A PRELIMINARY STUDY ON THE DIRECTION OF LEAF SPIRAL AND PHYLLOTAXY IN JUTE

By M. S. SARMA

Jute Agricultural Research Institute, Barrackpore

The Fibonacci series of phyllotaxis is considered to be a mechanism which enables the plant to expose to sunlight the maximum leaf surface by arranging the leaves in such a manner that the lowest is least shaded from light by the upper ones. The most common arrangement is considered to be the 2/5 phyllotaxy though other fractions such as 3/8, 4/13 and so on may also occur (Sinnott and Wilson, 1955). Such phyllotactic patterns are said to result from mechanical principles that manifest themselves when the stem apex differentiates the primordia of successive leaves (Fagerlind, 1950). Priestley and Scott (1938), however, state that it is difficult to see how leaf arrangement which is fixed at the time of origin of the leaf on the stem apex can be governed by the distribution of sunlight which the leaf is likely to experience on maturity. According to Esau (1953), phyllotaxy may change during the development of the plant and different shoots on a single plant may differ in the pattern.

On plants showing alternate leaf arrangement, the leaves are inserted in a helix which runs in a clock-wise (left) or an anticlock-wise (right) direction. D'Arcy Thompson (1917), quoting Beal's data on the left and right handed arrangements of scale leaves on cones of Norway Spruce, concluded that the two kinds occur in approximately equal proportions. Recent studies by Davis (1962, 1964) on large populations of coconut and Malvaceous plants indicate that the left-right difference is not genetically controlled and that a slight excess of left spirals is common. Both these conclusions of Davis were found to hold largely true in *Corchorus capsularis* (Kundu and Sarma, in press). However, no work has so far been carried out on phyllotaxy in jute and no information is available on the relation of the direction of helix and phyllotactic fractions, and factors which influence the two characters in any species.

General observations show that in both species of jute, *Corchorus capsularis* and *C. olitorius*, both left and right handed arrangements of leaves and 2/5 and 3/8 phyllotaxis are common. A preliminary study was, therefore, undertaken to determine whether (i) the phyllotactic fraction is constant in both right and left handed spirals and (ii) if plots receiving sunlight from different directions behave similarly with respect to the proportions of the two directions of spiral and phyllotaxy. Observations were recorded in the *capsularis* improved strain JRC-212, raised from Breeder's Stock of seeds. Small populations from (i) centrally located, (ii) east exposed and (iii) west exposed plots were scored for both characters. Rows in all three plots were planted in the north-south direction; the rows in the east and west exposed plots were numbered from the East and West sides respectively. The essential features of the three locations are the following:

(*i*) *Centrally located plot* — Plot surrounded by crop on all four sides. Density 55,000 plants per acre. Average height 79·64″. Due to the poor height and sparse

population, these plants received moderate to bright light on all exposed parts of the plant throughout the day.

(*ii*) *East exposed plot*—Plot of 25 rows, each 35′ in length and surrounded by jute crop on north, west and south. Density 92,500 per acre. Average height 94·63″. Due to relatively poor height, the interior rows received little light from sides and bright light from above while the 3 or 4 eastern-most rows received bright light in the forenoon and bright to moderate light in the afternoon.

(*iii*) *West exposed plot*—Vigorous plot of 25 rows, each 35′ in length and surrounded by crop on north, east and south. Density 75,000 an acre. Average height 118·94″. In this plot, the 3-4 western-most rows received light from above and west, while the others comprising the bulk of the plot received light from the mid-day and afternoon sun, mainly from above. Plants in this plot received little sun in the mornings.

The phyllotaxy and the direction of helix were scored on mature plants at a height of 3′-6′ on the stem, as close to the eye level as possible.

Selected rows in each plot were scored except in the centrally located plot where 12 consecutive rows of 12′ length each were chosen. The data for this plot are presented in groups of three adjacent rows each, to facilitate comparison with other plots where the row length was 35′.

The results of observations are given in Table 1.

The percentages of left spiralled plants in the three plots are, respectively, 43·96, 56·95 and 58·61. Thus, the centrally located plot in which the plants were exposed to moderate to bright light throughout the day showed an excess of right spirals while the other two plots contained an excess of plants with left spirals. The difference between the proportions of the two types in east and west exposed plots was, however, not significant. When the population of all three plots was considered, plants with left spirals formed 54·31%. The presence of a slight excess of left spirals is in accordance with the observations of Beal (1873) in cones of Norway Spruce, Davis (1962) in coconut and others. In regard to the proportions of left and right plants in different rows of a plot there was, however, less variation in the east exposed plot than in the other two. The general tendency for predominance of left in the material is evident even in the centrally located plots showing an overall excess of right since one of the plots shows 18 left and 14 right.

When data of all three plots are considered, the plants with 2/5 phyllotaxy form 44·56% and those with 3/8 arrangement, 55·44%. However, the two arrangements of phyllotaxy do not occur in equal proportions among the left and right spiralled plants. Among the lefts, 68·49% showed 2/5 arrangement, while, among the rights, only 16·10% belong to this phyllotaxy. The chi-square for independence of phyllotaxy and the direction of spiral is 194·9 showing that the association between left spiral and 2/5 phyllotaxy, and right spiral and 3/8 phyllotaxy is highly significant and chances of defects in sampling leading to such a conclusion are remote. The data of individual rows in the west exposed plot, a vigorous plot in which plants in the centre or east would be expected to receive light primarily from top and not from sides, shows that in such rows, the number of right spiralled plants possessing 2/5 phyllotaxy is very low. Again,

Table 1. *Arrangement of leaf spiral and phyllotaxy in different rows of plots.*

Plot	Left spiral			Right spiral			Total	Remarks
	Phyllotaxy 2/5	3/8	Total	Phyllotaxy 2/5	3/8	Total		
Centrally located plot	18	2	20	9	24	33	53	
	13	7	20	5	17	22	42	
	16	6	22	10	23	33	55	
	15	3	18	0	14	14	32	
Total	62	18	80	24	78	102	182	
East exposed plot	38	9	47	4	34	38	85	.. Row 1
	23	16	39	4	25	29	68	.. Row 2
	33	8	41	2	27	29	70	.. Row 25
Total	94	33	127	10	86	96	223	
West exposed plot	40	1	41	1	25	26	67	.. Row 25
	32	11	43	0	30	30*	75	.. Row 24
	17	14	31	1	19	20	51	.. Row 13
	8	23	31	9	22	31	62	.. Row 2
	10	21	31	7	11	18	49	.. Row 1
Total	107	70	177	18	107	125	302	
Grand Total	263	121	384	52	271	323	707	

χ_3^2 for 1/4 : 1/4 : 1/4 : 1/4=55·98.
χ_1^2 (for independence of phyllotaxy and direction of spiralling))=52·39.

χ_3^2 for 1/4 : 1/4 : 1/4 : 1/4=89·48.
χ_1^2 (for independence of phyllotaxy and direction of spiralling)=88·86.

χ_3^2 for 1/4 : 1/4 : 1/4 : 1/4=70·48.
χ_1^2 (for independence of phyllotaxy and direction of spiralling)=64·04.

χ_3^2 for 1/4 : 1/4 : 1/4 : 1/4=197·98.
χ_1^2 (for independence of phyllotaxy and direction of spiralling)=194·9.

*Two right spiralled plants showing 4/11 phyllotaxy not included here.

the left spiralled plants in the first and second rows of this plot, which receive little light from east, showed a large excess of 3/8 arrangement leading one to believe that the significant association between left and 2/5, and right and 3/8 is largely determined by environmental conditions, of which the direction of sun light may be considered

as one. With change in environmental conditions, the proportions of plants with left and right spirals appear to change ($\chi^2_2 = 10{\cdot}66$, $P = 0{\cdot}01$).

SUMMARY

Under the general conditions obtaining at this station, left and right spirals show close association with 2/5 and 3/8 phyllotaxis respectively in the *capsularis* jute strain JRC-212.

ACKNOWLEDGEMENT

Thanks are due to the Director, Jute Agricultural Research Institute for the facilities provided and to Mr. A. K. Jana for help in field work.

REFERENCES

BEAL, W. J. (1873). Quoted from Thompson (1917).

DAVIS, T. A. (1962). The non-inheritance of asymmetry in *Cocos nucifera*. *J. Genet.*, **58**, 42-47.

DAVIS, T. A. (1964). Aestivation in *Malvaceae*. Nature, **201**, 515-516.

ESAU, KATHERINE (1953). *Plant Anatomy*. John Wiley.

FAGERLIND, F. (1950). The phyllotaxy and the fundamental structure of higher cormophytes. *Proc. 7th. International Botanical Congress*, Stockholm, p. 387.

KUNDU, B. C. AND SARMA, M. S. ( ), Direction of leaf spiral in *Corchorus capsularis* L. (in press).

PRIESTLEY, J. H. AND SCOTT, L.I. (1938). *An Introduction to Botany*, Longmans. (Reprinted 1950.)

SINNOTT, E. W. AND WILSON, K. S. (1955). *Botany, Principles and Problems*, McGraw Hill.

THOMPSON, D'ARCY W. (1917). *On growth and form*, Vol. II. Cambridge University Press. (Reprinted 1952.)