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Genetic variability, heritability and genetic advance for herbage yield and its attributing traits in Thuthuvalai (*Solanum trilobatum* L.)

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ABSTRACT

Thuthuvalai (*Solanum trilobatum* L.) is an important medicinal plant in Indian system of medicines. The leaves are having several alkaloids. These alkaloids have been identified and used in large scale by pharmaceutical industries for formulating new drugs against many diseases and illness of human beings. In order to exploit this medicinal herb for commercial cultivation, the present investigation was carried out to study the genetic variability for growth, herbage yield and alkaloid content of Thuthuvalai (*Solanum trilobatum* L.). Thirty ecotypes were collected from all the agro climatic regions of Tamil Nadu and studied for mean performance, genetic variability, heritability, and genetic advance for growth, herbage yield, and alkaloid content of Thuthuvalai. The study revealed that The ecotype ST₇ (Vangal) performed well for better growth, herbage yield and alkaloid content in leaf. High GCV, PCV, habitability and genetic advance were recorded for most of the growth parameters, herbage yield and alkaloid content in Thuthuvalai.

Keywords: Thuthuvalai (*Solanum trilobatum* L.), genetic variability, heritability

Introduction

The cultivation of medicinal and herbal plants has assumed greater importance in recent days due to the tremendous potential they offer in formulating new drugs against many diseases and illness. Among the various medicinal and herbal plants, the green medicinal herb, Thuthuvalai (*Solanum trilobatum* L.) is one such green remedy in ISM and Homeopathy. Thuthuvalai (*Solanum trilobatum* L.), belonging to the family Solanaceae, is a branched climbing shrub with sharp and curved prickles. This medicinal plant is commonly found in the regions of South and North West India. It is a well-known medicinal plant, used for curing all kinds of lung disorders. The leaves of this medicinal plant are also used as vegetable. The steroidal alkaloid, solasodine is present in the leaves of Thuthuvalai (Barnabas *et al.*, 1989) [2]. All parts of this plant are used against asthma, chronic febrile affections and difficult parturition. The leaves are used for curing ear aches, cough and gastritis and leaf extract seems to increase male fertility, counteracts snake poison and cures lung diseases and physicians consider it as a stimulant, expectorant and tonic. In the Siddha system of medicine, paste prepared from this plant is used to cure tuberculosis (Raman and Jaiwal, 2000) [14]. It is mostly found growing naturally in forests. Existing knowledge on the genetic potential of Thuthuvalai and its related species are limited and scarcely found in India, which hinders the improvement of these species as well as their sustainable conservation. The study of genetic diversity is the prerequisite, for development of suitable Thuthuvalai variety with high yield and other quality parameters as any breeding programme depends upon the extent of genetic variability present in the population. There are no varieties have yet been developed through conventional breeding, but local variants or landraces have been used in cultivation of this crop. Also success in a recombination breeding depends on the exploitation of genotypes as parents for obtaining high heterotic crosses and transgressive segregants. Estimates of heritability and genetic advance can serve to identify the factors which can be used as indicators for high yield during selection. Keeping these things in view, the study was planned to assess the genetic variability, heritability and genetic advance with respect to various desirable characters in thirty ecotypes of Thuthuvalai collected from different locations of Tamil Nadu. The study was focused to identify the promising ecotypes of Thuthuvalai with

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higher herbage yield and high alkaloid content.

Materials and Methods

The experiment was carried out at the Botanical Garden, Department of Medicinal and Aromatic Crops, Horticultural College and Research Institute, TNAU, Coimbatore. The experimental material consisted of thirty ecotypes which are collected from all the agro climatic regions of Tamil Nadu. The detail of the ecotypes and source of collection is given in Table.1. The seeds were collected from the ecotypes by repeated selfing and sown in raised nursery beds. Forty five days old seedlings were transplanted in main field at a spacing of 60 x 30 cm in a Randomized Block Design (RBD) with three replications. The labeling and tagging was done properly and the plants were trained by GI wire with wooden poles. The quantitative traits such as Plant height (cm), Inter nodal length (cm), Stem girth (cm), No. of stem

prickles (15 cm^{-1}), No. of branches (plant^{-1}), No. of leaves (plant^{-1}), No. of lobes (leaf^{-1}), Leaf colour, No. of leaf prickles (leaf^{-1}), Leaf prickle colour, Leaf area (cm^2), Fresh herbage yield (g plant^{-1}), Dry herbage yield (g plant^{-1}), Total chlorophyll content (mg g^{-1}), Proline content ($\mu\text{g g}^{-1}$) and Alkaloid content in leaf (%) were computed by taking the mean values of five selected plants from each treatment per replication.

Analysis of variance of design of experiment was estimated according to the formula given by Panse and Sukhatme (1961) [13]. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were computed based on the methods given by Burton (1952). The heritability was computed based on the method given by Lush (1940) [10]. Genetic advance and genetic advance as percentage of mean were estimated according to the formula given by Johnson *et al.* (1955) [7].

Table 1: Ecotypes details

S. No.	Notation (Ecotypes)	Source		Agroclimatic zones of Tamil Nadu
		Place	District name	
1.	ST ₁	Thiruverkadu	Thiruvallur	I
2.	ST ₂	Utharamerrur	Kanchipuram	I
3.	ST ₃	Nattarampalli	Vellur	I
4.	ST ₄	Eraiyyur	Thiruvannamalai	I
5.	ST ₅	Chidambaram	Cuddalore	I
6.	ST ₆	Kottappatti	Dharmapuri	II
7.	ST ₇	Vangal	Karur	II
8.	ST ₈	Veerappanchatram	Erode	III
9.	ST ₉	Perur	Coimbatore	III
10.	ST ₁₀	Balakrishnampatti	Trichy	IV
11.	ST ₁₁	Valigandapuram	Perampalur	IV
12.	ST ₁₂	Thiruvonam	Tanjore	IV
13.	ST ₁₃	Chembannarkoil	Nagapattinam	IV
14.	ST ₁₄	Kannivadi	Dindugal	V
15.	ST ₁₅	Gandharvakottai	Pudukottai	V
16.	ST ₁₆	Singamponari	Sivagangai	V
17.	ST ₁₇	Vadugapatty	Theni	V
18.	ST ₁₈	Vadamalaiipuram	Virudhunagar	V
19.	ST ₁₉	Kadampoor	Tuticurin	V
20.	ST ₂₀	Cherrammadevi	Thirunellveli	V
21.	ST ₂₁	Kaliyakavalai	Kaniyakumari	VI
22.	ST ₂₂	Courtalam	Thirunellveli	VII
23.	ST ₂₃	Kollihills	Namakal	VII
24.	ST ₂₄	Yercaud	Salem	VII
25.	ST ₂₅	Kodaikanal	Dindugal	VII
26.	ST ₂₆	Kodanadu	Nilgris	VII
27.	ST ₂₇	Naduvattam	Nilgris	VII
28.	ST ₂₈	Gurubaraghalli	Dharmapuri	II
29.	ST ₂₉	Thirthani	Thiruvallur	I
30.	ST ₃₀	Parambikultam	Coimbatore	III

Results and Discussion

Data presented in table 2 and 3 revealed that The mean performance of Thuthuvalai ecotypes for the purpose of herbage yield exhibited a large number of promising ecotypes to obtain maximum herbage yield. All the ecotypes registered statistically significant difference among themselves for different growth and herbage yield characters. Among the ecotypes, ST₇ showed maximum number of branches, number of leaves, leaf area. However, ST₇ was on par with ST₆ followed by ST₁₀, ST₁₁, ST₁₂ and ST₁₃ for these traits but its were minimum in the ecotype ST₂₁. The maximum plant height and inter nodal length and stem girth were found in ST₂₃, ST₂₀, and ST₈, respectively. Among the 30 ecotypes

evaluated, the ecotypes ST₇ and ST₈ followed by ST₁₀, ST₁₁, ST₁₂ and ST₁₃ were recorded maximum herbage yield. It might be due to inherent potential of the ecotypes and it was also exhibited in yield attributing growth characters. The alkaloid content in leaf was also higher in ST₇, ST₆, ST₈ and ST₉ indicating the better quality of herbage yield. Based on the mean performance of different traits, the ecotype ST₇ and ST₆ could be considered for selection.

The data on phenotypic and genotypic coefficients of variation, presented in table 4 also confirms the existence of a wide range of variation. High GCV observed for leaf area, dry herbage yield, fresh herbage yield, number of stem prickles, number of branches, number of leaves, plant height, inter nodal length and number of

leaf prickles also confirms the extent of fixable variation that is present among the ecotypes which can be exploited. High amount of fixable variation has been reported by Misra *et al.* (1998) ^[11] and Das *et al.* (2011) ^[4] in ashwagandha and Mohanty (1999) ^[12] in brinjal.

Comparison of PCV and GCV clearly indicates that there is little difference between PCV and GCV in respect of leaf area, fresh herbage yield, inter nodal length, plant height, stem diameter, number of stem prickles, number of leaf prickles, number of branches and total chlorophyll content suggesting that these characters are less influenced by environment. This goes with the findings of Dwivedi *et al.* (2000) ^[6] in periwinkle. The traits like leaf alkaloid content, dry herbage yield, number of leaves, and proline content showed wide difference between PCV and GCV indicating that these characters interact with environment more than other characters. This goes in conformity with the findings of Singh (1999) ^[17], Sharma *et al.* and Ara *et al.* (2009) ^[16] in Tomato and Dubey (2010) ^[5] in Ashwagandha.

The heritability values are more for leaf area, fresh fruit yield, fresh herbage yield, inter nodal length, number of stem prickles, plant height, number of branches, number of leaf prickles, dry herbage yield (Table.5). The results corroborate with the earlier findings of Misra *et al.* (1998) ^[11] and Yadav *et al.* (2008) ^[18] in ashwagandha

and Sharma and Krishnan (2000) ^[15] in brinjal. Heritability itself does not provide any indication towards the amount of genetic progress that would result in selecting the best individual rather it depends upon the amount of genetic advance. Therefore genetic advance gains importance in providing an idea of the amount of progress that can be achieved by selection. The highest value of genetic advance as per cent of mean was observed for leaf area, dry herbage yield, fresh herbage yield, number of branches, number of stem prickles, number of leaves, and plant height. Results are in accordance with the findings of Misra *et al.* (1998) ^[11] in ashwagandha, Lal *et al.* (1990) ^[9] in isabgol and Kulkarni *et al.* (2010) ^[8] in chilli.

Heritability along with genetic advance as per cent of mean is usually more helpful than the heritability value alone in predicting of the selection of the best individual (Johnson *et al.*, 1955) ^[7] The data in table 5 clearly shows that leaf area, fresh herbage yield, number of branches, dry herbage yield possessed high value for both heritability as well as genetic advance. This indicates that additive genes control these traits and the improvement of these traits would be more effective through selection. Similar observations have been reported by Dwivedi *et al.* (2000) ^[6] in periwinkle.

Table 2: Mean performance of Thuthuvalai (*Solanum trilobatum* L.) ecotypes for stem characters

Ecotypes number	Plant height (cm)	Inter nodal length (cm)	Stem girth (cm)	No. of stem prickles (15 cm ⁻¹)	No. of branches (plant ⁻¹)	Stem prickle colour
ST1	96.34	11.21	6.85	18.39	18.92	Yellowish green
ST2	102.96	11.94	6.81	23.65	20.04	Yellowish green
ST3	103.68	12.07	6.79	24.14	20.76	Yellowish green
ST4	104.99	12.15	6.72	25.62	22.36	Yellowish green
ST5	106.07	12.24	6.63	26.07	23.61	Yellowish green
ST6	134.72	15.93	5.73	3.01	64.83	Green
ST7	142.26	16.27	5.66	3.69	65.04	Green
ST8	116.32	13.47	5.91	13.33	44.70	Green
ST9	121.43	13.81	5.82	13.84	44.62	Green
ST10	153.09	17.53	4.98	4.37	56.97	Green
ST11	154.56	17.96	4.91	5.42	56.02	Green
ST12	157.61	18.01	4.82	6.98	54.43	Green
ST13	160.82	18.16	4.71	8.07	52.98	Green
ST14	80.93	9.51	7.52	39.01	10.01	Green
ST15	79.19	9.27	7.54	38.64	9.27	Green
ST16	77.93	8.96	7.57	34.52	8.09	Green
ST17	75.08	8.78	7.66	33.36	7.35	Green
ST18	75.93	8.63	7.69	32.97	6.93	Green
ST19	74.32	8.52	7.71	31.36	6.41	Yellowish green
ST20	72.09	8.48	7.79	26.81	5.27	Green
ST21	170.93	19.39	4.06	15.98	4.01	Yellowish green
ST22	192.86	21.97	3.12	51.69	35.22	Green
ST23	194.94	22.01	2.98	44.29	36.07	Green
ST24	193.71	21.99	3.01	44.93	35.92	Green
ST25	192.02	21.89	3.24	47.45	34.68	Green
ST26	191.42	21.85	3.29	51.21	34.17	Green
ST27	186.15	20.98	3.32	45.76	32.82	Green
ST28	131.98	15.04	5.79	15.14	32.37	Green
ST29	91.89	10.71	6.89	17.01	18.42	Green
ST30	180.99	20.62	3.38	14.56	36.56	Green
Grand mean	130.57	14.98	5.63	25.38	29.96	-
CD (p = 0.05)	8.58	0.91	0.46	2.93	4.64	-
Sed	4.29	0.46	0.23	1.47	2.32	-

Table 3: Mean performance of Thuthuvalai (*Solanum trilobatum* L.) ecotypes for leaf characters

Ecotypes number	No. of leaves (plant ⁻¹)	No. of lobes (leaf ⁻¹)	Leaf colour	No. of leaf prickles (leaf)	Leaf prickle colour	Leaf area (cm ²)	Fresh herbage yield (g plant ⁻¹)	Dry herbage yield (g plant ⁻¹)
ST1	95.26	3.00	Light green	6.82	Green	658.91	28.48	4.56
ST2	98.44	3.00	Light green	8.52	Green	696.28	31.60	5.06
ST3	104.79	3.00	Light green	8.59	Green	756.56	34.48	5.52
ST4	106.37	3.00	Light green	8.64	Green	780.94	37.38	5.98
ST5	109.96	3.00	Light green	8.66	Green	825.47	38.49	6.16
ST6	284.71	3.00	Green	3.77	Green	5895.48	203.28	36.59
ST7	289.42	3.00	Green	3.98	Green	6025.35	208.38	37.51
ST8	199.02	3.00	Green	5.68	Green	3967.09	135.53	21.68
ST9	197.97	3.00	Green	5.72	Green	3889.46	133.23	21.32
ST10	252.52	5.00	Green	3.48	Green	5192.46	178.28	30.31
ST11	247.46	3.00	Green	3.27	Green	5036.48	173.96	29.57
ST12	241.38	3.00	Green	3.13	Green	4893.98	168.48	28.64
ST13	236.27	3.00	Green	3.02	Green	4756.56	163.97	27.87
ST14	56.46	3.00	Green	8.94	Green	368.49	14.45	2.60
ST15	54.39	3.00	Green	8.83	Green	345.53	12.89	2.32
ST16	52.47	3.00	Green	8.76	Green	324.56	11.23	2.02
ST17	49.92	3.00	Green	8.74	Green	303.60	9.63	1.73
ST18	48.21	3.00	Green	8.73	Green	288.94	8.73	1.57
ST19	44.73	3.00	Light green	8.71	Green	256.31	7.51	1.35
ST20	41.43	3.00	Green	8.69	Green	234.02	6.09	1.10
ST21	40.21	3.00	Light green	6.24	Green	220.95	5.07	0.91
ST22	154.74	5.00	Dark green	9.47	Black	2038.52	99.19	14.88
ST23	160.72	5.00	Dark green	9.84	Black	2207.12	106.56	15.98
ST24	157.89	5.00	Dark green	9.51	Black	2123.91	104.05	15.61
ST25	152.65	5.00	Dark green	9.26	Black	1960.76	96.02	14.40
ST26	150.42	3.00	Dark green	9.14	Black	1895.28	93.71	14.06
ST27	148.63	3.00	Dark green	9.07	Black	1827.71	89.48	13.42
ST28	147.21	3.00	Green	5.83	Green	1727.92	87.00	13.05
ST29	93.71	3.00	Green	6.47	Green	619.83	26.15	4.18
ST30	163.46	3.00	Green	5.78	Green	3139.34	109.35	16.40
Grand mean	130.36	-	-	7.18	-	2108.59	80.76	13.21
CD (p=0.05)	28.80	-	-	0.62	-	196.00	7.74	3.46
SEd	14.39	-	-	0.31	-	97.90	3.87	1.737

Table 4: Genetic variability components in Thuthuvalai (*Solanum trilobatum* L.) for herbage yield

S. No.	Characters	Gv	Gcv	Pv	Pcv
1	Plant height (cm)	1916.79	33.53	1944.29	33.77
2	Inter nodal length (cm)	23.96	32.68	24.27	32.89
3	Stem girth (cm)	2.84	29.94	2.92	30.36
4	No. of stem prickles (15 cm bits ⁻¹)	232.29	60.06	235.51	60.48
5	No. of branches (plant ⁻¹)	353.65	62.77	361.72	63.48
6	No. of leaves (plant ⁻¹)	5833.39	54.81	6143.90	56.24
7	No. of leaf prickles (leaf ⁻¹)	5.11	31.50	5.26	31.94
8	Leaf area (cm ²)	3735705.25	91.66	3750083.25	91.84
9	Fresh herbage yield (g plant ⁻¹)	4387.18	82.02	4409.60	82.23
10	Dry herbage yield (g plant ⁻¹)	128.24	85.72	132.73	87.20
11	Total chlorophyll content (mg g ⁻¹)	0.14	27.98	0.15	28.78
12	Proline content (µg g ⁻¹)	58.30	12.41	68.38	13.44
13	Alkaloid content in leaf (%)	0.16	27.11	0.19	28.94

Table 5: Heritability and genetic advance estimates in Thuthuvalai (*Solanum trilobatum* L.) for herbage yield

S. No.	Characters	Heritability	Genetic advance	Genetic advance (%) of mean
1	Plant height (cm)	0.9858	89.54	68.58
2	Inter nodal length (cm)	0.9872	10.02	66.88
3	Stem girth (cm)	0.9726	3.42	60.83
4	No. of stem prickles (15cm bits ⁻¹)	0.9863	31.18	122.88
5	No. of branches (plant ⁻¹)	0.9777	38.31	127.85
6	No. of leaves (plant ⁻¹)	0.9495	153.31	110.01
7	No. of leaf prickles (leaf ⁻¹)	0.9725	4.59	63.99
8	Leaf area (cm ²)	0.9962	3974.06	188.46

9	Fresh herbage yield (g plant ⁻¹)	0.9949	136.10	168.53
10	Dry herbage yield (g plant ⁻¹)	0.9662	22.93	173.56
11	Total chlorophyll content (mg g ⁻¹)	0.9448	0.74	56.02
12	Proline content (□g g ⁻¹)	0.8525	14.52	23.61
13	Alkaloid content in leaf (%)	0.8770	0.78	52.29

Summary

Thus, The mean performance of the ecotypes revealed that the ecotypes ST₇ (Vangal) and ST₆ (Kottapatti) followed by St₁₀ (Balakrishnampatti), St₁₁ (Valigandapuram), ST₁₂ (Thiruvonam) and ST₁₃ (Chembannarkoil) were registered maximum growth, hebage yield and alkaloid content except plant height, stem girth, number of prickles per stem and leaf, leaf area which were moderate. However, the ecotypes ST₈ and ST₉ had higher leaf area. Higher GCV and PCV were recorded for the traits like leaf area, dry herbage yield, fresh herbage yield, number of stem prickles, number of branches, leaves, plant height, inter nodal length and number of leaf prickles. The characters like, leaf area, fresh herbage yield, dry herbage yield exhibited high heritability and high genetic advance. Thus, the ecotypes ST₇ and ST₆ are recommended for further work followed by ST₁₀, ST₁₁, ST₁₂, ST₁₃ ST₈ and ST₉.

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