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Genetic Variation in Progeny Performance Traits in Soapnut (Sapindus Mukorossi Gaertn.) of Himachal Pradesh.

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Abstract: *Evaluation in Progeny performance traits was carried out among different twenty four seed sources and in two D.B.H. classes. Progeny performance traits of soapnut seedlings were recorded at intervals, of 3 months and 6 months growth period. All growth performance traits showed significant variation at 3 months and 6 months of intervals among different seed sources.Banjar (S_{16}) seed sources which has larger and heavier seeds showed best performance than under study. Large sized seeds of soapnut exhibited superior growth characteristics than medium and small sized. Banjar seed source is recommended for raising quality planting material and to get improved genetic gain.*

Keywords*:-Soapnut, Sapindus mukorossi, Genetic variation, Progeny performance traits, Nursery evaluation.*

I. Introduction

Sapindus mukorossi or Soapnut tree (Ritha) is an important multipurpose tree of North India, belonging to family Sapindaceae. The tree is native to China and Japan and much cultivated in North India, in moister tracts along the foot hills of Himalayas from Ravi eastward up to 1500 m elevation. The tree is also found wild in the valleys of North Western Himalayas, Assam and West Bengal [1]. The dried fruits of 'Ritha' are most valuable part of the plant. Its fleshy portion contains saponin, which is used in preparation of washing soap and as such is used for preparation of quality shampoos. The fruit is of considerable importance for its medical value as well. As per Ayurveda, Unani and Tibetan system of medication, it is useful in treating in number of human maladies like bad cold, facial pimples, irregularities in salivation, chlorosis, epilepsy, constipation, nausea, etc. It is also used as expectorant and antihelminthic in small doses [2].

Ritha importance lies in the sale of fruits, which are mainly sold in the local market. A number of farmers are earning livelihood by marketing and selling the fruits from their planted trees. As the domestication and cultivation started the demand for quality seedling also increased. It is therefore, worthwhile to determine the optimum seed size for improving the physical quality of the seedlings and growing stock.Considering vast semi-wild distribution of soapnut, it is expected to have considerable genetic variation. Sufficient information on such aspect is lacking in this species despite of its many uses. Environmental factors in combination with genetic and physiological factors play an important role in determination of plant potential for seed quality. These characters appear to be under strong genetic control [3]Among various factors responsible for successful plantation programme, use of quality seeds in terms of genetic and physical attributes is of paramount importance. The seed size have been found to have a marked bearing on the quality of the nursery stock in numerous species and *Sapindus mukorossi* need not necessarily provide an exception to this. It is therefore, the study was conducted to determine the best seed source and D.B.H. class for improving the genetic material for seedlings and growing stock on the basis of progeny performance.

II. Material and Methods

1.1 Site selection, tree selection and fruit collection

Multistage Random Sampling Technique was used to select the trees of soap nut. Six districts,viz., Chamba, Kangara, Mandi, Kullu, Sirmour and Solan were selected from the state of Himachal Pradesh and four seed sources were selected from each disrtict. From each seed source, two diameter classes, i.e., 10-40 cm D.B.H. (D_1) and 40-70 cm D.B.H. (D_2) were selected. Three trees were selected from each diameter class. The fresh fruits were collected manually and packed in gunny bags and brought to University campus in the departmental laboratory for detail studies and analysis. The fruits so collected and seeds extracted from such fruits of each site were kept separately with proper identify of the sites and passport data. Progeny performance traits were recorded in nursery after 3 and 6 months of sowing.

Experimental details:-

Seed source	:	24
Diameter classes selected at each site	:	2
Replication	:	3
Total treatment combination	:	24×2=48
Design employed	:	RBD (Factorial) in Field CRD (in Laboratory)

Table 1. Description of seed sources of Sapindus mukorossi Gaertn.) in **Himachal Pradesh under study**

Sr. no.	District	Seed source and code		Altitude (a msl)
1	Chamba	Trimuth	(S_1)	1003
		Tornu Kamni	(S_2)	1108
		Patka	(S_3)	1308
		Simble Ghatta	(S_4)	1280
2	Kangara	Jachh	(S_5)	532
		Nagrota Bagwan	(S_6)	550
		Jwalamukhi	(S_7)	609
		Palampur	(S_8)	1300
3	Mandi	Jogindar Nagar	(S_9)	1185
		Baggi	(S_{10})	1234
		Chail Chowk	(S_{11})	1268
		Pandoh	(S_{12})	1358
4	Kullu	Bhuntar	(S_{13})	1085
		Garsa	(S_{14})	1224
		Panarsa	(S_{15})	1200
		Banjar	(S_{16})	1530
5	Sirmour	Deothal	(S_{17})	1189
		Sarahan	(S_{18})	1380
		Naina Tikkar	(S_{19})	1365
		Nahan	(S_{20})	821
6	Solan	Kanda Ghat	(S_{21})	1428
		ThadiSubathu	(S_{22})	1260
		Shilly	(S_{23})	1480
		Jatoli	(S_{24})	1195

III. Results and Discussion

Genetic variation is important to get improved genetic gain on the basis of progeny performance. Hence present study was contemplated to select best seed source and best diameter and best individuals of the populations under study. Table 2 and Table 3 reveals , maximum significant mean 100 seed weight (226.05 g) and shoot length (23.35 cm; 57.30 cm), root length (18.47 cm; 41.50 cm), seedling height (41.82 cm; 98.80 cm), collar diameter (4.97 mm; 7.68 mm), number of leaves (66.67; 103.50), leaf area (11.08 cm^2; 44.38 cm^2) and seedling dry weight (3.35 g; 7.66 g) for Banjar (S_{16}) seed source after 3 months and 6 months growth of progeny. Also significantly Kandaghat (S_{21}) seed source showed minimum mean 100 seed weight (138.77 g), shoot length (11.28 cm; 34.60 cm), root length (8.65 cm; 26.95 cm), seedling height (19.93 cm; 61.55 cm), collar diameter (3.34 mm; 5.22 mm), number of leaves (31.00; 42.17), leaf area (4.57 cm^2; 6.74 cm^2) and seedling dry weight (1.83 g; 4.25 g) after 3 and 6 month, growth of the progenies and ranked at number 2 best seed source .Various progeny performance traits viz., shoot length, root length, seedling height, collar diameter, number of leaves, leaf area and seedling dry weight were studied during the course of investigation and analysis of variance attributed significant differences in these traits among different seed sources and non-significant difference between D.B.H. classes and interaction of seed sources and D.B.H. class (SxD). Progeny performance traits of soapnut seedlings were recorded at intervals, viz., 3 months and 6 months (months after sowing). All these traits showed significant variation at 3 months and 6 months of intervals among different seed sources. These resulted are parallel findings with the research findings of [4] who reported significant among different seed sources variation, while studying on *Albizia procera*. Studying on geographical variation in seed and seedling characteristics in *Dalbergia sissoo* reported significant seed sources variation in seed and seedling traits [5].

Variation in *Sapindus mukorossi* with respect to the seedling traits could be due to the fact that this species grow over a wide range of rainfall, temperature, altitude, and soil type of India. Similar type of research work report also observed in *Albizia procera* [4]. The seed source and provenance variation in nursery and field is essentially genetic in origin [6]. Variation in *Sapindus mukorossi* with respect to the progeny performance traits could be due to the fact that the large sized seeds excelled over seed category than all the seed traits, germinability attributes, growth characters and seedling biomass [7].

Conclusively Banjar and other seed sources which have larger and heavier seeds showed best performance in comparison to other seed sources which have smaller and lower seeds on various progeny performance traits. Large sized seeds of soapnut exhibited superior growth characteristics than medium and small sized. Seedling and growth characteristics are independent processes and are governed by the genetic make up, environment and seed traits [8]. Growth parameters have good positive relationship with seed size and weight. Maximum height and collar diameter in *Jatropha curcas* [9], Shoot length and root length in *Azadirachta indica* [10], Seedling height and collar diameter in *Castanea sativa* [11]. Shoot length in *Cryptocarya alba* [12]. Seedling height growth and seedling diameter in *Santalum album* [13]. Seedling height in *Salvadora persica* and *Jatropha curcas* [14]. Maximum total dry weight was found in seedlings raised from large seed in *Jatropa curcas* [9].

IV. Conclusion

Banjar seed source which has larger and heavier seeds showed best performance than other seed sources which have smaller and lower seeds on the basis of various progeny performance traits. Large sized seeds of soapnut exhibited superior growth characteristics than medium and small sized seeds. Non significant differences were observed for DBH classes and also for interaction of seed sources and D.B.H. class (SxD). Banjar seed source (S16) is recommended for raising quality planting materials and to get improved genetic gain.

References

[1]. Troup R S., Silviculture of Indian trees Vol. 3 Nasik, Govt. of India press. 1921, pp. 673-74.

[2]. Bahar Nawa and Singh V.R.R., Seed source selection of Sapindus mukorossi in H.P. Indian Forester 133(6), 2007, 731-736.

[3]. Roy S.M., Thapliyal R.Sc. and Ophartyal S.S., Seed Sources variation in cone, seed and seedling characteristics across the natural distribution of Himalayan low level pine Pinus roxburghii Serg. Silvae Genetica 53(3), 2004, 116-123.

[4]. Gera Mohit, Gera Rohit and Ginwal HS., Performance of eleven seed sources/provenances of Albizia procera Roxb. Under semi arid region of central India. Annals of Forestry 12(1), 2004, 73-80.

[5]. Vakshaya R K, Rajora O P and Rawat M S., Seed and seedling traits of Dalbergia sissoo Roxb. Seed sources variation studies among ten sources in India. Forest Ecology and Management 48(3/4), 1992, 265-275.

[6]. Sniezko R A and Stewart H T C., Range wide provenance variation in growth and nutrition of Acacia albida seedling propagated in Zimbabwe. Forest Ecology and Manangement 27, 1989, 179-197.

[7]. Attri Varun, Pant K.S., Dhiman Rajeev, Lal Chaman and Sarvade S., Effect of Seed Size and Pre-sowing Treatments on Growth Parameters and Biomass of Sapindus mukorossi (Gaertn) Seedlings under Nursery Condition. Environment & Ecology 33 (1), 2015, 46-49.

[8]. Pathak P S, Gupta S K and Roy R D., Autoecology of Leucaenea leucocephala Linn. De Wit III. Meterogylph analysis of seedling characteristics. Journal of Tree Science 3 (1/2), 1984, 15-19.

[9]. Singh Nidhi and Saxena A K., Seed size variation and its effect on germination and seedling growth of Jatropha Curcas L. Indian Forester 135 (8), 2009,1135-1142.

[10]. Uniyal A K, Singh Bhupendra and Todaria N P., Effect of seed size, sowing orientation and depth on germination and seedling growth in neem (Azadirachta indica). Seed Technology 29 (1), 2007, 68-75.

[11]. Cicek E and Tilki F., Seed size effect on germination, survival and seedling growth of Castanea sativa Mill. Journal of Biological Sciences 7 (2), 2007,438-441

[12]. Chacon P., Bustamante R. and Henriquez C., Effect of seed size on germination and seedling growth of Cryptocarya alba (Lauraceae) in Chile. Revista Chilena de Historia Natural 71 (2), 1998,189-197.

[13]. Effendi M and Sinaga M., Effect of seed size on growth of sandalwood (Santalum album L.) seedlings. Santalum 15, 1994, 15-23.

[14]. Dagar J C, Bhagwan Hari and Kumar Yogendra., Seed germination studies on Salvadora persica and Jatropha curcas. Indian Journal of Forestry 27 (3), 2004, 283-289.

Table 2. Variation in progeny performance traits of *Sapindus mukorossi* among different seed sources in two different D*BH classes*

Seed	100 seed weight			Shoot length (cm)						Root length (cm)						Seedling height (cm)					
				After 3 months			After 6 months			After 3 months			After 6 months			After 3 months			After 6 months		
	DBH classes		mean	DBH classes		mea	DBH classes		mea	DBH classes		mea	DBH classes		mea	DBH classes		mea	DBH classes		mea
	D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2	
S_1	141.73	146.83	144.28	12.57	13.37	12.97	37.40	38.90	38.15	9.60	10.60	10.10	29.11	29.81	29.46	22.20	23.97	23.08	66.51	68.70	67.61
S_2	145.37	143.77	144.57	12.93	12.93	12.93	38.10	37.80	37.95	9.80	10.10	9.95	29.61	29.20	29.41	22.73	23.03	22.88	67.71	67.01	67.36
S_3	139.67	141.60	140.63	12.13	12.10	12.12	37.10	37.20	37.15	9.10	9.37	9.23	28.53	28.91	28.72	21.23	21.47	21.35	65.64	66.11	65.87
S_4	160.30	161.13	160.72	14.80	15.07	14.93	42.80	43.20	43.00	10.57	11.43	11.00	33.21	33.43	33.32	25.37	26.50	25.93	76.01	76.63	76.32
S_5	163.00	161.53	162.27	15.50	15.27	15.38	44.20	43.50	43.85	11.20	11.40	11.30	34.21	33.70	33.96	26.70	26.67	26.68	78.41	77.20	77.81
S_6	160.30	161.83	161.07	14.90	15.07	14.98	42.70	43.60	43.15	11.27	10.93	11.10	33.20	33.80	33.50	26.17	26.00	26.08	75.90	77.40	76.65
S_7	169.77	168.40	169.08	17.83	17.60	17.72	46.80	46.40	46.60	13.47	13.10	13.28	36.30	36.00	36.15	31.30	30.70	31.00	83.10	82.40	82.75
S_8	167.63	166.17	166.90	17.37	17.43	17.40	46.20	46.10	46.15	12.93	12.93	12.93	35.90	35.70	35.80	30.30	30.37	30.33	82.10	81.80	81.95
S_9	179.60	182.73	181.17	19.10	19.77	19.43	49.70	50.65	50.15	14.70	14.85	14.75	38.60	39.00	38.80	33.80	34.57	34.18	88.30	89.60	88.95
S_{10}	176.37	177.87	177.12	18.33	18.83	18.58	48.40	49.10	48.75	13.30	13.90	13.60	37.60	38.20	37.90	31.63	32.73	32.18	86.00	87.30	86.65
S_{11}	176.60	177.00	176.80	18.50	18.60	18.55	48.30	48.80	48.55	13.70	13.97	13.83	37.50	37.90	37.70	32.20	32.57	32.38	85.80	86.70	86.25
S_{12}	175.27	174.97	175.12	18.43	18.13	18.28	47.40	47.15	47.25	13.20	13.07	13.13	36.90	36.40	36.65	31.63	31.20	31.42	84.30	83.50	83.90
S_{13}	179.40	181.50	180.45	19.30	19.60	19.45	49.80	50.40	50.10	14.37	14.83	14.60	38.70	39.00	38.85	33.67	34.43	34.05	88.50	89.40	88.95
S_{14}	223.77	213.23	218.50	22.63	21.67	22.15	56.20	54.70	55.45	17.50	17.37	17.43	42.40	42.00	42.20	40.13	39.03	39.58	98.60	96.70	97.65
S_{15}	181.70	188.87	185.28	19.80	20.13	19.97	50.90	51.10	51.00	14.37	14.43	14.40	39.30	39.50	39.40	34.17	34.57	34.37	90.20	90.60	90.40
S_{16}	225.7	226.3	226.0	22.9	23.7	23.3	57.2	57.4	57.3	18.3	18.6	18.4	41.4	41.6	41.5	41.2	42.3	41.8	98.6	99.0	98.8
	73	35	55	33	77	55	00	00	00	30	07	70	00	00	00	77	72	20	00	00	00
S_{17}	158.10	159.87	158.98	14.30	14.53	14.42	41.60	42.10	41.85	11.20	11.43	11.32	32.30	32.70	32.50	25.50	25.97	25.73	73.90	74.80	74.35
S_{18}	159.87	157.20	158.53	14.53	14.10	14.32	42.00	41.20	41.60	10.90	10.67	10.78	32.60	31.90	32.25	25.43	24.77	25.10	74.60	73.10	73.85
S_{19}	165.73	165.20	165.47	16.77	16.90	16.83	45.50	45.50	45.50	12.57	12.70	12.63	35.20	35.10	35.15	29.33	29.60	29.47	80.70	80.60	80.65
S_{20}	163.30	164.53	163.92	16.10	16.17	16.13	44.40	44.80	44.60	11.73	12.00	11.87	34.30	34.60	34.45	27.83	28.17	28.00	78.70	79.40	79.05
S_{21}	138.67	138.87	138.77	11.13	11.43	11.28	34.10	35.10	34.60	8.53	8.77	8.65	26.30	27.60	26.95	19.67	20.20	19.93	60.40	62.70	61.55
S_{22}	145.50	145.77	145.63	13.10	13.33	13.22	38.60	38.80	38.70	10.30	10.60	10.45	29.90	30.10	30.00	23.40	23.93	23.67	68.50	68.90	68.70
S_{23}	141.60	142.30	141.95	12.20	12.40	12.30	37.44	37.70	37.57	10.50	10.63	10.57	29.10	29.30	29.20	22.70	23.03	22.87	66.54	67.00	66.77
S_{24}	152.47	151.43	151.95	13.63	13.57	13.60	40.50	40.30	40.40	10.67	10.67	10.67	31.40	31.20	31.30	24.30	24.23	24.27	71.90	71.50	71.70
Mean	166.31	166.62		16.20	16.32		44.47	44.64		12.24	12.43		34.32	34.44		28.44	28.75		78.79	79.09	
$CD_{0.05}$																					
S	3.057			3.063			3.065			1.42			1.48			3.227			3.540		
D	NS			NS			NS			NS			NS			NS			NS		
S×D	4.324			NS			NS			NS			NS			NS			NS		

S= Seed Sources, D= DBH Classes, S×D= Interaction of Seed Source and DBH Classes

Table 3. Variation in progeny performance traits of *Sapindus mukorossi* among different seed sources in two different DBH classes

Seed	Collar diameter (mm)						Number of leaves						Leaf area (cm^2)						Seedling dry weight					
	After 3 months			After 6 months			After 3 months			After 6 months			After 3 months			After 6 months			After 3 months			After 6 months		
	DBH classes		mean	DBH classes		Mean	DBH classes		mean	DBH classes		mean	DBH classes		mean	DBH classes		mean	DBH classes		mean	DBH classes		Mean
	D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2		D_1	D_2	
S_1	3.48	3.54	3.51	5.29	5.59	5.44	51.00	53.33	52.17	80.67	80.33	80.50	4.72	5.28	5.00	6.76	7.38	7.07	2.02	2.12	2.07	4.76	4.81	4.79
S_2	3.49	3.49	3.49	5.31	5.35	5.33	46.33	47.33	46.83	57.00	58.00	57.50	4.85	4.78	4.82	6.81	6.76	6.78	2.02	2.06	2.04	4.78	4.72	4.75
S_3	3.47	3.47	3.47	4.24	4.23	4.24	43.00	45.67	44.33	50.00	72.00	61.00	4.42	4.70	4.56	6.39	6.56	6.48	1.97	1.98	1.97	4.57	4.62	4.60
S_4	3.53	3.59	3.56	5.81	6.08	5.95	37.67	38.03	37.83	54.67	54.33	54.50	5.78	7.08	6.43	8.09	9.83	8.96	2.23	2.27	2.25	5.66	5.65	5.66
S_5	3.61	3.62	3.62	6.21	6.26	6.24	40.33	36.00	38.17	58.33	57.33	57.83	7.29	7.89	7.59	9.99	10.33	10.16	2.36	2.34	2.35	5.81	5.77	5.79
S_6	3.57	3.56	3.56	6.01	5.97	5.99	37.67	40.33	39.00	58.33	56.00	57.17	7.05	6.23	6.64	9.81	8.99	9.40	2.31	2.29	2.30	5.64	5.71	5.68
S_7	3.79	3.72	3.76	6.65	6.54	6.60	34.00	35.67	34.83	45.00	47.33	46.17	8.87	8.53	8.70	12.11	11.16	11.64	2.68	2.63	2.66	6.31	6.25	6.28
S_8	3.73	3.74	3.73	6.59	6.52	6.56	46.67	47.00	46.83	73.67	69.00	71.33	8.83	8.81	8.82	11.71	11.70	11.71	2.60	2.59	2.60	6.20	6.18	6.19
S_9	3.93	3.98	3.96	7.02	7.15	7.09	36.33	35.67	36.00	58.33	58.00	58.17	10.14	10.42	10.28	13.22	13.71	13.47	2.88	3.04	2.96	6.87	6.94	6.91
S_{10}	3.85	3.90	3.88	6.67	6.79	6.73	38.33	38.33	38.33	57.67	56.67	57.17	9.72	10.01	9.87	12.47	12.92	12.69	2.72	2.81	2.77	6.65	6.72	6.69
S_{11}	3.86	3.84	3.85	6.78	6.76	6.77	34.67	34.67	34.67	57.00	56.33	56.67	9.95	9.54	9.75	12.89	12.55	12.72	2.75	2.78	2.76	6.58	6.63	6.60
S_{12}	3.82	3.75	3.79	6.69	6.68	6.68	56.00	53.67	54.83	93.67	88.00	90.83	9.15	8.89	9.02	12.46	12.15	12.31	2.71	2.68	2.70	6.44	6.37	6.41
S_{13}	4.21	4.29	4.25	7.01	7.21	7.11	67.00	69.33	68.17	110.00	109.00	109.50	10.79	10.78	10.79	14.06	14.03	14.05	2.85	2.98	2.92	6.85	6.94	6.89
S_{14}	4.80	4.72	4.76	7.54	7.59	7.56	68.00	69.00	68.50	99.67	101.33	100.50	10.87	10.91	10.89	14.16	14.18	14.17	3.37	3.32	3.35	7.47	7.41	7.44
S_{15}	3.97	3.97	3.97	7.16	7.13	7.15	61.33	62.00	61.67	87.67	86.00	86.83	10.25	10.37	10.31	13.34	13.51	13.42	2.91	3.08	3.00	7.01	7.07	7.04
S_{16}	4.88	5.06	4.97	7.68	7.67	7.68	67.33	66.00	66.67	105.00	102.00	103.50	11.08	11.07	11.08	14.39	14.38	14.38	3.51	3.54	3.53	7.62	7.70	7.66
S_{17}	3.56	3.55	3.56	5.76	5.93	5.84	46.67	50.33	48.50	87.33	88.67	88.00	6.86	6.04	6.45	9.30	8.90	9.10	2.23	2.26	2.24	5.38	5.47	5.43
S_{18}	3.55	3.56	3.56	5.80	5.69	5.75	72.67	72.67	72.67	112.67	111.33	112.00	5.92	6.97	6.45	8.23	9.41	8.82	2.22	2.15	2.19	5.45	5.37	5.41
S_{19}	3.69	3.68	3.68	6.41	6.47	6.44	57.00	57.33	57.17	81.00	79.33	80.17	8.37	8.27	8.32	10.94	10.84	10.89	2.51	2.53	2.52	6.07	6.04	6.05
S_{20}	3.61	3.63	3.62	6.24	6.39	6.31	66.33	65.67	66.00	93.00	91.00	92.00	7.37	7.98	7.68	10.01	10.64	10.33	2.39	2.44	2.41	5.88	5.93	5.91
S_{21}	3.42	3.43	3.43	5.21	5.23	5.22	31.00	31.00	31.00	42.33	42.00	42.17	4.56	4.59	4.57	6.64	6.83	6.74	1.82	1.84	1.83	4.21	4.28	4.25
S_{22}	3.51	3.51	3.51	5.47	5.53	5.50	40.00	39.00	39.50	58.00	56.67	57.33	4.99	5.08	5.04	6.97	7.01	6.99	2.09	2.10	2.09	4.84	4.89	4.87
S_{23}	3.50	3.50	3.50	5.38	5.42	5.40	44.67	44.67	44.67	70.67	70.67	70.67	4.92	4.89	4.91	6.86	6.84	6.85	2.03	2.05	2.04	4.64	4.73	4.69
S_{24}	3.61	3.53	3.57	5.64	5.63	5.64	48.00	50.33	49.17	85.67	85.00	85.33	5.31	5.24	5.27	7.40	7.37	7.39	2.15	2.13	2.14	5.20	5.13	5.16
Mean	3.77	3.78		6.19	6.24		48.83	49.29		74.06	74.01		7.59	7.68		10.21	10.33		2.47	2.50		5.87	5.89	
$CD_{0.05}$																								
S	0.274			0.570			11.703			16.070			1.18			1.17			1.101			0.095		
D	NS			NS			NS			NS			NS			NS			NS			NS		
S×D	NS			NS			NS			NS			NS			NS			NS			NS		

S= Seed Sources, D= DBH Classes, S×D= Interaction of Seed Source and DBH Classes