMU database

>3100 accessions cultivated/wild status unknown;



Aspects taken up in WRCP-

- Species diversity in the Indian region vis-à-vis global - native species, areas of availability, species characters, relationships among WRCP, and within crop genepool
- Stress tolerances of WR (also endemics, naturalised spp.) -
 - ✓ resistances expressed, occurrence vis-à-vis area of disease expression;
 - ✓ abiotic stresses related to plant phenology and behaviour and tolerances differing from crop species;
 - ✓ quality parameters shared by CWR and distinct from crop species
- Priority species –
 - ✓ 326 and additional 85 in updated list;
 - ✓ taxonomy, chromosome no./genome, distribution, distinguishing characters, infra-specific variation.

Associates: Jyoti Bhardwaj (RA- Mar. 2016 to Oct., 2017; K. Pradheep, Anjula Pandey)

300 genera (largely from Checklist of Crop Plants, 2003, NBPGR)

~170 native crop species

❑ 20 crops with 50% species native to Indian region (India/ Indian subcontinent)

❑ 100 major crops, with priority biotic & abiotic stresses worked out in crop and WR

❑ 50 minor crops/ species

Total introduced vs. naturalized taxa (Pradheep *et. al.*, 2014)

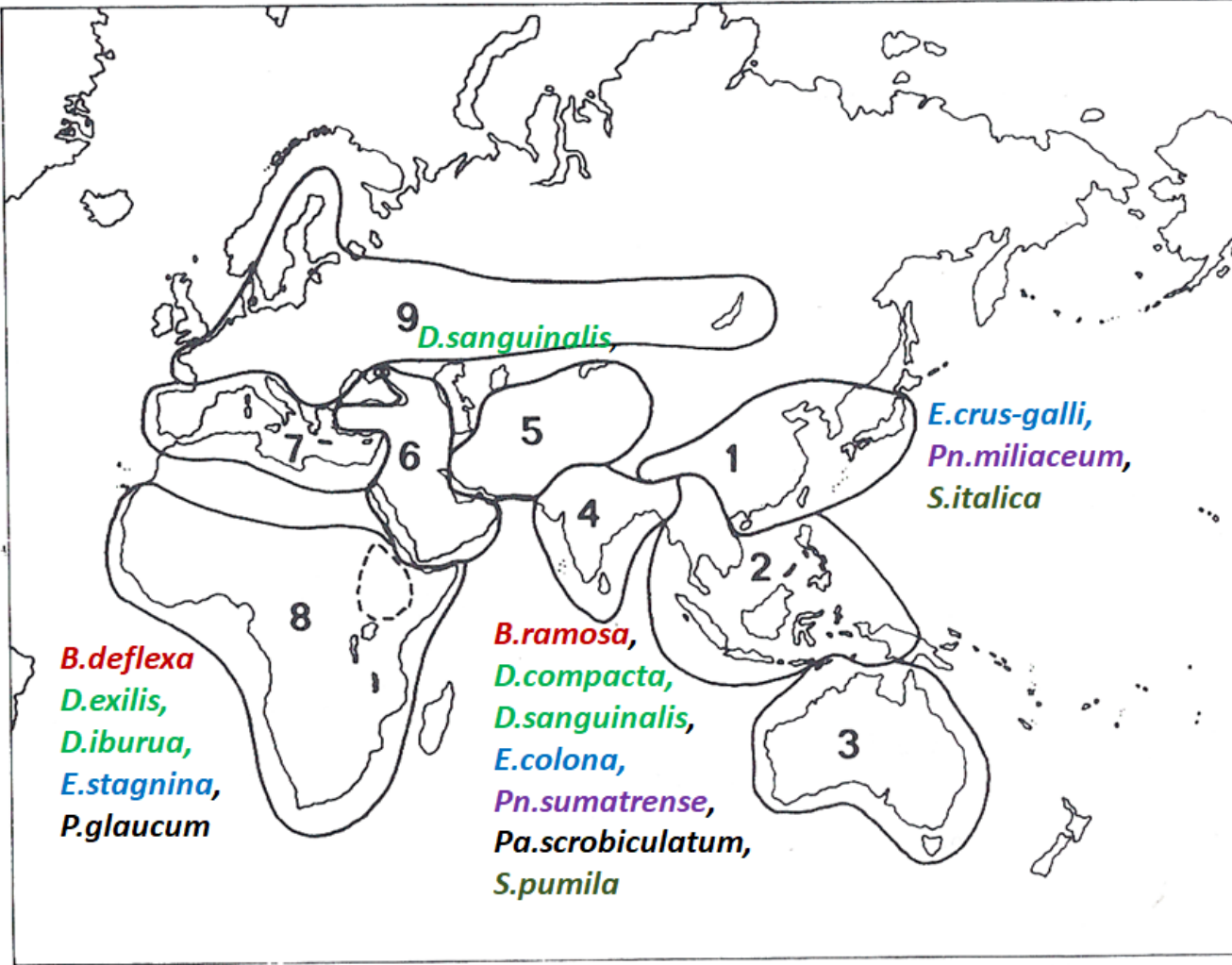
- Predominantly Asian:
Echinochloa [[distinct genepools](#)] Japanese & Indian barnyard millet, Burgu
Setaria [[Genome D \(India\)](#), [genome A \(China\)](#)]
 Foxtail- Italian and yellow (*S. glauca* auct.)
Panicum [[P.repens](#), [common relative](#)]
 Prosomillet, Little millet
- African- Asian:
Brachiaria [[Grp IB](#)]
 Browntop millet, Guinea millet
Digitaria [[Sect. Digitaria \(India\)](#), [Verrucipilae/ Clavipilae \(Afr\)](#)]
 Crabgrass, Raishan, fonio-acha & iburu
- African:
Pennisetum
 Pearl millet
- Asian domesticate:
Paspalum
 Kodomillet

Species numbers (Indian vs. total) for crop taxa (170 approx.):

Millets *Cajanus*

Categories	Species diversity (50 %) in India
Grain legumes	<i>Cajanus</i>
Edible tubers	<i>Flemingia</i>
Vegetables	<i>Abelmoschus</i>
Miscellaneous-	<i>Saccharum</i>

Millet crops- their Centres of domestication

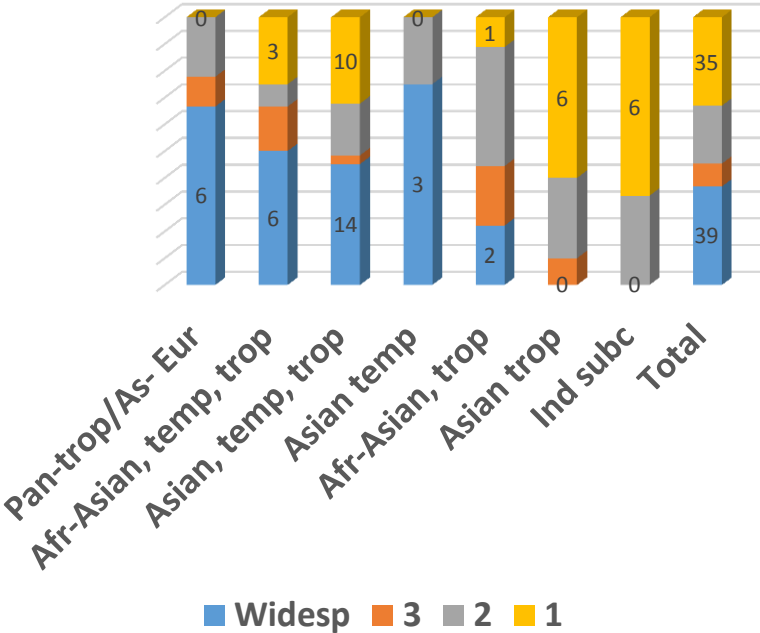


Domesticate		
<u>Predominantly Asian</u>	<i>Echinochloa</i>	distinct gene pools
	<i>Setaria</i>	Genome D (India), genome A (China)
	<i>Panicum</i>	<i>P. repens</i> - common to both crops
<u>African- Asian</u>	<i>Brachiaria</i>	Grp IB
	<i>Digitaria</i>	Sect.- Digitaria (India), Verrucipilae/ Clavipilae (Afr)
<u>African</u>	<i>Pennisetum</i>	SC India
<u>Asian</u>	<i>Paspalum</i>	Semi-domesticate

Distribution of species- India vs Global

	T#	Native	Ind/ subc	As trop	Afr As trop	Afr As/ As temp/ trop	Others	Natr	Total
<i>Echinochloa</i>	34	7	-	1	1	2*/2	1	-	AfAsAm
<i>Setaria</i>	103	9	-	-	2	3*	4	-	AmAfAsAu
<i>Panicum</i>	468	25	7	2	1	3/12*		5	AmAfAs
<i>Brachiaria</i>	121	13	2	6	3	-		1	Af
<i>Digitaria</i>	261	20	3	6	-	8*	3	3	AfAmAs
<i>Paspalum</i>	321	9	-	2		1*	4	2	Am
<i>Pennisetum</i>	83	18	-	-	2	2/5		9*	AfAsAm
			12	17	9	7/31			

Species distribution: Ind/ global



#Pradheep et al., 2014
*Cultivated spp.

Priority taxa- Native diversity*

Crop-wild-weedy complex: *Paspalum scrobiculata* (Kodo) and *Echinochloa colona* (Sama)- gathered for food from wild, in Africa

Digitaria compacta- domesticated (NE) ~ wild (PI)

Widespread vs in selected areas:

African/Asian (widespread) - Asian - endemic components:

B.ramosa/B.deflexa - *B.kurzii/B.remota* (EI/PI) - *B. semiverticillata* (PI)

B.reptans - *B.villosa* (NE/PI) - *B.nilagirica* (SI)

D.ciliata - *D.sanguinalis/crucata* complex (widespread)- *D.duthieana* (EI)

P. repens complex (sharing a genome with Proso millet & also with Little millet)

Naturalised taxa:

Resistances (none in native spp.)

Downy mildew (*Sclerospora graminicola*): *P.polystachyon* (NE to CI & PI), *P.pedicellatum* (thr.);

Leaf rust (*Puccinia substriata* var. *indica*): *P. purpureum* (EP, SI).

Habitat change(?)

Pennisetum hordeoides (NE/EI)- species of cultivated areas in India, but of swampy areas in Africa

Species relationships- elucidating relationships between CWR

Crop genus	Taxonomic/ biosystematic study	Reference
<i>Brachiaria</i>	Biology, agronomy & improvement- emphasising fodder species	Miles <i>et al.</i> , 1996
<i>Digitaria</i>	Study of spp- N America, SW Europe, Mexico, Pakistan; morphology of spikelet, morphology-based cladistics analysis	Vega & Agrasar,2001; Vega <i>et al.</i> ,2009
<i>Echinochloa</i>	Study of weed complexes, biosystematics with emphasis on Japanese species	Yabuno,1966; Yamaguchi <i>et al.</i> ,2005
<i>Panicum</i>	Crops and weeds, phylogeny	Aliscioni <i>et al.</i> ,2003; Ellstrand,2010
<i>Paspalum</i>	Diversity within crop	de Wet <i>et al.</i> ,1983
<i>Pennisetum</i>	Crossability, domestication and evolution	Dujardin & Hanna,1989; Remigereau <i>et al.</i> ,2011;
<i>Setaria</i>	Diversity and distribution, genome identification in domesticated species in North America and Europe to Chinese regions	Dekkar,2003; Zhao <i>et al.</i> ,2013; Nani <i>et al.</i> ,2015; Jia <i>et al.</i> ,2013; Huang <i>et al.</i> ,2014,2016

TAXON SHEETS

GENUS

Total species, centre of diversity, climatic preferences

Uses

Indian region:

Wild species, phytogeographic areas of species diversity;

Native & naturalised species

Distribution India vs Global

SPECIES CLASSIFICATION & CHARACTERS FOR ID. & images

SPECIES DESCRIPTION

Species and synonyms; classification. Chrom no./ genome

Habitat; distribution India, world; Spot characters and diagnostic characters; variation. Phenology. Related species.

Brachiaria ramosa (L.) Stapf 2n=32, 36. Widespread in the wild, forest undergrowth, rocky hill slopes, grasslands, open patches in plantations, weed on roadsides and cultivated fields (750-900~1200 m); across Indian subcontinent, China, Indo-China, Middle East, West Asia, Africa; naturalised elsewhere in tropics. Annual, loosely ascending, the longest raceme branching, spikelets (2.5-5 mm) paired, on short pedicels, glabrous or pubescent, contiguous and appressed to racemes, lower glume- one-third to half the length of spikelet, membranous or crustaceous, (and surface faintly rugose), upper lemma granulose to rugose. Spikelet disarticulate, but variable in wild and weedy populations (hills of central & peninsular India where cultivated for millet). Fl/Fr: Jul-Oct. Intergrading with *B. deflexa*.

Brachiaria

Over 100 spp., tropical and subtropical areas of world; Centre of diversity in Africa (Clayton et al., 2006 onwards). High diversity in species of value as fodder and pasture grasses (Miles et al, 1996). Two widespread and variable species domesticated for millets- one in India (*B. ramosa*, Browntop millet), other in West Africa (*B. deflexa*, Guinea millet).

Indian region: 18 species in India (Santapau & Henry, 1974; Bor, 1960; Pradheep et al., 2014). Peninsular, eastern plains and north eastern areas with maximum species diversity in the Indian region. Diversity represented in 13 native, and one introduced and naturalised wild species.

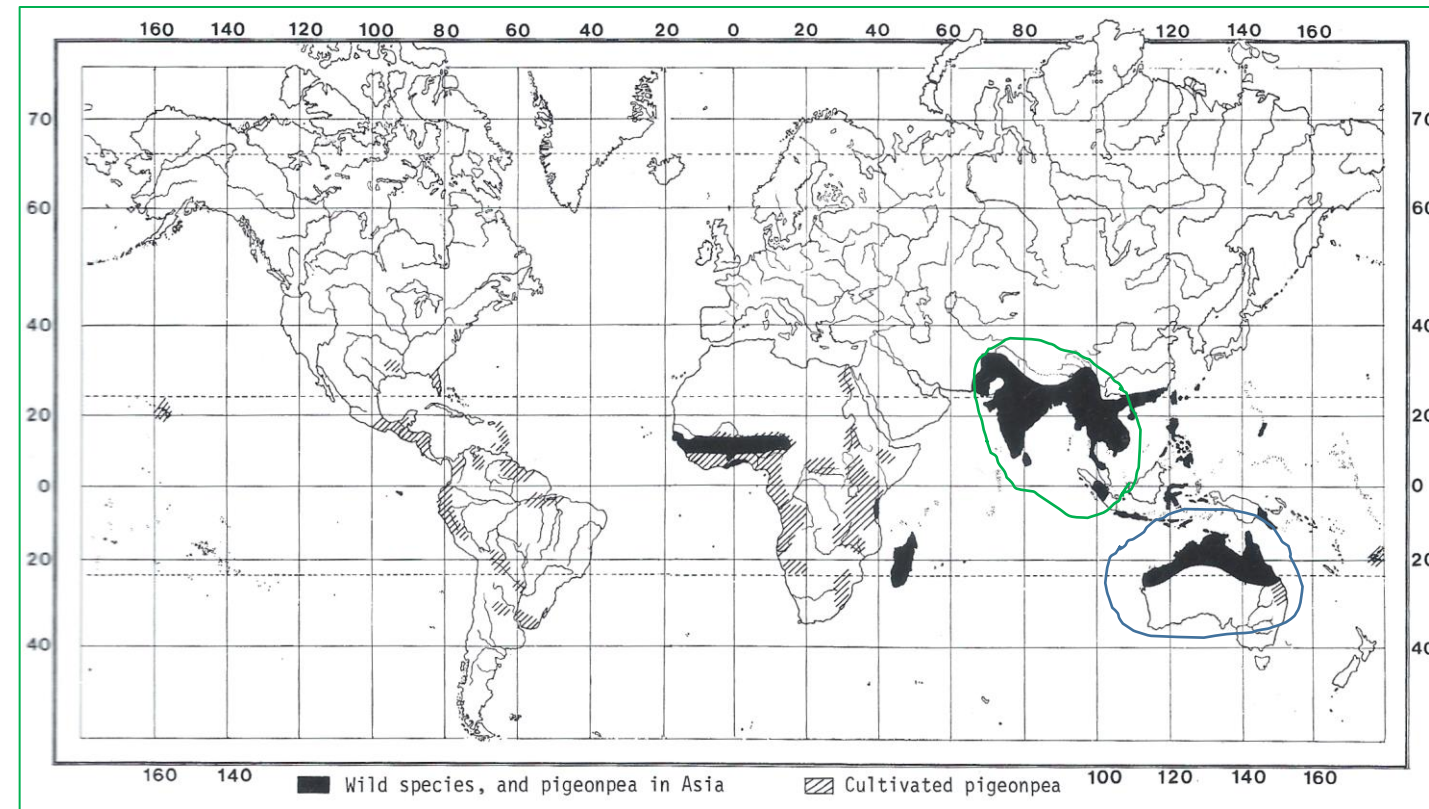
with more diversity of species in the eastern and peninsular areas as compared to the north western parts (www.eflora.org). African- Asian species (3): *B. ramosa*, *B. deflexa* and *B. reptans*, widespread in the wild, and the former with localised wild-weedy-domesticate populations (in peninsular India).

- Predominantly Asian species, related to the above (6): *B. kurzii* and *B. remota* (eastern plains and peninsular India, and also in NEI in the former), *B. villosa* (represented by different varieties in north eastern and peninsular areas) and *B. semiundulata* (hills of peninsular India); *B. eruciformis*, *B. distachya* (widespread).
- Species of the Indian subcontinent- *B. semiverticillata*, endemic species, and *B. nilagirica* (mainly in peninsular/ southern areas).
- Naturalised species (1): *B. mutica*, introduced and cultivated in damp places, and widely naturalised.

Species groups* (spp. no.)	Characters	African- Asian	Asian/ n-African	Asian- Indian subcontinent	Naturalised
	Triquetrous rachis, racemes along central axis- few to many, and sometimes with branching of lower ones, spikelets, solitary, paired or in clusters, lower glume upto half the length of spikelet, weakly or strongly cuff-like;				
1A (3)	Pedicels short, spikelets dense, often appressed	<i>B. reptans</i>	<i>B. villosa</i>	<i>B. nilagirica</i>	
1B (5)	upper lemma rugose, papillose or granulate. Pedicels of spikelet pair unequal, one longer and spreading; spikelets lax, nor appressed	<i>B. ramosa</i> , <i>B. deflexa</i>	<i>B. kurzii</i> , <i>B. remota</i>	<i>B. semiverticillata</i>	
3 (1)	Rachis flat, herbaceous, ribbon-like, spikelets solitary with short pedicels in more than two rows, arranged densely, upper lemma rugulose. Racemes spreading, spikelets narrowly ovate, lower glume ovate and flat. Perennial, culms stout and trailing, nodes villous, and hairs at base of lower branching racemes.				<i>B. mutica</i>
4 (1)	Rachis flat and narrow, spikelets solitary with short pedicels in two rows, arranged densely or loosely and spreading, upper lemma rugulose. Racemes erect or ascending, spikelets ovate or narrowly ovate, turgid or compressed, lower glume cuff-like and stipitate.		<i>B. distachya</i>		
7 (1)	Racemes 3-15, rachis: very narrow, wingless, spikelets elliptic-oblong, lower glume very small, upper lemma smooth and blunt		<i>B. eruciformis</i>		
Ungrouped (1)	Spikelets solitary, in two rows, not appressed, obovate, lower glume very short, not cuff-like, upper lemma papillose striate		<i>B. semiundulata</i>		

Cajanus cajan: Native crop

Sections	Habit	Australia	India, Myanmar, Sri Lanka, Java	Phil., Indonesia	Africa	
Atylia	Erect	<i>C. cinereus</i> , <i>C. confertiflorus</i> , <i>C. lanuginosus</i> , <i>C. reticulatus</i> var. <i>grandifolius</i> , <i>C. reticulatus</i> var. <i>reticulatus</i> , <i>C. reticulatus</i> var. <i>maritimus</i>	<i>C. lineatus</i> , <i>C. sericeus</i> *, <i>C. trinervius</i> *			
Cajanus			<i>C. cajan</i> *, <i>C. cajanifolia</i> *			
Cantharosperrum	Climbing	<i>C. scarabaeoides</i> var. <i>pedunculatus</i> , <i>C. scarabaeoides</i> var. <i>scarabaeoides</i>	<i>C. albicans</i> *, <i>C. elongatus</i> , <i>C. goensis</i> **, <i>C. rugosus</i> **, <i>C. scarabaeoides</i> * var. <i>scarabaeoides</i>			
Fruticosa	Erect	<i>C. pubescens</i> var. <i>mollis</i> , <i>C. acutifolius</i> , <i>C. aromaticus</i> , <i>C. crassicaulis</i> , <i>C. laceolatus</i> , <i>C. latisepalus</i> , <i>C. pubescens</i> var. <i>pubescens</i> , <i>C. viscidus</i>	<i>C. niveus</i>		<i>C. kerstingii</i>	
Rhynchosoides	Trailing	<i>C. mareebensis</i> , <i>C. marmoratus</i>	<i>C. platycarpus</i> **			
Volubilis	Climbing		<i>C. grandiflorus</i> , <i>C. heynei</i> **, <i>C. mollis</i> **, <i>C. villosus</i> , <i>C. volubilis</i> ** var. <i>volubilis</i> , <i>C. volubilis</i> var. <i>burmanicus</i>			
?						
Total species		15	17			
Endemics		13	8			

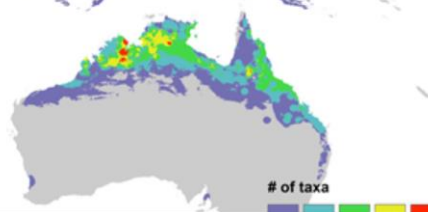


*Closely related taxa; ** Tertiary genepool

Monograph: van der Maesen, 1985. *Cajanus* DC. and *Atylosia*

Gap analysis

<https://www.cwrdiversity.org/>
Pigeonpea gap richness



- *Cajanus cajan* (Arhar, tur/ pigeon pea) native to India
- Semi-wild and naturalized plants in Asia and Africa
- Primary genepool (Sec. *Cajanus*), Secondary genepool (Sec. *Volubilis*) and tertiary genepool represented in Asia/ Australia
- Endemic species in S/ SE Asia
- Majority of species in Australia endemics – centre of speciation

Cajanus and Flemingia (Tribe Phaseoleae, subtribe Cajaninae)

Moderately large genera (35-40 species each). Genera with 50 percent species represented in India.

Global distribution

	India	China	Australia	Rest of Oceania	Africa	Americas	Eur
<i>Cajanus</i>	15	7	14	1	1	-	-
<i>Flemingia</i>	18	15	4	-	1	-	-

Cajanus (syn. *Atylosia*)

Species distribution- global: Over 35 species of tropical and subtropical regions. Over 50 percent of species occurring in the Asian region- mainly in the Indian, Chinese and Indo-Chinese regions (18) and a secondary build-up of species (14) in the Australian region; habit ranging from erect forms to shrubby and creeping forms.

Crop species: *Cajanus cajan*, the major domesticate, native of the Indian region.

Indian region: 15 species, more in the warmer and moist parts as compared to dry areas of north western India-

Endemics in eastern plains (5), extending to north eastern, north western and peninsular parts; maximum species in peninsular parts and Sri Lanka (4), north eastern parts and extending to Indo-Chinese region (3),

Species classification: Taxonomic classification of species in Sections designated on the basis of morphology were associated with differences in habitat features, area of concentration of species, crossability and resistances to diseases.

Disease/ pest resistance: Diseases maximum in north western plains, central and eastern plains and peninsular India. Maximum resistances too in species of *Atylosia*- co-evolved with disease. Abiotic- varied in their preferences for temperature, precipitation and altitudinal ranges, tolerance to salinity, followed by drought.

Species distribution in India

	<i>Cajanus</i>	<i>Flemingia</i>
Maximum spp. concentration	peninsular (4) and north eastern parts (3), extending to Indo-Chinese region	widespread in Indian region & Chinese, Malesian and Indonesian regions (10)
Endemics	eastern plains, extending to adjacent parts (5)	peninsular region and Western Ghats (6)

1 Crop genera

S.No.	Genus	Family	Category	spp.list	biotic/abioti c	GRIN	UPI
9	Paspalum	Poaceae	C/Mi	✓	✓	✓	✓
10	Pennisetum	Poaceae	C/Mi	✓	✓	✓	✓
11	Secale	Poaceae	C/Mi	✓	✓	✓	✓
12	Setaria	Poaceae	C/Mi	✓	✓	✓	✓
13	Sorghum	Poaceae	C/Mi	✓	✓	✓	✓
14	Triticum	Poaceae	C/Mi	✓	✓	✓	✓
15	Zea	Poaceae	C/Mi	✓	✓	✓	✓
	Urochloa	Poaceae	C/Mi				
16	Alocasia	Araceae	Et	✓		✓	✓
	Amorphoph						
17	hallus	Araceae	Et	✓		✓	✓
18	Colocasia	Araceae	Et	✓	✓	✓	✓

2 Major biotic stresses

Crop	Disease	Causal organism	Management	Region/Occurrence	Remarks
Pearl millet (Pennisetum glaucum)	Fungal (Downy mildew)	<i>Sclerospora graminicola</i>	Hybrid varieties. Seed treatment with Agron 3550 @ 2g a.i./kg seeds followed by metazaly spray @ 125 mg a.i./litre of water 20-25 days later will effectively check the disease. Rotation of different/ improved varieties in alternate years is evident in arresting spread of mildew (handbook of Agri.).	The disease is of great economic importance in India and in many countries in Africa, including Senegal, Mali, Burkina Faso, Niger, Nigeria, Togo, Chad, Tanzania, Zambia, and Mozambique. The pathogen has been reported in more than 20 countries. (Singh et al., 1993) In India, the disease is present in all the states where pearl millet is cultivated	less prone to pests and diseases (handbook of Agri.). Most important disease of pearl millet
	leaf rust	<i>Puccinia subsperta</i>	Pre-treatment of pearl millet with salicylic acid (SA) conferred resistance to a virulent isolate of the rust fungus Cronartea et al., 2009	http://egpoptea.iti.ac.in/ United States, Asia, India, Sri Lanka, Pakistan http://www.bfnu.org.uk/inf/fungal/diseases/PM.htm	
	eye spot disease	<i>Rhizaria sacchari</i> <i>Claviceps fusiformis</i>	Field ploughing to expose and kill the inoculum var. v: KCP 8203 and ICM 155 (handbook of Agri.). The use of clean, sclerotia-free seeds, judicious use of fertilizers/NPK on pearl millet varieties (particularly open-pollinated varieties), early sowing and the diseaseous use of fertilizers/NPK can help to reduce the incidence of ergot considerably (Sharma et al., 1984b; Thakur and King 1992; Chahal et al., 1994a; Thakur, 1994b)	Present in And. & Nic., AP, AS, KR, MP, MH, RJ, TN, UP, EWBI CABI widespread in Africa & India. In India widespread (Mhikil present in AP, DL, GU, HR, KR, MP, RJ, TN & UP) CABI, Compendium	wild host of R. sacchari
	Ergot		Field ploughing to expose and kill the inoculum var. v: KCP 8203 and ICM 155 (handbook of Agri.). The use of clean, sclerotia-free seeds, judicious use of fertilizers/NPK on pearl millet varieties (particularly open-pollinated varieties), early sowing and the diseaseous use of fertilizers/NPK can help to reduce the incidence of ergot considerably (Sharma et al., 1984b; Thakur and King 1992; Chahal et al., 1994a; Thakur, 1994b)		
Crop	Dise	causal	Management	Region/Occur	Remarks
ase	organi	sm		ence	
	witch weed	<i>Striga hermonthica</i>	Intercropping, seed treatment with herbicides		crop is other host of weed
	Fungal (Blatt)	<i>Pycnarhiza grisea</i>	Plant resistant varieties where available, treat seeds with appropriate fungicide; sowing of appropriate varieties may also be required to control the disease in the field; good sanitary practices are essential to limit the spread of the disease (https://www.plantville.org/). Growing resistant varieties. Treating seeds with Thiram or Mancozeb or Carbendazim @ 250 kg/ha seeds 24 hr before sowing, early sowing in season, replacing Nitrogen with either formulated manure, control and fertilizers reduce the blast severity. Spray of Carbendazim (0.05%) or Difenophos (0.1%) or Mancozeb (0.2%) (handbook)	Occurs in all areas of Africa and Asia where millet is grown. Severe in Burkina Faso	serious disease of finger millet and causes considerable reduction in yield (handbook)
	Finger millet (Eleusine coracana)				
	Helminthosporium blight/ Brown spot nodules	<i>Helminthosporium blight</i>	same as that of blast other than carbendazim and spray of fungicide at flowering stage if necessary, with mancozeb or zineb (0.2%) (handbook)	especially on long duration varieties or late - sown crop at flowering stage	
	Mottle streak and streak virus		Application of carbendazim (10%) granules 230-350 g a.i./ha 7 or 7.5 mm x 1.2 m, 2 days before sowing; Spray Dithionate 30% EC (0.05%) or methyl dithionate (0.05%) before transplanting. Remove the infected plants from the main field (handbook)	prevalent in KR, TN & AP (handbook)	viruses have also been responsible for total yield loss in South India. During the 1940s and 1960s two viral epidemics occurred in Karnataka (handbook of Agri., 2010)
	stem/bark borer	<i>Sesamia inferens</i>	Spraying crop with dimethoate (0.05%) or Monocrotophos (0.04%) (handbook)	sporadic	
	Kodo millet (Pennisetum scriboculatum)	(Head) <i>Sonoporum paspali-</i> Thunberg	Use seed with Emkian / (Chlorobactin) or Mancozeb @ 20-25 kg seed before sowing and growing tolerant var. GUPK 3 & KMV 20 (handbook)		
	Ergot	<i>Claviceps paspali</i>	Use seed that is free of ergot sclerotia. Cultivation of tillage should be greater than 40 mm, so that the germinating sclerotia cannot reach the soil surface to release spores. Paddock rotations using non host crops will help reduce sclerotia levels in the soil. Control of grasses within cereal crops will help prevent cross infection. This is best achieved by preventing seed set in the season before cropping, by clear fallowing, hand grazing or by cutting, together with the use of selective herbicides. Headlands and roadsides should be free from grasses mature to eliminate potential ergot reservoirs http://agri.cruce.org.au/agriculture/		
	shooty (only serious pest)		sowing the onset of monsoon is beneficial, adopting higher seed rate 1.12 times (not recommended) seed rate, need based application of insecticides (handbook)		
	Foot rot (Setaria green ear disease infest)	<i>Sclerospora graminicola</i>	seed treatment with ridomil MZ @ 2g/kg and clean irrigation		

3 Species uses & distribution

species	distribution	habitat	uses	remarks	GRIN	UPI
<i>Paspalum canarae</i> (Steud.) Veldkamp	(w) SI, ? NEI, EI				Ind to Thai (Kew)	
<i>Paspalum conjugatum</i> P.J. Berg.	(w) throughout India, ©	grasslands, rice fields	fodder		Afr, Chn, Bhu, Ind, SL, IndChn, Aust, New W, Pacific	✓
<i>Paspalum convexum</i> Fluegge	America, (Intr.)				New W; Nat- elsewhere, incl. US & Cuba	
<i>Paspalum dilatatum</i> Poir.	S America, (n), ©		forage		New W; Nat- Afr ,Caucas, Chn, Jap, Cyp, Isrl, Jor, Turk, Ind, SL, IndChn, Males, PNG, Aust, Eur, New W, Pacific	✓
<i>Paspalum distichum</i> L.	(w) throughout India, ©		fodder		Neqw W; Nat- Afr, Arab, Bangl, Ind (AS, BH, HP, JK, KL, MK, MN, MG, NL, UP, WB), Nep, Pak, SL, IndChn, Males, Philip	✓
<i>Paspalum fasciculatum</i> Willd. ex Flüggé	Mexico to S America, (Intr.)				New W; Nat- elsewhere	
<i>Paspalum juergensii</i> Hack.	S America, (Intr.)				New W	
<i>Paspalum longifolium</i> var. <i>lorirhachis</i> Bor	NEI				syn of <i>Paspalum sumatrense</i> (Kew)	
<i>Paspalum longifolium</i> Roxb. var. <i>longifolium</i>	(w) EH, EI., NEI, TN, KL, PB, UK, UP, MP				Chn, Jap, Ind (AS, NL, TR, UP), nep, SL, IndChn, Males, Philip, PNG, Aust, Pacific	

4 WR- biotic & abiotic stresses

Stresses		P. antdl	P. trgd	P.vrgt	P. schz							a=1893, b=1915, c=2051
Panicum miliaceum												
	Fall armyworm (Spodoptera frugiperda)			√ a								
	Soil conservation	√		√								
	Tolerant to drought	√ b	√ b									
	Sand-dune stabilization		√									
	Adaptive to saline conditions				√ c							

CWR in selected crop genera- potential use, biotic and abiotic stresses/ traits

Crop spp.	Biotic stresses						Area of biotic stresses					CWR- potentially important#				CWR- traits					
	T	F	V	I	N	Wd	T	nwp	ci	ep	pi	T	W	Intr	natr	T	B	P	A	Q	Br
Cajanus	12	2	1	7	2	-	9	8	-	9	9	9	7	3	-	67	24	15	11	8	9
Saccharum	15	8	5	-	2	-	8	5	-	6	8	8	8	-	-	16	6	6	4	1	-
Pennisetum	6	4	-	1	-	1	5	5	4	4	5	9	2	3	4	17	8	6	2	-	-
Panicum	1	1	-	1	-	-	1	-	-	-	-	4	2	2	-	4	1	-	3	-	-
Setaria	1	1	-	-	-	-	1	1	1	1	1	1	1	-	-	2	-	1	1	-	-
Paspalum	2	-	-	-	-	-	2	-	-	-	-	2	-	2	-	1	1	-	-	-	-
Echinochloa	4	3	1	-	-	-	2	1	2	1	2	2	2	-	-	1	-	-	1	-	-

T (total)

Biotic stresses: F- fungus, I- insect, N-nematode, V- virus, Wd- weed

Areas of abiotic stress: ci- central India, ep- eastern plains, nwp- north western plains, pi- peninsular India

CWR- Potentially important: intr- introduced, natr- naturalised, wild native

CWR traits: P- Plant characters, B- biotic, Br- PGR use, A- Abiotic habitat tolerances, Q- Quality traits

1. Resistance (rv) in crop & CWR (w, wild; and introduced, intr) for fungi and viruses; CWR for pests & nematodes.
2. Resistances more in CWR of native origin (7) as compared to introduced ones (3); no additional resistances in latter.
3. Maximum resistance in species of Sections *Cantharospermum* and *Atylia*, with native diversity in the Indian region.
4. Diseases maximum incidence in north western plains, central and eastern plains and peninsular India.

Disease-/ pest-resistance related to classification of species on basis of habit etc.; Sects. Rhynchosoides[Atr>Ind,1]> Atylia[Atr>Ind,3]> Cantharospermum[Ind>Atr,1]>Volubilis[Ind]>Cajan[Ind].

Aegilops tauschii Coss. Synonyms: *A. squarrosa* auct. non. L.; *Triticum tauschii* (Coss.) Schmalh. (Family Poaceae, Subfamily Pooideae, Tribe Triticeae) Diploid $2n=14$, genome formula DD.

Western Himalaya, Kashmir, very common at stony places, sandy areas, and in disturbed areas. Plants in the Indian and adjacent areas of Pakistan and China mainly conform to high altitude forms of subsp. *tauschii* with short culms, long spikes, small spikelets and florets. Primary centre of diversity, south of Caspian Sea, and Transcaucasia, extending to East Turkey, Crimea and Caucasus to the west and Pakistan, Kashmir and Tibet in the East. Occurring from sea level to high altitudes (1800m and above).

Highly variable species¹, subsp. *tauschii* with wider distribution upto higher altitudes in China and Kashmir. Naturalised in Central and NE Syria, parts of China and occurring with cultivated wheat. Autogamous forms with small anthers and facultatively allogamous ecotype with long anthers found (Zeven & de Wet, 1982). Fig. 1.

¹ represented by subsp. *strangulata*, restricted distribution in disjunct areas- SE parts of Iran adjacent to Caspian Sea and Transcaucasia, and subsp. *tauschii* (vars. *typica*, *anathera* and *meyeri*, described in original collections, but not clearly demarcated). Introgression between the ssp. *strangulata* and ssp. *tauschii*, in Iran, higher than in Transcaucasia.

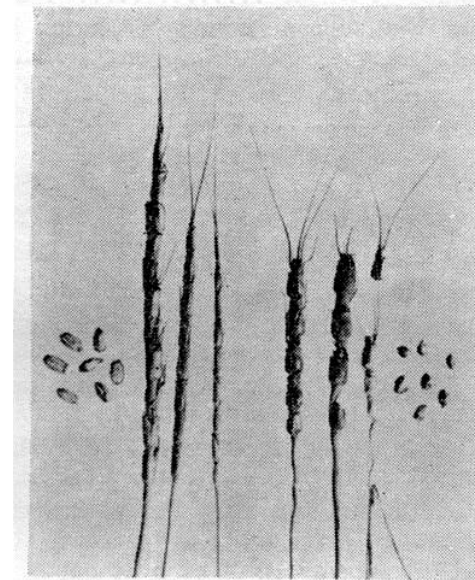
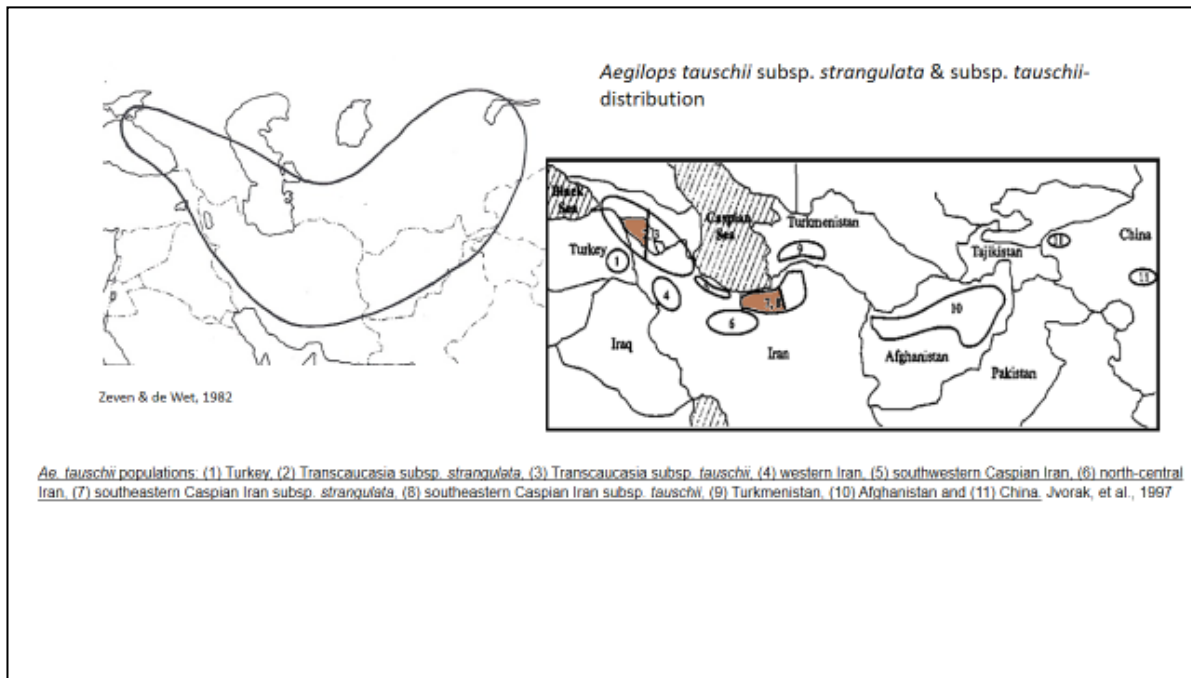


Fig. 1

Kihara, Yamashita & Tanaka, 1965

Sum-up

Native diversity- Species Indian/ Global; distribution- Indian (phytogeographic) vs global (TDWG)

Databases- Species nos., distribution, crop- stresses; CWR- stresses

Descriptions- species; genus

Priority species- e.g. millets (7 genera): 16 out of 58 native species

Additional species added to priority list of species- 85 species (in 34 genera) were added with potential value as sources of resistance and desirable traits

Diversity within genus/ genera- Subtribe Cajaninae (Cajanus/Atylosia-Dunbaria-Rhynchosia-Flemingia-Eriosema); part of subtribe Phaseolinae (Macrotyloma-Lablab-Dolichos-Nesphostylis-Stenostylis)

Diversity within species-

- crop-weed-wild complexes
- high species diversity as an indicator of favourable conditions for the crop genepool; areas of high species diversity versus high diversity in the crop species/ individual spp.
- wild forms versus naturalized forms*
- native and endemic species, from 'type' localities; new records of distribution

*Potential high risk populations- Closely related species that are secondary hosts of major diseases/ pests, and/ or invasive, and recommended for removal

Nomenclature changes in crop and wild genepools- blurring/ or loss of information of PGR value