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A COMPARATIVE STUDY OF THE MORPHOLOGICAL CHARACTERS OF SIX SUGARCANE VARIETIES

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Abstract

Present studies were carried out at the experimental field area of National Agricultural Research Centre (NARC), Islamabad during 1998-99. Six exotic sugarcane varieties (CP84-1198, CP85-1491, CP88-1165, CP89-846, TCP86-3368 and CP77-400) were included in the study. The study was conducted to evaluate these varieties for their morphological description. Morphological differences in various parts as in stalks, leaves, blade joints and in general appearance were noted in all the varieties. It is therefore contended that the qualitative and quantitative characters are essential for the identification of a proper variety for cultivation in different ecological regions of Pakistan, which are described and discussed in the present study.

Introduction

Sugarcane is a large tropical grass with an unusual ability to store sucrose in stem cell vacuoles. The ability to store sucrose, along with high biomass potential makes sugarcane one of the world's most productive agricultural crops. Sugarcane is grown in tropical and subtropical regions of the world in a range of climates from hot dry environments near sea level to cool, moist environment about 609 meters elevation (Silva, 1984). Sugarcane is thought to have originated in Asia. East Indonesia/New Guinea is a particularly rich source of *Saccharum* germplasm (Berding and Roach, 1987). Southern Louisiana (last 30° N) represents, the near northern limit of commercial sugarcane production (Burner *et al.*, 1997).

Higher productivity of cane and sugar depends on the selection of high yielding cultivars, proper management of the crop and balanced nutrition (Akhtar and Silva, 1997, 1999). To keep the purity of a variety in the field, it is necessary for our scientists working in this particular area to be well aware of the description of the morphological characters of a variety. Different sugarcane varieties generally resemble each other in their appearance, but factually each variety has different morphological characters. The characters those are generally influenced by environmental factors are usually quantitative characters as size, number and colour of various parts of sugarcane plant. These characters are not as valuable in identifying a variety, as are stable characters; like shape of vegetative organs (Artschwager, 1942, 1948) shape and arrangement of various floret parts (Artschwager, 1939; Grassl, 1956).

Many attempts have been made to define the morphological and agricultural characteristics for identification of different sugarcane varieties (Barber, 1915; Cowgill, 1917). These characteristics are size, number and colour of stalks, bud, node and nodal characteristics, ivory markings, splits, bud groove, leaf characteristics, adult root system and underground branching. The agricultural and morphological characters of a variety, which support mechanized cultivation, should be considered carefully during evaluation and development of new better varieties. This is possible in the light of technical break through. This invites the scientists to be involved in research for more efficient plant production technology

and evolve new better varieties for successful and better crop production. The main objective of the present study was to provide the information that help in the identification of different sugarcane varieties in the field.

Materials and Methods

Present studie was carried out at the experimental field area of the National Agricultural Research Centre, Islamabad during the crop season 1998-99. The experiment was planted during September 1998 and harvested during December 1999. Six exotic varieties of sugarcane i.e. CP84-1198, CP85-1491, CP88-1165, CP77-400, CP89-846 and TCP86-3368 were planted in a randomized complete block design with three replicates. Two budded double sets were planted end to end with a raw spacing of 90 cm. All the varieties were treated with the similar agronomic practices. 115 kg P_2O_5 and 150 kg of K_2O ha^{-1} was applied at the time of planting. Nitrogen was applied @230 kg ha^{-1} in five splits. First dose of nitrogen was applied at planting. Rest of the four nitrogen doses were applied during March, April, May and 2nd week of June. Similar levels of irrigation were given to all the varieties. Morphological description of Artschwager (1930, 1940, 1948, 1951a), Baber (1919), and van Dillewijin(1952)were followed to describe the various parts of all the varieties included in the study.

Morphological description: Morphological characters of all the varieties were determined when the crop was fully mature aging 15 months. Stalks from the center of each plot were taken for this purpose. Those stalks were taken for morphological characters determination, which were not exposed to the sun. Following morphological characters were determined for each variety.

Stalk: Various morphological characters of the stalk like, colour, shape, thickness, shape of individual joints were recorded from stalks selected from the middle of the field; those were not exposed to the sun. Following characters on the node and internode were noted. Shapes of internodes, presence or absence of ivory markings and bud groove were observed. Width of growth ring, root zone and wax band was also determined. Bud shape, size, presence of flanges and germpore characters were recorded from the buds. These characters were noted from the middle portion of the stalk and from the top most joint whose leaf was dried. According to the diameter of the stalk, following classification was done.

Cane or Stalk:

< 2 cm diameter	=	thin
2 – 2.5 diameter	=	medium thin
2.5 – 3 diameter	=	medium
3 – 3.5 diameter	=	medium thick
> 3.5 diameter	=	thick

Width of the growth ring was noted as follows:

Growth rings: Width

< 3 mm	=	narrow
3 – 4 mm	=	medium

> 4 mm	=	wide

Width of the root zone was noted as follows:

Root zone: width

6 – 8	=	narrow
< 8	=	board

Leaf: Second green leaf above topmost dry leaf was taken to describe various characters of the leaf.

i) Leaf Lamina

Colour, size, width at its broadest was noted. Leaf size was classified as follows:

Leaf lamina/blade: Wide at its broadest

Below 4 cm	=	narrow
4-6 cm	=	medium
> 6	=	board

ii) Leaf sheath

Colour, presence or absence of spines on the back was identified.

Blade joint: Shape of the dewlap, size and presence or absence of wax was determined. Shape of the ligule was also described. Presence or absence of auricles and their shapes were also noted.

Habit or general appearance: The habit, thickness and colour of cane and nature of leaves were noted.

Results

Morphological description: Comparative morphological description of six varieties of sugarcane i.e., CP84-1198, CP85-1491, CP88-1165, CP89-846, TCP86-3368 and CP77-400 is presented through Table 1-5. Ten guarded stools from each replication of a variety were randomly selected and used to note the following diagnostic morphological characters.

Leaf characters: Maximum leaf length was noted in the variety CP88-1165 (201 cm) and the minimum leaf length (165 cm) was measured in the variety CP85-1491. The mean leaf length of the variety CP84-1198 was 117 cm, CP77-400 was 173 cm, CP89-846 was 120 cm and TCP86-3368 was 195 cm (Table 1).

At maturity minimum number of green leaves was found in the variety CP89-846, while highest number was noted in the variety TCP86-3368 (Table 1). Varieties CP84-1198 and CP89-846 had narrow leaf blade while in varieties CP85-1491, CP88-1165, CP77-400 and TCP86-3368 medium leaf blades were observed (Table 1). Among the six varieties of sugarcane different sheath colours were observed. Sheath colour in variety CP84-1198 was yellowish green, CP85-1491 purplish green, CP88-1165 purplish green, CP77-400 green upper and light brown lower, CP89-846 purplish yellow and in TCP86-3368 it was light yellowish green.

In variety CP84-1198 scanty leaves were noted, while in varieties CP85-1491, CP88-1165, CP77-400, CP89-846 and TCP86-3368 abundant leaves were found.

Erect with tips drooping carriage was noted in the varieties CP88-1165, CP77-400 and CP89-846, while in the varieties CP84-1198, CP85-1491 and in TCP86-3368 strictly erect carriage was observed (Table 1). In varieties CP77-4000 and CP89-846 open top was observed, while compact top was noted in the varieties CP84-1198, CP85-1491, CP88-1165 and in TCP86-3368. Leaf scraious boarder was noted in all the varieties of sugarcane under study. Leaf scars were absent in the varieties CP85-1491, CP88-1165, CP77-400 and in TCP86-3368 while in the varieties CP84-1198 and CP89-846 leaves scars were present. Spines on back of the leaves were found in the varieties CP88-1165, CP77-400, CP89-846 and in TCP86-3368, while in the varieties CP84-1198, CP85-1491 spines were absent (Table 1).

Blade joint or dewlap characters: Tall-triangular dewlap with convex upper and lower margin Rayada was found in CP84-1198 (Fig. 1), while in varieties CP88-1165, CP77-400 and in CP85-1491.squarish-subcrescent dewlaps with horizontal upper margin and downward-sloping base line were observed (Figs. 2,5,6). Deltoid dewlap with horizontal base line was noted in CP89-846 (Fig. 3), while triangular dewlap with horizontal basal margin was found in TCP86-3368 (Fig. 4). In the varieties CP84-1198, light purplish green; CP85-1491, light purplish dirty green, CP88-1165; purplish dirty green; CP77-400, light green; CP89-846, purplish dirty green and in TCP86-3368 dark green colours of the dewlaps were noted. Dewlap wax was noted in all the six varieties under study (Table 2).

Ligule character: It was noted that in the varieties CP84-1198, CP85-1491, CP88-1165 and CP89-846 deltoid (w- lozenge) ligules were present. While crescent-shaped (w-narrow lozenge) of ligules were observed in the varieties CP77-400 and TCP86-3368 (Table 2).

Ligular process or Auricles characters: Ascending transitional types of auricles were found in the varieties CP84-1198 (Fig. 1), CP77-400 (Fig. 5) and in CP89-846 (Fig. 3), while dentoid types of auricles were noted in the varieties CP88-1165 and TCP86-3368 (Figs. 2, 4). In CP85-1491 deltoid type of auricle was noted (Fig.6).

Cane or stalk characters: Medium thin diameters were noted in the varieties CP84-1198, CP88-1165, CP77-400, and CP89-846 and in TCP86-3368, while medium diameter was noted in CP85-1491 (Table 3). These diameters may differ in different environmental and management conditions. Colour of the stalks also varied within the varieties. Purplish green colours were observed in CP85-1491, and CP88-1165, while in varieties CP84-1198, CP77-400 light purplish green colours of the stalks were noted CP89-846 had yellowish green coloured stalk, while TCP86-3368 had light purplish green and light purplish yellow coloured stalks.

Joint/Internode shape characters: In the varieties CP84-1198, CP89-846 and TCP86-3368, cylindrical shaped internodes were observed (Figs. 7, 10, 11). While obconoidal shaped was found in the variety CP85-1491 (Fig. 8). Variety CP88-1165 had convex-concave shpaed internodes (Fig, 9), while bobbin shapes of internodes were noted in the variety CP77-400 (Fig. 12). Splits in the internodes were absent in

all the varieties except CP85-1491. Ivory markings or cracks were observed in all the varieties under study.

Bud groove characters: In varieties CP85-1491, CP77-400, CP89-846 and in TCP86-3368 bud grooves were absent. In CP84-1198 long and deep and in CP88-1165 long and shallow bud grooves were observed.

Growth ring characters: Wide growth rings were observed in CP84-1198 and CP89-846, while medium one was noted in the variety TCP86-3368. Narrow growth rings were found in CP84-1198, CP88-1165 and CP77-400 (Table 4). Yellowish green coloured growth ring was observed in CP89-846, while light purplish green to purplish green coloured growth rings were noted in all the other varieties under study. Swollen types of growth rings were present in all the varieties under study (Table 4).

Root zone characters: Narrow root zones were observed in all the six varieties under study (Table 4). Yellowish green colours of root zones were noted in CP84-1198, CP85-1491, CP77-400 and in CP89-846. Root zone of CP85-1165 was dark green coloured, while purplish light green colour was observed in TCP86-3368. Depressed root zones were observed in CP84-1198, CP88-1165, CP77-400 and in CP89-846 (Figs. 13,15,18,16). Swollen root zones were noted in CP85-1491 (Fig. 14). Regular root eyes were noted in the varieties CP88-1165, and CP89-846. Staggered root eyes were present in CP84-1198, CP85-1491, CP77-400 and in TCP 86-3368. Heavy wax bands were found in all the varieties under discussion, which were constricted in CP84-1198, CP85-1491, CP89-846 and in TCP86-3368 (Figs.13, 14,16,17), while swollen types were noted in the varieties CP88-1165 and in CP77-400 (Fig. 15,18).

Bud characters: Table 5 represents the size of buds of six sugarcane varieties. Pentagonals buds were noted in the varieties CP84-1198, CP88-1165 and in CP77-400 (Figs.13, 15,18). Ovate with wing boarding towards apex type of buds was observed in the varieties CP85-1491 (Fig. 14) and in CP89-846 (Fig. 16). Shape of the bud in the variety TCP86-3368 was ovate with emarginated wings towards apex (Fig17). In CP88-1165 flanges were absent, while in all the other varieties flanges were present.

Germ pore characters: In CP88-1198 apical germ pore was noted. Sub-apical germ pores were found in the varieties CP85-1491, CP89-846 and in TCP86-3368.While Dorsal germ pores were present in CP88-1165 and in CP77-400 (table 5).

Discussion

There are many commercial varieties being cultivated by the farmers in the country. So this has become very necessary for our scientists to keep the purity of a variety in the field and have awareness of the morphological description of different sugarcane varieties. Similarly, morphological and agricultural characters of the sugarcane crop effect the mechanization for its cultivation. Some of these characters, as shape of the cane stalk and loading of the cane are major constraints

in mechanization of some of the crop management practices. The characters most influenced by the environment are generally quantitative characters such as size, number and colour etc. These quantitative characters have less value in cane identification than do the stable characters such as shape of vegetative organs (Artschwager, 1942; 1951a, b) and shape and arrangements of stem and leaf (Artschwager, 1925, 1930). According to Almeida and Crocomo (1994.1) width of the medium leaf blade, dewlap shape, ligule and sheath auricles are the outstanding characters of value for identification of different sugarcane varieties. Piscitelli (1994), reported that the most important exomorphological characteristics of sugarcane varieties are shape, colour and wax of aerial organs. Almeida and Crocomo (1994.2) stated that the most outstanding, organographic characters of the sugarcane stalk was the bud shape. Farooq (1989) reported that small round buds, straight cane stalk, lesser leaves with erect lemina, lesser spreading range and smaller blade joint, are the qualities which make a variety the most suitable for mechanical cultivation and post harvest handling. In view of the above information all the above-mentioned morphological characters were considered very carefully in the present study.

Table 1. Various leaf morphological characters of six sugarcane varieties.

Name of variety		CP84-1198	CP85-1491	CP88-1165	CP77-400	CP89-846	TCP86-3368
Mean leaf length (cm)		171	165	201	173	120	195
Number of green leaves		11	10	10	10	7	12
Leaf lamina blade Width at its broadest (cm)		3.5 narrow	4.2 medium	4.4 medium	4.5 medium	1.4 narrow	4.1 medium
Leaf sheath colour		Yellowish green	Purplish green	Purplish green	Green upper light brown lower	Purplish yellow	Light yellowish green
Leaves	Scanty	*					
	Abundant		*	*	*	*	*
Carriage	Spreading						
	Erect with tips drooping			*	*	*	
	Strictly erect	*	*				*
Top	Open				*	*	
	Compact	*	*	*			*
Leaves	Scarious boarder	*	*	*	*	*	*
	Non-Scarious boarders						
Leafscar	Absent		*	*	*		*
	Present	*				*	
Spines on back of leaves	Present			*	*	*	*
	Absent	*	*				

* Represents the character

Table 2.Various leaf morphological characters (Dewlap, ligule and auricle) of six sugarcane varieties.

Name of variety		CP84-1198	CP85-1491	CP88-1165	CP77-400	CP89-846	TCP86-3368
Blade joint or dewlap	Shape	Tall-triangular with convex upper and lower margin Rayada	Squarish-subcrescent dewlap with horizontal upper margin and downward sloping baseline	Squarish subcrescent dewlap with horizontal upper margin and downward sloping baseline	Squarish subcrescent dewlap with horizontal upper margin and downward sloping baseline	Deltoid dewlap with horizontal baseline	Triangular dewlap with horizontal basal margin
	Size	16 mm	14 mm	10 mm	8 mm	7 mm	10 mm
	Colour	Light purplish green	Light purplish dirty green	Purplish dirty green	Light green	Purplish dirty green	Dark green
	Wax	*	*	*	*	*	*
Ligule	Shape	Deltoid (deltoid-w-lozenge)	Deltoid (deltoid-w-lozenge)	Deltoid (deltoid-w-lozenge)	Crescent shaped (w-narrow-lozenge)	Deltoid (deltoid-w-lozenge)	Crescent shaped (w-narrow-lozenge)
Ligular process or auricle	Shape	Ascending-transitional	Deltoid	Dentoid	Ascending transitional	Ascending transitional	Dentoid

* Represents the character

Table 3. Morphological characters of cane stalk (diameter, colour, shape, splits, ivory marking and bud groove) of six sugarcane varieties.

Name of variety		CP84-1198	CP85-1491	CP88-1165	CP77-400	CP89-846	TCP86-3368
Cane or stalk	Diameter (cm)	2.36 medium-thin	2.61 medium	2.46 medium-thin	2.40 medium-thin	2.47 medium-thin	2.33 medium-thin
	Colour	Light purplish green	Purplish green	Purplish green	Light purplish green	Yellowish green	Light purplish green and light purplish yellow
Joint or internode	Shape	Cylindrical	Obconodal	Convex-concave	Bobbin-shaped	Cylindrical	Cylindrical
	Splits	Present	*				
		Absent *		*	*	*	*
Ivory marking or cracky cracks	Present	*	*	*	*	*	*
	Absent						
Bud groove	Long	*		*			
	Short						
	Deep	*					
	Shallow			*			
	Absent		*		*	*	*

- Represents the character

Table 4. Morphological characters of cane stalk (growth ring, root zone, root eyes and wax band) of six sugarcane varieties.

Name of variety		CP84-1198	CP85-1491	CP88-1165	CP77-400	CP89-846	TCP86-3368
Growth ring	Width (mm)	5 wide	3 narrow	3 narrow	3 narrow	11 wide	7 medium
	Colour	Light purplish green	Purplish green	Purplish green	Purplish green	Yellowish green	Purplish light green
	Depressed						
	Swollen	*	*	*	*	*	*
Root zone	Width (mm)	6 narrow	7 narrow	6 narrow	7 narrow	3 narrow	5 narrow
	Colour	Yellowish green	Yellowish green	Dark green	Yellowish green	Yellowish green	Purplish light green
	Depressed	*		*	*	*	
	Swollen		*				*
Root eyes	Regular			*	*	*	
	Staggered	*	*		*		*
Wax band	Heavy	*	*	*	*	*	*
	Light						
	Constricted	*	*			*	*
	Swollen			*	*		

* Represents the character

Table 5. Bud and germ pore characters of six sugarcane varieties.

Name of variety			CP84-1198	CP85-1491	CP88-1165	CP77-400	CP89-846	TCP86-3368
Bud	Size	Diameter	6	6	6	6	6	6.5
		Length (mm)	5	5	4.5	5	5	5
	Shape		Pentagonal	Ovate with wing boarding towards apex	Pentagonal	Pentagonal	Ovate with wing boarding towards apex	Ovate with emerginate wing towards apex
	Flanges	Present	*	*		*	*	*
		Absent			*			
Germ pore	Apical		*					
	Sub-apical			*			*	*
	Dorsal				*	*		

* Represents the character.

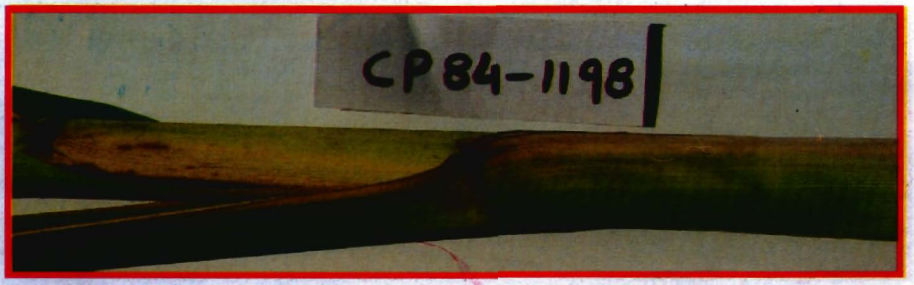

Figure 1. Photograph of second green leaf above top most dry leaf of the sugarcane variety CP84-1198 (d, dewlap; a, auricle).

Figure 2. Photograph of second green leaf above top most dry leaf of the sugarcane variety CP88-1165 (d, dewlap; a, auricle).

Figure 3. Photograph of second green leaf above top most dry leaf of the sugarcane variety CP89-846 (d, dewlap; a, auricle).

Figure 4. Photograph of second green leaf above top most dry leaf of the sugarcane variety TCP86-3368 (d, dewlap; a, auricle).

Figure 5. Photograph of second green leaf above top most dry leaf of the sugarcane variety CP77-400 (d, dewlap; a, auricle).

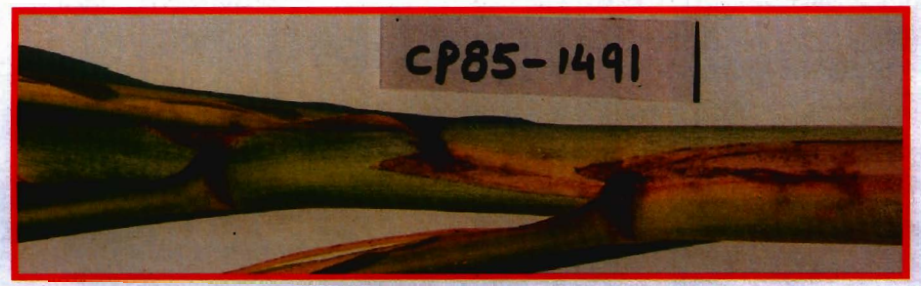

Figure 6. Photograph of second green leaf above top most dry leaf of the sugarcane variety CP85-1491 (d, dewlap; a, auricle).

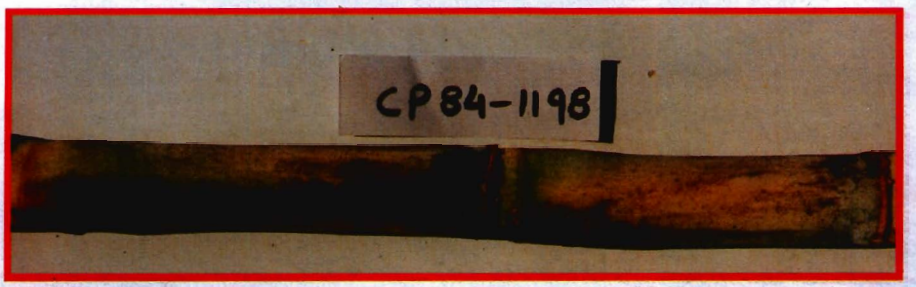

Figure 7. Photograph of the cane stalk of the sugarcane variety CP84-1198 showing the shape of internodes.

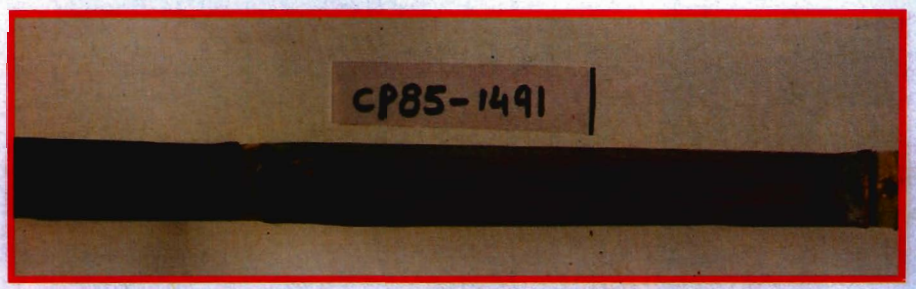

Figure 8. Photograph of the cane stalk of the sugarcane variety CP85-1491 showing the shape of internodes.

Figure 9. Photograph of the cane stalk of the sugarcane variety CP88-1165 showing the shape of internodes.

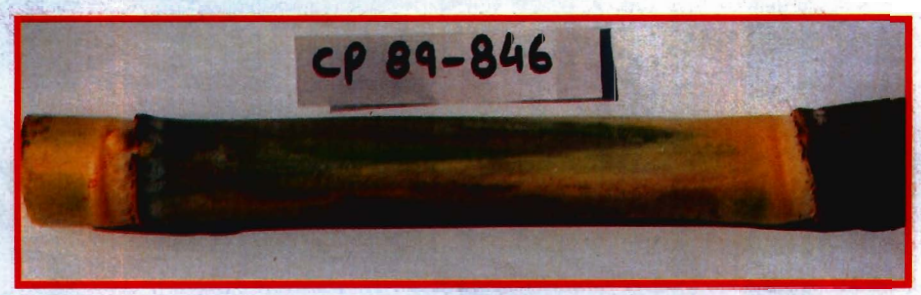

Figure 10. Photograph of the cane stalk of the sugarcane variety CP89-846 showing the shape of internodes.

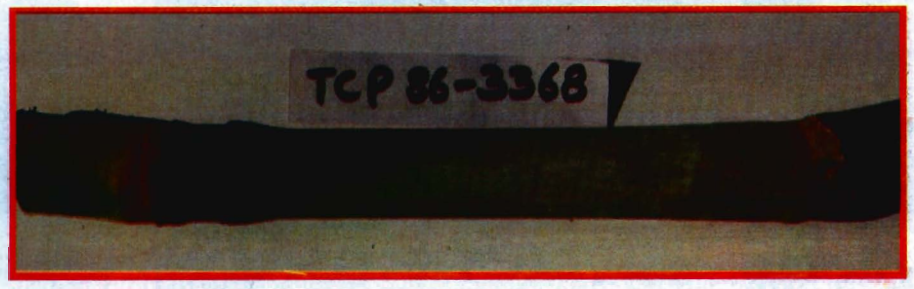

Figure 11. Photograph of the cane stalk of the sugarcane variety TCP86-3368 showing the shape of internodes.

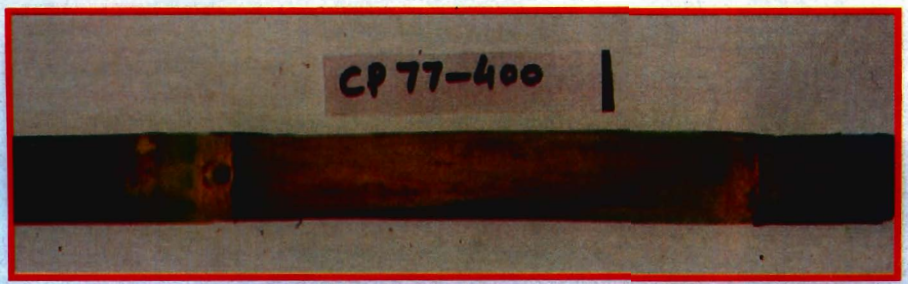

Figure 12. Photograph of the cane stalk of the sugarcane variety CP77-400 showing the shape of internodes.

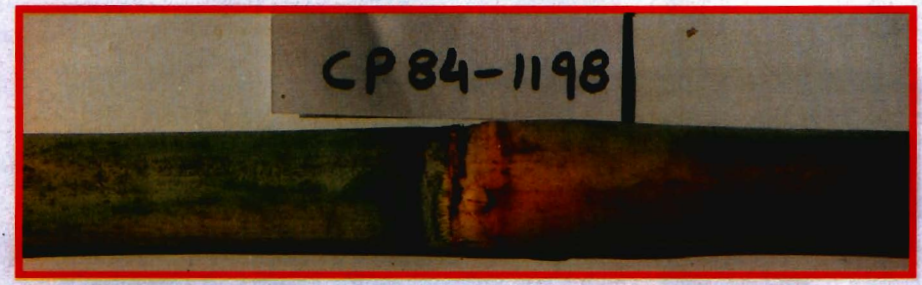

Figure 13. Photograph of the cane stalk of the sugarcane variety CP84-1198 showing root zone, wax band and bud.

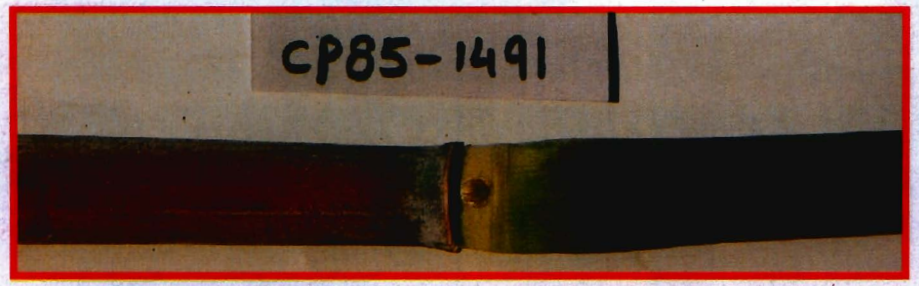

Figure 14. Photograph of the cane stalk of the sugarcane variety CP85-1491 showing root zone, wax band and bud.

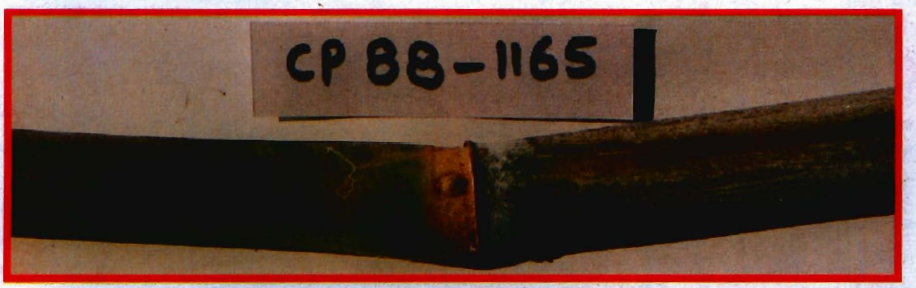

Figure 15. Photograph of the cane stalk of the sugarcane variety CP88-1165 showing root zone, wax band and bud.

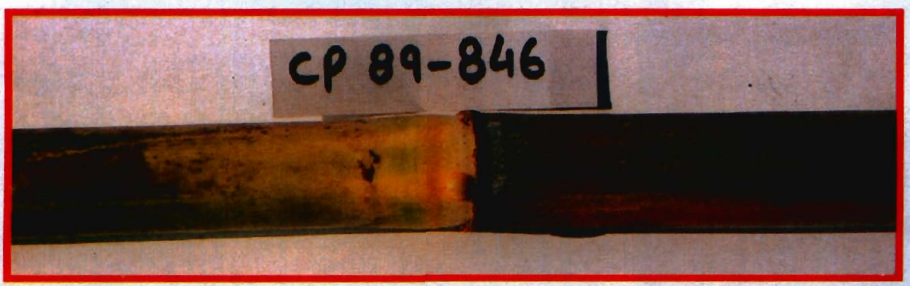

Figure 16. Photograph of the cane stalk of the sugarcane variety CP89-846 showing root zone, wax band and bud.

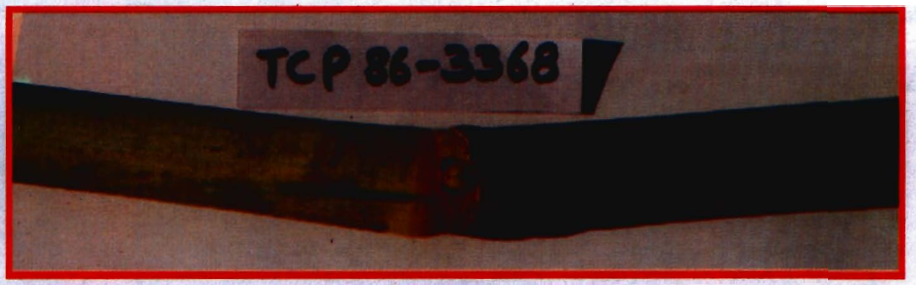

Figure 17. Photograph of the cane stalk of the sugarcane variety TCP86-3368 showing root zone, wax band and bud.

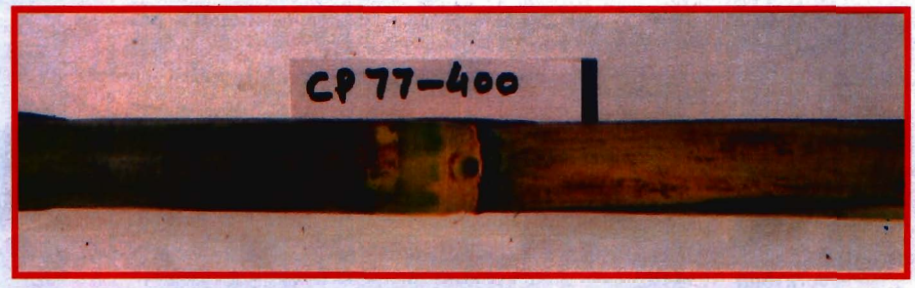

Figure 18. Photograph of the cane stalk of the sugarcane variety CP77-400 showing root zone, wax band and bud.

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