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Assessment of genetic variability in *Acacia catechu* willd

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Abstract

The present investigation entitled “Assessment of genetic Variability in *Acacia catechu* Willd.” was carried out in the Department of Tree Improvement and Genetic Resources, Y.S Parmar University of Horticulture and Forestry. Field survey was carried out across the populations of *Acacia catechu* throughout HP to select well represented ten seed sources viz. S₁ (Badlech), S₂ (Dhaulakuan) S₃ (Maryog) S₄ (Bhojnagar) S₅ (Dilman) S₆ (Subathu) S₇ (Hamirpur) S₈ (Kangra) S₉ (Jacch) and S₁₀ (Bilaspur). The seed collection from individual trees was done to study variability status of individual mother trees selected. Progenies of individual tree were raised in Randomized Block Design to assess growth performance with respect to seedling height, collar diameter and number of branches and number of leaves. The data analyzed by RBD revealed that there was significant variation between seed sources was observed. Significant high gain obtained for variation between most of the seed sources on mean value basis. Similarly progeny performance revealed significant variation within seed source, suggesting scope for single tree selection.

Keywords: *Acacia catechu* Willd., nursery studies, randomized block design

Introduction

Acacia catechu Willd. Is small to moderate sized tree with light feathery crown. Pods are 10-15 cm long, dark brown, shining (mature), it is found in greater parts of India except in very humid and temperate regions. It is the characteristics tree of Khair- Sisso forest, very dry Teak forest, dry Sal bearing forest. In Himachal Pradesh, *Acacia catechu* is widely distributed in Mandi, Hamirpur, Kangra, Solan, Sirmaur, Una, Shimla and Bilaspur districts below 1300 meters elevation above mean sea levels [1].

The most important product is katha obtained from the chips of heartwood using hot water extraction method. Seeds of *Acacia catechu* are very good source of protein. *Acacia catechu* extract is used in paan (chewing betel leaf) leaves and branches are also food of goats and other animals. *Acacia catechu* contains tannic acid which causes the tanning of protein in leather industries.

Genetic variation is essential for the long term survival of a species by developing consistency in changed environmental conditions for better adaptability. The amount of genetic variation available within species also determines the potential for improving species through suitable breeding programmes. The seeds being the key carrier of the genetic package, when sown to raise the seedlings under a particular environment, express the variability in totality. Magnitude of genetic variation, spatial distribution of genotype and breeding systems of the population influence and contribute towards genetic composition and quality of the seed collected for tree improvement programme.

Material and methods

Survey was conducted depending upon the distribution of species, 10 seed sources were selected from Himachal Pradesh depending upon the distribution and abundance of species.

Selected seed sources of *Acacia catechu* Willd.

S. No	Source code	Source name	District	Location
1.	S ₁	Badlech	Solan	Badlech
2.	S ₂	Dhaulakuan	Sirmour	Dhaulakuan
3.	S ₃	Maryog	Solan	Mallah
4.	S ₄	Bhojnagar	Solan	Bhojnagar
5.	S ₅	Dilmon	Sirmour	Dilmon
6.	S ₆	Subathu	Solan	Subathu
7.	S ₇	Hamirpur	Hamirpur	Nalti
8.	S ₈	Kangra	Kangra	Banoi
9.	S ₉	Jachh	Kangra	Jassur
10.	S ₁₀	Bilaspur	Bilaspur	Nauni

Seeds collected from different seed sources were sown in polybags in glasshouse and raised in RBD design. Subsequent irrigation was given as and when required. Individual trees from seed sources are raised under 3 replications. The growth performance of one year age were recorded for the following morphometric traits. Height of seedling was measured from five seedlings per replication from ground level to apex with the help of scale. Collar diameter was measured from five seedlings per replication with the help of digital calliper at collar region.

Number of branches was counted from five seedlings per replication and noted down. Number of leaves/plant counted and noted down. The root length was recorded from the collar region to the tip of main root using scales. Five leaves per plant were taken, the leaf area was recorded with the help of

leaf area meter.

Statistical analysis: The data obtained were subjected to analysis using RBD design. The analysis for each parameter was carried out and the analysis of variance (ANOVA) table and genetic estimates were also estimated.

Results and Discussion

Collar diameter (mm)

The seedling obtained from seeds of S₈ (Kangra) seed source has maximum collar diameter with mean value as 1.97 mm which was statistically at par with S₇ (Hamirpur) (1.71) and S₁₀ (1.65), where as minimum collar diameter was obtained from S₅ (Dilman) with mean value of 1.15 mm which statistically at par with S₃ (Maryog) (1.19) and S₁₀ (1.65).

Table 1: Variation in seedling traits between different seed sources of *Acacia catechu* Willd. After one year growth under nursery conditions

Nursery traits					
Seed Source	Site	Collar diameter(mm)	Seedling height(cm)	Number of leaves	Number of branches
(S ₁)	Badlech	1.27	27.77	8.57	0.45
(S ₂)	Dhaulakuan	1.28	24.48	8.37	0.48
(S ₃)	Maryog	1.19	17.06	6.74	0.16
(S ₄)	Bhojnagar	1.38	27.25	10.92	0.60
(S ₅)	Dilman	1.15	20.37	10.16	0.30
(S ₆)	Subathu	1.52	20.83	9.77	0.67
(S ₇)	Hamirpur	1.71	21.92	10.29	0.20
(S ₈)	Kangra	1.97	20.00	9.33	0.25
(S ₉)	Jachh	1.30	29.17	8.33	0.42
(S ₁₀)	Bilaspur	1.65	21.41	8.73	0.15
	Mean	1.44	23.03	9.12	0.39
	CD	0.54	6.52	1.34	0.38

Seedling height (cm)

The seedlings obtained from seeds of S₉ (Jachh) has maximum seedling height among all seed sources with mean value of 29.17 cm which was statistically at par with S₁ (27.77), S₄ (27.25 cm), whereas minimum seedling height was obtained from S₃ (Maryog) with mean value of 17.06 cm which was statistically at par with S₈ (20.00), S₅ (20.37).

Number of leaves

The seedling obtained from S₄ (Bhojnagar) recorded maximum number of leaves with mean value 10.92 which was statistically at par with S₇ (10.29), S₅ (10.16), whereas minimum number of leaves was 6.74 recorded from S₃ (Maryog) with mean value 6.74 which was statistically at par with S₉ (8.33) and S₁₀ (8.73).

Number of branches

Maximum mean value for number of branches was obtained from S₆ (Subathu) with mean value of 0.67 which was statistically at par with S₄ (0.60), S₂ (0.48) whereas minimum mean value for number of branches was obtained from S₁₀ (Bilaspur) with mean value of 0.15 which was statistically at par with S₃ (0.16) and S₇ (0.20).

Seedling height (cm)

For seedling height shown that all seed sources are non significant except S₉. With respect to growth parameters S₇ (Hamirpur) seed source proved to be most outstanding one among the all seed sources, whereas, S₈ (Kangra) and S₉ (Jachh) showed most promising results.

Table 2: Variation in seedling height (cm) after one year traits between different seed sources of *Acacia catechu* Willd. After one year growth under nursery conditions

Tree No.	Seed source									
	Badlech S ₁	Dhaulakuan S ₂	Maryog S ₃	Bhojnagar S ₄	Dilman S ₅	Subathu S ₆	Hamirpur S ₇	Kangra S ₈	Jachh S ₉	Bilaspur S ₁₀
T ₁	36.33	25.70	19.40	18.83	19.83	20.30	22.30	17.57	21.43	22.20
T ₂	31.07	22.90	23.57	26.67	24.67	23.97	20.63	19.60	17.70	24.00
T ₃	33.13	25.90	20.30	21.87	21.40	20.90	21.53	22.13	19.63	25.60
T ₄	26.97	18.67	19.97	27.33	16.50	21.50	20.00	22.43	25.20	19.27
T ₅	29.60	24.70	2.67	29.17	17.00	16.03	21.70	17.20	23.73	17.87
T ₆	26.63	28.67	19.63	29.27	13.67	15.20	24.27	25.60	22.87	23.07
T ₇	22.67	28.67	22.77	31.30	22.53	20.67	21.07	19.17	21.40	18.20
T ₈	23.47	18.10	9.33	31.80	25.50	20.23	24.93	20.00	25.93	20.93
T ₉	22.20	25.27	23.17	25.73	19.00	24.83	24.67	17.87	23.07	21.56
T ₁₀	25.60	26.20	9.83	30.50	23.60	24.67	18.07	18.40	90.73	21.43
Mean	27.77	24.48	17.06	27.25	20.37	20.83	21.92	20.00	29.17	21.41
	NS	NS	NS	NS	NS	NS	NS	NS		NS
CD _{0.05}	Between Seed Source								:	6.52
	Within seed sources								:	NS

Collar diameter (mm)

Table 3 shown that all seed sources are significant except S₈, S₅, S₃ and S₇. In S₁ (Badlech) seed source maximum collar diameter was recorded in T₇ with mean value of 1.49 mm which was statistically at par with T₅ (1.43) and T₃ (1.41), whereas minimum collar diameter was recorded from T₂ with mean value of 1.06 mm which was statistically at par with T₁ (1.09) and T₆ and T₈ (1.21). In S₂ (Dhaulakuan) seed source maximum collar diameter was recorded for T₇ with mean value of 1.98 mm which was statistically at par with T₉ (1.74) and T₈ (1.59), whereas minimum collar diameter was recorded for T₂ with mean value 0.84 mm which was statistically at par with T₃ (0.97) and T₁ (1.01). In S₃ (Maryog) maximum seedling height was recorded for T₇ with mean value of 1.96 mm which was statistically at par with T₅ (1.62) and T₂ (1.56), whereas minimum collar diameter was recorded for T₅ with mean value 0.13 mm was statistically at par with T₁₀

(0.45) and T₈ (0.49). In S₄ (Bhojnagar) seed source maximum collar diameter was recorded for T₃ with mean value of 1.75 mm which was statistically at par with T₅ (1.74) and T₂ (1.54), whereas minimum collar diameter was recorded for T₁ with mean value 0.80 mm which was statistically at par with T₇ (1.20) and T₈ (1.25).

In S₅ (Dilman) seed source maximum collar diameter was recorded for T₁₀ with mean value of 2.02 mm which was statistically at par with T₈ (1.70) and T₇ (1.53), whereas minimum collar diameter was recorded for T₁ with mean value 0.81 mm which was statistically at par with T₂ (0.89) and T₉ (0.97). In S₆ (Subthau) seed source maximum collar diameter was recorded for T₉ with mean value of 2.73 mm which was statistically at par with T₄ (1.75) and T₆ (1.74), whereas minimum collar diameter was recorded for T₂ with mean value 0.79 mm which was statistically at par with T₃ (1.04) and T₇ (1.28).

Table 3: Variation in collar diameter (mm) after one year traits between different seed sources of *Acacia catechu* Willd. after one year growth under nursery conditions

Tree No.	Seed source									
	Badlech S ₁	Dholakuan S ₂	Maryog S ₃	Bhojnagar S ₄	Dilman S ₅	Subathu S ₆	Hamirpur S ₇	Kangra S ₈	Jachh S ₉	Bilaspur S ₁₀
T ₁	1.09	1.21	1.41	0.80	0.81	1.67	1.34	1.60	1.66	0.90
T ₂	1.06	0.84	1.56	1.54	0.89	0.79	1.83	1.68	1.67	2.05
T ₃	1.41	0.97	1.32	1.75	1.41	1.04	2.64	2.97	0.88	1.81
T ₄	1.24	1.01	1.62	1.33	0.42	1.75	1.86	2.21	1.22	1.43
T ₅	1.43	1.14	0.13	1.74	0.52	1.53	1.35	1.92	1.48	2.02
T ₆	1.21	1.09	1.53	1.33	1.25	1.74	2.19	1.31	1.42	2.04
T ₇	1.49	1.98	1.96	1.20	1.53	1.28	1.27	2.17	0.98	1.63
T ₈	1.21	1.59	0.49	1.25	1.70	1.34	1.67	2.12	1.39	1.87
T ₉	1.14	1.74	1.44	1.43	0.97	2.73	1.50	1.61	1.24	1.70
T ₁₀	1.37	1.20	0.45	1.41	2.02	1.31	1.43	2.07	1.06	1.02
Mean	1.27	1.28	1.19	1.38	1.15	1.52	1.71	1.97	1.30	1.65
	NS	NS		NS		NS			NS	NS
CD_{0.05}	Between Seed Source								:	0.54
	Within seed sources								:	1.71

In S₇ (Hamirpur) seed source maximum collar diameter was recorded for T₃ with mean value of 2.64 mm which was statistically at par with T₆ (2.19) and T₄ (1.86), whereas minimum collar diameter was recorded for T₁ with mean value 1.34 mm which was statistically at par with T₅ (1.35) and T₆ (1.27). In S₈ (Kangra) seed source maximum collar diameter was recorded for T₃ with mean value of 2.97 mm which was statistically at par with T₄ (2.21) and T₇ (2.17), whereas minimum collar diameter was recorded for T₆ with mean value 1.31 mm which was statistically at par with T₁ (1.60) and T₈ (1.61). In S₉ (Jachh) seed source maximum collar diameter was recorded for T₂ with mean value of 1.67 mm which was statistically at par with T₁ (1.66) and T₄ (1.48), whereas minimum collar diameter was recorded for T₃ with mean value 0.88 mm which was statistically at par with T₇ (0.98) and T₅ (1.06). In S₁₀ (Bilaspur) seed source maximum source maximum collar diameter was recorded for T₂ with mean value of 2.05 mm which was statistically at par with T₆ (2.04) and T₅ (2.02), whereas minimum collar diameter was recorded for T₁ with mean value 0.90 mm which was statistically at par with T₁₀ (1.02) and T₄ (1.43).

In S₁ (Badlech) seed source, seedlings of trees T₇, T₅, T₃ performed well, hence may be selected for further selection. In S₂ (Dhaulakuan) seed source seedlings of trees T₇, T₈ performed well, hence may be selected for further selection. In S₃ (Maryog) seed source seedlings of trees T₇, T₈ performed well, hence may be selected for further selection.

In S₄ best trees are T₃, T₅ and T₂, where as in S₅ best progenies are obtained from T₁₀, T₈ and T₇. In S₆ best trees are T₉, T₄ and T₆, where as in S₇ best trees are T₃, T₆ and T₄. In S₈ promising progenies are obtained from T₃, T₄ and T₇, where as in S₉ best trees are T₂, T₁ and T₄. In S₁₀ best trees are T₂, T₆ and T₅.

Number of leaves

Study on character number of leaves shown that all seed sources are non-significant except S₄ and S₅. In S₁ (Badlech) seed source maximum number of leaves was recorded in T₂ with mean value of 10.73 which was statistically at par with T₅ (10.31) and T₃ (9.80), where as minimum number of leaves was recorded from T₆ with mean value of 6.78 which was statistically at par with T₈ (6.85) and T₇ (7.45). In S₂ (Dhaulakuan) seed source maximum number of leaves was recorded for T₇ with mean value of 10.77 which was statistically at par with T₈ (9.40) and T₄ (9.25), whereas minimum number of leaves was recorded for T₅ with mean value 6.28 which was statistically at par with T₃ (7.58) and T₁₀ (7.83). In S₃ (Maryog) maximum number of leaves was recorded for T₁₀ with mean value of 8.71 which was statistically at par with T₁ and T₃ (8.53) and T₄ (7.97), whereas minimum number of leaves was recorded for T₆ with mean value 3.33 was statistically at par with T₉ (3.40) and T₆ (6.25).

Table 4: Variation in number of leaves between different seed sources of *Acacia catechu* Willd. after one year growth under nursery conditions

Tree No.	Seed source									
	Badlech S ₁	Dholakuan S ₂	Maryog S ₃	Bhojnagar S ₄	Dilman S ₅	Subathu S ₆	Hamirpur S ₇	Kangra S ₈	Jachh S ₉	Bilaspur S ₁₀
T ₁	8.20	8.63	8.53	4.17	13.67	11.33	11.57	7.83	6.43	8.93
T ₂	10.73	8.13	6.93	9.90	8.50	9.38	10.37	9.47	7.20	9.17
T ₃	9.80	7.58	8.53	8.43	12.27	8.01	8.83	11.13	9.22	8.20
T ₄	8.64	9.25	7.97	10.10	8.75	9.17	10.37	7.87	8.55	9.65
T ₅	10.31	6.28	6.17	12.95	7.50	10.47	9.19	11.67	6.89	10.50
T ₆	6.78	7.90	3.33	11.83	7.83	9.42	10.44	8.02	9.97	7.92
T ₇	7.45	10.77	6.25	12.60	10.20	8.23	10.93	10.30	8.08	9.67
T ₈	6.85	9.40	7.62	12.40	12.33	9.33	9.30	10.52	9.12	7.20
T ₉	9.41	7.89	3.40	15.33	12.67	10.33	12.30	7.92	8.43	6.75
T ₁₀	7.55	7.83	8.71	11.47	7.83	12.00	9.57	8.62	9.45	9.33
Mean	8.57	8.37	6.74	10.92	10.16	9.77	10.29	9.33	8.33	8.73
	NS	NS	NS			NS	NS	NS	NS	NS
CD _{0.05}	Between Seed Source				:	1.34				
	Within seed sources				:	4.24				

In S₄ (Bhojnagar) seed source maximum number of leaves was recorded for T₉ with mean value of 15.33 which was statistically at par with T₅ (12.95) and T₇ (12.60), whereas minimum number of leaves was recorded for T₁ with mean value 4.17 which was statistically at par with T₃ (8.43). In S₅ (Dilman) seed source maximum number of leaves was recorded for T₁ with mean value of 13.67 which was statistically at par with T₉ (12.67) and T₈ (12.33), whereas minimum number of leaves was recorded for T₅ with mean value 7.50 which was statistically at par with T₆ T₁₀ (7.83) and T₂ (8.50).

In S₁ promising trees for further selection are T₂, T₅ and T₃, where as in S₂ promising trees are T₇, T₈ and T₄. In S₃ best trees are T₁₀, T₁ and T₃, where as in S₄ best trees are T₉, T₅, T₇. In S₅ promising progenies from trees are obtained from T₁, T₉ and T₈ where as in S₆ promising progenies are obtained from trees T₁₀, T₁ and T₅. In S₇ best trees are T₁, T₉ and T₂ where as in S₈ promising trees are T₅, T₃ and T₈. In S₉ best

trees are T₆, T₁₀ and T₈ where as in S₁₀ best trees are in T₅, T₇ and T₄. The maximum mean value for number of leaves obtained from S₄ (10.92) and minimum mean value for no. of leaves obtained from S₃ (6.74).

Number of branches

Table 5 shown that all sources are significant except S₁, S₃, S₄ and S₈. In S₁ maximum no. of branches belong to T₁ with mean value of 0.87 where as in S₂ maximum number of branches belong to T₁ 0.67. In S₃ maximum no. of branches belong to T₄ 0.42. In S₄ maximum no. of branches found in T₉ with mean value of 1.35 and minimum no. of branches belong to T₆ 0.20 where as in S₅ maximum no. of branches belong to T₁ with mean value of 1.00. in S₆ maximum no. of branches belong to tree T₁ with mean value of 0.97, where as in S₇ maximum no of branches belong to T₁ with mean value of 0.57.

Table 5: Variation in number of branches after one year traits between different seed sources of *Acacia catechu* Willd. after one year growth under nursery conditions

Tree No.	Seed source									
	Badlech S ₁	Dholakuan S ₂	Maryog S ₃	Bhojnagar S ₄	Dilman S ₅	Subathu S ₆	Hamirpur S ₇	Kangra S ₈	Jachh S ₉	Bilaspur S ₁₀
T ₁	0.80	0.67	0.20	0.33	1.00	0.97	0.58	0.27	0.00	0.00
T ₂	0.42	0.50	0.13	0.50	0.00	0.60	0.42	0.00	0.00	0.00
T ₃	0.43	0.08	0.20	0.23	0.33	0.00	0.30	0.20	0.00	0.13
T ₄	0.23	0.58	0.42	0.18	0.37	0.28	0.53	0.48	0.37	0.43
T ₅	1.17	0.07	0.08	0.57	0.17	0.37	0.00	0.67	0.68	0.08
T ₆	0.17	0.00	0.08	0.20	0.00	0.25	0.00	0.00	0.47	0.00
T ₇	0.58	0.45	0.27	0.83	0.33	0.34	0.00	0.33	0.57	0.08
T ₈	0.27	1.93	0.00	1.13	0.00	0.42	0.00	0.00	0.75	0.36
T ₉	0.00	0.00	0.17	1.35	0.27	0.08	0.00	0.48	0.57	0.22
T ₁₀	0.44	0.50	0.00	0.65	0.50	0.63	0.17	0.08	0.77	0.17
Mean	0.45	0.48	0.16	0.60	0.30	0.39	0.20	0.25	0.42	0.15
	NS		NS	NS				NS		
CD _{0.05}	Between Seed Source				:	NS				
	Within seed sources				:	0.40				

In S₈ maximum no of branches belong to T₉ with mean value 0.48 in S₉ maximum no. of branches belong to T₁₀ with mean

value of 0.77 and in S₁₀ maximum number of branches belong to T₄ with mean value of 0.43.

Table 6: Genetic estimates after after one year traits between different seed sources of *Acacia catechu* Willd. after one year growth under nursery conditions

Nursery characters	GCV%	PCV%	Heritability%	Genetic advance	Genetic gain %
Seedling height	17.41	58.27	9	2.48	10.8
Collar diameter	24.23	45.84	28	0.38	26.44
No. of branches	6.93	13.2	28	0.46	7.61
No. of leaves	14.64	32.39	2	1.21	13.34

Genotypic coefficient of variability (%): Maximum value was recorded for collar diameter with value 24.23 percent followed by seedling height 17.41. Phenotypic coefficient of variability Maximum value of 58.27 percent was recorded for seedling height which was followed by collar diameter having value of 45.84 percent and no. of leaves with value of 32.39 percent, whereas minimum value was recorded for no. of branches with value 13.20 percent. Heritability is maximum for seedling height and no. of branches. Maximum genetic advance is obtained for seedling height and no. of leaves. Maximum value of genetic gain 26.44 percent was recorded for collar, whereas minimum value was recorded for no. of branches with value 7.61 percent.

Discussion

Maximum mean value seedling height was obtained from S_9 (29.17) and minimum seedling height was obtained from S_3 (17.06). A study ^[2] revealed that plant height, based diameter, number of branches and volume were highly significant which indicate higher variability, contradictorily some found ^[3] no significant differences among the three *Acacia* species were observed with regard to the determined growth parameters and inter-specific difference was found in seedlings root dry weight. Maximum mean value collar diameter was obtained from S_8 (1.97) and minimum collar diameter was obtained from S_6 is 1.15. The maximum mean value for number of leaves obtained from S_4 (10.92) and minimum mean value for no. of leaves obtained from S_3 (6.74) some ^[4] results exhibited wide differences among the *Acacia* species in morphological traits such as number of leaves, seed length, pinna length, leaf base and top length. In S_8 maximum no of branches belong to T_9 with mean value 0.48 in S_9 maximum no. of branches belong to T_{10} with mean value of 0.77 and in S_{10} maximum number of branches belong to T_4 with mean value of 0.43. In ^[5] *Acacia nilotica* for plant height, clear bole height, collar diameter number of branches, first, second and third inter branch distances and angles of first, second and third branches with reference to main stem.

Conclusion

Higher values for phenotype coefficient of variation as compared to genotypic coefficient of variation in seedling growth characters, indicating that the characters are greatly influenced by the field environment. The heritability and expected genetic gain were also observed to be high to moderate for these characters ^[6]. Heritability mean of 0-0.3 is low, 0.4-0.6 moderate, and 0.6 and above high. Seed sources S_4 (Bhojnagar), S_7 (Hamirpur), S_8 (Kangra), S_9 (Jachh) can be selected for further improvement work on the basis of nursery seedling growth traits.

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