



# Genetic Diversity Studies of Cluster Bean (*Cyamopsis tetragonoloba* L.): An Emerging Industrial Crop

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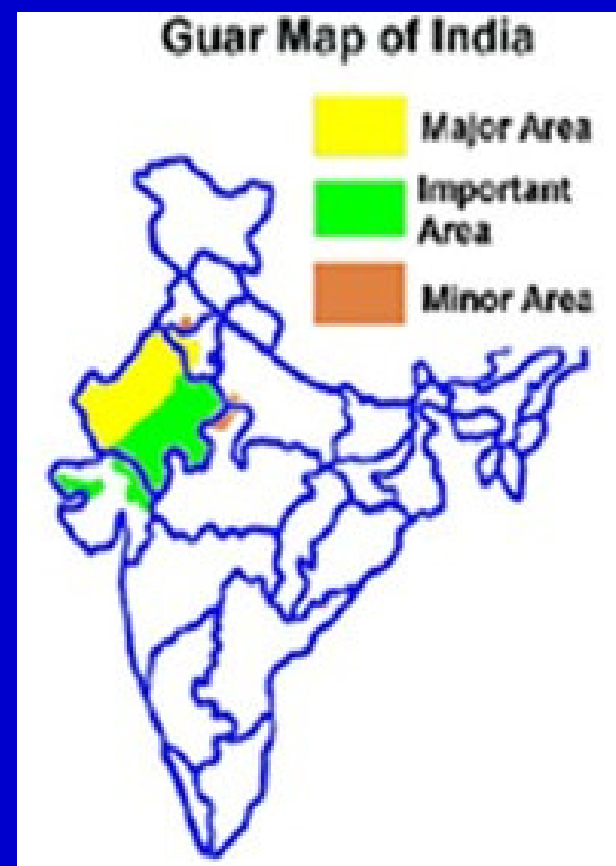


# Introduction

- ❖ Cluster bean, commonly known as '**guar**', is an important annual N<sub>2</sub> fixing arid legume.
- ❖ Cluster bean is drought tolerant/deep roots – mostly grown in arid and semi-arid regions.
- ❖ It is grown as food, forage and green manure crop.
- ❖ Most importantly it is grown for “Galactomannan” – a natural hydrocolloid, commonly called “**Guar gum**”.
- ❖ In arid farming systems - taming drought conditions, diversification of agriculture and an important industrial crop.

# Cluster Bean Production

- ❖ Major countries - India, Pakistan, USA, Italy, Morocco, Germany and Spain.
- ❖ India accounts for about 80% of the world cluster bean production.
- ❖ In India - Rajasthan, Haryana, Gujarat and Madhya Pradesh.
- ❖ Estimated area, production and yield (India) during 2013-14 are 5.6 M ha, 2.7 MMT, and 485 kg/ha respectively.



# Production Statistics of Cluster Bean in India

Year	Area ('000 ha)	Production ('000 tons)	Yield (kg/ha)
2009-10	2996	595	199
2010-11	3382	1965	581
2011-12	3444	2218	644
2012-13	5152	2461	478
2013-14 <sup>±</sup>	5603	2715	485

Year	Area ('000 ha)			Production ('000 tons)			Yield (kg/ha)		
	R*	H*	G*	R	H	G	R	H	G
2009-10	2581	252	133	201	329	45	78	1305	337
2010-11	3001	256	125	1546	333	73	515	1300	586
2011-12	3000	215	37	1847	290	33	616	1350	892
2012-13	4526	-	-	2023	-	-	447	-	-

R\* - Rajasthan, H\* - Haryana, G\* - Gujarat

Source: Min of Agril/Commerce, GOI

# Industrial Applications

Industry	Uses	Functions
Food	Bread, cakes, pastry, yoghurt, ice cream	moisture retention, increased shelf life
Pharmaceutical	Laxative/slimming/acidity/diabetes	appetite depressant, reduces glucose loss, reducing agent
Cosmetics	Shampoo/conditioner/ointment/lotions	protective film forming & thickening/lubricating agent
Textile printing	Cotton, silk, wool sizing and carpet printing	Reduces wrap breakage, thickening for dye
Mining	Ore concentration and filtration	Flocculating and settling agent
Explosive	Stick explosive and blasting Slurries	Water proofing/gelling agent
Oil well drilling	Drying fluids and hydraulic fracturing	Water loss control, viscosity/suspension/turbulence and friction reduction

# Cluster Bean Gum

- ❖ Cluster bean gum consists of mannose backbone with galactose side units.
- ❖ Ratio of mannose to galactose is about 2:1 (Robinson et al 1982).
- ❖ The molecular weight is 200,000 – 300,000 Da (Glicksman 1969).
- ❖ Galactomannan has good water binding and viscous dispersion forming ability (in water).
- ❖ Viscosity of the gum varies with particle size and moisture content.



# Experimental Outlay

- ❖ **Number of lines screened:**

140 + 5 check varieties (RGC 112/RGC 936/RGC 1003/RGC 1031/RGC 1066).

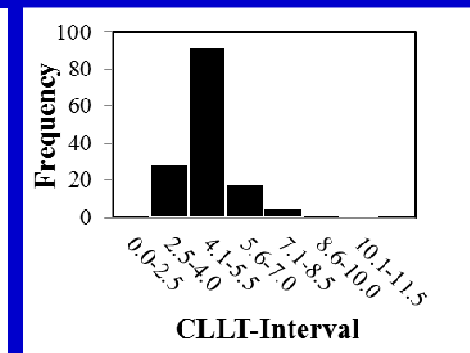
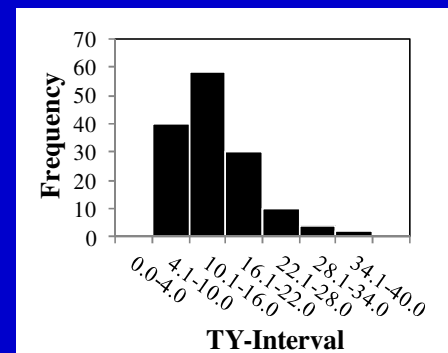
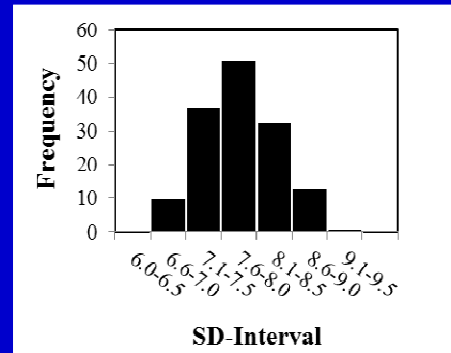
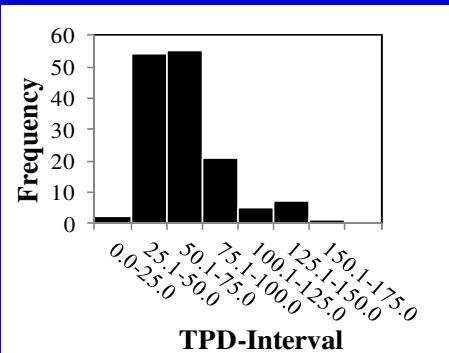
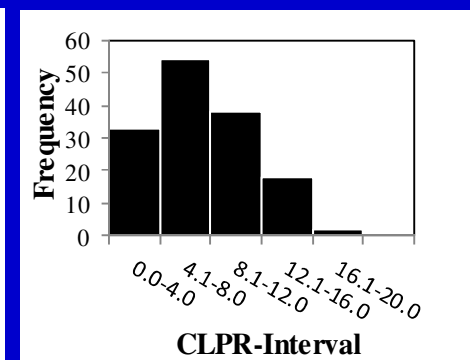
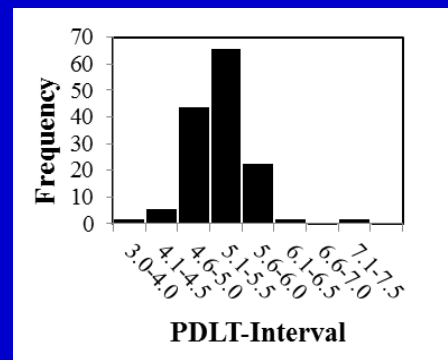
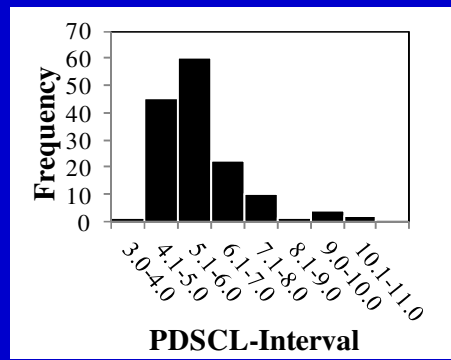
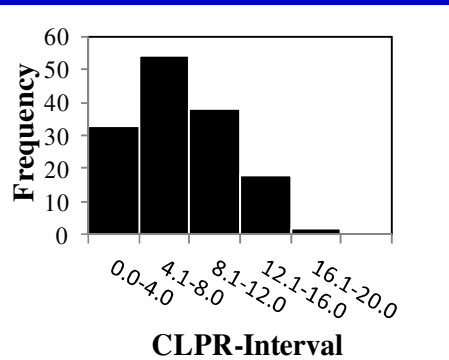
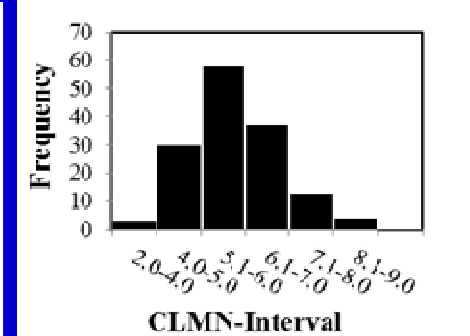
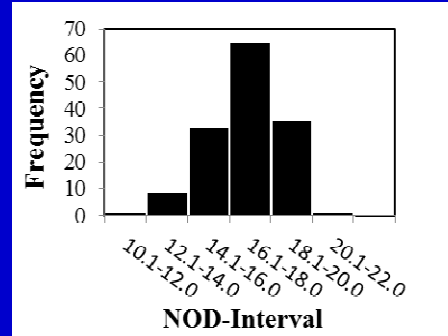
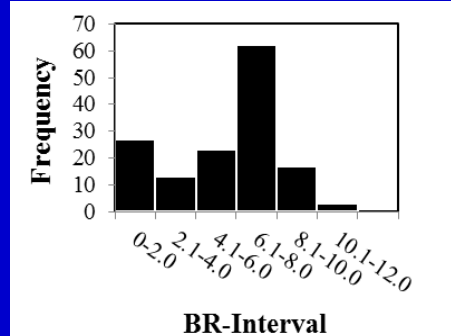
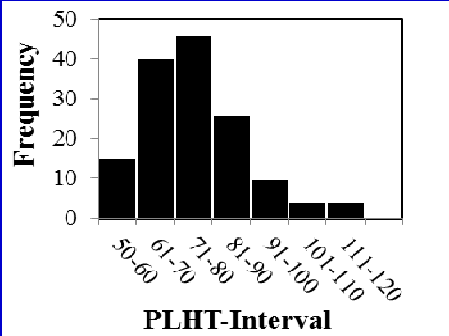
- ❖ **Seasons evaluated:** Kharif 2012 (CAZRI farm, Jodhpur)  
Summer 2013 (ARS farm, Mandore)

- ❖ **Recommended agronomic practices followed with a spacing of 50 x 15 cm in 4m rows in augmented design.**

- ❖ **Data recorded on:** plant height, number of branches/nodes/pods, clusters on main/primary branch, cluster length, pod length, pods/cluster, seed number, yield/plant.

- ❖ **Statistical tools used:** SAS software

# Frequency Distribution





# Genetic Parameters

Character	Mean	SD	GCV	PCV	h <sup>2</sup> (%)	GAM (%)
PLHT (cm)	74.3	12.8	159.8	180.1	88.7	31.5
BR	7.2	1.8	7.0	9.9	70.9	39.9
NOD	17.4	1.6	2.6	3.0	87.1	16.6
CLMN	5.9	1.1	1.0	1.2	82.1	30.4
CLPR	8.4	3.0	14.6	19.9	78.4	53.9
CLLT (cm)	5.2	0.8	0.9	1.1	83.3	26.5
PDSCL	6.0	1.3	1.5	1.9	89.4	34.6
PDLT (cm)	5.2	0.4	17.0	22.0	77.3	11.7
TPD	64.7	24.5	399.4	531.7	75.1	58.7
SD	7.8	0.5	0.2	0.3	79.3	10.5
TY (gm)	16.9	5.9	22.6	27.1	83.4	60.3

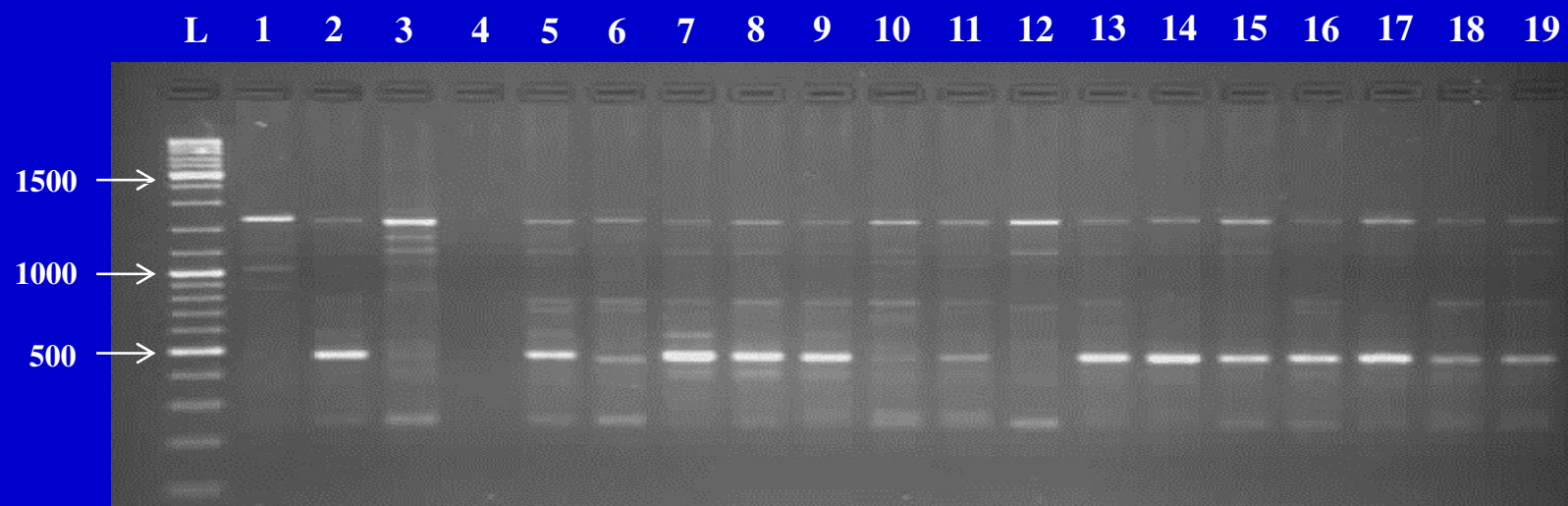
# Principal Component Analysis

Trait	PC1	PC2	PC3	PC4
PLHT	0.37	0.19	-0.15	-0.29
BR	-0.46	0.01	0.17	-0.14
NOD	-0.10	0.43	-0.12	-0.16
CLMN	0.16	0.34	-0.29	-0.16
CLPR	-0.47	0.14	0.11	-0.01
CLLT	0.39	0.27	0.05	0.32
PDSCL	0.42	0.19	-0.06	0.35
PDLT	0.22	0.12	0.48	-0.30
TPD	-0.30	0.39	0.07	0.25
SD	0.21	0.11	0.54	-0.12
TY	-0.24	0.33	0.19	0.19
<b>Variation Explained</b>	<b>30.2</b>	<b>24.1</b>	<b>11.5</b>	<b>5.0</b>

# Correlation Analysis

Trait	PLHT	BR	NOD	CLMN	CLPR	CLLT	PDSCL	PDLT	TPD	SD	TY
PLHT	1.0										
BR	-0.5**	1.0									
NOD	0.2	0.2	1.0								
CLMN	0.5**	-0.3**	0.3**	1.0							
CLPR	-0.5**	0.9**	0.3**	-0.1	1.0						
CLLT	0.6**	-0.5**	0.2	0.3*	-0.4**	1.0					
PDSCL	0.4**	-0.4**	0.4**	0.4**	-0.2	0.6**	1.0				
PDLT	0.2*	-0.2	0.1	0.2	-0.2	0.3*	0.2	1.0			
TPD	-0.2	0.5**	0.5**	0.3*	0.7**	0.2	0.3**	-0.1	1.0		
SD	0.3	-0.2	-0.1	0.1	-0.2	0.3*	0.2	0.6*	-0.1	1.0	
TY	0.3**	0.4**	0.4**	0.2	0.6**	0.1	0.3*	-0.1	0.8**	0.2	1.0

# RAPD Analysis of Cluster Bean Lines



L – ladder (bp); 1-15 : experimental lines; 16-19 – checks; Total primers tested – 12; Total amplicons – 104; Polymorphic loci – 76; Polymorphism (%) – 73%; Polymorphic range – 65 – 85%

# High Gum Yielding Lines

S.No	Line No.	Gum Content (%)	Yield (gm/pt)
1	IC-116626	29.74	19.13
2	IC-311405	29.79	18.13
3	IC-311443	30.09	25.95
4	IC-311421	30.76	13.27
5	IC-415163	31.32	18.56
6	IC-31392	31.43	27.90
7	RGC 112 <sup>±</sup>	28.21	21.87
8	RGC936 <sup>±</sup>	29.62	19.28
9	RGC 1031 <sup>±</sup>	31.27	20.19

± check varieties

# High Yielding Germplasm Lines

S.No	Line No.	PDSCL	TPD	TY (gm/pt)
1	IC-311401	10.60	92.66	23.42
2	IC-311428	6.60	122.20	28.67
3	IC-311432	6.60	108.80	26.31
4	IC-311443	5.60	113.00	25.95
5	IC-370563	7.40	134.00	31.16
6	IC-373438	7.80	136.00	30.95
7	IC-421807	6.60	112.60	26.86
8	IC-421815	6.60	139.80	31.53
9	RGC 936 <sup>±</sup>	5.20	71.80	19.28
10	RGC 1031 <sup>±</sup>	7.36	65.50	20.19
12	RGC 1066 <sup>±</sup>	6.20	53.40	16.25
13	RGM 112 <sup>±</sup>	6.20	71.00	21.87

<sup>±</sup> check varieties

# Conclusions

- ❖ Several traits exhibited high heritability and genetic advance.
- ❖ Total yield has significant positive correlation with CLPR (0.6), PDSCL (0.3) and TPD (0.8).
- ❖ RAPD analysis revealed good genetic diversity among the lines evaluated.
- ❖ **IC-311443** (30.1%) and **IC-31392** (31.4%) had high gum content.
- ❖ **IC-370563** (31.2 gm/pt) and **IC-421815** (31.53 gm/pt) were the best performing lines.

*Thank You*