

## Research Article

# Study of Genetic Variability for vegetative and flowering characters in Palash [*Butea monosperma* L.]

Dalveer Singh\*, Ashutosh Mishra, S.K. Moond, Pawan Kumar Pareek, Vinod Suthar, and P. K. Bola

Department of Floriculture & Landscaping, College of Horticulture & Forestry, Jhalawar (Rajasthan)  
Agriculture University, Kota

## Abstract

A field experiment was conducted on 30 trees of palash in completely randomized design with five trunk DBH groups in and around the Jhalawar and Jhalrapatan cities during 2011-2012 to study their performance and genetic variability expressed among them under Jhalawar (Rajasthan) conditions. The performance result of the trees depicted that TG<sub>5</sub> had the maximum tree height (11.18 m), maximum diameter at breast height (44.23 cm), maximum crown diameter (7.93 m), maximum number of flowers per panicle (19.50), maximum panicles per tree (77.50), panicle length (19.04 cm), largest flower size (4.96 cm) and longest duration of flowering (93 days). Genetic variability among the trees was estimated in terms of GCV, PCV, heritability and genetic gain for 12 characters. The value of PCV was higher than the GCV for all characters. The maximum PCV (34.59 %) was for main scaffold branches and GCV (27.18 %) was found for diameter at breast height.

The highest heritability was found for diameter at breast height (98.40 %). Genetic gain was found highest for diameter at breast height (55.54 %). Analysis of variance exhibited significant differences for tree height, diameter at breast height, main scaffold branches, crown diameter, number of flowers per panicle, number of panicles per tree, panicle length, flower size and duration of flowering.

**Keywords:** Genetic variability, GCV, PCV

## \*Correspondence

Author: Dalveer Singh

Email: dalveer.singh26@gmail.com

## Introduction

*Palash* [*Butea monosperma* (Lam.) Taub.] commonly known as “Flame of the Forest” / “Parrot Tree”, belongs to the family Fabaceae. It is locally called as Khankhra/Dhak. It was a punishment given to him by Goddess Parvati for distributing her and Lord Shiva’s privacy. It is a species of *Butea* native to tropical southern Asia, from Pakistan, India, Bangladesh, Nepal, Srilanka, Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia and western Indonesia. It is said that the tree is a form of Agnidev, God of Fire [1]. It is found in mixed or dry deciduous forests in western and central parts of India. It is tree of tropical and sub-tropical tract of the world. It is capable of growing in waterlogged situations, black cotton soils, saline, alkaline, swampy badly drained soils and on barren lands except in arid regions. It is a multipurpose tree for both local people and pharmaceutical industry. It is a medium sized tree with crooked branches and large tri-foliolate leaves. It is also good plant for avenue planting in a dry tract of the Rajasthan. This attains a height of 6-15 metre and diameter of about 40-45 cm at maturity. Bark is rough, fibrous slate grey to pale brown blaze fibrous, pink veined with red. [2]. Almost all the parts of the plant namely root, leaves, fruit, stem bark, flowers, gum young branches are used as medicine, food, fibre and for other miscellaneous purposes such as fish poison, dye, fodder, utensils, etc. About 45 medicinal uses are associated with the plant and out of these claims almost half the claims have been scientifically studied and reported [3,4]. In nature, the performance of a species depends upon its genetic constitution with a significant contribution of the prevalent climatic conditions on expression of the characters. However, no research work has been conducted on *Palash* to work out the genetic variability of the trees growing under Jhalawar conditions of Rajasthan. Therefore, to exploit the potential for ornamental and industrial uses and to characterize the genetic variability present in *palash* trees growing in Jhalawar District, the present investigation has been planned to study genetic variability among the *Palash* trees growing in Jhalawar district.

## Materials and Methods

The present investigation entitled “Study of Genetic Variability and Molecular Characterization in *Palash* [*Butea monosperma* (Lim.) Taub.]” was conducted during the year 2011-12 on *palash* trees growing in the Jhalawar district. The research work was carried out on 30 *palash* trees growing naturally towards the road side and forest area of Jhalawar and its surrounding. The selected trees were categorized in following trunks (diameter at breast height) groups for observation of vegetative and flowering characters:

S. No.	D.B.H. group	Notation	No. of trees in the D.B.H. group
1.	20-25 cm DBH	TG <sub>1</sub>	T <sub>1</sub> , T <sub>2</sub> , T <sub>3</sub> , T <sub>4</sub> , T <sub>5</sub> and T <sub>6</sub>
2.	25-30 cm DBH	TG <sub>2</sub>	T <sub>7</sub> , T <sub>8</sub> , T <sub>9</sub> , T <sub>10</sub> , T <sub>11</sub> and T <sub>12</sub> ,
3.	30-35 cm DBH	TG <sub>3</sub>	T <sub>13</sub> , T <sub>14</sub> , T <sub>15</sub> , T <sub>16</sub> , T <sub>17</sub> and T <sub>18</sub>
4.	35-40 cm DBH	TG <sub>4</sub>	T <sub>19</sub> , T <sub>20</sub> , T <sub>21</sub> , T <sub>22</sub> , T <sub>23</sub> and T <sub>24</sub>
5.	40-45 cm DBH	TG <sub>5</sub>	T <sub>25</sub> , T <sub>26</sub> , T <sub>27</sub> , T <sub>28</sub> , T <sub>29</sub> and T <sub>30</sub>

The genetic variability of the above mentioned experimental material was studied with respect to the below mentioned vegetative and flowering characters. The details of methodologies followed for observing these characters and procedures followed for studying the genetic variability are described here.

## Observations Recorded

### *Vegetative Characters*

#### *Tree height (m)*

The height of the trees was measured with measuring tape from base to top in meters.

#### *Bole height (m)*

Bole height was measured in meters with the help of measuring tape by recording the height of base point of first branch on the tree trunk from the ground level.

#### *Diameter at breast height (DBH) (cm)*

Diameter at breast height in centimeters of the selected trees was recorded by measuring diameter of main trunk at 1.37 m height from the ground level with the help of Tree Calipers at right angles and later on average was calculated.

#### *Crown diameter (m)*

The crown spread of the tree in North-South and East-West directions was measured with the help of measuring tape and its average was expressed as crown diameter of the tree in meters.

#### *Number of main scaffold branches*

The number of main scaffold branches arising on the main trunk of the tree was counted and noted.

### *Flowering Characters*

#### *Number of flowers per panicle*

Five panicles were randomly selected on each tree and number of flowers per panicle was counted and average was calculated later.

#### *Number of panicles per tree*

The total number of panicles produced on each selected tree was counted.

*Panicle length (cm)*

The five randomly selected panicles on each tree were measured for panicle length with the help of measuring tape and later on average panicle length was calculated.

*Number of primary branches per panicle*

The number of primary branches was counted on each of the five randomly selected panicles on each tree and average was calculated.

*Flower size (cm)*

Ten flowers were randomly selected on each tree and flower diameter was measured in centimeters with measuring scale and average was calculated.

*Days to flower opening*

The number of days taken to first flower opening on each panicle after emergence was noted for first five panicles on each tree and later on average was calculated.

*Duration of flowering (Days)*

The duration of flowering was calculated by counting the number of days from opening of first flower to the cessation of flowering on each selected tree.

***Estimation of variability parameters****Genetic variance*

It is the variance which is contributed by genetic makeup of the genotypes (individual trees). It was calculated using the following formulae:

$$V_g = \frac{MSV - V_E}{r}$$

Where,  $V_g$  = Genotypic variance; MSV = Mean square for varieties;  $V_E$  = Error mean square and  $r$  = Number of replications

*Phenotypic variance*

It is the sum of variance contributed by genetic causes and environmental factors and was computed with the following formulae:

$$V_p = V_g + V_e$$

Where,  $V_p$  = Phenotypic variance;  $V_g$  = Genotypic variance, and  $V_e$  = Error variance

*Genotypic coefficient of variation (GCV)*

The magnitude of genetic variation existing in a character was estimated by the following formula.

$$GCV = \frac{\sqrt{V_g}}{X} \times 100$$

Where,  $V_g$  = Genotypic variance, and  $X$  = General mean of the character under study

*Phenotypic coefficient of variation (PCV)*

The magnitude of phenotypic variation existing in a character was estimated by the following formulae:

$$PCV = \frac{\sqrt{V_p}}{X} \times 100$$

Where,  $V_p$  = Phenotypic variance and  $X$  = General mean of the character under study

*Heritability*

Heritability in the broad sense was calculated by the following formula.

$$H = \frac{V_g}{V_p} \times 100$$

Where,  $H$  = Heritability (in broad sense);  $V_g$  = Genotypic variance;  $V_p$  = Phenotypic variance

*Expected genetic advance*

Expected genetic advance was measured by the formula.

$$GA = \frac{V_g}{\sqrt{V_p}} \times K$$

Where,  $GA$  = Genetic advance;  $V_g$  = Genotypic variance;  $V_p$  = Phenotypic variance, and  $K$  = Selection differential (constant) i.e. 2.06 at 5 % selection intensity

*Genetic gain*

Genetic gain was calculated by the following formula.

$$\text{Genetic gain} = \frac{GA}{X} \times 100$$

Where,  $GA$  = Genetic advance;  $X$  = General mean of the character under study

**Result and Discussion**

The data recorded for various vegetative and floral characters of palash were subjected to statistical analysis for comparison and workout of variability parameters, and results have been interpreted.

**Vegetative Characters*****Tree height (m)***

The analyzed data pertaining to tree height of different tree groups have been presented in **Table 1**. The variation in height of trees of different trunk DBH groups was highly significant with a range of 7.67 m to 11.18 m and a mean height of 9.40 m. The  $TG_5$  recorded the tallest trees (11.18 m) followed by  $TG_4$  (11.08 m). It may be due to the genotypic variations and environmental conditions which could have contributed to different genotype-environmental interactions [5, 6].

***Bole height (m)***

The data for bole height of trees in different trunk DBH groups have been presented in Table 1. The variation in bole height of trees under different DBH groups was found to be non-significant. However, the  $TG_5$  recorded the maximum bole height (2.73 m) which was followed by  $TG_4$  (2.60 m). The minimum bole height was recorded in  $TG_3$

(2.12 m) and TG<sub>1</sub> (2.12). The variations observed in bole height could be attributed to the genetic makeup of the trees and heterogeneous nature of DBH groups comprising seedling trees influencing the expression of bole height [6].

**Table 1** Tree height, bole height, diameter at breast height, number of main scaffold branches and crown diameter of Palash as recorded under different trunks of DBH groups.

S. No.	Tree of DBH group	Tree height (m)	Bole height (m)	Diameter at breast height (cm)	Number of main scaffold branches	Crown diameter (m)
1.	TG <sub>1</sub>	7.67	2.12	21.75	2.17	4.67
2.	TG <sub>2</sub>	8.37	2.18	26.47	2.67	5.33
3.	TG <sub>3</sub>	8.68	2.12	32.22	3.17	5.88
4.	TG <sub>4</sub>	11.08	2.60	36.98	3.00	6.78
5.	TG <sub>5</sub>	11.18	2.73	44.23	4.33	7.93
	Mean	9.40	2.35	32.33	3.07	6.12
	SEm±	0.46	0.25	0.46	0.31	0.31
	C.D. (0.05)	1.33	NS	1.33	0.90	0.91
	C.V. (%)	11.90	26.50	3.47	24.69	12.48

### *Diameter at breast height (DBH) cm*

A close view of the data presented in Table 1 illustrate that the palash trees of different DBH groups had highly significant differences for tree trunk diameter at breast height (DBH). The range was observed from 21.75 cm to 44.23 cm with a mean DBH of 32.33 cm. The trees in TG<sub>5</sub> had the maximum (44.23 cm) DBH while the minimum diameter of 21.75 cm was observed in TG<sub>1</sub>. Trees of medium DBH were recorded in TG<sub>3</sub> (32.22 cm). The variation in diameter at breast height amongst the trees comprising various DBH groups could be attributed to their varied growth stages and the genotype differences in phenotypic expression of diameter at breast height [7].

### *Number of main scaffold branches*

The analyzed data for number of main scaffold branches have been presented in Table 1. A closer sight of the data reveals that the trees under various DBH groups demonstrated highly significant differences for number of main scaffold branches which ranged from 2.17 to 4.33 with the mean of 3.07. However, the variations in number of main scaffold branches per tree could be attributed to genotypic variations [8].

### *Crown diameter (m)*

Perusal of the data illustrated in Table 1 reveals that variation in crown diameter was highly significant with a range of 4.67 m to 7.93 m with a mean of 6.12 m. TG<sub>5</sub> recorded the largest diameter of crown (7.93 m) whereas TG<sub>1</sub> recorded the minimum crown diameter of (4.67 m). It could be stated that variations crown diameter of trees might have resulted due to the genotypic differences resulting in different growth forms of trees and varied growth stages and rates of the trees along with contribution of different genotype-environmental interactions [9].

## **Flowering Characters**

### *Number of flowers per panicle*

The analyzed data for number of flowers per panicle have been presented in **Table 2** which shows highly significant differences. A perusal of the data reveals that the maximum number of flowers per panicle was recorded in TG<sub>5</sub> (19.50) followed by TG<sub>4</sub> (17.50) and TG<sub>3</sub> (15.00) with the least number of flowers per panicle (14.17) in TG<sub>2</sub> and in TG<sub>1</sub> (12.83). The differences in number of flowers produced per panicle appeared to be related with DBH of the trees as well as their genotypic variations that might have been further influenced by the environmental conditions [10, 11].

### *Number of panicles per tree*

The numbers of panicles produced per tree Table 2 showed highly significant differences that varied from 41.50 to 77.50 with a mean value of 59.90. The maximum number of panicles per tree was recorded in TG<sub>5</sub> (77.50) which

were followed in descending order by TG<sub>4</sub> (62.50), TG<sub>3</sub> (61.83) and TG<sub>2</sub> (56.17) with the least number of panicles (41.50) in TG<sub>1</sub>. The differences in number of panicles produced per tree could be primarily attributed to the differential branching at different levels in the trees, as normally trees with more branches and sub-branches had more number of panicles per trees on the shoot apices [12].

**Table 2** Number of flowers per panicle, number of panicles per tree, panicle length, number of primary branches per panicle, flower size, days to flower opening and duration of flowering of palash as recorded under different trunksof DBH groups

S. No.	Tree of DBH group	Number of flowers per panicle	Number of panicles per tree	Panicle length (cm)	Number of primary branches per panicle	Flower size (cm)	Days to flower opening	Duration of flowering (days)
1.	TG <sub>1</sub>	12.83	41.50	14.69	3.67	4.69	16.50	83.50
2.	TG <sub>2</sub>	14.17	56.17	15.54	3.67	4.83	17.67	85.33
3.	TG <sub>3</sub>	15.00	61.83	15.85	4.00	4.72	17.00	85.50
4.	TG <sub>4</sub>	17.50	62.50	16.02	4.17	4.63	17.33	84.67
5.	TG <sub>5</sub>	19.50	77.50	19.04	4.50	4.96	19.50	93.00
	Mean	15.80	59.90	16.23	4.00	4.76	17.60	86.40
	SEm±	0.73	3.70	0.57	0.27	0.05	0.73	1.64
	C.D.(0.05)	2.14	10.78	1.65	NS	0.19	1.50	4.79
	C.V. (%)	11.37	15.13	8.57	16.58	2.43	7.16	4.66

### *Panicle length*

The variation in panicle length amongst the various tree DBH groups was found to be highly significant Table 2. However, it was found to be the maximum in TG<sub>5</sub> (19.04 cm) and the minimum in TG<sub>1</sub> (14.69 cm). The differences in length of panicle produced on trees of different DBH groups could be attributed to the vigour of trees as well varied genotypic responses due to their possible differential endogenous hormonal levels leading to varied cell division and cell sizes [13].

### *Number of primary branches per panicle*

The data presented in Table 2 clearly reveals that the differences for number of primary branches per panicle amongst the various DBH groups of palash trees were non-significant. However, it was found to be the highest in TG<sub>5</sub> (4.50) and the lowest in TG<sub>2</sub> (3.67) and also in TG<sub>1</sub> (3.67). The differences in number of primary branches per panicle could be due to the variation in genotypes and their phenotypic expression of growth rates, vigour and carbohydrate reserves of the trees leading to ultimate size of panicles [14].

### *Flower size (cm)*

The data related to flower size have been presented in Table 2. A perusal of the data represents highly significant differences amongst the DBH groups with respect to flower size that ranged from 4.63 cm to 4.96 cm with a mean value of 4.76 cm. The largest sized (4.96 cm) flowers were recorded in TG<sub>5</sub> while TG<sub>2</sub> (4.83 cm), TG<sub>3</sub> (4.72 cm) and TG<sub>1</sub> (4.69cm) recorded medium sized flowers and TG<sub>4</sub> (4.63 cm) recorded the smallest sized flowers. Variation in size of flowers in the trees of different DBH groups might be due to their genetic constitutes and variation in phenotypic expressions of flower size due to sum and products of genotypes and environmental conditions [14].

### *Days to flower opening*

Perusal of the data illustrated in Table 2 reveal that number of days to flower opening was found to be highly significant. However, the maximum number of days to flower opening was recorded in TG<sub>5</sub> (19.50) and the minimum (16.50) days in TG<sub>1</sub> with the mean of 17.60 days. The variation in number of days to flower opening of trees of different ages may be attributed to genotypic variations for accumulation of carbohydrates, ultimately resulting in flower buds developing into flowers [15].

### Duration of flowering (days)

The data pertaining to duration of flowering have been presented in Table 2. A perusal of the data elucidates highly significant differences amongst the DBH groups for duration of flowering with a range of 83.50 to 93.00 days and average of 86.40 days. The duration of flowering was longest in TG<sub>5</sub> (93.00 days) which was significantly longer over rest of the DBH groups. It was followed in decreasing order by TG<sub>3</sub> (85.50 days), TG<sub>2</sub> (85.33 days), TG<sub>4</sub> (84.67 days) and TG<sub>1</sub> (83.50 days). The differential duration of flowering showed in trees of various DBH groups could be attributed to different carbohydrate reserves of the trees due to differences in photosynthetic areas of the trees resulting from genotypic and environmental effects.

### Genetic Variability

The data presented in **Table 3** reveal that tree height ranged between 7.67 m (TG<sub>1</sub>) and 11.18 m (TG<sub>5</sub>) with a mean of 9.40 m  $\pm$  0.46. Phenotypic and genotypic coefficients of variation were 20.45 and 16.33 percent, respectively. Heritability and genetic gain recorded for this trait were 66.14 and 27.86 percent, respectively.

**Table 3** Range, mean, standard error, PCV, GCV, ECV, heritability and genetic gain in Palash.

Character	Range	Mean	S.Em $\pm$	PCV (%)	GCV (%)	ECV (%)	H (%)	GG (%)
X <sub>1</sub>	7.67 – 11.18	9.40	0.46	20.45	16.33	11.90	66.14	27.86
X <sub>2</sub>	2.12 – 2.73	2.35	0.25	27.24	6.29	26.50	5.34	3.00
X <sub>3</sub>	21.75 – 44.23	32.33	0.46	27.40	27.18	3.47	98.40	55.54
X <sub>4</sub>	2.17 – 4.33	3.07	0.31	34.59	24.22	24.69	49.04	34.94
X <sub>5</sub>	4.67 – 7.93	6.12	0.31	23.76	20.22	12.48	72.43	35.45
X <sub>6</sub>	12.83 – 19.50	15.80	0.73	19.87	16.30	11.37	67.28	27.55
X <sub>7</sub>	41.50 – 77.50	59.90	3.70	25.68	20.75	15.13	65.28	34.54
X <sub>8</sub>	14.69 – 19.04	16.23	0.57	12.83	9.56	8.57	55.45	14.66
X <sub>9</sub>	3.67 – 4.50	4.00	0.27	17.53	5.68	16.58	10.51	3.79
X <sub>10</sub>	4.63 – 4.96	4.76	0.05	3.50	2.52	2.43	51.74	3.73
X <sub>11</sub>	16.50 – 19.50	17.60	0.51	9.23	5.82	7.16	39.81	7.57
X <sub>12</sub>	83.50 – 93.00	86.40	1.64	6.10	3.93	4.66	41.53	5.22

Maximum bole height was recorded in TG<sub>5</sub> (2.73 m) while minimum bole height was exhibited in TG<sub>1</sub> and TG<sub>3</sub> (2.12 m) with a mean value of 2.35 m  $\pm$  0.25. The phenotypic coefficient of variation recorded for this trait was 27.24 percent whereas genotypic and environmental coefficients of variation were 6.29 and 26.50 percent, respectively. Heritability and genetic gain recorded for this trait were 5.34 and 3.00 %, respectively.

Diameter at breast height (DBH) varied from 21.75 cm in TG<sub>1</sub> to 44.23 cm in TG<sub>5</sub> with a mean value of 32.33 cm  $\pm$  0.46. The genotypic coefficient of variation (27.18 %) for this trait was lower than phenotypic coefficient of variation (27.40 %) and environmental coefficient of variation (3.47 %). Heritability and genetic gain recorded for this trait were 98.40 % and 55.54 %, respectively.

The data presented in Table 3 illustrate that number of main scaffold branches ranged between 2.17 (TG<sub>1</sub>) and 4.33 (TG<sub>5</sub>) with a mean of 3.07  $\pm$  0.31. The phenotypic coefficient of variation (34.59 %) was higher than genotypic coefficient of variation (24.22 %) and with an environmental coefficient of variation 24.69 % for the character. Heritability and genetic gain recorded for this trait were 49.04 % and 34.94 %, respectively.

Maximum crown diameter was recorded in TG<sub>5</sub> (7.93 m) while minimum crown diameter was exhibited by TG<sub>1</sub> (4.67 m) with a mean value of 6.12 m  $\pm$  0.31. The phenotypic coefficient of variation (23.76 %) was higher than genotypic coefficient of variation (20.22 %) and with an environmental coefficient of variation 12.48 %. The heritability and genetic gain recorded for this trait were 72.43 % and 35.45 %, respectively.

Number of flowers per panicle varied from 12.83 in TG<sub>1</sub> to 19.50 in TG<sub>5</sub> with a mean value of 15.80  $\pm$  0.73. The character showed 19.87 % phenotypic coefficient of variation, 16.30 % genotypic coefficient of variation and environmental coefficient of variation 11.37 % for the character. Heritability and genetic gain recorded for this trait were 67.28 % and 27.55 %, respectively.

The number of panicles per tree ranged between 41.50 (TG<sub>1</sub>) and 77.50 (TG<sub>5</sub>) with a mean of 59.50  $\pm$  3.70. The phenotypic coefficient of variation (25.68%) recorded for this trait was higher than genotypic coefficient of variation

(20.75 %) and environmental coefficient of variation (15.13 %) with a heritability (65.28 %) and genetic gain (34.54 %), respectively.

Maximum panicle length (19.04 cm) was exhibited in TG<sub>5</sub> while minimum (14.69 cm) was recorded in TG<sub>1</sub> with an average of 16.23 cm  $\pm$  0.57. The genotypic coefficient of variation of this trait (9.56 %) was lower than phenotypic coefficient of variation (12.83 %) and environmental coefficient of variation (8.27 %). The trait showed heritability (55.45 %) and genetic gain (14.66 %).

The maximum number of primary branches per panicle (4.50) was recorded in TG<sub>5</sub> while the minimum number of primary branches (3.67) per panicle was noted in TG<sub>1</sub> and TG<sub>2</sub>, respectively, with an average of 4.00  $\pm$  0.27. The phenotypic coefficient of variation (17.53 %) recorded for this trait was higher than genotypic coefficient of variation (5.68 %) and environmental coefficient of variation (16.58 %). It also had low heritability (10.51 %) and genetic gain (3.79 %).

The largest flower size recorded in TG<sub>5</sub> (4.96 cm) and shortest in TG<sub>4</sub> (4.63 cm) with an average of 4.76 cm  $\pm$  0.05. The phenotypic, genotypic and environmental coefficients of variation observed for this trait were 3.50 %, 2.52 % and 2.43 %, respectively. The trait demonstrated moderate heritability (51.74 %) and low genetic gain (3.73 %).

The number of days to flower opening ranged from 16.50 days in TG<sub>1</sub> to 19.50 days in TG<sub>5</sub> with an average of 17.60 days  $\pm$  0.51. The phenotypic, genotypic and environmental coefficients of variation recorded were 9.23 %, 5.82 and 7.16 %, respectively. The trait had heritability (39.81 %) and genetic gain (7.57 %).

Duration of flowering ranged from 83.50 days (TG<sub>1</sub>) to 93.00 days (TG<sub>5</sub>) with a mean of 86.40 days  $\pm$  1.64. The phenotypic coefficient of variation noted for this trait was 6.10 %, whereas genotypic coefficient of variation and environmental coefficient of variation were 3.93 and 4.66 %, respectively. This trait showed heritability (41.53 %) and genetic gain (5.22 %).

Where, X<sub>1</sub> = Tree height (m), X<sub>2</sub> = Bole height (m), X<sub>3</sub> = Diameter at breast height (cm), X<sub>4</sub> = Number of main scaffold branches, X<sub>5</sub> = Crown diameter (m), X<sub>6</sub> = Number of flowers per panicle, X<sub>7</sub> = Number of panicles per tree, X<sub>8</sub> = Panicle length (cm), X<sub>9</sub> = Number of primary branches per panicle, X<sub>10</sub> = Flower size (cm), X<sub>11</sub> = Days to flower opening, X<sub>12</sub> = Duration of flowering (Days). Coefficients of variation were 1.80 and 1.65 percent, respectively. Heritability and genetic gain recorded for this trait were 54.47 and 2.74 %, respectively.

Analysis of variance revealed that mean square due to DBH groups were significant for tree height, diameter at breast height, number of main scaffold branches, crown diameter, number of flowers per panicle, number of panicle per tree, panicle length, flower size and duration of flower opening indicating considerable variability present in Palash trees. In general, phenotypic coefficient of variation was greater than the corresponding genotypic coefficient of variation for all the characters, indicating the importance and influence of environment on expression of the characters [16, 17].

The highest genotypic coefficients of variation values were recorded for number of diameter at breast height and number of main scaffold branches denoting wide range of genetic variation amongst the trees of different trunk of DBH groups for these characters [5, 11]. The characters tree height and diameter at breast height, crown diameter, number of panicle per tree expressed the moderate values for heritability and genetic gain indications. Selection would be ineffective for these traits because high heritability shall have been exhibited due to favorable influence of environment rather than genotype [8, 14].

## Conclusion

On the basis of results of the present investigation it may be concluded out of the 30 trees studied in and around the Jhalawar and Jhalarapatan cities of Rajasthan, TG<sub>5</sub> showed the maximum tree height (11.18 m), maximum diameter at breast height (44.23 cm), maximum crown diameter (7.93 m), maximum number of flowers per panicle (19.50), maximum panicles per tree (77.50), maximum panicle length (19.04 cm), largest flower size (4.96 cm), longest duration of flowering (93 days). The value of PCV was higher than the GCV for all characters. The maximum PCV (34.59 %) was for main scaffold branches and GCV (27.18 %) was found for diameter at breast height. The highest heritability was found for diameter at breast height (98.40 %) followed by crown diameter (72.43 %), number of flower per panicles (67.28 %) and tree height (66.14 %). Genetic gain was found highest for diameter at breast height (55.54 %) followed by crown diameter (35.45 %) and number of panicle per tree (34.94).



## References

- [1] Rai, G., Rajak, P., Sandhu, N., Vasudeva, N. and Jindal S. 2011. International research journal of pharmacy, 2 (7): 98-108.
- [2] Chopra, A.K. 2007. Indian medicinal plants: conservation, cultivation and utilization, pp. 313-314.
- [3] Dhale, D., Chamle, D. 2010. Panchal V Evaluations of Phytochemical Constituents and Antimicrobial Activity of *Butea monosperma* (Fabaceae). *J. Phytol.*, 12(2): 17-21.
- [4] Ginwal, H. S. and Mandal, A. K. 2004. Variation in Growth Performance of *Acacia nilotica* Wild. Ex Del. Provenances of Wide Geographical Origin: Six Year Results. *Silvae Genetica*, 53:264-269.
- [5] Mugasha, A. G., Chamshama, S. A. O., Singo, K. I. and Mgangamundo, M. A. 2005. Early performance of *Azadirachta indica* provenances at Mkundi and Chamwino, Tanzania. *J. Tropical Forest Sci.*, 17 (1):45-62.
- [6] Toky, O. P. and Arya, S. 2005. Intraspecific Biodiversity in Important Trees of Arid India and its conservation. *Bulle. National Instit. Eco.*, 15: 19-24.
- [7] Rawat, R. S. and Nautiyal, S. 2006. Genotype-site interactions in growth, physiological and biochemical parameters in clones of *Dalbergia Sissoo* Roxb. *Silvae Genetica.*, 56(5): 201-206.
- [8] Rao, G. R., Korwar, G. R., Shankar, A. K. and Ramkrishna, Y. S. 2007. Genetic association, variability and diversity in seed characters, growth, reproductive phenology and yield in *Jatropha curcas* L. accessions. *Tree: Structure and Function*, 22(5): 697-709.
- [9] Singh, B. and Bhatt, B. P. 2008. Provenance variation in pod, seed and seedling traits of *Dalbergia sissoo* Roxb., in Central Himalaya, India. *Trop. Ag. Res. Ext.* 11: 39-44.
- [10] Divakara, B. N., Alur, A. S. and Tripathi, S. 2010. Genetic variability and relationship of pod and seen traits in *Pongamia pinnata* (L.) Pierre. a potential agroforestry tree. *Int. J. Plant Prod.*, 4(2): 129-141.
- [11] Raut, S. S., Narkhede, S. S., Rane, A. D. and Gunaga, R. P. 2011. Seed and fruit variability in *Pongamia Pinnata* (L.) Pierre from Konkan region of Maharashtra. *J. Biodiversity*, 2(1): 27-30.
- [12] Das, S., Misra R. C., Mahapatra, A. K., Gantayat, B. P. and Pattnaik, R. K. 2010. Genetic variability, character association and path analysis in *Jatropha curcas*. *World App. Sci. J.*, 8 (11): 1304-1308.
- [13] Mohapatra, S. and Panda, P. K. 2010. Genetic variability on growth, phonological and seed characteristics of *Jatropha curcas* L. *Not. Sci. Biol.*, 2(2): 127-132.
- [14] Negi, R. S., Sharma, M. K., Sharma, K. C., Kshetrapal, S., Kothari, S. L. and Trivedi, P. C. 2011. Genetic diversity and variations in the endangered tree (*Tecomella undulata*) in Rajasthan. *Ind. J. Plant. Fund. App. Life. Sci.*, 1(1): 50-58.
- [15] Kaushik, N., Kumar, S., Kumar, K., Beniwal, R. S. and Roy, S. 2007. Genetic variability and association studies in pod and seed traits of *Pongamia pinnata* (L.) Pierre in Haryana, India. *Genetic Resour. Crop Evol.*, 54(8): 1827-1832.
- [16] Aabd, N. A., Ayadi, F. E., Msanda, F. and Mousadik, A. E. 2011. Evaluation of agro-morphological variability of Argan tree under different environmental conditions in Morocco: Implication for selection. *Int. J. Biodiv. Conser*, 3(3): 73-82.

### Publication History

Received	22 <sup>nd</sup> Feb 2017
Revised	10 <sup>th</sup> Mar 2017
Accepted	13 <sup>th</sup> Mar 2017
Online	30 <sup>th</sup> Mar 2017

© 2017, by the Authors. The articles published from this journal are distributed to the public under “**Creative Commons Attribution License**” (<http://creativecommons.org/licenses/by/3.0/>). Therefore, upon proper citation of the original work, all the articles can be used without any restriction or can be distributed in any medium in any form.