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Morphological diversity of local land races and wild forms of mungbean

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ABSTRACT

A set of genotypes comprising 81 local land races, four wild forms and four improved varieties of mungbean were grouped into 15 genetic clusters. The genotypes revealed wide variation in stable morphological characters as well as agronomic traits which provided the necessary base for genetic divergence. The wild forms TCR 192, TCR 213 and TCR 243 were viny with late maturity and had distinctly different leaflet, inflorescence and pod characteristics. Whereas, a wild accession TCR 20 was erect with sturdy stem, vigorous growth, broad ovate leaflets, long pods, profuse poding with high yield potential and resistance to biotic (bruchids, CLS, PM and YMV) and abiotic(drought) stresses. Clustering pattern confirmed more proximity of TCR 20 with cultivated forms and therefore, it may be amenable for hybridization with cultivated land races and improved varieties for transfer of its desirable traits. Balarampur Keonjhar local was quite distinct from other land races owing to its vigorous growth, broad leaves and long pods with very bold seeds, but worst affected by YMV. In contrast, TARM 1 had high field resistance to diseases including YMV. Nipania munga -an elite land race of Kalahandi district of Odisha was highly drought tolerant with dwarf plant type and good initial vigour. These above genotypes being morphologically unique and having unique desirable agro-economic traits, formed small divergent clusters and hence, may serve as valuable material for genetic improvement in mungbean through hybridization.

Key words: Genetic variation, Local land races, Mungbean (*Vigna radiata* L.Wilczek), Wild forms.

INTRODUCTION

India has a rich heritage of local land races of mungbean. At Asian Vegetable Research and Development Centre (AVRDC), Taiwan, where the largest mungbean collection is maintained (5736 accessions in 2008), the majority of germplasms (2705 accessions) is originated from India (AVRDC, 2008). In Eastern India, two-third of the area under mungbean is cultivated using local cultivars during winter season mainly in rice fallow under rain fed situation in less fertile marginal and sub-marginal lands. In the process of such continuous minimal cultivation, the local land races sustained low productivity and the plant types have adapted to survival following natural selection against biotic and abiotic stresses. This resulted in a large number of land races adapted to a wide range of agro-climatic conditions. Genetic variability in available germplasm of mungbean is limited. Besides, repeated use of selected genotypes in various breeding programs has resulted genetic erosion in gene pool. This becomes a major concern for increased vulnerability of crop plants to biotic and abiotic stresses (Smith *et al.* 2004, Reif *et al*. 2010). The existing varieties bred so far have low yield potential and are mostly vulnerable to cold stress and diseases. The paradox is that in order to enable to develop truly revolutionary new cultivars for tomorrow, plant breeders will need to have access to the wealth of genes which exists now only in exotic and/or local genetic backgrounds (Kole *et al.* 2000) including wild related species. In this context, morphological characterization of genetic resources is a vital step in generating new desirable plant types that help in increasing crop production as well as quality of the produce. However, no systematic work has been done on characterization and evaluation of available local germplasm in mungbean. In the present investigation, a set of local land races including a few wild accessions of mungbean (*Vigna radiata* var. sublobata) was studied for genetic variability, varietal identification and genetic diversity based on morphological traits.

MATERIALS AND METHODS

A set of 89 popularly adapted *Vigna* local land races (Table 1) including four standard ruling varieties (Jyoti, Durga, Pusa Vishal and TARM 1 as checks) and four wild accessions of *Vigna radiata* var. sublobata (TCR 20, TCR 213, TCR 192 and TCR 243 received from NBPGR, New Delhi) were laid out in Augmented Design with five blocks and 17 test genotypes plus four promising standard checks in each block to assess their comparative performance. The crop was raised following recommended package of practices at EBII Section, Dept. of Plant Breeding & Genetics, CA, OUAT, Bhubaneswar. Observations on all morpho-economic traits including seedling vigour

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(1-5 scale), yield and yield component characters, tolerance to cold stress and extent of powdery mildew and *Cercospora* leaf spot diseases (0-9 scale) were recorded in *rabi* 2012-13. Similar field experiment comprising the same set of test genotypes was necessitated for proper assessment of drought and YMV (yellow mosaic virus disease) tolerance (0-9 scale) during Summer 2014. Actual values of agronomic data were adjusted as per the standard procedure of augmented design to eliminate block effects from actual data recorded.

Block effect rj for each block = Bj-M where, Bj= mean of all checks in the jth block, M= Grand mean of all checks, Adjusted data= Actual data- block effect.

The adjusted morphological data were subjected to SAS (Statistical Analysis System) software programme (version 9.2) to estimate Euclidian genetic distance between paired genotypes and clustering of genotypes were done based on Norm Root Mean Square tie distance values between succeeding clusters. Cluster composition was set up for 15 clusters and the corresponding cluster means for twelve agro-economic traits were derived from adjusted mean performance of the test genotypes.

RESULTS AND DISCUSSION

Characterization of mungbean genotypes with regard to stable simple inherited characters is a pre-requisite for varietal identification (Tripathy *et al.* 2011). Mungbean seeds are normally green, but there exists a wide range of seed colour variation (Fig 1.) among the test genotypes (Table 1). These include deep green, shiny green, dull green, yellowish green, shiny yellowish green, brownish green, greenish yellow, greenish brown, brown, shiny brown, dull brown, blackish brown, reddish brown, dull reddish brown, black, shiny black, shiny greenish black and dull black. Most of the land races had green, dull green or dull brown seeds. Blackish brown seed colour was specific to Tigiria local C. Shiny green seeds usually fetch consumers' preference. Phulbani local-B, Makarjhola local-A, Purusattam local, Khadabhanga local-A and Samarjhola local exhibited appealing shiny green seed colour. Whereas, three local land races, e.g., Kodala local-A, Kopergaon local and Paralakhemundi local had shiny yellowish green seed coat colour. Genotypes with glossy seed lusture are usually tolerant to pulse beetle owing to inconvenience in oviposition.

Seed size is one of the most limiting factor for productivity. Balarampur Keonjhar local was very large seeded (100 seed wt. =8.86g) followed by Jharsuguda local D, Khadabhanga local-A, Kodala local-A, Kopergaon local and Purusattam local. In contrast, Phulbani local-B was identified to have very small seeds. Almost all local land races including standard check varieties were erect to semi-erect. The wild accessions TCR 213, TCR 192 and TCR 243 had shown viny growth habit with mostly single solitary flowers from nodes (Fig 2)., but TCR 20 was tall and erect with sturdy stem and bunch of flowers in the peduncle (Fig 3). Among the test entries, Balarampur Keonjhar local bore very long pods with more than 12 seeds per pod (Fig 3). Mungbean *in vogue* bears purple and rarely green hypocotyle. But, few land races e.g., Sudhasarangi local-B had light green; and Sashna Ambagaon local-B, Sidheswar local, Sikri local and Sharagada local exhibited light purple hypocotyle. All land races including standard checks and the wild accession TCR 20 bore normal ovate leaves. In contrast, the viny wild forms e.g., TCR 213, TCR 243 and TCR 192 had conspicuous lobed leaves and the latter bore very small deeply lobed leaflets.

The extent of genetic variability for morpho-economic traits facilitates identification and selection of the desirable trait(s) (Nisar *et al*. 2008) for upgrading the

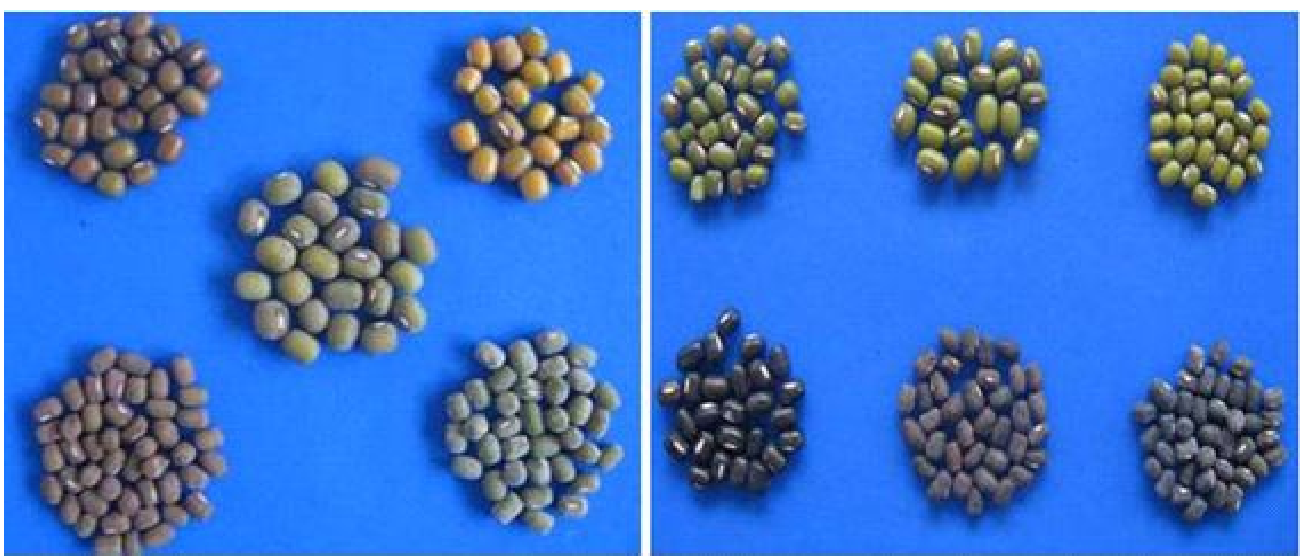

Fig 1: Seed colour variation among different land races of mungbean.

Table 1: Details of stable morphological traits, yield performance and *inter se* euclidian genetic distance of mungbean genotypes.

Genotype	Seed coat colour	Seed size	Hypocotyle colour	Seed Yield/ plant(g)	Genetic distance with other genotypes	
					Range	Mean
Banapur local A	Reddish brown	N	Green	1.97	3.2-66.7	13.8
Banapur local B	Green	N	Green	1.22	2.1- 65.5	12.8
Jagatsinghpur local A	Reddish brown	N	Purple	1.24	3.8-64.6	12.2
Jagatsinghpur local B	Shiny greenish black	N	Green	1.45	3.8-58.6	12.5
Berhampur local	Reddish brown	N	Green	1.03	3.8-65.1	13.5
Bhawanipatna local 2A	Reddish brown	N	Green	1.90	3.8-64.0	13.5
Bhawanipatna local 2B	Dull black	N	Purple	2.05	3.6-62.8	11.6
Bawanipatna local 2C	Dull green	N	Green	1.64	2.9-63.1	11.4
Bhawanipatna local 1	Brown	N	Green	1.77	3.8-58.8	10.3
kopergaon local	Shiny yellowish green	B	Purple	2.15	3.8-56.4	12.7
Sashna ambagaon local A	Reddish brown	N	Green	0.58	3.4-63.5	13.3
Sashna Ambagaon local-B	Dull green	N	Light purple	2.02	3.8-63.9	12.0
Paralakhemundi local	Shiny yellowish green	N	Purple	1.85	3.8-50.6	14.5
Sidheswar local	Dull green	S	Light purple	0.51	3.7-67.6	14.7
Sikri Local	Brown	N	Light purple	1.73	3.8-65.0	12.9
Makarjhola local -A	Shiny green	N	Purple	1.96	3.8-52.2	14.2
Sharagada local	Dull brown	N	Light purple	0.89	3.8-65.9	13.6
Purusattam local	Shiny green	B	Purple	2.15	4.4-56.0	11.7
Anandapur local-A	Shiny black	N	Purple	1.24	5.8-55.3	14.1
Anandapur local-B	Dull green	N	Purple	1.02	3.6-63.9	11.9
Dayapalli local	Shiny brownish green	N	Purple	1.90	6.6-55.0	12.8
Ratila local	Green	N	Purple	1.20	3.6-55.5	11.9
Khadabhanga local-A	Shiny green	B	Purple	2.29	6.8-52.1	14.2
Khadabhanga local-B	Dull black	B	Purple	1.62	8.1-57.6	17.9
Samarjhola local	Shiny green	N	Purple	1.62	4.6-61.2	11.4
Mayurbhanj local A	Black	N	Purple	1.50	4.4-57.8	10.7
Mayurbhanj local B	Green	N	Purple	1.89	5.8-59.4	13.1
Mayurbhanj local C	Dull green	N	Light purple	2.01	3.6-55.4	12.6
Banakhandi local A	Black	N	Light purple	1.20	5.5-58.1	13.5
Banakhandi local B	Green	N	Light purple	1.59	5.7-56.6	12.6
Sudhasarangi local-A	Dull green	N	Green	0.75	4.5-62.7	13.4
Sudhasarangi local-B	Dull green	N	Light green	1.05	5.9-59.1	12.8
Sudhasarangi local-C	Dull black	N	Purple	1.78	6.4-57.7	12.5
Gope local-A	Brown	N	Purple	1.31	5.9-60.5	11.8
Gope local-B	Green	N	Green	1.54	6.6-54.0	14.3
Sheragarh local	Dull reddish brown	N	Green	1.50	4.9-57.3	12.0
Athamallik local A	Glossy greenish mosaic	N	Light purple	1.53	5.5-54.6	14.2
Athamallik local B	Glossy mosaic black	N	Green	1.48	5.4-56.2	13.0
Kalamunga -1A	Glossy black	N	Green	1.39	4.9-55.3	12.7
Kalamunga -1B	Glossy mosaic green	N	Green	1.60	5.8-55.0	15.1
Tigiria local B	Dull green	N	Green	1.00	5.4-64.2	14.0
Tigiria local C	Blackish brown	N	Purple	0.62	2.1-66.3	13.7
Kodala local A	Shiny yellowish green	B	Purple	1.84	4.8-62.3	11.6
Kodala local B	Reddish brown	N	Green	0.92	3.5-65.9	13.4
Kendrapara local B	Dull black	N	Purple	0.89	3.8-59.5	10.9
Kendrapara local C	Brown	N	Purple	0.77	3.5-65.2	13.4
Kendrapara local D	Dull brown	N	Purple	0.96	5.8-63.6	13.5
Phulbani local –A	Shiny greenish black	N	Purple	0.83	4.7-66.7	13.3
Phulbani local –B	Shiny green	S	Purple	0.45	2.9-64.4	12.4
Phulbani local –D	Shiny brown	N	Purple	1.37	3.8-66.1	13.4
Hinjli local –A	Dull green	N	Green	1.15	3.6-60.6	11.1
Hinjli local –B	Reddish brown	N	Green	2.24	5.5-59.4	12.2
Nayagarh local-A	Reddish brown	N	Green	0.66	5.4-61.3	11.8

Contd........

Nayagarh local-B	Dull green	N	Green	0.72	5.2-60.9	11.6
Nayagarh local-C	Brownish green	N	Purple	1.68	4.9-50.5	15.0
Nayagarh local-D	Dull black	N	Purple	0.34	2.8-63.8	12.4
kalamunga 1C	Dull black	N	Light purple	1.20	4.4-56.5	10.9
Deogaon local	Glossy black	N	Green	1.25	4.0-58.0	11.4
Jyoti (Hyb 4-3)	Green	N	Light Purple	2.76	5.1-56.2	12.2
Nandika local	Dull green	N	Purple	2.48	5.4-55.0	11.9
Jharsuguda local-A	Dull green	N	Green	0.74	4.9-60.3	11.6
Jharsuguda local-B	Greenish black	N	Purple	0.67	5.1-61.5	11.7
Jharsuguda local-C	Brown	N	Green	0.86	5.4-57.5	12.1
Jharsuguda local-D	Dull black	N	Purple	1.68	6.5-54.5	18.6
Dhenkanal local	Dull green	N	Light purple	0.34	4.5-64.4	15.2
Charapalli local	Brownish green	N	Purple	1.05	2.8-63.7	12.6
Raipur local	Green	N	Purple	1.08	4.7-58.8	13.0
Kamakshya local A	Dull greenish brown	N	Light Purple	0.88	4.6-55.0	11.8
Kamakshya local B	Glossy greenish black	N	Green	0.98	3.2-56.7	12.2
kamakshya local C	Dull green	N	Green	1.20	4.6-54.2	12.8
Ambagaon local A	Dull black	B	Light Purple	1.22	1.4-58.2	11.9
Ambagaon local B	Dull green	N	Light Purple	1.00	3.0-59.4	11.1
Mahimunda local	Black mosaic	N	Purple	1.25	3.0-59.0	11.5
Jhaimung Kharsel	Dull greenish brown	N	Purple	1.22	3.0-58.0	11.3
Jhaimung Kharsel sel.1	Dull greenish mosaic	N	Light Purple	0.98	4.9-57.5	13.8
Jhaimung Kharsel sel.2	Dull green	S	Green	1.80	3.3-56.8	11.4
Jhaimung Kharsel Sel.3	Dull black	S	Light Purple	1.20	3.0-55.1	12.1
Jhaimung Kharsel Sel.4	Dull black	B	Green	1.00	1.4-58.7	11.7
Jhaimung Kharsel Sel.5	Brownish grey	B	Light Purple	1.08	3.0-56.4	12.4
Jhaimung Kharsel sel.6	Glossy green	N	Purple	1.28	3.3-56.1	11.4
Balarampur kjr. local	Brownish green	VB	green	4.98	9.4-48.8	17.5
Nipania munga	Dull green	N	Purple	1.42	8.9-64.2	15.3
TCR 20	Reddish brown	N	Purple	7.67	18.9-61	51.1
TCR 192	Brownish black	S	Light Purple	3.67	8.5-56.6	47.6
TCR 213	Brownish black	N	Purple	1.90	15.2-67	57.9
TCR 243	Brownish black	S	Light purple	2.66	8.5-49.1	40.7
PUSA VISHAL	Brownish green	B	Purple	2.58	7.7-58.5	15.0
DURGA (OBGG 52)	Green	N	Green	3.23	8.6-54.0	16.5
TARM 1	Green	N	Purple	2.54	9.3-53.4	16.6

N.B.: N-normal, S-Small, B-Bold and VB-very bold size seeds

Fig 2: Wild accessions of mungbean: TCR 213 (left) and TCR 192 (right).

prevailing genotypes by systematic breeding programme. With a quest to identify genetic worth and breeding potential of a set of large collection of mungbean land races, the genotypes were assessed for different morpho-economic traits including biotic and abiotic stress tolerance. The present set of germplasm displayed wide spectrum of genetic variation in almost all characters (Table 3) which is indicative of the probable effectiveness of selection. The genotypes which represent the favourable extreme boundary of the range variation may occur at very low frequency, but these would provide the necessary base for the desired direction of selection. Some of the genotypes which have merit in relation to specific traits have been sorted out in Table 2.

Initial seedling vigour was assessed on 1-5 scale after 10 days of sowing. Balarampur Keonjhar local, Nipania munga, Khadabhanga local A and TCR 20 were found to have excellent seedling vigour (4.5-5.0) among the test genotypes (Table 2). Early flowering and dwarf plant type are often desired to restructure plant architecture in crop plants. But, very dwarf and early flowering genotypes invariably led to low productivity. However, both being mostly controlled by additive gene effect (Kousar *et al.* 2007), it would favour better selection response to obtain suitable plant type. Khadabhanga local B and Mayurbhanj local B had shown 50% flowering within 30days. Among the local land races, Nipania munga, Phulbani Local –A and Banapur local A revealed extremely short plant stature. Pods per plant is the most important yield contributing trait (Tripathy 2005) and it could be improved through selection (Patil *et al.* 2003). It displayed high genetic variability as also reported by Kousar *et al.* (2007) among diverse germplasms in mungbean. TCR 20 bore profuse pods per cluster and per plant. Besides, Jharsuguda local D and Khadabhanga local B recorded more number of pods per plant among local land races (Table 2). In the present investigation, mean seed yield per plant revealed a spectacular wide array of variation ranging from 0.34gm to as high as 7.67gm in the wild genotype TCR 20 as against the best standard check Durga (3.23gm). TCR 192 also yielded high (3.67g) as it bore more pods over a long span of maturity duration (50days). However, the productivity of most of the land races was very poor except Balarampur

Table 2: Promising mungbean genotypes in relation to specific agro-economic traits.

Characters	Range	Promising mungbean genotypes
Seedling vigour (SV)	Score 0-5	Excellent seedling vigour(Score 5.0) : Nipania munga, Balarampur keonjhar local High seedling vigour(score 4.5- 5.0) : Nandika local, Khadabhanga local A, TCR 20
Days to 50% flowering(DF)	30.22-59.22	Early(30.22days) :Khadabhanga Local-B and Mayurbhanj local B Late(40days) : Sudhasarangi local A), Sudhasarangi local B, Gope local B Very late(50-59days):TCR 213, TCR 20, TCR 243 and TCR 192(all wild genotypes)
Plant height (PHT)	12.06 - 70.74	Dwarf : Nipania munga, Phulbani Local –A and Banapur local A Med. tall : Balarampur keonjhar local, Paralakhmundi Local, Nayagarh local-C Very Tall : TCR 213(70.74cm), TCR 20(59cm), TCR 192(64 cm), TCR 243(56cm)
No. of clusters/ Plant(NC/Pl)	1.52 -5.17	Wild genotypes : TCR 213: 15.67 and TCR20: 6.97 Land race : Jharsuguda local D :5.17 nos.
No. of pods/ Cluster(NP/C)	1.34- 6.04	Land race (>6.0) : Sharagada local, Jharsuguda Local-C
No. of pods/ plant(NP)	8.92 - 36.82	Wild genotype : TCR 20 (36.82) Local land race : Jharsuguda Local-D(27.42), Khadabhanga Local-B(24.42)
Seed yield/ Plant(SY/Pl)	0.34-7.67	Wild genotype :TCR 20: 7.67g Land race(= 2.0) :Balarampur keonjhar local (4.98g), Nandika local, Hinjli local B Purusattam local, Khadabhanga local A and Kopergaon local
Cercospora leaf Spot tolerance (CLS)	Score 0-9	Resistant : Pusa Vishal Highly tolerant : TCR 20, TCR 192
Powdery mildew tolerance(PM)	Score 0-9	Resistant: Wild var. - TCR 213 Improved Vars. - TARM 1 Land race -Dhenkanal local, and Nayagarh local A, Charpalli local Highly tolerant : Nandika local, Sikri local, Sashna Ambagaon local A, Sidhaswara local, Banpur local A, Tigiria local A, Tigiria local B
Yellow mosaic virus tolerance(YMV)	Score 0-9	Resistant : TCR 20 Highly tolerant : TARM 1
Drought tolerance(DT)	Score 0-9	Resistant : Land race:-Nipania munga :Wild var, -TCR 20, TCR 243, TCR 192 Highly tolerant : Paralakhmundi local, Kalamunga -1A
Cold tolerance(CT)	Score 0-9	Highly tolerant : TCR 213, Durga, Athamallik local A

Fig 3: Wild accession of mungbean :TCR 20(left) and a local land race:Balarampur Keonjhar local(right).

Table 3: Cluster composition and cluster means of twelve agro-economic traits in a set of 89 mungbean local landraces.

Clusters	Genotype Sl. No(s).	SV	DF	PHT (cm)	NC /pl	NP/ C	NP	SY/pl (g)	CLS	PM	YMV	DT	CT
I	85	2.5	59.2	70.7	5.6	1.3	25.5	1.90	1.4	0.06	2.5	1.9	0.3
II	86,84	3.3	50.0	60.0	4.8	3.1	15.0	3.16	1.1	1.0	3.0	0.4	1.0
III	83	4.5	55.2	58.7	7.0	5.5	36.8	7.67	0.4	0.9	0.5	0.06	1.3
IV	81	5.0	42.0	28.0	3.8	4.0	15.2	4.98	7.8	5.0	8.5	2.9	1.3
V	89	1.0	34.9	25.4	2.8	5.4	18.2	2.54	1.4	0.8	0.03	9.4	8.5
VI	64,24	1.0	30.7	24.8	5.0	5.5	25.9	1.65	7.4	6.9	7.5	6.9	7.3
VII	88	2.3	30.4	26.5	3.0	5.3	19.7	3.23	4.9	5.6	2.6	7.5	0.4
VIII	87	1.0	30.4	22.6	3.1	5.2	16.7	2.58	0.6	8.4	9.0	7.2	6.3
IX	27,40,19,55,16	1.2	33.5	24.4	4.0	5.4	20.3	1.67	5.2	1.2	7.0	7.5	5.5
X	35, 52, 29, 37, 39, 36, 63, 38, 28, 22, 60, 68, 59, 26, 18, 23, 13	2.0	35.1	22.9	2.9	5.4	17.4	1.59	6.5	4.6	7.9	4.6	6.2
XI	82	5.0	37.2	13.7	5.8	5.6	10.4	1.42	8.4	4.9	6.5	0.06	6.3
XII	75, 73, 74, 72, 80, 76, 79, 77, 78, 71, 69, 70, 67	1.8	35.1	21.9	3.3	3.4	10.9	1.17	4.5	5.5	7.2	4.9	3.9
XIII	10, 34, 32, 21, 62, 58, 45, 9, 61, 51, 7	1.4	36.5	19.4	2.6	5.3	13.1	1.35	6.4	5.1	7.4	7.0	8.5
XIV	47, 30, 4	1.6	38.8	17.2	3.1	5.4	16.1	3.36	8.7	0.8	4.0	7.4	8.3
XV	65, 31, 41, 33, 53, 43, 25, 54, 6, 46, 44, 12, 48, 3, 50, 17, 66, 56, 11, 15, 20, 49, 8, 5, 14, 42, 2, 1	1.4	35.2	14.9	2.0	5.4	10.6	1.09	7.1	2.3	7.4	7.7	7.0

Keonjhar local which has excellent yield potential to the tune of 4.98gm/plant. Besides, few other local land races which recorded seed yield more than 2.0gm per plant were listed as promising. These include Nandika local, Hinjli local B, Purusattam local, khadabhanga local A and Kopergaon local. Rupesh-Kumar *et al*. (2001) and Venkateswarlu (2001) also reported wide genetic variation of seed yield in different sets of mungbean germplasm.

None of the check varieties could successfully combat abiotic stresses (cold and drought) except Durga (score 0.44) which withstand winter low temperature stress condition. Besides, the wild accession TCR 213 and Athamallik local A also survived well under cold stress. Among the test genotypes, Nipania munga and TCR 20 followed by TCR 243, TCR 192, Paralakhemundi local and Kalamunga 1A had shown high degree of drought tolerance. Pusa Vishal and the wild forms TCR 20 and TCR 192 scored resistant to *Cercospora* leaf spot (CLS) while, almost all local land races exhibited incidence of CLS. Five test genotypes e.g., Dhenkanal local, Charapalli local, Nayagarh local A, TARM 1 and the wild accession TCR 213 were considered prominantly resistant to powdery mildew. Yellow mosaic virus is a dreadful disease in mungbean and tolerance to such a disease is rarely durable. The present investigation revealed wide range of genotypic response (0-9 score) to the incidence of YMV. TCR 20 and TARM 1 were found to have satisfactory level of YMV resistance (Table 2) while, Balarampur Keonjhar local was worst affected by YMV despite its excellent yield potential among the local land races.

Many workers (Loganthan *et al*. 2000, Venkateswarlu 2001, Abbas *et al.* 2010, Abna *et al*. 2012 and Tiwari *et al*. 2012) revealed genetic diversity in mungbean using different sets of materials, but reports on land races and wild forms are indeed scanty. The knowledge of genetic diversity is useful for efficient sampling and utilization of germplasm either by identifying and/or eliminating duplicates to develop a core collection of genotypes (prebreeding). An attempt was taken to assess the range and average *inter se* genetic distance of each genotype with rest of the test genotypes. The extreme boundary of the range for genetic distance is around 50.0-65.0 (Table 1). On verification, it was found that such a high *inter se* genetic distance of each genotype happens to be between the cultivated genotype with either one of the wild accessions of mungbean under study. In the present pursuit, the wild accessions revealed high average genetic distance (40.7-57.9) as against improved varieties e.g., Durga, TARM-1 and Pusa Vishal which estimated to have genetic distance of 15.0 -16.6. In this context, Jharsuguda local-D (18.6), Khadabhanga local B (17.9), Balarampur keonjhar local (17.5), Nipania munga (15.3), Dhenkanal local (15.2) and Kalamunga 1B (15.1) exhibited higher average genetic distance compared to rest of the local land races.

Cluster analysis is *in vogue* used to study genetic relationship among a large number of accessions. This enables breeders to use appropriate gene pool for combining desirable genes in a single genotype through recombination breeding. In the present pursuit, 89 genotypes comprising 81 local land races, four wild accessions of mungbean and erstwhile mentioned four standard check varieties of mungbean were grouped into 15 genetic clusters (Fig. 4). Kumararathna *et al.* (2013) revealed genetic variation among 65 land races including few exotic mungbean germplasm lines which distributed into three major clusters with distinct genetic variation and 2 minor groups having considerable genetic similarity. In the present investigation, all four wild accessions were separated from the cultivated mungbean genotypes at 3.0 tie distance (scale shown) forming a distinct group that constituted Cluster I (V85-TCR 213), Cluster II (V86-TCR 243 and V84-TCR 192) and Cluster III (V83-TCR 20). Further, at around 0.975 tie distance; Balarampur Keonjhar local (V81) was shown to form a single genetic cluster (Cluster-IV) by separating from rest of the cultivated genotypes. This followed formation of two broad genetic clusters containing 28 and 56 test genotypes respectively at approximately 0.80 tie distance. TARM 1 (V89) and Nipania munga (V82) were clearly separated into two single clusters from the above respective broad genetic groups. Besides, Khadabhanga local B (V24), Jharsuguda local D (V64), Durga (V88) and Pusa Vishal (V87) were found to have high genetic divergence with reference to their position in the dendrogram (Fig 1). Hence, these divergent genotypes may be sorted out as valuable material for genetic improvement in mungbean. Swamy and Reddy (2002), Rao *et al.* (2006) and Muhammad *et al.* (2007) also highlighted the presence of considerable genetic divergence and selection of divergent genotypes using different sets of mungbean genotypes.

It is worth to note that a few test genotypes have been separated into different small clusters (Cluster I to Cluster VIII) owing to their specific morphological and agronomic features distinct from rest of the germplasm lines (Table 3). Isolation of few divergent genotypes into small clusters was also reported by Sardar (2011). Prakash *et al*. (2007) studied genetic diversity of 36 exotic and indigenous mungbean genotypes collected from AVRDC (Taiwan) and India which grouped into 7 clusters and they had shown appreciable amount of genetic variation among cluster means for different morpho-economic characters. Narasimhulu et *al*. (2013) identified a group of accessions with yield enhancing traits and high seed yield. Vijay-Prakash (2006) grouped sixty four mungbean genotypes into eight clusters and found 100-seed weight contributed most towards divergence. Bhattacharya and Vijaylaxmi (2005) identified most diverse clusters based on inter cluster PCA values. In the present pursuit, wild forms in Cluster I (TCR 213) and Cluster II (TCR 243 and TCR 192) had comparatively high seedling vigour, significantly delayed flowering, higher plant height (Table 3), viny habit which contributed higher biomass production. Cluster I that contained TCR 213, had 1-2 pods/ cluster and could thrive better in low temperature. Besides, cluster III comprising TCR 20 was erect with sturdy stem, vigorous growth, long pods, profuse poding with high yield potential and resistance to biotic (bruchids, CLS, PM and YMV) and abiotic(drought) stresses. Above characteristic features of wild mungbean accessions might have contributed towards high divergence from the cultivated test entries. The wild accession TCR 20 is morphologically similar and genetically more close to mungbean than urdbean (Sardar 2011). This was also confirmed from its erstwhile mentioned morphological features and its position in the dendrogram (Fig 1). Therefore, it may be amenable for hybridization with cultivated land races and improved varieties. Balarampur Keonjhar local which formed Cluster IV was quite distinct from other land races owing to its vigorous growth, broad leaves and long pods with very bold seeds. TARM 1

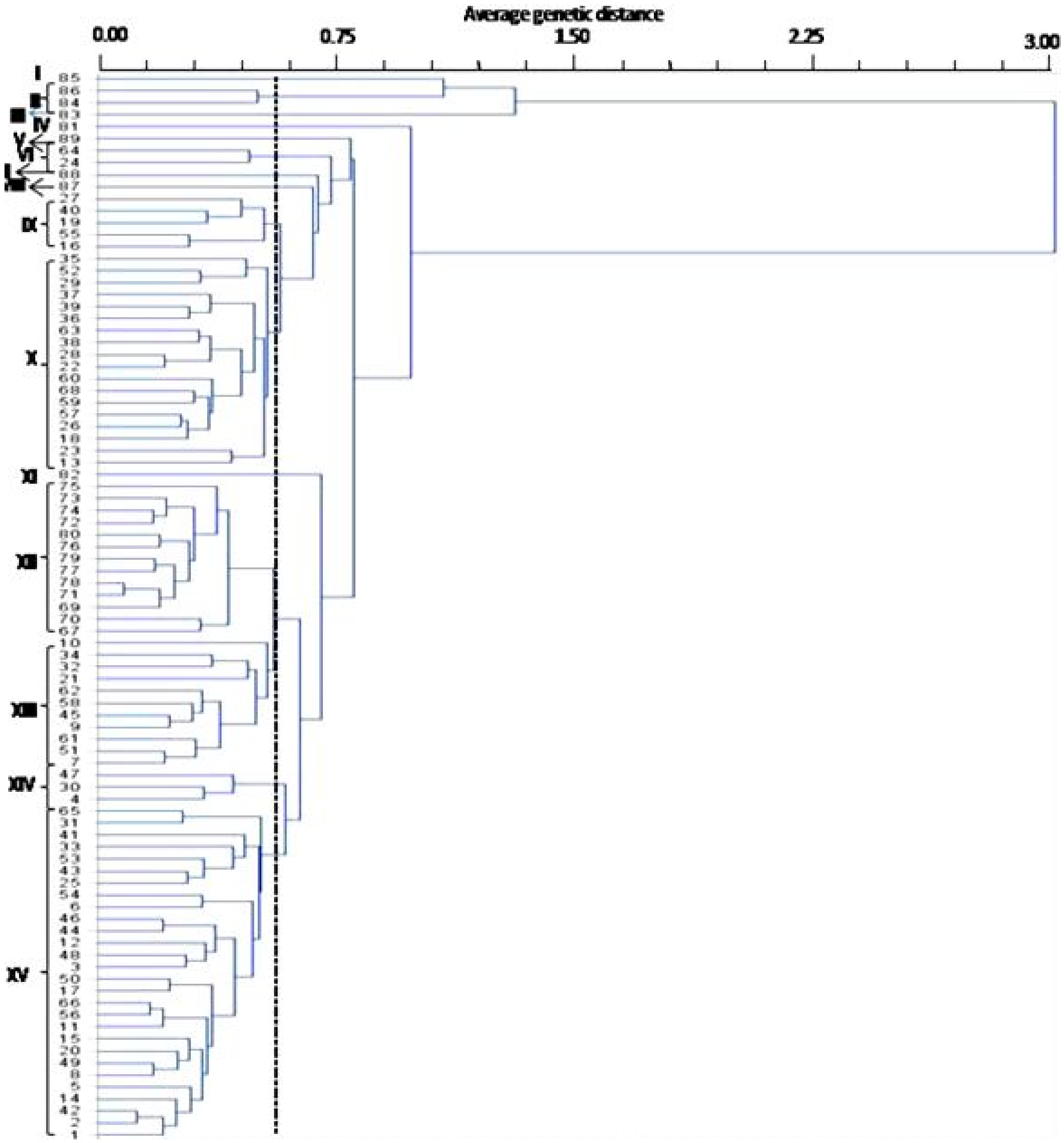

Fig 4: Dendrogram showing genetic diversity of local land races and wild forms (marked as per Sl. No. of genotypes in Table 1) of mungbean based on morpho-economic traits.

constituting Cluster V was highly resistant to all three diseases under study. Among the clusters, Cluster III (TCR 20), IV (Balarampur Keonjhar local), VII (Durga) and XIV (V47-Kendrapara local D, V30-Banakhandi local B, and V4-Jagatsinghpur local B) had shown high seed yield. Khadabhanga local B and Jharsuguda local D (Cluster VI) produced bold pods with high pod number, but exhibited poor productivity owing to susceptibility to biotic and abiotic stresses. Genetic improvement of these genotypes could be achieved by hybridization with donors for stress resistance (Table 2). The single variety cluster (Cluster XI) containing Nipania munga (V82) showed good seedling vigour which otherwise favoured it to survive well in drought stress. Cluster XIV contained three genotypes having characteristic dwarf plant types with delayed flowering and higher tolerance to powdery mildew. The above divergent genotypes with specific desirable traits may serve as valuable materials to harness useful genes for genetic improvement in mungbean.

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