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ANALYSIS OF DIFFERENT PHENOTYPIC CHARACTERS OF *MESTA* (*HIBISCUS SABDARIFFA* L.) TO OBSERVE THE EFFECT OF VARIOUS VARIETIES OF THE PLANT

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Abstract

"Mesta" is a potentially profitable crop which is not in surplus in today's world but proves to be a useful raw material for industrialization and domestic uses. The purpose of this research programme is to study the effect of different varieties of Mesta (*Hibiscus sabdariffa* L.) in the presence of different phenotypic characters like Plant height (cm), No. of branches plant^{-1}, No. of leaves plant^{-1}, No. of nodes plant^{-1} and Basal diameter (cm) plant^{-1}. Randomised Complete Block Design (RCBD) layout is considered to carry out this interdependence .

To fulfil the objective of this work, the measurements of various plants were taken for the preparation of various data discrimination and specifications to achieve a goal through ANOVA Table which signifies the interdependence of various parts of the plant.

Key words : *Hibiscus sabdariffa* L., one way classified data, phenotypic characters, Randomised Complete Block Design.

Introduction

Mesta is scientifically known as *Hibiscus sabdariffa* L. which produces good fibre of commerce. It is a shrubby plant, belongs to the family Malvaceae. This plant is thought of as a native to Asia (India to Malaysia) and tropical Africa. The plant is widely grown in tropical areas like Caribbean, Central America, Africa, Brazil, Australia, Florida, Phillipines and India as a home garden crop. It is known in India by different names such as Rosseli, Java jute, Thai jute, Pusa hemp, Tengrapat, Lalambadi, Chukair, Yerragogu, Palechi etc. At the time of partition of the country during 1947, India had to loose about 80% of the total jute production area. At present Mesta is grown in an area of more than 26 lakh hectares with a production of more than 12 lakh bales.

In India, *sabdariffa* mesta is generally grown in larger parts covering areas from Karnataka to Tripura including West Bengal. In West Bengal it is grown in sandy to sandy loam marginal lands. Mesta can grow in a wide range of climate and soil conditions; its cultivation has been restricted due to certain constraints which affect the fibre yields in this crop. But harvesting time is very important in bast fibre crops like jute and mesta. From the economic point of view, mesta fibre production offers distinct advantage over other crops specially for developing countries like India on the following grounds :

- **i)** Mesta provides as domestic resources, the raw materials for industrialization.
- **ii)** It requires less labour than jute and can be produced more cheaply.
- **iii)** It provides a greater cash return than other crops.
- **iv)** It is a potentially profitable crop.
- **v)** The fibre is useful for every country.

Although the fibres of jute and mesta are used more or less in the same manner, the prices of both vary from time to time. The mesta fibre is always cheaper than jute.

Mesta has many varieties cultivated and suitable for different countries. Most of the countries of the world have bred their own varieties for their local needs. On the plea, this research work has been carried out for studying the effect of different varieties of 'Mesta' *(Hibiscus sabdariffa* L.) for which the analysis of two way classified data for proper statistical comparisons among population means is prepared.

In the two way analysis, it is assumed that the error terms are independently and identically distributed normal random fluctuations with suitable mean and variance. For avoiding the computational hazards, the square root transformation of the data is obtained for the no. of branches, no. of leaves and no. of nodes which are discrete in nature. Thus the resulting transformed variables can be assumed to be normally distributed.

For the analysis of two way classified data, ANOVA is the technique of systematically splitting the total variation present in a set of observations into as many components as the number of defined sources of variations (Douglas, C.M. 2001). It allows one to test a hypothesis comparing several normal population means. The problem of comparing several population means arises quite naturally in practice. Quite often in agriculture, an experimenter is interested in comparing the yielding abilities of several varieties of a crop, for example - wheat. The plant has various economic uses on pharmacology daily uses of rural Bengal (Salah *et al.* 2002; Plotto, 1999, Vitoon *et al.* 2008). In any experiment, variability arising from a nuisance factor can affect the results. Generally, a nuisance factor is defined as a design factor that probably has an effect on the response. Therefore, efforts are being made to prepare the experimental error as small as possible in order to remove the variability arising from a certain factor from the experimental error.

Materials and Methods

Research work had been carried out having four replications and ten varieties with one observation per replication of each variety. The 'Mesta' plants were cultivated in the month of May, 2012 while the data were collected in the month of October, 2012. The plants were less branching and attained a height between 150 cm. to 250 cm. with a basal diameter of about 4-5 cm. The leaves in 'Mesta' were generally palmate, deeply lobed and alternately borne on the stem. Phenotypic characters *viz*. i) Plant height (cm), ii) No. of branches plant^{-1}, iii) No. of leaves plant^{-1}, iv) No. of nodes plant^{-1} and v) Basal diameter (cm) plant^{-1} were considered for experimentation. The experimental site was taken at the Agricultural Farm, Golapbag, Burdwan. The experimental field was situated at $23^0 15'$N latitude and $87^0 50'$E longitude. It was situated 1100 km from New Delhi and a little less than 100 km north-west of Kolkata on the Grand Trunk Road (NH-2) and Eastern Railway. The area had tropical climate, characterized by high temperature, high relative humidity and heavy rainfall. The soil of the experimental plot belongs to clay-loams category. Soil sample from the plot was collected and tested for physical and chemical properties in the Soil Testing Laboratory, Government of West Bengal, Kalna Road, Burdwan. Soil pH was measured by pH meter through potentiometric method (Jackson, 1974), organic carbon was estimated by wet digestion method (Walkely and Black, 1934). Available phosphate was determined by Bray's method (Bray and Kurtz, 1945), available potash was also determined by ammonium acetate extraction method (Rich, 1965). Apart from these available nitrogen was measured by Alkaline $KMnO_4$ method (Subbiah & Asija, 1956).

The soil testing results have been cited below in a tabulated form.

Soil Testing Results

Soil characteristics	Results	Comment
Physical nature	Clay-loam	-
Soil pH	6.75	Normal
Dissolved salts (DS/m)	0.13	Normal
Organic Carbon (%)	0.58	Medium
Available Phosphate (Kg/ha)	253	High
Available Potash (Kg/ha)	185	Low
Available Nitrogen (Kg/ha)	275	Medium

The experimentation was done for interdependence of different parts of 'Mesta' *(Hibiscus sabdariffa* L) plants by using Randomized Complete Block Design (RCBD) for proper statistical comparisons among varieties.

Results and Discussion

Essentially this is an empirical research programme which is partly analytical and partly descriptive type. For this purpose, four replications and ten varieties with one observation per replication of each variety were taken into consideration for experiment. Plant specifications were thoroughly observed and the following phenotypic characters *viz*. i) Plant height (cm), ii) No. of branches plant^{-1}, iii) No. of leaves plant^{-1}, iv) No. of nodes plant^{-1}

Table 1 : Plant height (cm).

Variety	R-I	R-II	R-III	R-IV	Sum	Mean
1	165.4	161.2	106.4	162.0	595.0	148.75
2	209.6	213.2	211.8	211.6	846.2	211.55
3	230.2	229.0	225.0	229.8	914.0	228.50
4	198.6	200.4	200.6	203.2	802.8	200.70
5	198.4	200.4	201.6	203.4	803.8	200.95
6	199.4	203.2	199.4	204.8	806.8	201.70
7	213.8	211.0	216.6	216.6	858.0	214.50
8	208.0	207.4	212.8	218.8	847.0	211.75
9	229.0	230.2	230.4	233.2	922.8	230.70
10	199.8	200.8	201.2	201.4	803.2	200.80
Sum	2052.2	2056.8	2005.8	2084.8	8199.6(GT)	
Mean	205.22	205.68	200.58	208.48		

Table 2 : No. of branches plant^{-1}

Variety	R-I	R-II	R-III	R-IV	Sum	Mean
1	18.6	18.8	19.4	20.6	77.4	19.35
2	26.0	26.0	27.0	25.4	104.4	26.1
3	27.0	28.4	28.4	30.2	114.0	28.5
4	22.4	24.4	24.2	25.0	96.0	24.0
5	25.0	26.2	24.4	25.2	100.8	25.2
6	22.6	24.8	25.0	25.6	98.0	24.5
7	26.8	26.2	27.0	28.6	108.6	27.15
8	24.2	25.4	25.0	24.8	99.4	24.85
9	29.2	30.6	30.0	30.4	120.2	30.05
10	25.0	23.6	24.8	26.8	100.2	25.05
Sum	246.8	254.4	255.2	262.6	1019.0(GT)	
Mean	24.68	25.44	25.52	26.26		

Table 3 : No. of leaves plant^{-1}

Variety	R-I	R-II	R-III	R-IV	Sum	Mean
1	22.4	21.6	23.4	23.6	91.0	22.75
2	27.6	27.8	26.2	24.8	106.4	26.60
3	30.0	32.4	30.6	32.0	125.0	31.25
4	24.6	26.4	26.4	26.4	103.8	25.95
5	29.0	26.6	26.6	28.6	110.8	27.70
6	25.6	26.4	25.6	27.6	105.2	26.30
7	28.2	28.4	29.8	30.2	116.6	29.15
8	26.6	26.4	29.0	30.0	112.0	28.00
9	33.0	30.6	30.8	33.4	127.8	31.95
10	25.3	25.2	25.2	26.2	101.9	25.47
Sum	272.3	271.8	273.6	282.8	1100.5(GT)	
Mean	27.23	27.18	27.36	28.28		

Table 4 : No. of nodes plant^{-1}

Variety	R-I	R-II	R-III	R-IV	Sum	Mean
1	20.6	20.4	22.0	22.2	85.2	21.30
2	25.8	26.2	24.6	23.4	110.0	25.00
3	28.4	28.8	28.4	30.6	116.2	29.05
4	23.2	24.4	24.6	25.0	97.2	24.30
5	27.0	25.4	24.8	26.8	104.0	26.00
6	24.2	24.8	24.4	26.6	100.0	25.00
7	26.6	27.0	28.4	29.6	111.6	27.90
8	25.0	24.8	27.6	28.2	105.6	26.40
9	31.2	28.6	29.0	31.4	120.2	30.05
10	23.4	24.0	23.8	24.8	96.0	24.00
Sum	255.4	254.4	257.6	268.6	1036.0(GT)	
Mean	25.54	25.44	25.76	26.86		

and v) Basal diameter (cm) plant^{-1} had been recorded properly for further biometrical calculations through tables (1– 5).

The mean values of observations were calculated and exhibited in tables (1-5) wherein the minimum and maximum plant heights, number of branches, number of leaves, number of nodes and basal diameter were found to be 106.4 to 233.2 (Table 1), 18.6 to 30.6 (table 2), 21.6

Table 5 : Basal diameter (cm) plant^{-1}

Variety	R-I	R-II	R-III	R-IV	Sum	Mean
1	4.38	4.50	4.44	4.58	17.90	4.48
2	4.60	4.62	4.70	4.60	18.52	4.63
3	4.64	4.82	4.66	4.82	18.94	4.74
4	4.52	4.48	4.56	4.60	18.16	4.54
5	4.54	4.56	4.54	4.54	18.18	4.55
6	4.54	4.60	4.52	4.64	18.30	4.58
7	4.74	4.72	4.70	4.74	18.90	4.73
8	4.60	4.62	4.66	4.78	18.66	4.67
9	4.82	4.74	4.80	4.74	19.10	4.78
10	4.54	4.54	4.54	4.54	18.16	4.54
Sum	45.92	46.20	46.12	46.58	184.82(GT)	
Mean	4.59	4.62	4.61	4.66		

to 33.4 (table 3), 20.4 to 31.4 (table 4) and 4.38 to 4.82 (table 5) respectively which were grown in four replications *viz*. R-I, R-II, R-III and R-IV. Though the date of sowing, transplantation and all other agronomical measures of the above tables were almost same in each variety, the result of this experiment variety-wise in terms of attributes were variable into some extent which had been reflected in the ANOVA table below.

Combined ANOVA Table for the Study of different Phenotypic Characters:

Phenotypic characters	Source of variation	df	SS	MS (SS/df)	F
Plant height (cm)	Replication	3	321.6	107.2	0.421
	Variety	9	18475.7	2052.8	8.071
	Error	27	6866.6	254.3	-
No. of branches plant^{-1}	Replication	3	12.5	4.2	6.542
	Variety	9	298.2	33.1	51.832
	Error	27	17.2	0.639	-
No. of leaves plant^{-1}	Replication	3	8.024	2.674	0.861
	Variety	9	272.76	30.30	9.756
	Error	27	83.8	3.106	-
No. of nodes plant^{-1}	Replication	3	12.82	4.273	3.985
	Variety	9	241.42	26.82	25.013
	Error	27	28.95	1.07	-
Basal diameter (cm) plant^{-1}	Replication	3	0.023	0.007	2.640
	Variety	9	0.367	0.041	14.124
	Error	27	0.0781	0.0028	-

Where,

df : Degree of freedom **SS** : Sum of Squares
MS : Mean Squares **F** : Ratio of variances

In general, the contribution of the factor towards variability will always be greater than that by the error. The error sum of squares is just total sum of squares minus the sum of squares due to the factors. If null hypothesis (H_0) is true in the universe then the contribution of the factor will be as insignificant compared to the error and as a consequence population F will be 1. If the observed value of F is less than 1, then the null hypothesis will be trivially accepted. Testing of hypothesis is the procedure which approaches the comparison among means. In biological sciences, statistical test of hypothesis plays an important role. Null hypothesis (H_0) can be defined as the hypothesis which is a test for possible rejection under the assumption that it is true, *i.e.* it is accepted.

Analysis :

If F>1 then it is likely that differences between class means exist. These results are then tested for statistical significance or P-value, where the P-value is the probability that a variety would assume a value greater than or equal to the value observed strictly by chance. If the P-value is small (e.g. P<0.01 or P=1%) then this implies that the means differ by more than that expected by chance alone. By setting a limit on the P-value (*i.e.* 1%), a critical F value can be determined. Values of F greater than the critical value denote the rejection of the null hypothesis, which prompts further investigation into the nature of the differences of the class means. In this way ANOVA can be used to prune a list of features.

We obtain $F_{ß,3,27}$ and $F_{ß,9,27}$ for ß = .01, .05. The decision rule is as follows. If $F_{observed} > F_{ß,m,n}$, we say that the character is significant at ß level of significance. The critical values of the F statistic are $F_{.01,3,27} = 4.600$, $F_{.05,3,27} = 2.9604$, $F_{.01,9,27} = 3.1494$, $F_{.05,9,27} = 2.2501$. The value of variance ratio was found to be significant at both 1% and 5 % level of significance if the source of variation is due to variety only. Replication wise, it is not significant for plant height (cm), number of leaves/plant and basal diameter (cm)/plant. However replicationwise, it is 1% and 5% significant for number of branches/plant and 5% significant for the number of nodes/plant.

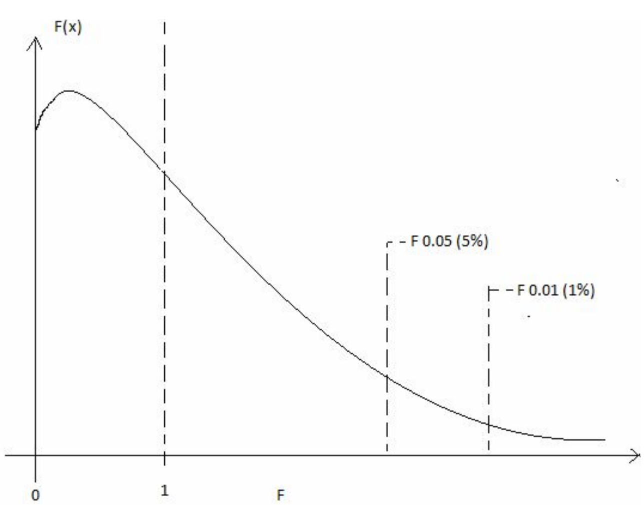

Fig.1 : Example F distribution (for low df) showing possible 5% and 1% intervals.

Fig.1 shows the example of F_{crit}-Fisher statistic critical values for a low df distribution (*i.e.* a small dataset). As df increases (*i.e.* the dataset size increases) the F distribution will become 'tighter' and more peaked in appearance, while the peak will shift away from the × axis towards F=1.

The F value gives a reliable test for the null hypothesis, but it cannot indicate which of the means is responsible for a significantly low probability. To investigate the cause of rejection of the null hypothesis post-hoc or multiple comparison tests can be used.

Conclusion

The results of the study clearly shows that the replications of the plant were not up to the mark besides the varieties of the plant were satisfactory and the attributes were interdependent. However, it is easily concluded that the plants need further experimentation in various locations with proper layout design having uniform agronomic measures to the field of cultivation.

References

Bray, R.H. and L.T. Kurtz (1945). Determination of total, organic, and available forms of phosphorus in soils. *Soil Sci.,* **59(1)**: 39–45.

Douglas, C.M. (2001). Design and Analysis of Experiments.

Jackson, M.L. (1974). Soil chemical analysis. Englewood Cliffs. *N.J. Prentice Hall.*

Plotto, A. (1999). Hibiscus, Post production management for improved market access for Herbs and spices, Compandium of post harvest operation.

Rich, C.I. (1965). Elemental analysis by flame photometry. In: Black CA, editors. Methods of soil analysis, part 2: chemical and microbiological properties. Madison (WI): *American Society of Agronomy,* 849–864.

Salah, A.M., J. Gathumbi and W. Vierling (2002). Inhibition of Intestinal motility by methanol extract of *Hibiscus sabdariffa* L (Malvaceae) in rats, *Phytother Res.,* **16(3)**: 283-285.

Subbiah, B.V. and G.L. Asija (1956). A rapid procedure for assessment of available nitrogen in soils. *Current Sci. India,* **25(8)**: 259–260.

Vitoon, P., W. Sarchet, S. Pote and K. Veerapol (2008). Uricosuric effect of roselle (*Hibiscus sabdariffa)* renal stone former subjects. *J. Ethnopharmacol,* **117(3)**: 491-495.

Walkley, A. and I.A. Black (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci.,* **37(1)**: 29–38.