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Plus tree selection and progeny testing of Khejri (*Prosopis cineraria* (L.) Druce)

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Abstract
The study was conducted by collecting seeds from plus trees from areas around Bhiwani, Fatehabad, Bawal and Bhattu in Haryana based on the desirable characters of economic interest. A considerable amount of variation for different morphological characters such as height, clear bole height, girth at breast height etc. was found among twenty one plus trees from Haryana. Ample genetic variation was also observed for field emergence, seedling height, basal diameter, root: shoot ratio etc. among the progenies of the selected plus trees. Among all the progenies, the progeny of PC11 from Bawal was found most outstanding followed by the progeny of PC8 from Fatehabad.

Keywords: Khejri, candidate plus tree, sustainable variability and progeny

Introduction
The most common approach to start any tree improvement programme involves the selection of trees from natural stands based on their apparent superiority in traits of economic interest such as growth rate, stem form, branching habit, disease resistance, etc. The selected trees are referred as 'plus trees'. Plus trees occur in low frequency and therefore, special efforts are needed to locate them (Dogra 1981) [7].

Prosopis cineraria holds an important place in the desert ecosystem (Jatasra and Paroda, 1981; Shankarnarayan *et al*., 1987) [8, 15]. The tree is known locally as Jandi or Khejri (India), Jand (Pakistan), and Ghaf (Arabic). Its synonym is *Prosopis spicigera*. It belongs to the family Leguminosae and subfamily Mimosoideae. It is distributed mainly in dry regions of Southwest Asia and Africa (Khatri *et al*., 2010) [12]. In the most important areas of *Prosopis cineraria* distribution, the climate is dry to arid and rainfall shows considerable variation 100 to 600 mm annually with long dry season. It is being regarded as 'King of desert', 'Golden Tree of Desert', 'Love Tree', and 'Pride of the Desert', because every plant part of this versatile tree is utilized. This tree is so important in arid region that their number forms the major criterion for the value of land (Singh *et al*., 1998) [16]. It is the true multipurpose species and often referred to in ancient literature as the 'Kalpvriksha' of the desert (Mahoney, 1990) [13]. It provides fuelwood, fodder, small timber, medicines, gum and tannins and also helps in improving the soil fertility and sand dune stabilization (Singh *et al*., 1998) [16]. The fodder from its leaves, commonly known as loong is very nutritious, protein rich (12- 18% crude protein) and palatable to the animals (Bhandari *et al*., 1979; Bohra and Gosh, 1980) [2, 3]. It is a tree with great potential for agroforestry systems as it is highly compatible with agricultural crops (Puri *et al*., 1994) [14] due to its deep root system, monolayer canopy, nitrogen fixing ability and high efficiency of recharging the soil with organic matter (Toky and Bisht, 1992) [18].

Selection is based on the external appearance for desirable characters, so it is necessary to test the progenies of plus trees to confirm that they really possess genotype for which selection has been made (Kedharnath, 1982) [11]. The plus trees which are approved as having good breeding value on the basis of progeny test are known as 'elite trees'. Progeny test are, therefore, essential to increase the magnitude of the genetic gain.

Materials and Methods
Survey was conducted in areas around Bhiwani, Dadri, Fatehabad, Bawal and Bhattu in Haryana where Khejri was growing naturally for selection of its plus trees during June-July, 2015. The plus tree selection was made on phenotypic assessment of desirable characters of economic interest such as stem straightness, self pruning ability; clear bole height, low branching habit, disease resistance, etc. A total of 21 morphological superior trees (plus trees) were selected and sufficient amount of good quality ripened pods were collected from these trees (Table 1). 480 polythene bags having equal proportion of sand, soil and FYM were arranged randomly in four replications in the Nursery, Department of Forestry, CCS Haryana

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Agricultural University, Hisar. Two seeds were sown in each bag during the 3rd week of July, 2015. The polythene bags soon after seed sowing were irrigated with the help of garden sprinkler and thereafter, proper moisture was maintained as and when considered necessary. The field emergence percentage was observed by counting the number of seeds successfully germinated under each replication. Observations on field emergence were recorded weekly upto one month after sowing. After obtaining the age of six months, 4 seedlings from each replication were randomly taken for measurement.

Results and Discussion
The total height of the selected plus trees varied from 5.5 m (PC19 from Bhattu and PC5 from Fatehabad) to 12.3 m (PC15 from Bawal) with mean of 8.3 m. Girth at breast height was observed maximum in PC 15 from Bawal (109.3 cm) and minimum in PC 5 from Fatehabad (61.2 cm). The clear bole height of the selected plus trees varied from 1.8 m (PC 1 from Bhiwani, PC 7 from Fatehabad and PC 19 from Bhattu) to 3.9 m (PC 15 from Bawal) with mean of 2.4 m. Selected trees in the present study had fairly good straightness, compact crown and clear bole. A number of plus trees based on apparent growth, clear bole and stem straightness and the traits of priority were selected in different tree species viz. *Azadirachta indica* (Dhillon *et al.,* 2003) [5], *Dalbergia sissoo* (Bangarwa, 1993; Yadav *et al.,* 2005) [1, 19], *Melia composita, Acacia catechu, Albizia procera* and *Eucalyptus spp.* (Chauhan and Gera, 2012) [4]. Association of different morphological characteristics of selected plus trees in present study, it was observed that the total height of the naturally occurring trees exhibited a positive and highly significant correlation with clear bole height, girth at breast height (gbh), height: gbh ratio and crown height but its positive association with straightness was significant at 5 per cent. But total height displayed a negative and highly significant correlation with clear bole: total height ratio. Age of tree displayed negative and highly significant correlation with clear bole: total height ratio (Table 2). Johar *et al.* (2016) [9] selected plus trees from the naturally occurring *Melia composite* on the basis of

straightness and other economic traits. They reported highly significant and positive correlation between age and other morphological characters viz. height, clear bole height and GBH.
In present study at the age of six months, highly significant variation due to progenies for field emergence, seedling height, shoot length, root length, basal diameter, number of branches seedling^{-1}, root: shoot ratio and dry weight, open a way to go ahead for further improvement in the material through further selection (Table 3). Progeny of PC11 from Bawal was found significantly superior than their respective general means for seedling height, root length, basal diameter and dry weight. Progenies of PC3 from Bhiwani, PC10 and PC11 from Bawal were also found significantly superior than the general mean for root length whereas progenies of PC8 from Fatehabad and PC 20 from Bhattu were found significantly superior than the general mean for shoot length. The present study reflected the best performance of the progeny of PC11 from Bawal on the basis of very important growth characters like seedling height, root length, basal diameter and dry weight. It was followed by the progeny of PC8 from Fatehabad on the basis of basal diameter, shoot length and field emergence. These findings are in agreement with the observations of Bangarwa (1993) [1] and Dogra *et al.* (2005) [6] in *Dalbergia sissoo.* Solanki *et al.* (1999) [17] and Dhillon *et al.* (2003) [5] in *Azadirachta indica* and Kaushik *et al.* (2011) [10] in *Pongamia pinnata identified superior progenies on the basis of growth characters.*
Index score analysis was carried out in 21 progenies of *Prosopis cineraria* using data on field emergence and other seedling growth characters (Table 5) which reflected the overall superiority for progeny of PC-11 from Bawal. Progenies of PC-2 and PC-3 from Bhiwani were ranked second with index score of 19. Progenies of PC1 from Bhiwani and PC8 from Fatehabad and PC10 from Bawal were ranked third with index score of 18.
Conclusively progeny of PC11 from Bawal was found best followed by PC2, PC3 from Bawal (19 score), PC1 from Bhiwani, PC8 from Fatehabad and PC10 from Bawal (18 score).

Table 1: Morphological characters of selected plus trees of *Prosopis cineraria* naturally growing in Haryana

Accession Code	Geographical location	Age (approx. yrs)	Total height (m)	Clear bole height (m)	gbh (cm)	Clearbole : total height ratio	Total height:gbh ratio	Crown height (m)	Crown Spread (m) E-W	N-S	Straightness
PC1	Parhladgarh, Bhiwani	14	6.7	1.8	73.80	0.27	9.08	4.9	6	8	4
PC2	Ninan, Bhiwani	25	11.2	2.7	94.50	0.24	11.85	8.5	12	10	5
PC3	Gignau, Dadri	12	6.1	2.4	70.00	0.39	8.71	3.7	4	7	2
PC4	Kitlana, Bhiwani	14	6.7	2.1	74.50	0.31	8.99	4.6	8	5	4
PC5	Fatehabad	11	5.5	2.1	61.20	0.38	8.99	3.4	5	3	3
PC6	-do-	15	7.6	2.2	76.00	0.29	10.00	5.4	7	9	2
PC7	-do-	11	5.5	1.8	62.00	0.33	8.87	3.7	5	3	1
PC8	-do-	18	9.2	2.7	84.00	0.29	10.95	6.5	7	6	4
PC9	-do-	12	6.1	2.4	72.00	0.39	8.47	3.7	4	6	3
PC10	Bawal	25	11.1	3.0	94.00	0.27	11.81	8.1	9	8	5
PC11	-do-	20	10.2	2.1	86.20	0.21	11.83	8.1	10	12	4
PC12	-do-	20	10.4	2.7	88.30	0.26	11.78	7.7	12	13	4
PC13	-do-	25	11.3	3.1	95.20	0.27	11.87	8.2	10	13	5
PC14	-do-	17	8.8	2.1	83.00	0.24	10.60	6.7	11	10	3
PC15	-do-	22	12.3	3.9	109.30	0.32	11.25	8.4	13	9	3
PC16	-do-	22	11.9	2.9	96.80	0.24	12.29	9	10	9	2
PC17	Bhattu	15	7.6	2.1	75.80	0.28	10.03	5.5	10	8	4
PC18	-do-	15	7.9	2.8	78.40	0.35	10.08	5.1	11	9	2
PC19	-do-	11	5.5	1.8	63.80	0.33	8.62	3.7	4	6	1
PC20	-do-	11	5.6	1.9	65.00	0.34	8.62	3.7	3	6	3
PC21	-do-	12	6.2	2.5	72.40	0.40	8.56	3.7	6	7	3

| Range | | | 5.5-12.3 | 1.8-3.9 | 61.2-109.3 | 0.21-0.40 | 8.47-12.29 | 3.4-9.0 | 3-13 | 3-13 | 1-5 |
| Mean | | | 8.3 | 2.4 | 79.82 | 0.31 | 10.16 | 5.8 | 8 | 8 | 3.19 |

Table 2: Correlation coefficients among different traits of plus trees of *Prosopis cineraria*

	Age (approx. yrs)	Total height (m)	Clear bole height (m)	gbh (cm)	Clear bole : total height ratio	Height : gbh ratio	Crown height (m)	Straightness
Age (approx. yrs)								
Total height(m)	0.966**							
Clear bole height(m)	0.712**	0.776**						
gbh (cm)	0.928**	0.975**	0.845**					
Clear bole : total height	-0.708**	-0.692**	-0.097^NS	-0.590**				
Height : gbh	0.945**	0.961**	0.628**	0.879**	-0.789**			
Height of crown (m)	0.963**	0.986**	0.661**	0.938**	-0.798**	0.979**		
Straightness	0.633**	0.510*	0.303^NS	0.501*	-0.466*	0.509*	0.527*	

Significant at 5% level
*Significant at 1% level

Table 3: Mean performance of the plus tree progenies of *Prosopis cineraria* for emergence and seedling characters

Accession Code	Geographical location	Field emergence (%)	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Basal diameter (mm)	No. of branches seedling^{-1}	Root: shoot ratio	Dry weight (g)
PC1	Parhladgarh, Bhiwani	68.00	45.64	12.51	33.13	0.65	8.25	2.68	0.12
PC2	Ninan, Bhiwani	58.75	46.72	11.51	35.21	0.82	7.00	3.13	0.14
PC3	Gignau, Bhiwani	65.38	47.64	10.65	36.99	0.82	6.00	3.54	0.11
PC4	Kitlana, Bhiwani	64.63	39.51	10.42	29.09	0.74	5.75	2.81	0.10
PC5	Fatehabad	69.25	40.56	11.26	29.30	0.78	4.75	2.64	0.09
PC6	-do-	56.50	37.49	12.41	25.08	0.85	6.00	2.04	0.11
PC7	-do-	60.13	40.26	12.21	28.05	0.75	4.75	2.32	0.09
PC8	-do-	75.50	36.27	15.15	21.12	1.00	7.00	1.45	0.14
PC9	-do-	55.18	37.48	11.96	25.52	0.73	5.50	2.21	0.09
PC10	Bawal	63.88	48.14	11.02	37.12	0.78	6.00	3.48	0.14
PC11	-do-	61.00	50.64	14.34	36.31	0.94	6.75	2.59	0.15
PC12	-do-	55.50	43.00	11.09	31.91	0.73	4.25	2.89	0.08
PC13	-do-	62.75	36.10	12.54	23.56	0.73	4.75	1.89	0.07
PC14	-do-	62.25	38.98	11.26	27.72	0.68	5.00	2.46	0.10
PC15	-do-	61.13	43.90	11.87	32.03	0.70	5.75	2.76	0.09
PC16	-do-	67.88	40.49	12.70	27.79	0.85	6.50	2.24	0.13
PC17	Bhattu	61.63	38.20	13.77	24.43	0.88	7.25	1.80	0.12
PC18	-do-	54.13	45.88	13.39	32.49	0.79	4.25	2.50	0.10
PC19	-do-	61.38	34.59	11.21	23.38	0.65	5.75	2.12	0.09
PC20	-do-	67.75	37.68	15.81	21.87	0.92	6.50	1.53	0.13
PC21	-do-	83.50	40.38	15.11	25.27	0.83	6.50	1.70	0.14
Range		54.13-83.50	34.59-50.64	10.42-15.81	21.12-37.12	0.65-1.00	4.25-8.25	1.45-3.54	0.07-0.15
Mean		63.62	41.41	12.48	28.92	0.79	5.92	2.42	0.11
CD at 5%		9.93	7.18	2.65	7.19	0.14	1.52	0.88	0.04

Table 4: Index score of seedlings of *Prosopis cineraria*

Plus trees	Field emergence (%)	Seedling height (cm)	Shoot length (cm)	Root length (cm)	Basal diameter (mm)	No. of branches seedling^{-1}	Root: shoot ratio	Dry weight (g)	
PC1	2	3	2	3	1	3	2	2	18
PC2	1	3	1	3	2	3	3	3	19
PC3	2	3	1	3	2	3	3	2	19
PC4	2	1	1	2	1	2	2	1	12
PC5	2	2	1	2	2	1	2	1	13
PC6	1	1	2	1	2	2	1	2	12
PC7	1	2	1	2	1	1	2	1	11
PC8	3	1	3	1	3	3	1	3	18
PC9	1	1	1	1	1	1	2	1	9
PC10	1	3	1	3	2	2	3	3	18
PC11	1	3	3	3	3	2	2	3	20
PC12	1	2	1	3	1	1	3	1	13
PC13	1	1	2	1	1	1	1	1	9
PC14	1	1	1	2	1	1	2	1	10
PC15	1	2	1	3	1	2	2	1	13

PC16	2	2	2	2	2	2	2	2	16
PC17	1	1	2	1	2	3	1	2	13
PC18	1	3	2	3	2	1	2	1	15
PC19	1	1	1	1	1	2	1	1	9
PC20	2	1	3	1	3	2	1	2	15
PC21	1	2	3	1	2	2	1	3	15

Index score

				PC17							
PC19				PC15		PC21			PC10		
PC13			PC6	PC12		PC20			PC8	PC3	
PC9	PC14	PC7	PC4	PC 5		PC18	PC16		PC1	PC2	PC11
9	10	11	12	13		15	16	17	18	19	20

Index value

Characters	1	2	3
Field emergence (%)	≤ 63.92	63.93- 73.71	> 73.71
Seedling height (cm)	≤ 39.94	39.95- 45.29	> 45.29
Shoot length (cm)	≤ 12.22	12.23- 14.02	> 14.02
Root length (cm)	≤ 26.45	26.46- 31.78	> 31.78
Basal diameter (mm)	≤ 0.77	0.78- 0.89	> 0.89
No. of branches seedling^{-1}	≤ 5.58	5.59- 6.91	> 6.91
Root: shoot ratio	≤ 2.15	2.16- 2.85	> 2.85
Dry weight (g)	≤ 0.10	0.11- 0.13	> 0.13

References

1. Bangarwa KS. Studies on provenance variation, progeny testing and reproductive biology in *Delbergia sissoo* Roxb. Ph.D. Thesis, CCS Haryana Agricultural University, Hisar, India, 1993.
2. Bhandari DS, Govil HN, Hussain A. Chemical composition and nutritive value of Khejri (*Prosopis cineraria*) tree leaves. Annals of Arid Zone. 1979; 18:170-173.
3. Bohra HC, Ghosh PK. The nutritive value and digestibility of long. In: Khejri in the Indian Desert. CAZARI-ICAR, 1980, 45-47.
4. Chauhan, Suresh and Gera, Mohit. Selection of candidate plus trees of commercially important agroforestry species in Punjab. Indian Journal of Forestry. 2012; 35(2):135-142.
5. Dhillon RS, Bisla SS, Arya S, Hooda MS. Genetic variation, heritability and correlation for growth parameters in *Azadirachta indica* A. Juss. Annals of Forestry. 2003; 11(2):215-221.
6. Dogra AS, Nautiyal S, Nautiyal DP, Singh S. Evaluation of field performance of 34 progenies of *Dalbergia sissoo* in Punjab. Ann. For. 2005; 13(2):199-209.
7. Dogra PD. Forest genetics research and application in Indian forestry I and II. Indian Forester. 1981; 107:190-219, 263-288.
8. Jatasra DS, Paroda RS. *Prosopis cineraria* an unexploited treasure of Thar desert. Forage Research. 1981; 7:1-12.
9. Johar V, Sharma KB, Rachana, Kumar P. Plus tree selection and progeny testing of Burma Dek (*Melia composite* Wild.). Indian Journal of Ecology. 2016; 43(1):364-367.
10. Kaushik N, Mann, Suman and Kumar, Krishan. Variability in growth characters among progenies of *Pongamia pinnata* (L.) Pierre. Range Management and Agroforestry. 2011; 32(2):131134.
11. Kedarnath S. Plus tree selection- a tool in forest tree improvement. In: Khosla, P.K. (Ed.) Improvement of Forest Biomass. India Society of Tree Science, H.P. University, Solan (India), 1982, 13-20p.
12. Khatri A, Rathore A, Patil UK. *Prosopis cineraria* (L.) Druce: A boon plant of desert- An overview. International Journal of Biomedical and Advance Research. 2010; 01(05):141.
13. Mahoney D. Trees of Somalia - A field guide for development workers. Oxfam/HDRA, Oxford, 1990, 133-136p.
14. Puri S, Kumar A, Singh S. Productivity of *Cicer arietinum* (Chickpea) under a *Prosopis cineraria* agroforstry system in the arid regions of India. Journal of Arid Environments. 1994; 27:85-98.
15. Shankarnarayan KA, Harsh LN, Kathju S. Agroforestry in arid zones of India. Agro forsetry Systems. 1987; 5:69-88.
16. Singh VP, Jhorar BS, Dhillon RS. Natural resource management for biomass production in desert ecosystem. ln: N.E. Bassam *et al*. (Eds) "Sustainable Agroforestry for Food, Energy and Industry". James & James (Science Publishers) Ltd., London, U.K., 1998, 504-510.
17. Solanki KR, Muthana KD, Jindal SK, Arora GD. Variability, heritability and correlations for growth parameters in *Prosopis cineraria*. Journal of Tree Sciences. 1984; 3:86-88.
18. Toky OP, Bisht RP. Observations on the rooting patterns of some agroforestry trees in an arid region of north-western India. Agroforetry Systems. 1992; 18(3):245-263.
19. Yadav MK, Dhillon RS, Singh VP. Plus tree selection and progeny testing in Shisham (*Dalbergia sissoo* Roxb.*).* Legume Res. 2005; 28(1):55-58.