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Lodging of sugarcane in strong winds

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1. Introduction

Lodging of sugarcane can occur due to its being blown down by wind, particularly after the cane has completed elongation. Deterioration of juice takes place in the sugarcane when it is lodged and results in reduced quantity of sugar recovered. It may, therefore, be helpful to the farmer, if he is warned of the possibility of occurrence of high winds.

2. Varieties of sugarcane and practices to prevent lodging

Fig. 1 shows the areas in India where sugarcane is grown as a crop. A large number of varieties differing in their characteristics are grown. New strains are being continuously developed at the Central Sugarcane Breeding Station at Coimbatore and at other centres and released from time to time. Of these, the variety Co 419 is now grown over larger areas in all the cane tracts of India. Though it has many useful qualities regarding growth, yield, adaptability to different types of weather and soil, it is rather brittle and has a tendency to lodge, particularly in strong winds.*

In the case of top heavy varieties which are more easily liable to slant due to winds with the risk of breaking, a certain amount of propping is done, *e.g.*, the tying together of canes in a clump and of two or more clumps. In some tracts, lodging is prevented by the use of strong bamboo props. However, bamboo uprights and cross poles used for propping are expensive and have to be replaced from time to time. It becomes a difficult problem when the area sown is large.

3. The seasons in which the crop is sown and harvested

The time of planting of the crop varies considerably from place to place. At Shakarnagar (Hyderabad), the planting is from July to September, at Padegaon and Poona (Bombay) from October to February, at Mandya and Babbur (Mysore) in November and December, and at Samalkot (Andhradesa) in December to April. As we move northwards, the date of planting is later, so that at Adhartal (north Madhya Pradesh) the plantation time is from late January to middle of February, while at Jullundur, planting is not done before middle of March.

The time of harvest in north India is generally earlier than in the south. Thus, at Jullundur the crop is cut by the middle of January at the latest, at Adhartal by the middle of February, while at Shakarnagar, it may be as late as the middle of April.

Climatic conditions impose a restriction on the length of the growing season for the sugarcane crop. Thus, in the northern regions of India, the crop is planted about March-April, but has to complete its life-cycle within a period of about ten months to escape the winter frosts, while the crop in the south can remain in the field all the year round, so that even a crop of 20 months' duration can be grown.

The date of planting is governed very greatly by the soil temperature which has to attain a suitable value for the successful germination of the crop. It takes some time after the late and comparatively colder winter season at Jullundur, before suitable soil

*Dutt, N. L. and Rao, T. J.—Coimbatore canes in cultivation, p. 42

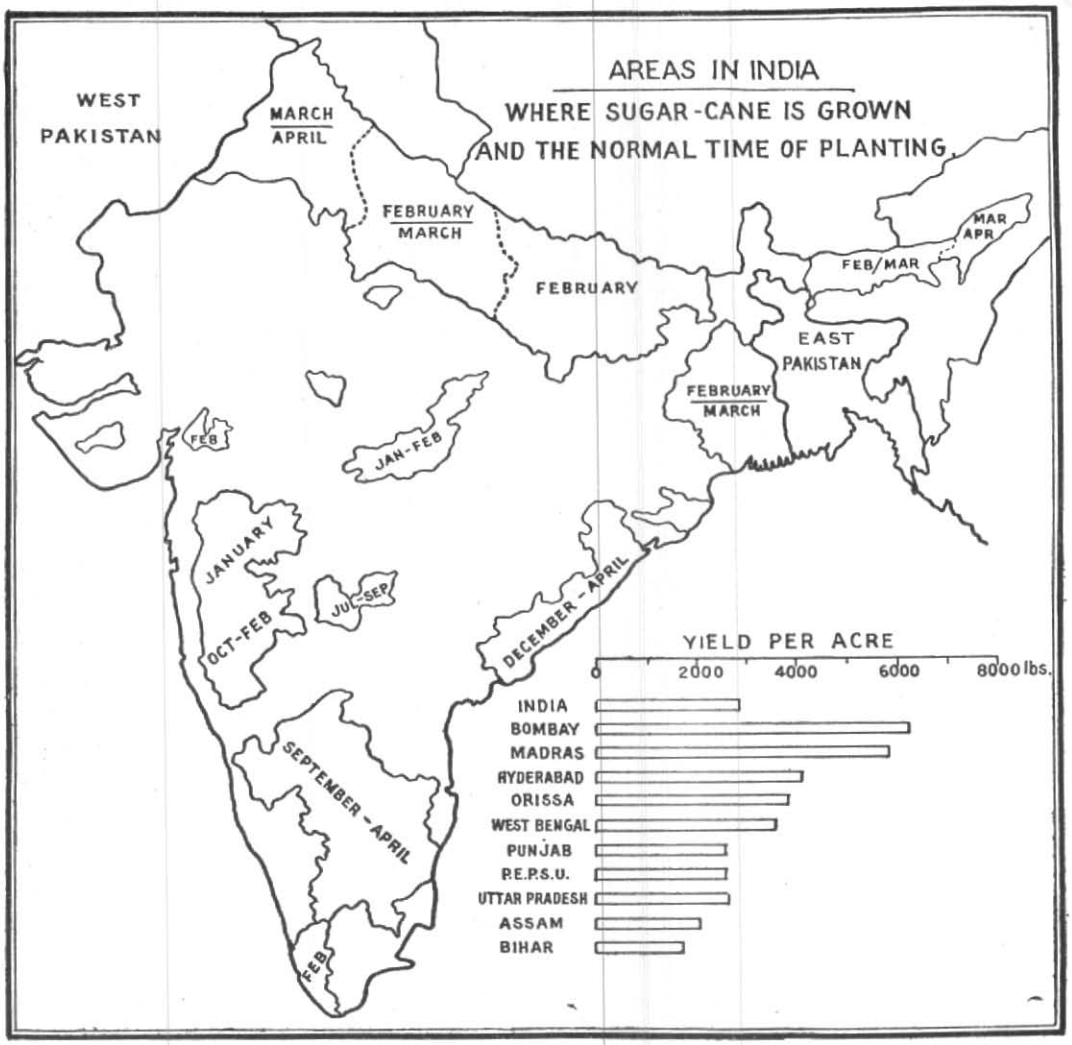

Fig. 1

conditions are attained and hence the late planting at Jullundur. The cold winter similarly necessitates the harvesting of the crop before the frost sets in. There are no such climatic limitations in the south where the crop can be planted at any time and can also be allowed to remain in the field for a sufficient length of time to ensure a heavy tonnage.

4. Meteorological conditions causing lodging of sugarcane in Crop Weather Observatories

Detailed observations are being recorded on sugarcane crops along with meteorological data at a number of observatories in India. Table 1 gives (a) the date of sowing, (b) the date of completion of grand period of elongation, (c) maximum height of the crop in centimetres, (d) maximum leaf area per cane in square centimetres, and (e) date of harvest for the different varieties grown at a few Crop Weather Stations in India. It will be seen from this table that the phase of elongation has a longer period in the central and southern parts of the country, and the crop has more time to grow than in north India.

Table 2 shows that out of the 9 years for which data are available, the Co 419 crop at Poona had suffered from lodging in 4 years

although the POJ variety did not lodge in any year. Lodging occurred at Shakarnagar also in 4 crops, but in this area both Co 419 and POJ 2878 suffered.

Sugarcane is, generally speaking, an irrigated crop and it appears from Table 2 that at Poona, for which data are available, the lodging has taken place mainly due to the high winds associated with thunderstorms. The effect of the wind may be either to break the cane or to uproot the clump if the mature root system provides poor anchorage. This may happen particularly after a heavy rain or immediately after irrigation when the soil may be loose. Lodging due to winds depends on the nature of the soil also. If silty, like that in the Punjab, it is likely to lodge more easily.

It is interesting to note the following from Table 2—

(a) The lodging occurs mostly due to strong squalls of wind associated with thunderstorms in the post monsoon season at Poona when the crops have nearly attained their maximum growth. At Poona the crop is planted in January and harvested about a year later.

(b) At Shakarnagar, however, lodging has occurred during May to October, whenever a thundersquall has passed over the station. This is due to the fact that the crop is sown between July to September in different years and harvested after about 18 months. The crops that have lodged at this place are generally more than 10 months' old by which time they are all nearly 300 cm in height and have attained almost their maximum elongation. The soil is also moist due to the monsoon rains and may have also been eroded to some extent.

(c) Though the observations for Jullundur and Adhartal do not extend for many years, it can be seen that the crops are sown early in the year and harvested within a year. In these areas, the crops do not grow to such heights as in the south and moreover, their maximum elongation is attained in a season when the chances of occurrence of thundersqualls and heavy rains are appreciably less.

5. Lodging of the sugarcane crop at the Crop Weather Observatory at Poona on 6 October 1953

From the above consideration, it appears that the main cause for the lodging of the crops is due to strong winds exerting their force on the crown which exposes a fairly large surface to the wind. Appreciable lodging of the sugarcane crop occurred in the Agricultural College farm adjacent to the Central Agricultural Meteorological Observatory at Poona during a thunderstorm on 6 October 1953. Fig. 2 shows roughly, the lodging that occurred in the crop on this day.

The sugarcane in this field was harvested from 10 to 17 February 1954. At this time, a complete enumeration of all the canes of variety Co 419 was made; the number that got slanted or uprooted and the number that broke during the thunderstorm were recorded (Table 5). Other details, like the mean weight, brix reading etc were also recorded. By harvest time, there has been appreciable reduction in the mean weight of cane, brix reading and the amount of juice in the lodged canes. Gur was prepared separately from (a) the canes that did not lodge, (b) those that got bent or uprooted and (c) those that broke. It will be seen from this table that the loss in quantity of gur is very appreciable; in the case of the canes that broke, the recovery of gur is only about 57 per cent of that from the unaffected canes.

Immediately after the thunderstorm of 6 October 1953, the force required to lodge the crop was determined experimentally by applying a horizontal pull at the centre of gravity of the foliage of the canes. It was found that Co 419 with the central portion of the foliage at a height of nearly 220 cm broke and lodged when the pulling force was approximately 3 lbs. But variety POJ 2878 did not break even with a force of nearly 15 lbs applied at a height of nearly 200 cm.

It is observed from Table 2 that at Poona, lodging of the crop Co419 occurred only when the maximum speed of the wind in the squall exceeded 40 mph, which corresponds to a force of nearly 5 lbs per square foot. The total area of the leaves on the crown is of the order of about $2\frac{1}{2}$ square feet and as a

TABLE 1

Station	Variety	Date of sowing	Date of completion of elongation		Date of harvest		Maximum height (cm)		Maximum leaf area (sq cm)	
			V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Shakarnagar	V1-Co419 V2-POJ2878	1-7-47	16-10-48	3-9-48	28-1-49	28-1-49	444	397	2540	2900
		13-7-48	Crop lodged		26-11-49 to 30-11-49	26-11-49 to 30-11-49	Lodged		3400	3380
		11-9-49	29-10-50	6-11-50	30-1-51	30-1-51	293	291	2800	2900
		19-9-50	12-11-51	13-11-51	5-2-52	5-2-52	347	336	2933	3300
		11-9-51	22-10-52	23-10-52	4-2-53	4-2-53	347	326	Discontinued	
Padegaon	V1-Co419 V2-POJ2878 Changed to Co475 from 1949-51	26-1-46	15-11-46	30-11-46	16-3-47	28-2-47	404	365		
		28-1-47	16-11-47	16-11-47	14-2-48	14-2-48	400	375	3100	3500
		24-1-48	30-11-48	16-11-48	23-2-49	23-2-49	424	421	3020	4120
		19-1-49	15-11-49	1-11-49	4-2-50	4-2-50	330	293	3180	3950
		29-12-49	31-10-50	31-10-50	23-2-51	15-2-51	332	357	1900	2200
		29-11-50	19-11-51	22-11-51	11-2-52	9-2-52	345	374	1790	2030
		26-10-51	Lodged	Lodged	6-1-53	6-1-53	Lodged		1530	1640
Mandya	V1-Co419 V2-HM 320	6-12-51	15-11-52	19-10-52	13-12-52	13-12-52	267	198		
Babbur	V1-Co419 V2-HM 661	24-11-51	24-9-52	24-9-52	15-12-52	15-12-52	325	358		
Poona	V1-Co419 V2-POJ2878	8-1-45	13-12-45	29-10-45	10-2-46 to 18-2-46	29-1-46 to 9-2-46	338	303		
		25-1-46	Lodged	9-12-46	31-1-47 to 5-2-47	31-1-47 to 5-2-47	Lodged	452	Lodged	3250
		10-1-47	3-11-47	17-11-47	4-2-48 to 9-2-48	16-1-48 to 20-1-48	343	398	3270	4480
		14-1-48	Lodged	29-11-48	14-2-49 to 20-2-49	3-2-49 to 10-2-49	Lodged	350	2140	2870
		28-1-49	24-11-49	24-11-49	23-1-50 to 3-2-50	14-1-50 to 18-1-50	353	367	1650	2160
		22-1-50	28-11-50	13-11-50	15-1-51 to 18-1-51	22-1-51 to 25-1-51	349	356	2270	2940
		14-1-51	Lodged	1-11-51	22-1-52	16-1-52	Lodged	335	2070	2670
		9-1-52	24-10-52	24-10-52	5-2-53	22-1-53	341	333	2220	2570
Samalkota	V1-Co419 (only one variety)	4-2-50	25-11-50		10-2-51		426		2470	
		19-2-51	22-12-51		18-2-52 to 23-2-52		375		1330	
		23-2-52	29-12-52		28-2-53		331		1630	

TABLE 1—*(contd)*

Station	Variety	Date of sowing	Date of completion of elongation		Date of harvest		Maximum height (cm)		Maximum leaf area (sq cm)	
			V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Adhartal	V1-Co419	10-2-47	24-9-47	24-9-47	10-2-48	10-2-48	288	259	2020	1750
	V2-Co290	26-1-48	12-11-48	12-11-48	21-1-49 to 3-2-49	21-1-49 to 3-2-49	308	304	Data incomplete	
		9-2-49	9-11-49	9-11-49	18-1-50 to 30-1-50	18-1-50 to 30-1-50	328	295	1830	1290
		18-2-50	3-10-50	3-10-50	9-1-51 to 13-1-51	22-1-51 to 28-1-51	321	274	1300	890
		Crop not grown for lack of irrigation facilities								
		30-1-52	4-11-52	4-11-52	9-1-53	4-1-53	362	304	900	810
Jullundur	V1-Co312	1-4-50	8-11-50	8-11-50	27-11-50	27-11-50	111	104	750	630
	V2-CoL9	15-3-51	27-10-51	27-10-51	11-1-52 to 31-1-52	11-1-52 to 31-1-52	213	169	890	830
		15-3-52	10-11-52	24-10-52	7-12-52	7-12-52	144	128	1110	930
Gurdaspur	V1-CoK30 V2-Co312	4-4-52	1-10-52	1-10-52	12-1-53	12-1-53	161	166	1100	1070

TABLE 2

Station and year	Variety	Date of lodging	Age of crop (days)	*Ht. of crop (cm)	Mid. Oce. (cm)	Reason for lodging	Rainfall during preceding lodging	Max. gust of wind (mph)
Poona—								
1946-47	Co419	29-9-46 (*i*)	247 (*i*)	261 (*i*)	9·5 (*i*)	High winds	0·48	54
		18-11-46 (*ii*)	297 (*ii*)	..	..	Do.	1·24	47
1948-49	Co419	22-11-48	313	293	8·8	Heavy rain and high winds	5·39	48
1951-52	Co419	22-10-51	281	309	8·9	Do.	4·20	46
1953-54	Co419	6-10-53	251	241	8·9	High winds	1·67	42
Padegaon—								
1951-53	Co419	30-9-52	340	308	8·8	High winds	0·74	
	Co475	30-9-52	340	298	9·3	Do.	0·74	
Shakarnagar—								
1948-50	Co419	8-5-49	299	291	9·0	Hail storm and high winds	3·15	
	POJ2878	8-5-49	299	249	10·1	Do.	3·15	
1950-52	Co419	16-7-51 (*i*)	300 (*i*)	249 (*i*)	10·9 (*i*)	High winds	3·80	
		17-9-51 (*ii*)	363 (*ii*)	307 (*ii*)	11·3 (*ii*)	Do.	0·71	
	POJ 2878	16-7-51 (*i*)	300 (*i*)	222 (*i*)	10·0 (*i*)	High winds	3·80	
		17-9-51 (*ii*)	363 (*ii*)	290 (*ii*)	10·5 (*ii*)	Do.	0·71	
1952-54 (black soil)	Co419	21-8-53 (*i*)	344 (*i*)	284 (*i*)	10·0 (*i*)	High winds	2·59	
		2-10-53 (*ii*)	386 (*ii*)	292 (*ii*)	9·7 (*ii*)	Do.	5·67	
	POJ 2878	2-10-53	386	275	9·1	Do.	5·67	
1952-54 (Chalka soil)	Co419	20-6-53 (*i*)	282 (*i*)	214 (*i*)	9·2 (*i*)	Heavy rain and wind	8·01	
		26-9-53 (*ii*)	380 (*ii*)	303 (*ii*)	8·3 (*ii*)	Do.	3·61	
	POJ 2878	20-6-53 (*i*)	282 (*i*)	208 (*i*)	9·5 (*i*)	Do.	8·01	
		26-9-53 (*ii*)	380 (*ii*)	282 (*ii*)	9·3 (*ii*)	Do.	3·61	
Babbur—								
1951-53	Co419	3-10-52	319	325	9·0	Heavy rain	7·52	
	HM 661	3-10-52	319	358	8·1	Do.	7·52	

*Height is measured from ground level to the topmost fully opened leaf of the tallest cane of 72 clumps under observation

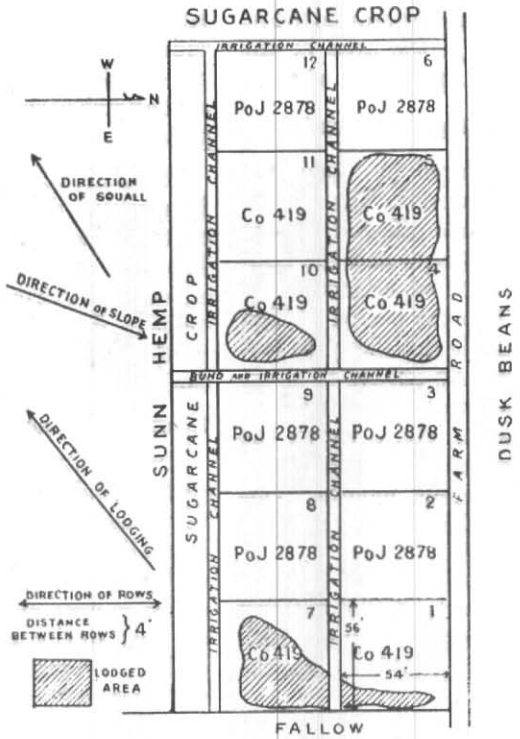

Fig. 2 (a). Lodging of sugarcane grown at Poona in 1953-54 season (6-10-1953)

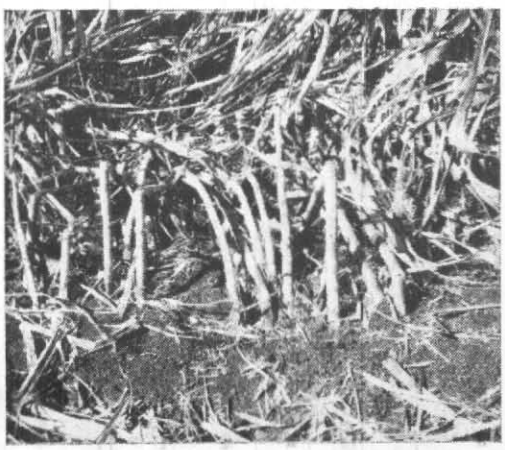

Fig. 2 (b)

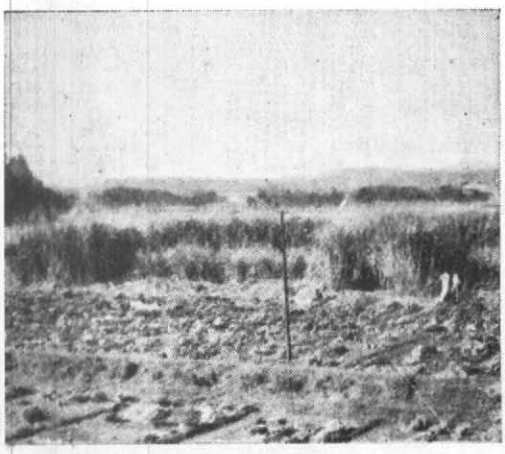

Fig. 2 (c)

Sugarcane crop at Poona looking from East showing lodging in plots Nos. 1 and 7 (6-10-1953—see Fig. 2a)

force of about 3 lbs is required at the centre of gravity of the foliage for the crop to lodge, it appears that about 1/4 the area of the leaves is effectively resisting the flow of wind.

6. Occurrence of winds exceeding 40 mph over India

Winds exceeding 40 mph are generally associated with thunderstorms. The coastal regions of India which are affected by the cyclones in the Bay of Bengal and the Arabian Sea, are also liable to experience winds exceeding 40 mph. While the period of high winds in thunderstorms is not likely to last about half an hour, it may extend to hours in the case of cyclonic storms and will also occur over a wider area. Fig. 3 shows the frequency of occurrence of thunderstorms over India during different months. This gives roughly the areas likely to experience winds exceeding 40 mph.

An analysis of the records of wind velocity obtained at observatories equipped with anemographs, is given in Table 3 for the period 1948 to 1952.

It will be seen from Table 3 that in latitudes to the south of Visakhapatnam, squalls exceeding 40 mph are rare during the period November to March. In the areas to the north of this latitude, the corresponding period is November to February.

Fig. 3 shows also the number of storms and depressions that crossed different sections of the coast in 50 years (1891 to 1940). The Bay of Bengal coasts are particularly exposed to storms or depressions during the months September to November in the northern half and October to January in the lower half.

7. Some suggestions to reduce lodging due to high winds

Every district in India is liable to be affected by squalls exceeding 40 mph during certain seasons, but the damage due to lodging is less likely to occur in the northern districts of India where the crop is harvested within about a year and the maximum growth is attained during a period when strong winds and heavy rain are rare. However, in the southern half of India, where the crop is

TABLE 3

Number of squalls with maximum speed in gust equal to 40 mph or more in five years (generally 1948 to 1952)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Calcutta (Alipore)			13	18	26	12	1		2	2			74
Allahabad		1	5	1	8	3	7		4			1	30
New Delhi	1	1	3	14	35	21	10	2	2	2			91
Jodhpur			4	5	7	16	12	1	5				50
Visakhapatnam				5	7	2	1	4	2	4	2		27
Kodaikanal					4	9	4	2	1	1			21
Bangalore (1950-52)×5/3				2	10	2							14
Bombay (1948-51)×5/4			1		2	2	8	4					17
Poona (1930-49)÷4			1	5	8	4	2	1	2	3	1		27
Madras (1941-50)÷2				1	3	2	5	1	1		1	1	15
Cochin (1943-52)÷2			1	3	6	17	14	6	3	1	1		52

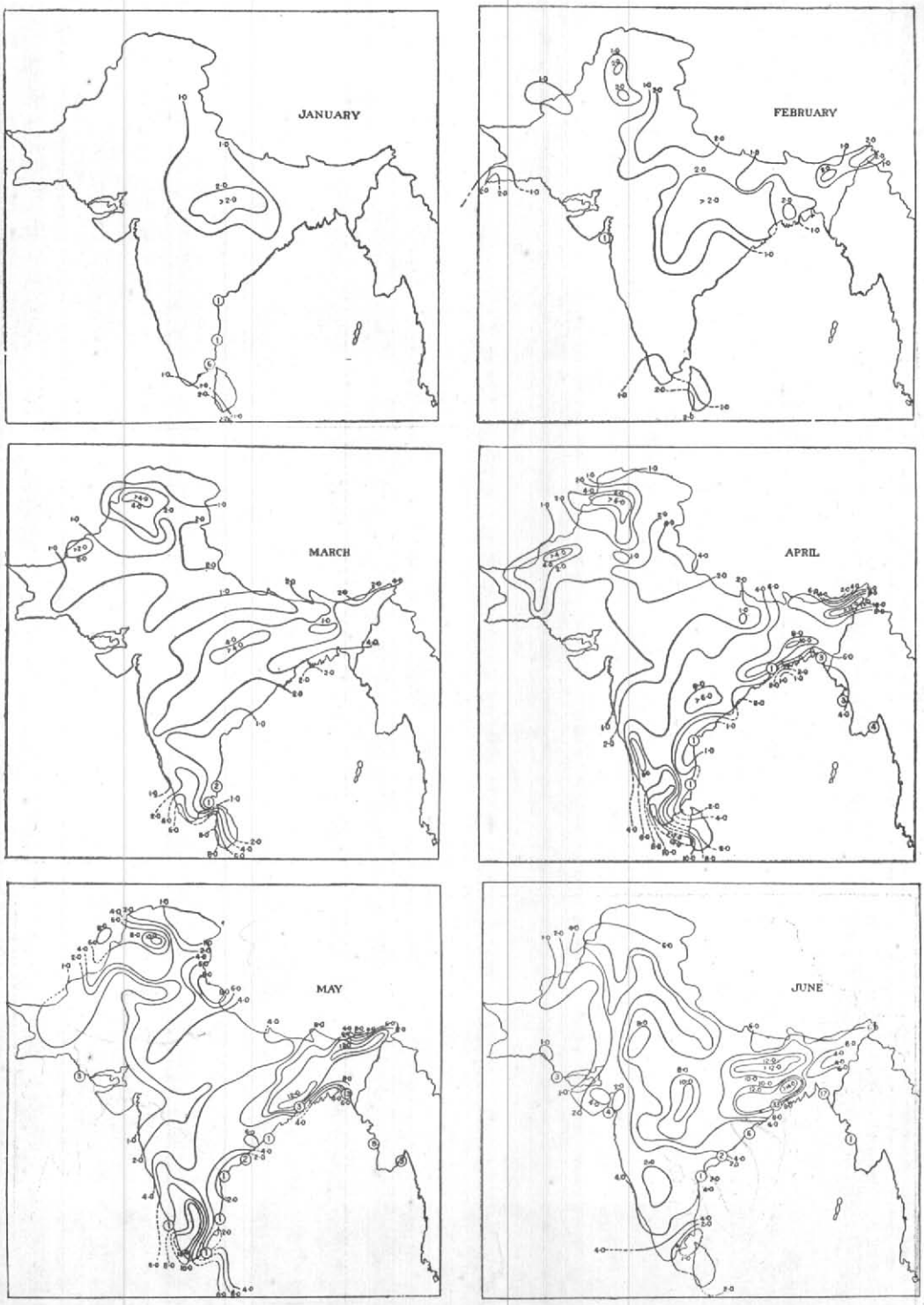

Fig. 3. Average number of days of thunder (based on data, 1935-1949) and number of storms and depressions that crossed different sections of the coast in 50 years, 1890-1940 (shown inside the circles)—January to June

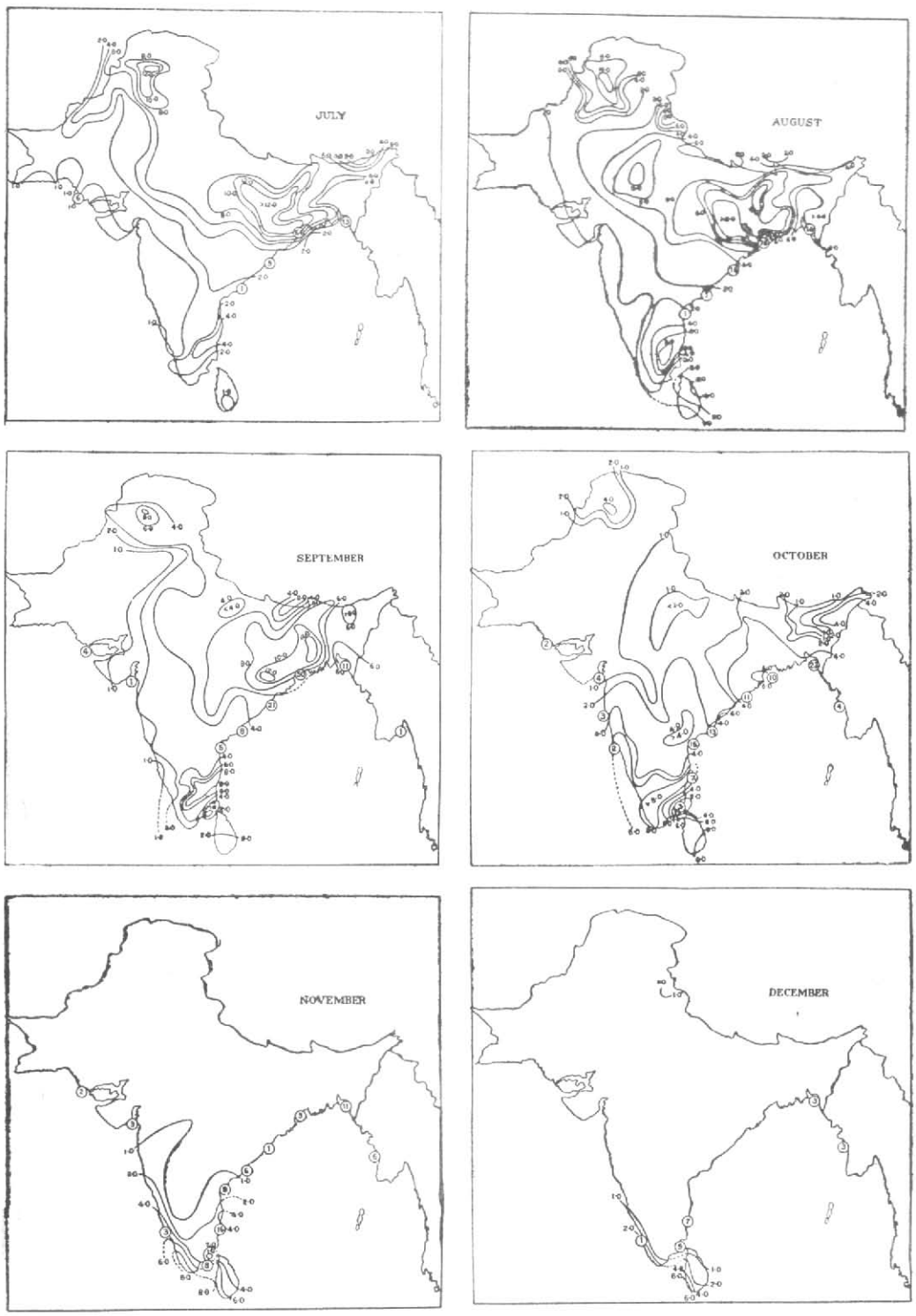

Fig. 3. Average number of days of thunder (based on data, 1935-1949) and number of storms and depressions that crossed different sections of the coast in 50 years, 1890-1940 (shown inside the circles)—June to December

grown for 18 months, the chances of lodging, due to high winds and rain, are much greater. It may, therefore, be worthwhile considering the feasibility of postponing the sowing of the crop to such a date that the crop is not grown so fully as to be lodged due to squalls and heavy rain during the monsoon. It may, however, happen that in this case, the crop may not get the full benefit of the monsoon during the grand period of its growth, and there may be difficulties of rotation of crops. These questions will have to be looked into carefully.

Other ways of mitigating the effects of the squalls may be the following—

(a) Reduce the leaf area on the crown of the plant to reduce the resistance to the flow of the wind by removing dried leaves and cutting down some of the green leaves.

(b) Prop the canes with strong bamboos, or by tying together the canes in a clump and of two or more clumps over the sides of the crop over which they are likely to affect. Fig. 2 shows that the lodging was greatest at Poona on the side on which the wind was blowing. Table 4 shows the direction of squalls at Poona in different seasons. It will be seen from this, that the squalls at Poona come mostly from between north and east during the months September to March. It may be advantageous to run the rows in Poona from northeast to southwest so that the flow of wind through the crop may be easier.

(c) In the cyclone belts of the east coast of Madras and Andhradesa, the winds will blow

TABLE 4

Direction of Squalls—Poona

	N	NE	E	SE	S	SW	W	NW
Apr-Jun	4	5	3	5	3	9	15	9
Jul-Aug	—	—	—	—	—	4	5	1
Sep-Oct	2	5	3	1	1	3	1	1
Nov-Mar	—	1	1	1	—	1	1	1

TABLE 5

Details regarding the performance of lodged (both slant and broken) and unlodged (normal) sugarcanes at Poona

Date of harvest 10–17 February 1954
(lodged on 6 October 1953)

Plot No. under Co419	Number of canes: Normal	Slant or uprooted	Broken	Total number of canes
1	710 (28·9)	754 (30·7)	994 (40·4)	2458
4	278 (13·5)	547 (26·7)	1227 (59·8)	2052
5	173 (8·4)	453 (22·0)	1437 (69·6)	2063
7	379 (16·7)	686 (30·3)	1202 (53·0)	2267
10	1567 (83·1)	41 (2·2)	277 (14·7)	1885
11	2160 (100·0)	0 (0·0)	0 (0·0)	2160
Mean weight of a cane in lbs as calculated from the first four plots	2·73	2·38	2·24	2·38
Brix reading	19·4	17·7	17·8	—
$\frac{\text{Wt. of juice}}{\text{Wt. of cane}} \times 100$	75%	66%	54%	—
$\frac{\text{Wt. of gur}}{\text{Wt. of juice}} \times 100$	22·2%	19·0%	17·4%	—
$\frac{\text{Wt. of gur}}{\text{Wt. of cane}} \times 100$	16·6%	12·6%	9·5%	
Loss of gur	Nil	24%	43%	
Quality of gur	Golden yellow and crystalline	Yellow and fairly crystalline	Blackish brown and amorphous	

Values within brackets give the percentage of total number of canes

from all directions during the passage of the storm, and it is necessary to have proper propping with bamboo uprights and cross poles unless the sowing season can be suitably adjusted.

8. Acknowledgements

The authors are very thankful to the Agricultural College, Poona, for the preparation of gur from the lodged and unlodged canes separately, and for some of the data in Table 5. We are indebted, also, to all our colleagues who cheerfully co-operated in the complete enumeration of the canes in the plots, and to Dr. L. A. Ramdas for some of the valuable suggestions.