A DEVELOPMENTAL STUDY OF SIX GRASS SPECIES
UNDER TRINIDAD CONDITIONS.

Owing to the sudden illness of the laboratory assistant and in
the present of more in the laboratory, the dry season climatic results
are not available.

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This report is the result of each table very interest for

1959
D.T.A. Report

Submitted in part fulfilment for the Diploma of Tropical
Agriculture of the Imperial College of Tropical Agriculture,
Trinidad.
Owing to the sudden illness of the laboratory assistant and to the pressure of work in the laboratory, the dry season chemical analyses of the grasses could not be completed.

Blank spaces at the end of each table were intended for comments on the results.
ACKNOWLEDGEMENTS.

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Introduction

This project was carried out as part of the Imperial College of Tropical Agriculture Grassland Research Programme and consists essentially of an investigation of the vegetative and floral characteristics of six selected grass species. A botanical description is given for each species together with a review of the relevant literature. The grasses concerned were established on plots measuring 14 ft. by 14 ft. on the Old Farm, whose soil is described by Mills (1949) as being of a very heterogeneous nature varying from a sand to a clay loam with a very low nutrient status and with a slightly acid reaction. The soil was observed to pack very tightly after wetting and to crack during the dry season. Since rainfall has an important bearing on forage production, it is given in the appendix.

Within the past few decades, especially in the temperate countries, grasses have become so important that they are receiving equal, if not greater attention than some of the major crops. This change has caused numerous investigations to be undertaken on the various aspects of grass and grassland management in the tropics. The biggest problem confronting the investigation in tropical countries is the finding of a grass species suitable for temporary pastures. At this point it may be well to state some of the chief characteristics which are being taken into account in assessing the value of a grass. These are (a) palatability, (b) nutritive value, (c) ability to yield well with a high proportion of leaf, (d) ability to persist under the conditions superimposed, (e) ability to recover quickly after cutting or grazing, (f) good seeding qualities. Drought resistance is of particular importance in countries which experience a dry season. It is by no means easy to find grasses which conform to all these criteria. In Kenya, a considerable number of grasses tested by Edwards (1954) have been rejected on account of failure to satisfy one or more of these requirements. Similar difficulties have been encountered at the
Impérial College of Tropical Agriculture and several species imported from other tropical countries where they have shown promise have failed to give satisfactory results under Trinidad conditions.

The area bounded by the tropics includes a great complexity of climates and it is not surprising therefore that grasses which do well in one part of the tropics may fail completely in another. The need obviously arises for testing grasses in the country in which they are to be used.

The question of seeding qualities in grasses has been given a considerable amount of attention both by workers in Trinidad and by workers elsewhere. The object of the seed studies in Trinidad has been aimed firstly at selecting species giving abundant high quality seed and secondly to obtain information on optimum conditions of storage. It is often argued that the development of cultivated pastures under more intensive management is dependent on the facility with which such pastures can be established. Seed establishment is undoubtedly the most economical method of grass establishment but to reject a grass on the grounds of its failure to set viable seed would be foolish at this stage. As the emphasis at present is on long term pastures, investigation should be aimed at the improvement of vegetative establishment using both machine and hand planting.

The problem which faces the farmer in Trinidad is the need for increased forage production during the dry season. Few of the indigenous grass species have proved to be of much value under intensive management. Savannah grass (*Axonopus compressus*), although providing a succulent growth in the wet season, fails miserably in the dry season. There arises, therefore, the problem of supplying feed in the dry season and in the search for new grass species, this most urgent problem should not be lost sight of.

Livestock, although receiving considerable attention in
Trinidad, have not developed to the point where their products appreciably curtail imports and in 1957, meat production from slaughter houses represented only 21 per cent of the weight imported. The expenditure per person on imported meats and dairy produce is estimated at 27.5 B.W.I. dollars. This, together with the large importations of dairy produce, emphasises the need for a greater development of livestock enterprises, preferably on a mixed farming basis.

Prior to and shortly after the Second World War, grassland activities in the British Caribbean countries were confined to the planted tufted grasses such as Elephant grass (*Fenisetum purpureum*), Guinea grass (*Panicum maximum*) and Guatemala grass (*Tripsacum laxum*) for cutting as soilage. This earlier preoccupation with the above species and system still influences farming practices over a wide area. Recently, however, workers have focussed their attention on the grazing grasses rather than on soilage grasses which tend to leave many bare patches of soil between the individual plant roots, and render the soil susceptible to erosion. The immediate necessity is to provide for a periodic soil cover in the crop rotation which will not throw the land out of use for years at a time as does the present bush fallow of shifting cultivation and which will prevent soil erosion.

This project is concerned with the preliminary evaluation of six potential grazing species. Following the preliminary small plot trials, tests will then have to be made on a larger scale, with or without fertilisers and with the grass subjected to different intensities, frequencies, and times of trampling, and to varying rates and intervals of defoliation before any of the grasses could be recommended for widespread use.
Common name: Pangola grass, Nelspruit Finger grass (South Africa).

Taxonomy:

*Digitaria decumbens* Stent. is classified in the family Gramineae, the sub-family Panicoideae, and the tribe Paniceae. The genus *Digitaria* is characterised by the spikelets which have the margins of the upper lemma flat, thin and folded over the palea, not inrolled and hard as in most of the *Paniceae*. The inflorescence is a simple or slightly compound raceme usually arranged digitately or sub-digitately. The genus is composed of about one hundred species distributed in the warmer regions of both hemispheres (Chippindall, 1955).

Morphological description:

*Digitaria decumbens* Stent. is a stoloniferous perennial that grows to a height of 2 to 3 feet. The culms are very much branched, creeping below and erect above, with roots arising from the lower nodes of the creeping stems. The stolons have very hairy nodes and often a purplish red tinge on the exposed stem below the node.

The lowest leaf sheaths are densely hairy at the base, the lower hairy with long fine hairs, and the upper almost glabrous. The leaf sheaths are split and keeled.

The leaf blades are glabrous or hairy, 13 to 20 cms. long and about 5 mm. wide, expanded. The ligule is membranous, up to 5 mm. long.

The inflorescence is made up of many spike-like racemes digitately arranged on an axis which arises from the decumbent stems.

The spikelets are 2.5 to 3 mm. long, and apparently quite glabrous, the hairs on the upper glume and lower lemma being fine, short and inconspicuous.

Ecology and economic uses:

*Digitaria decumbens* Stent. is a native of South Africa occurring in the Nelspruit district of the eastern Transvaal from
DIGITARIA DECUMBENS. Slott. (x \frac{1}{2})

A. Inflorescence (x \frac{1}{4}); B. Outer glume; C. Inner glume (Much enlarged)
whence it derived its name "Nelspruit Finger Grass" in South Africa. Subsequently, plants of Digitaria decumbens cultivated in Pretoria were referred to as the "Pongola River Strain of Woolly Finger Grass". The name has become changed to Pangola and it is by this name that it is known throughout the West Indies and in the Southern States of America (Chippindall, 1955).

Digitaria decumbens was collected in South Africa by an English agricultural worker in 1939 and sent to America with more than thirty samples of grasses belonging to the same genus. These were tested at the Florida Agricultural Experiment Station and Digitaria decumbens was chosen as the best strain to use for forage (Wheeler, 1950).

Digitaria decumbens is best adapted to fertile and moist soils. It does not grow well on soils liable to flooding or on highly acid soils (Florida, 1945). In Hawaii, plantings from sea-level to 5,000 feet elevations have done remarkably well. Its performance in dry regions, however, is poor, but under irrigation in dry climates it makes heavy growth (Hosaka et Goodell, 1954). The following quotation from the "Farmer" (1957) published in Jamaica confirms the wide adaptability of Pangola grass: "A remarkable thing about Pangola is the wide range over which it flourishes. It thrives from sea-level up to 3,000 feet and in areas with annual rainfall ranging from 30 inches up to 100 inches. Though it is a grass which does not mind dry conditions it grows more luxuriantly in areas of high rainfall. With 30 inches of rainfall it is possible to get six grazings per annum while at 100 inches there can be ten or eleven without any danger of overgrazing."

Pangola grass did not increase in popularity in Florida until about 1946 when it was estimated that only one hundred and twenty farms had established it. Florida has now over one million acres of established pangola grass. In spite of the fact that it did not produce seeds in Florida, its establishment by
vegetative means did not prove a very great handicap. Pangola is not winter-hardy and it is not recommended for plantings North of Florida (U.S.A., 1946). It is also extensively cultivated as a forage grass in Hawaii (Hosaka et Goodell, 1954) and was successfully introduced into Venezuela in 1949 (Mondolfi et Rios, 1956).

The management of Pangola during the early period of establishment is important if a good stand is to be obtained. The primary aim is to give it the best possible treatment while the plants are being established. Experience has shown that light grazing in the early stages is beneficial to reduce weed competition. The animals, in moving over the pasture, will help to trample the stems into the ground which will encourage the trailing stems to spread out and cover the open areas (Archer and Bunch, 1953). The consolidation provided by the animals' hooves will also have a beneficial effect. After the cuttings have become well established, the grass should be grazed properly, as grazing too closely will damage the stem.

The height at which a Pangola grass stand is mown or grazed seems to have a profound effect on its subsequent yield. Experiments performed in Florida have proved conclusively that the grass mowed closely (1 to 2 inches) at intervals after the grass had reached a height of 8 to 10 inches yielded only fifty per cent as much forage for the season as the same grass mowed back to a four inch height at each cutting (Florida, 1954). In Hawaii, light grazing starts in about three to four months after planting. When the plants are well established they are allowed to reach a height of 16 to 18 inches and then grazed down to 4 inches. Barrie-Smith (1958) advocates strip-grazing for maximum production. In Trinidad, in the wet season, a rest period of 15 to 20 days has been found sufficient. No figure is given for the dry season, but it is obvious that the rest period should be lengthened and the farmer must guard against overgrazing.

Excellent responses have been obtained in Florida from
the use of nitrogen, phosphorus, and potassium. A pure stand of Pangola grass gave a linear response to levels of nitrogen ranging from 24 pounds to 288 pounds per acre (Blue et Sammon, 1957).

In Trinidad, responses have been obtained from sulphate of ammonia applied after grazing at the rate of 12 cwt. per acre, two or three times a year (Barrie-Smith, 1958). In Hawaii, the lack of phosphate in the soil gave very slow establishment and subsequent poor growth (Hosaka et Goodell, 1954).

Pangola grass has shown itself to be a high producer of green fodder and dry matter in its establishment year in Trinidad. Oliver (1958) obtained 28,600 lbs. of green herbage per acre from a sward fertilised with 12 cwt. of sulphate of ammonia per acre. The cut was taken at the beginning of March from a sward established at the beginning of November the previous year. In Florida, a heavily manured pangola sward has given 59,847 pounds of green herbage per acre per year (Hosaka et Goodell, 1954).

Pangola grass has been ensiled successfully in Florida either alone or in mixture with dried citrus pulp (Becker et al., 1954).

Pangola grass was first introduced to Trinidad by the Imperial College of Tropical Agriculture on the 15th April, 1953, from the Turrialba Research Station in Costa Rica. A second introduction came from the Agricultural Experiment Station, Pamaribo, Surinam, and was received on the 2nd October, 1953.

Experimental observations:

Pangola grass was planted on the 28th October, 1953, from off-setts taken from a young sward established in a field on the "Old Farm". In an attempt to have the off-setts as uniform as possible, three rooted erect tillers were planted per hole spaced at 2 ft. apart. The soil was subsequently firmly pressed around the base of the plants.

Humid weather at, and after planting, ensured a successful "take" and by the third week in November, lateral runners with internodes as much as 6 inches long were being put out by all the
to plant one acre (Archer and Bunch, 1953).

The method of planting in Trinidad described by Barrie-Smith (1958) consists in placing good sized clumps of the planting material in holes made with a cutlass at a distance of 13 inches apart. It is also necessary to press the soil around the plants to ensure contact with the roots. The planting material is usually taken from nurseries and it is estimated that one acre of good nursery should provide sufficient planting material in any one year to plant ten acres.

Mechanised planting has also been adopted in Trinidad and this consists of spreading cutlassed material thinly over the surface and discing it in.

A small experiment was carried out in earth boxes to obtain an estimate of the relative success of two methods of Pangola grass establishment and the best type of planting material to use. The treatments used were as follows:-

1. Stolons consisting of 2 nodes and left on the surface.
2. Stolons consisting of 2 nodes and buried for half their length to a depth of 3 inches.
3. Stolons consisting of 4 nodes and left on the surface.
4. Stolons consisting of 4 nodes and buried for half their length to a depth of 3 inches.
5. Erect tillers consisting of 2 nodes and left on the surface.
6. Erect tillers consisting of 2 nodes and with one node allowed to protrude above ground.
7. Erect tillers consisting of 4 nodes and left on the surface.
8. Erect tillers consisting of 4 nodes with 2 nodes allowed to protrude above ground.

During the course of the experiment which was carried out in the greenhouse, continuous wet weather was assumed and each box received two pints of water per day equivalent to 0.24 inches of rain, applied with a very fine rose. The technique of burying the stolons was devised in an attempt to simulate the discing-in method in the field.
To measure the effectiveness of the different methods of establishment it was decided to count the number of plants that had rooted four weeks after planting. These counts were made on an unreplicated trial and the results can only be taken as a guide to the value of a certain treatment.

There was no "take" in any of the boxes and the failure of the cuttings to "root" was attributed to the dryness of the soil caused by the rapid evaporation of water from the boxes and to the hard packing of the soil in the boxes.

Consequently, it was decided to repeat the experiment using the same soil type but placing the boxes among some young rubber seedlings to provide some shade and to keep the boxes reasonably cool. It was not considered necessary to water the boxes daily as the soil could be kept reasonably moist for a period of about three days under these conditions. Watering was therefore limited to twice a week and each box received 0.24 inches of water per application.

The results of the experiment, expressed as a percentage, are given in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Left on Surface</th>
<th>Buried</th>
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<tbody>
<tr>
<td></td>
<td>2 nodes</td>
<td>4 nodes</td>
</tr>
<tr>
<td>Stolons</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Tillers</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The above table shows that stolons made the best type of planting material and that the longer the stolon the better the "take". When left on the surface, however, the cuttings are subject to desiccation and a very poor "take" is consequently obtained. It is possible, moreover, that the amount of rainfall during the initial period of rooting and the soil type might affect the number of cuttings which successfully "root" and it is suggested...
that in future experiments these two possibilities should be investigated. Erect tillers, on the whole, made very poor cuttings and were slower to establish than stolons. It is felt, however, that tillers, under favourable conditions, could be successfully established but this remains to be investigated.

Recommendations:

Pangola grass develops very rapidly after planting and becomes well established in the first year. The ground is thus quickly covered with a thick "bottom" growth of grass. This capacity for rapid and reliable establishment is one of its most valuable characters. In its rate of development, habit of growth, tillering capacity and most other respects, Pangola grass is a grazing grass "par excellence". In the dry season there is an inevitable slackening of growth, but under good treatment it will contribute largely to the pasturage from January to May. Taking the whole year throughout, it is definitely a high yielding pasture plant. Its low dense growth will enable it to thrive under the treading of cattle.

Its comparative ease of establishment and its reliable yields suggest its extensive use for rotation and permanent grass.
Common name: Batiki Blue Grass (non-tainting Fiji strain).

Taxonomy:
The genus *Ischaemum* L. is comprised of about 50 species, distributed mainly in the Old World except three which are found in Tropical America. It belongs to the family *Gramineae*, the sub-family *Panicoideae*, and the tribe *Andropogoneae*. The inflorescence of members of the genus is composed of 2 to 7 (very rarely 1) spike-like racemes in pairs or arranged sub-digitately. The spikelets are arranged in pairs, usually one of the pair is sessile and fertile, while the other is pedicellate and either like the sessile or showing all stages of reduction, sometimes represented by a small glume, especially in the upper part of the raceme. The sessile spikelets are two flowered, the lower floret being male or sterile and the upper bisexual (Chippindall, 1955).

Morphological description:

*Ischaemum aristatum* L. is a perennial grass growing in clumps to a height of about four feet and spreading rapidly by stolons. The clump-forming habit is obvious only when isolated roots are allowed to grow.

The stems are either erect or geniculately ascending, sometimes decumbent below and rooting at the nodes, glabrous and slender. The nodes are bearded.

The leaf blades are flat, long and narrow, measuring 5 to 15 cms. long by 4 to 13 mm. wide, usually loosely to densely hairy, finely pointed and narrowed towards the base. The leaf margins are fringed with fine hairs and rough to the touch when stroked downwards.

The leaf sheaths are glabrous or loosely hairy, flattened and split. The ligule is 1 to 1.5 mm. long, membranous and ragged at the top.

The roots are matted and fibrous. The exposed roots often have a red tinge. Roots are readily produced from all nodes near
ISCHAEUM ARISTATUM A. Inflorescence (x ½).
The inflorescence consists of two fragile racemes, 3 to 6 cm. long, usually set at an acute angle to each other. The axes and the pedicels are shortly ciliate. The spikelets are 3 to 5 mm. long, the sessile and the pedicelalled closely pressed together. The pedicelalled spikelets are about as long as the sessile ones. The sessile spikelets are awned; the outer glume is oblong, minutely two-toothed and margins narrowly incurved, rounded and smooth below the middle, flatter and veined above the middle, glabrous or sparingly hairy. The inner glume is as long as the outer, papery, acuminate or shortly awned, 3 to 5 nervsed, keel narrowly winged towards the tip. The lemma is ovate-lanceolate, acuminate, and membranous. The palea is lanceolate with a purplish awn 1 cm. or more long. The pedicelalled spikelet is inarticulate on a very thick short pedicel which is densely or sparsely hairy.

This grass is a very variable one. There is much variation in the breadth and length of the leaves and in the markings and hairiness of the spikelets.

Ecology and economic value:

*Ischaemum aristatum* L. is a native of tropical Asia but is now distributed in several tropical regions of the world. It is reported to be present in the uplands of Mauritius (Hubbard and Vaughan, 1940) and throughout India, Ceylon, China, Malaya and Australia (Blatter and McCann, 1935). It has also been introduced to Surinam (Dutch Guiana) where it is considered as a very promising grass for the improvement of Surinam grasslands, and has been reported in the West Indies, British Guiana, West Africa and Fiji. The first record of its collection in Fiji was about 1919, but it has since been collected several times and is now well established in the vicinity of Naduruloulou where its excellent growth on poor red-earth hill slopes has been under observation (Parham, 1945).

In Trinidad, a strain of *Ischaemum aristatum* L. is commonly
referred to as "Tabaquite" or "Toco" grass. No exact information has been found to indicate the date or circumstances of its introduction to Trinidad, but it was first found growing at the now defunct oilfield at Tabaquite in Central Trinidad and it is believed to have been introduced there from Hong Kong in the straw of packing cases. A large area of an estate at Toco was subsequently planted with this new introduction from whence most of the present planting material in Trinidad has emanated (Howes, 1953).

Its value as a potential grazing grass in Trinidad began to decline in 1952 when complaints about a milk taint began to be received in ever increasing numbers by the dairy of the Imperial College of Tropical Agriculture. A subsequent investigation into its possible causes traced the taint down to the grazing of a pure stand of the Trinidad strain of *Ischaemum aristatum* L. This taint which is described as "yeasty", "sour" and "akin to molasses" had not been noticed previously since only non-milking stock had been kept on the few available pure stands of *Ischaemum aristatum*. The intensity of the taint was found to be dependent on the quantity of *Ischaemum aristatum* fed, and the time which had elapsed since feeding. No taint whatsoever was observed when this grass was mixed with large quantities of other grasses or when the grass had been eaten more than twenty-four hours previously. The objectionable flavour was noticed as being more pronounced when the grass was fed in the flowering stage (Howes, 1953).

It is interesting to note, however, that this milk taint has not been reported from areas where this grass has existed in pastures for several years. Parham (1945) records that in Fiji the grass is palatable to stock of all ages, forming when grazed a close leafy turf which holds well. He notes also that pastures of this species are very free from weeds owing to its ability to flourish in the shade as well as on poor soils in the open field. Payne et al., writing in 1955, mention that under experimental conditions in Fiji, *Ischaemum aristatum* was found to be very
palatable and did not appear to be seasonal in its growth. Its extensive use for wet zone pastures is strongly recommended.

Considering the above findings, it seems very probable that the strain of *Ischaemum aristatum* growing in Fiji is not the same as the strain growing in Trinidad. In view of the fact that the Trinidad strain has shown great possibilities of being a useful pasture grass, the Imperial College of Tropical Agriculture therefore decided to introduce the Fijian strain. The first consignment of the Fijian strain arrived in Trinidad on the 19th January, 1957, and was immediately planted in a small plot in the College Museum. Tests carried out at I.C.T.A. have shown that this new strain does not possess undesirable properties. It is hoped in the present study to gather information on the adaptability of the new strain in Trinidad.

The Trinidad strain of *Ischaemum aristatum* is reported to grow well on poor soils where other tropical grasses either show poor growth or fail completely. It is a very vigorous strain and is able to compete extremely well with weeds. In an observation plot, *Mimosa pudica* was smothered out completely by *Ischaemum aristatum* (Barrie-Smith, 1950).

**Experimental observations:**

*Ischaemum aristatum* (Fijian strain) was planted out on the 28th October, 1958, from off-setts obtained from a field on the "New Farm". In view of its trailing habit, the off-setts which consisted of "three rooted erect tillers" were spaced at a distance of 2 ft. by 2 ft.

The plants took extremely well and grew vigorously throughout the remainder of the wet season, namely from November to January. Seven weeks after planting several of the plants flowered and the grass continued to flower throughout the season with a peak when the dry season began.

Growth of this grass was very characteristic and appeared to take place in two distinct stages. Soon after planting, tillering at the root base was very profuse so that the plant appeared to
and subjected to a germination test between damp filter papers. No germination was recorded. Examination under a dissecting lens showed that the florets consisted of empty lemmas and paleas without caryopses.

Recommendations:

The growth of *Ischaemum aristatum* (Fiji strain) in the present trial was rather slow and in the dry season the plants became very much dwarfed with the foliage turning red. The thin creeping stolons are very shallow rooted and the plant seems to depend upon surface moisture for optimum growth.

It is suggested that this grass should be included in future trials in view of the fact that it was not properly established at the onset of the dry season. Owing to its extensively branching stolons, it will form a dense mat-like covering of "bottom herbage" which will aid in the conservation of surface moisture and prevent the establishment of weeds. It produces a fairly high proportion of leaf and even the stems are never coarse.
Common names: Molasses grass; Brazilian grass; Stink grass; Brazilian stink; Cordura grass; Yaragua; Yaraguay; Honey grass; Efawatakala grass; Kifuta (Uganda).

Taxonomy:

*Melinis minutiflora* Beauv. belongs to the family Gramineae, the sub-family Panicoideae, and the tribe Melinideae. The genus *Melinis* is comprised of sixteen species indigenous to tropical South America, Africa and Madagascar. The inflorescence of the genus is a panicle, contracted or open, usually narrow and longer than wide; the spikelets are pedicelled and consist of one upper perfect floret with an empty lemma below it. At maturity the spikelets disarticulate from the tips of the pedicels with extreme readiness (Chippindall, 1955).

Morphological description:

*Melinis minutiflora* is a viscid, hairy perennial grass of loosely straggling habit forming a loose mat two feet or more in thickness with a rather poor root anchorage.

The stems are either erect or ascending from a usually prostrate base. The plant spreads quickly by means of the creeping stems which can reach a length of five feet or more. The culms are weak and brittle, round, hairless or hairy, and usually very much branched and many jointed.

The leaf blades are flat, 6.5 to 18 cm. long, and 4 to 13 mm. wide, rounded at the base and tapering upwards to a fine point. They are minutely and densely hairy on both sides with a characteristic somewhat sweet smell, and the margins are hairy and rough. The hairs are most numerous on the leaf-sheaths which increase in circumference upwards and overlap. The structure of the glandular hairs and the viscid oil secreted from them has been fully described in Kew Bulletin, 1922. From this, it appears that two types of hairs are produced; one with a rounded apex and the other with a sharp point. Oil is secreted in both types of hairs but is only excreted from the blunt hairs. The ligules are reduced
MELINIS MINUTIFLORA. P. Beauv. (x ½)
A. Leaf showing Ligule (lig.); the sheath (sh.); the blade (bl.) (XI)
MELINIS MINUTIFLORA, P. Beauv.
A. Inflorescence (× 1); B. Spikelet; C. Outer glume;
D. Inner glume; E. Lemma of lower floret; F. Upper floret;
G. Lemma; H. Palea (much enlarged).
to short hairy rims.

Aerial roots are readily produced on this grass from the base of the branching young stems and from the nodes of the main stems. All the young branching stems have very short internodes at the base. The roots branch when they strike solid material, such as the ground surface.

The inflorescence is a panicle which is spreading when newly emerged, but closing at maturity and becoming dense and narrow, 15 to 20 cm. long, erect, rigid, usually of a striking reddish-brown colour with fine filiform branches. The spikelets are numerous, about 2 mm. long, quite hairless, with two florets of which only the upper one is fertile. The lower glume is reduced to a tiny scale up to 0.3 mm. long, very thin and nerveless; the upper glume is as long as the spikelet, bifurcated at the tip, membranous and seven-nerved. The lower floret is sterile and without a palea; the lemma is similar in appearance to the upper glume but slightly narrower and with a fine delicate purple awn 6 to 15 mm. long emerging from the base of the two lobes. The upper floret is fertile with a lemma and palea about 1.5 mm. long, thin, whitish and almost nerveless.

Ecology and economic value:

*Melinis minutiflora* Beauv. is said to be a native of Africa, although it occurs commonly in Central and South America where it has been introduced accidentally from Africa through the slave trade (Chase, 1944). Although it is indigenous to Africa, it is not common in Kenya, and it has been recorded only from certain isolated localities mainly in the Scattered Tree Grassland (Low tree - High grass). It usually occurs on rocky ground in hilly country and in such places it forms a more or less pure stand (Edwards and Bogdan, 1951).

Molasses grass was introduced into Queensland some forty to fifty years ago, and it has been successfully established along the tropical eastern coastlands from Rockhampton to the Daintree (Queensland, 1955). It has now been successfully established in many tropical areas throughout the world.
Molasses grass is essentially a tropical grass which cannot tolerate low temperatures. In Queensland, however, observations in recent years have shown that the grass will withstand a considerable period of light frost without actual plant loss. Serious frost "browning" may occur, but vigorous regrowth takes place during the summer months (Queensland, 1955). These observations have been confirmed by Ritchey and Hull (1949) in the extreme south of Florida (U.S.A.) where two winter hardy strains of this grass have been found to survive four winter seasons.

This grass has also shown considerable drought resistance in Queensland although the most vigorous growth has been obtained on the well-drained tropical coastal areas. It will not, however, stand up to waterlogging and complete failure has been obtained in areas subject to seasonal high water table levels or subject to periodic flooding. It prefers a moist well-drained soil but it is also reported to make excellent growth on acid clay loams and on poor sandy soils (Queensland, 1955). In Hawaii, it has been established in areas with as little as thirty inches of annual rainfall and as much as two hundred inches or more (Hosaka et Ripperton, 1953). Strange (1954) notes that, in Kenya, molasses grass has a possible altitude range of up to 8,000 feet above sea-level with a possible low rainfall limit of thirty inches per annum. In the central plateau of Brazil, naturally occurring molasses grass has been found on soils with pH ranging from 4.30 to 5.05 (Alvim, 1953).

Owing to its ease of establishment and to its capacity to cover the ground quickly, molasses grass has been recommended for the sowing down of temporary pastures in many parts of the tropics. It is reported, however, that under normal grazing it tends to disappear rapidly and will only persist for three to four years (Strange, 1958). Its persistency, moreover, can be greatly increased under proper management of the ley. It will not stand continuous heavy grazing as its growing buds are above the ground, but
experiments have shown that it will respond well to rotational grazing. Overgrazing, especially during the flowering period, will seriously reduce the vigour of the stand often to the extent that the grass may be entirely suppressed by vigorous weeds (Queensland, 1955). These observations have been confirmed by experiments at Kitale where hard grazing produced a noticeably greater number of flowering heads and allowed poorer species of grasses to come in (Kenya, 1953). During the flowering period, the grass is at its weakest and animals should be kept off. Grazing can recommence two months after the flowering period is over. Light grazing is recommended in the early stages of establishment to encourage the plant to form crown-like clumps (Hosaka et Ripperton, 1953). Australian authorities recommend that the grass should be grazed down to a height of 6 to 9 inches and then allowed to make regrowth to a height of approximately 14 to 18 inches before again being grazed. Under these conditions a pure stand of molasses grass has been maintained for six years (Queensland, 1955).

It is reported that in some areas stock, at first, show a distinct distaste to molasses grass owing to its hairiness and strong odour but on well established pastures they readily become accustomed to it (Whittet, 1924; Haarer, 1951). Tests have also shown that the aromatic flavours are not passed on to the dairy produce (Queensland, 1955).

A study of the seasonal changes in the chemical composition of molasses grass has been carried out at the Bureau of Tropical Agriculture at South Johnstone in North Queensland. Conclusions were reached that, in the wet season, this grass has a crude protein content of ten to eleven per cent which may be accepted as satisfactory as a supplier of protein. It tends to fall however during the dry season. Moreover, the fibre content of the grass is not high so that provided that stock have access to succulent leaf, the intake of the growth and energy producing constituents is adequate (Queensland, 1954).

In Queensland, molasses grass has been grown in
association with *Calopogonium* species, and with *Pueraria phaseoloides*. *Pueraria* seems to be the most palatable of the legumes and is readily grazed (Queensland, 1950-51). In Ceylon, molasses grass and *Stylosanthes gracillis* have been found to be the best pasture components for the dry zone (Ceylon, 1950).

This grass has also been used very effectively on eroded soils in Queensland owing to its ability to cover the ground quickly and to compete with weed growth. Its greatest disadvantage, however, lies in the fact that it will take fire readily, and if the field is carrying a considerable growth, the heat can be so intense as to wipe out a stand completely, necessitating re-sowing (Queensland, 1955).

Although primarily a grazing species, molasses grass has been conserved as hay or silage. When it is grown for this purpose, it is usually cut before the crop flowers owing to the fact that it becomes ligneous as soon as flowering begins (Rio de Janeiro, 1941). In Kenya, it is not recommended for hay as much of its re-growth is made from the stems above the ground, and is therefore retarded by close mowing (Strange, 1958).

One of the most attractive characteristics of this grass is its repellent effect to ticks. Watkins et Chavez (1946) note that in Venezuela it is included in pastures primarily for this reason. It is believed that the resinous material around the hairs of the leaves causes the death of the ticks although no experiments have apparently been conducted to verify this belief. Chase (1944) claims that cattle kept in *Melinis* pasture are likely to be free of ticks but not because it kills the ticks. Ticks when mature drop from the animals to the ground and the infant "seed ticks" climb the vegetation and attach themselves to passing animals. On *Melinis* pastures "seed ticks" are caught in the gummy velvety foliage and are not transferred to grazing livestock.

**Experimental observations:**

Molasses grass was planted in small plots measuring 14 ft.
by 14 ft. on the 28th October, 1958, approaching the end of the wet season. Owing to the absence of viable seeds, the grass was propagated vegetatively, using off-setts taken from an adjoining field on the Old Farm. In an attempt to standardize the size of the planting material, it was decided to plant three rooted tillers per hole at a distance of 2 ft. by 2 ft. These off-setts took extremely well and about a fortnight after planting, bud growth was visible on all the plants. It must be noted however, in connection with this successful "take", that the weather at the time of, and shortly after planting was extremely favourable for the growth of the off-setts. No thinning was done and this subsequently hampered developmental studies because it was difficult to establish from how many "plants" the tillers and the leaves were produced.

Weekly recordings of the emergence of tillers, and the height of the plant were made using a sample of ten plants taken at random. In order to obtain an estimate of the rate of spread of the grass one stolon on each of the sample plants was tagged and its rate of elongation measured weekly. These weekly measurements are presented in graphical form in order to avoid the presentation of a mass of purely relative figures. They represent more clearly the general trends.

At about the middle of December, aerial roots began to develop from the nodes at the base of the branching young stems, and from the main stems. These young branching stems have very short internodes at the base. The number of aerial roots which successfully reached the ground, however, was dependent on the height of the plant. Plants with low crowns, that is, those with their stems close to the ground, produced roots which reached the soil after growing only a short distance. These roots branched when they struck the ground and formed new plants which developed independently of the mother plants. On the other hand, if the roots developed at a point high above the ground they often withered and died out before they reached the ground.
Both leaf and tiller production were extremely vigorous in this grass and by the end of December, that is, eight weeks after planting, a loose mat of stem and leaves, 18 inches or more in thickness had been formed. At this stage low-growing weeds such as *Portulaca oleracea*, *Euphorbia* species and *Cyperus rotundus* were completely smothered out and the only weed that was able to grow through this loose sward was *Amaranthus* species. The herbage produced remained green and succulent from December to April and at no time did it become coarse in appearance. There was no indication that the grass suffered in the dry season.

During the month of January at the onset of the dry season, one half of the plot was cut to within a few inches of the ground and the other half dressed with the equivalent of two hundredweights per acre of a fertiliser mixture made up of four parts by weight of sulphate of ammonia and one part by weight of muriate of potash.

New shoots began to develop from the upper green portions of the old stems within a week of cutting. Subsequent growth was extremely good; an appreciable amount of herbage being produced within four weeks.

The chemical composition of the grass during the wet and the dry season is given in the following table.

<table>
<thead>
<tr>
<th>Time of cutting</th>
<th>Crude protein</th>
<th>Fat</th>
<th>Fibre</th>
<th>Ash</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet season</td>
<td>14.6</td>
<td>2.50</td>
<td>27.36</td>
<td>9.8</td>
<td>90.2</td>
</tr>
<tr>
<td>Dry season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A crude protein content of 14.6 per cent of the dry matter indicates that molasses grass can be regarded as a satisfactory supplier of protein. Such high crude protein contents are very seldom encountered in tropical grasses and in this case it is thought to be due to the fact that the sample was taken while the grass was in a very active stage of growth.
Average number of tillers per plant.

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Number of panicles per plot.

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Average height of plant in inches.

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Plot: Average number of tillers per plant.

Plot: Number of panicles per plot.

Plot: Average height of plant in inches.
The growth of molasses grass was so vigorous in the dry season that it was decided to obtain an estimate of the yield of the plot. Cutting of the whole plot took place in the third week of April and the green herbage weighed. No allowance was made for the cut which was taken at the beginning of January because it appeared that the grass on half the plot which was cut had actually caught up with the uncut section of the plot. A yield of 203 pounds of green herbage, equivalent to 40,013 pounds per acre was obtained.

Propagation and seed setting ability:

Molasses grass commenced to flower in early December about six weeks after planting and a maximum was reached by the end of December. Thereafter the number of flowering heads formed began to decline. When the flowers first open, the flower head appears fluffy and spreading, and as the seed ripens it closes in close to the stem.

Tuley (1954) made regular monthly collections of seeds of molasses grass under Trinidad conditions and concluded that dry season collections showed "germination percentages high enough to warrant its use for seed establishment."

In Kenya, seed production has reached a commercial scale and Strange (1954) recommends a sowing rate of 10 lbs. per acre providing the sample contains ten per cent pure germinating seed. Improvement of germination was obtained when the seeds were subjected to a six months' maturation period.

Reports from Hawaii (Hosaka et Ripperton, 1953) and from British Guiana (1948) indicate that this grass can be successfully established by seed. In British Guiana, direct seeding after ploughing and harrowing the natural savannah has resulted in a good grass cover. In Hawaii, the seeds are usually passed through a hammer-mill to remove the long awns which would tend to clog the drill openings. If broadcasting is to be adopted, the seeds are usually mixed with sand or soil.
Seed production in Queensland is confined mainly to North Queensland where hand harvesting is undertaken. Mechanical harvesting of seed does not appear to be practical in view of the extreme lightness of the seed.

Seed collection also appears to be extremely difficult as the seeds are easily shed and lost when allowed to ripen in the open. Gathering of the seeds will have to be done as soon as the panicles have closed and ripening of the seeds carried out indoors. Further delay will result in shedding and loss of seeds. Indoor ripening will require great care as it heats and moulds very rapidly.

Molasses grass can also be easily propagated vegetatively in Trinidad, but it is a laborious and expensive method.

Recommendations:

Molasses grass can be regarded as the most promising species grown in the present trial. Its establishment and development were fairly rapid and it grew well during both the wet and dry seasons producing a mass of succulent herbage which remained in good condition throughout the period under observation.

The grass is able to yield fairly heavily and is also able to recover and produce a vigorous growth of succulent material after cutting. The proportion of leaf to stem remained high and at no time did it appear coarse even when this plant was in bloom.

One of the drawbacks of this grass, however, is its loose habit of growth and it appears that unless careful management is practised it will tend to die out fairly rapidly. Under proper management it would be a very suitable grass for leys of three or more years' duration and for alternate husbandry generally. Its permanence and value will depend to a large extent upon the nature of the soil, climate, and on the management. Its rapid and heavy production will make very great demands upon the land, but this is also true of most plants that develop rapidly and produce heavy and nutritious crops.

Molasses grass certainly warrants further trial with special regard to its production and persistence under repeated grazing or cutting.
**Paspalum Paniculatum L.**

**Common names:** Russel River Grass (Australia); Herbe duvet (Mauritius)

**Taxonomy:**

*Paspalum paniculatum* L. belongs to the tribe *Panicaceae*, the sub-family *Panicoidae* and the family *Gramineae*. The genus *Paspalum* is characterised by the structure of the spikelets, the lower glume being usually suppressed, while the upper glume is adjacent to the axis on which the spikelet is borne; the axis of the raceme or spike terminates in a spikelet. The spikelets are awnless, usually flattened on one side, rounded on the other. The lower floret is reduced to a lemma similar to the upper glume but flat on the back; the upper floret is bi-sexual, slightly shorter than the lower, indurated, smooth, glossy and brittle (Chippindall, 1955).

**Morphological description:**

*Paspalum paniculatum* L. is a coarse tufted perennial, measuring up to three feet high under favourable conditions. The culms are erect or geniculately ascending, stout and glabrous.

The leaf-blades are linear to narrowly lanceolate, acuminate, 9 to 30 cm. long, and 10 to 25 mm. wide, widest below the middle, flat, stiffly hairy to almost glabrous.

The leaf-sheaths are keeled, coarsely hairy to nearly glabrous. The ligule is truncate, very short and backed by hairs 4 cm. long.

The inflorescence is of variable length and may be 5 to 30 cm. long. The racemes are numerous (8 to 50), very slender, dense and finally spreading, 4 to 12 cm. long. The rachis is slender.

The spikelets are minute, sub-hemispheric, 1.2 to 1.5 mm. long, straw-coloured to purplish-brown, minutely hairy. The outer glume is absent, the inner glume is pubescent, five nerved and papery. The sterile lemma is five nerved and purplish. The fertile lemma is smooth and hard.
Paspalum Paniculatum

A. Leaf showing ligule (lig.); the blade (bl.); the sheath (sh.) (x 1)
B. Inflorescence; D. Floret (x 10)

A. and C. Two views of spikelet (x 10)
Ecology and economic value:

Paspalum paniculatum L. is an indigenous grass of the West Indies flourishing in moist open ground and bushy slopes, along ditches, and is looked upon as a weed of cultivated ground (Hitchcock, 1936). It is also reported to be present as one of the dominant species in the upland grasslands of Mauritius. Its source of origin and its method of introduction into Mauritius have not been ascertained, but it is now very widely distributed and may be found from sea-level to 1,500 feet (Hubbard and Vaughan, 1940). It is described by Hubbard and Vaughan (1940) as being widely spread in Tropical America; introduced into Tropical Africa and North-Eastern Australia.

Where typical tropical conditions exist in Australia, it is looked upon as a useful pasture grass (Franca, 1940). At the Kitale Research Station (Kenya) at an altitude of about 6,000 ft. and an average rainfall of 45 inches, Paspalum paniculatum has emerged from small scale grazing trials as being a very promising pasture grass (Kenya, 1956).

In Trinidad, Paspalum paniculatum L. has never been cultivated in pure stands, but Hinds (1940) reports that in localities where it flourishes it is cut and fed to stock.

The effect of season and stage of growth on the chemical composition of Paspalum paniculatum have been thoroughly studied in the Queensland "wet belt". It was found that it had an adequate crude protein content during the wet season but in the dry season the fibre content was fairly high and the protein content correspondingly low (Cartmell, 1944).

Experimental observations:

Paspalum paniculatum was planted out from off-setts on the 27th October, 1958. The planting material was obtained from a roadside verge in Curepe. Three rooted tillers were planted per hole at a distance of 2 ft. by 1 ft.

Weekly observations were made using a sample of ten plants chosen at random and the emergence of tillers and inflorescences
were noted. The tillers were counted on the sample plants, the average number of inflorescences per plot was counted and the total height of the plant recorded.

After about a fortnight, it was observed that ten per cent of the off-setts had not "taken" and these were immediately replaced. Depredations by mole crickets were responsible for about fifty per cent of the replacements.

Three weeks after planting, about fifteen per cent of the plants began to flower in spite of having produced very few new tillers. These plants subsequently tillered very poorly and in some cases died out after flowering. This was possibly due to the fact that the off-setts were taken from plants which were actually in flower and consequently, they may have been from flowering culms. Care should thus be taken when planting vegetatively on a large scale to take planting material when the majority of the plants are still in a vigorous vegetative phase and to select tillers which have not flowered. Otherwise, although the planting material will "take", subsequent growth will be slow and tillering poor.

Tiller production was very slow and weak in this grass. The first sign of new tiller production was observed six weeks after planting when the average height of the plants was only ten inches. Intra-vaginal tillers were formed giving the plant a very tufted habit of growth which provided a very poor ground cover.

After flowering, the grass became rather hard and fibrous and it was apparent that it would never be capable of forming a dense sward. Some of the older leaves tended to die back after flowering and in some cases the whole plant died out.

In mid January, half the plot was cut down to ground level in an endeavour to study the reaction of the grass to cutting. A fertiliser mixture containing four parts by weight of sulphate of ammonia and one part by weight of muriate of potash was applied to the whole plot at the equivalent rate of two hundred weights per acre.
---Number of panicles per plot.

Average number of tillers per plant.

Nov. 23rd, Weeks, Jan. 25th.
There was a very poor recovery after cutting and tiller production was again very slow. The grass burned very badly during the "dry season" and it produced very little new growth leaving the ground completely bare.

The following table shows the chemical composition of the grass in the wet and in the dry season.

<table>
<thead>
<tr>
<th>Time of cutting</th>
<th>Crude protein</th>
<th>Fat</th>
<th>Fibre</th>
<th>Ash</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet season</td>
<td>10.88</td>
<td>1.54</td>
<td>25.31</td>
<td>11.52</td>
<td>90.28</td>
</tr>
<tr>
<td>Dry season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The crude protein content of this grass appears to be very high considering that it was cut while in full bloom. There seems to be no logical explanation for it.

Propagation and seed setting ability:

Paspalum paniculatum commenced to flower three weeks after planting and a peak was reached by the end of December. Thereafter the intensity of flowering began to decline but flowering heads were still being produced in February and March.

Samples of the seed were collected and routine germination tests on wet filter paper were carried out. Germination results showed that the seeds were not viable. On closer examination, it was found that the seeds contained no caryopses.

This grass can be propagated vegetatively using off-setts but as it is susceptible to mole-cricket damage, proper control measures should be taken at planting.

Recommendations:

In Triniđad, Paspalum paniculatum appears to be of very little value. It is not capable of producing a satisfactory yield of succulent herbage or of forming adequate ground cover. Its early growth was disappointing as regards the production of tillers.
It does not appear to be drought resistant and consequently it burns very badly in the dry season. It cannot be recommended for further trials.
PASPALUM NOTATUM Flugge

Common name: Bahia grass.

Taxonomy:
The genus Paspalum contains about two hundred species occurring mainly in Tropical America but a few are present in the Old World. It belongs to the family Gramineae, the sub-family Panicoideae, and the tribe Panicae (Bews, 1929).

Morphological description:

Paspalum notatum Flugge is a low-growing perennial spreading by short, stout, woody stolons. When pieces of the thick stolons are planted firmly, they root readily and make a turf with a mat of large stolons covering the ground.

The blades are hairy, about 13 cms. long and 8 mm. wide, sharply compressed near the base, flattening out in the centre and tapering to a fine point. The blade margins are rough to the touch as the result of being fringed with minute spiny hairs.

The ligule is very greatly reduced and is represented by a short and inconspicuous rim fringed with fine short hairs. Auricles are absent.

The leaf-sheaths are longer than the internodes and, as a result, successive sheaths are keeled and owing to the alternate arrangement of the leaves on the culm, a stolon with its mass of leaves presents the appearance of a fan. The sheath is marked off from the blade by being purple in colour. The sheath margins are fringed with fine silky hairs.

The root system is represented by a mass of coarse fibrous roots which develop from the nodes in contact with the ground, going straight downwards to a considerable depth.

During the period under observation Paspalum notatum did not flower and the description of the inflorescence is taken from the literature.

The inflorescence is borne on a stalk 1 to 2½ feet high and usually has two, very rarely three spike-like racemes,
subconjugate, thick and usually 4 to 7 cms. long. The spikelets are ovate to obovate 2.5 to 3.8 mm. long, green in colour, glossy in appearance and not marked. The caryopsis is enclosed in a chamber formed by a thick and tough lemma on the dorsal (germ) side, and by an equally tough palea on the ventral side. The lemma has its edges inrolled very tightly around the palea edges along the lateral ridges of the caryopsis. Outside the palea is the thin upper glume and outside the lemma is the equally thin lower glume.

Ecology and economic value:

Paspalum notatum was introduced to the Imperial College of Tropical Agriculture as "root setts" from the Institute of Agriculture, Venezuela, in January, 1948. It is reported to be growing wild in Cuba, and Mexico in the North to Argentina in the South, and is one of the commonest grasses of Uruguay and of several Brazilian States. Its centre of origin is believed to be the region comprising the South of Brazil, Uruguay and Paraguay (Brazil, 1946). Chase (1929) reports that Paspalum notatum has been introduced as a pasture grass in the Gulf States under the name of Bahia grass. It now forms the main constituent of native pastures in Cuba, Puerto Rico, and in parts of Costa Rica, Brazil, Uruguay and Argentina. Davies (1940) describes Paspalum notatum as being one of the most important constituents of natural grasslands in South America.

Paspalum notatum has now spread from South America and is becoming naturalised in many parts of the world. It was first introduced in the United States in 1913 and was first planted at the Florida Agricultural Experiment Station in May, 1913 (Scott, 1920). In 1924 Paspalum notatum was introduced to Uganda by the Veterinary Department, and was first planted at Entebbe (Thomas, 1942).

Numerous strains of Paspalum notatum are known and in Florida (U.S.A.), it has been found that strains differ considerably in their rate of spread, forage production and frost resistance.
Of the forty plant selections made in Florida in 1952, one narrow-leaved selection showed superiority in forage production and rate of spread. The narrow-leaved *Paspalum notatum* also showed more resistance to frost than selections made from the broad-leaved types (Florida, 1954). Two forms have been found to occur in Natal (South Africa), one of them with hairy leaves, and the other almost glabrous (Chippindall, 1955).

On account of its deep root system, *Paspalum notatum* is able to remain green and grow during periods of moisture stress (Thomas, 1942). It is not easily killed by burning; in fact, burning-over appears to give very much improved growth (Killinger et al., 1948) and tends to stimulate seed production (Burton, 1944).

Reports from Zanzibar seem to suggest that *Paspalum notatum* is difficult to establish and is not very palatable. Its advantage, however, lies in the fact that it is very vigorous and is able to compete successfully with weeds (Zanzibar, 1953). This aggressive character of *Paspalum notatum* is made use of in Uganda for the control of *Digitaria scalarum* (Couch grass) (Uganda, 1950). Thomas (1942) states "When *Paspalum notatum* has been planted in land infested with *Digitaria scalarum*, the former has increased, and the latter has diminished, until it is impossible to find it in the mass of *Paspalum*, although the couch persists for some time, at any rate near the edges." In Nyasaland, *Paspalum notatum* has been found to be extremely slow to establish itself, although a good ground cover is obtained in the second year (Nyasaland, 1951). It is very extensively employed in soil conservation work in Nyasaland and in Uganda for the planting of ditches, bunds and roadways (Maher, 1949). It is particularly useful for the planting of bunds because it does not produce such a marked border effect as will the larger grasses and it is able to root into any soil which may creep down (Thomas, 1942). The value of *Paspalum notatum* in Uganda is summarised by Thomas (1942) in the following words, "it is fortunate for Uganda that a grass introduced originally for
Pasturage has proved to be so suited to the wetter parts of the country and to be of such value in many ways."

Its importance as a pasture grass lies in the fact that it is able to withstand excessive grazing and will persist in good condition for many years under proper management. Heavy grazing seems to stimulate the grass to cover the ground with a mat of large stolons whilst, if it is left uncut or ungrazed, it forms a tufted mass of leaves about nine inches high (Thomas, 1942).

The grass in the experimental area was not sufficiently grown for samples to be taken for analysis and its chemical composition, as determined by American workers, is shown in the following table (Fraps et Fudge, 1945).

<table>
<thead>
<tr>
<th>Stage of growth</th>
<th>Protein</th>
<th>Lime</th>
<th>P2O5</th>
<th>Crude fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young growth</td>
<td>10.1</td>
<td>-</td>
<td>0.61</td>
<td>-</td>
</tr>
<tr>
<td>Intermediate growth</td>
<td>6.4</td>
<td>1.13</td>
<td>0.50</td>
<td>28.8</td>
</tr>
<tr>
<td>Mature growth</td>
<td>5.9</td>
<td>-</td>
<td>0.33</td>
<td>-</td>
</tr>
</tbody>
</table>

Experimental observations:

*Paspalum notatum* was planted out on the 28th October, 1959.

The planting material, obtained from the museum plot at the Old Farm, consisted of three short pieces of the thick stolons and was planted at a distance of 2 ft. by 2 ft.

After about a fortnight, one hundred per cent of the plants had "taken", and the only indication of growth was the development of short stout stolons which emerged from the axils of the old leaves on the planting material. Development of the grass was extremely slow, very little growth being produced in the six months under observation.

In order to measure the rate of spread, one stolon on each of the ten sample plants was tagged and their lengths measured weekly. These results are presented in graphical form and show very clearly that its rate of establishment is extremely slow. For this reason, it was not very successful in checking the incursion of weeds or "volunteer" plants and frequent weeding had to be
resorted to in order to prevent the plants from being smothered out.

One of its most valuable characters was that it remained green and continued to grow slowly during the dry season. As this grass in Trinidad is not burdened with flower production, it appeared palatable and succulent during the whole period under observation.

At the onset of the dry season, the whole plot was dressed with the equivalent of two hundredweights per acre of a fertiliser mixture made up of four parts by weight of sulphate of ammonia and two parts by weight of muriate of potash. Its response to fertiliser was not very marked and by the end of April, only small tufts of herbage had been formed which left a considerable amount of bare ground.

**Propagation and seed setting ability:**

During the period under observation, only one inflorescence was produced although the grass was left on the plot up to the end of April. It is a very shy seeder and Knight and Bennett (1953), working in America, have found that flowering in this grass is correlated with temperature and day-length. They have observed that flowering will only take place under fourteen and sixteen hour photoperiods at temperatures of 70° to 80°F. by day and 70°F. by night. A low night temperature of 55°F., however, inhibited flowering.

In Uganda, this grass is characterised by flowering once generally in its first six months if left ungrazed or uncut and then never again unless severely treated by harrowing. Under Trinidad conditions, however, Norman and Evans (1954) were unsuccessful in inducing flowering with continuous cutting, application of fertilisers, burning, or with the use of flowering hormones, but drastic cutting of the root system produced flowers. Further investigation is needed in this field. They also found that the seeds required a long dormancy period, varying from six
to twelve months. This dormancy period seems to be mechanical rather than physiological, and is attributed to the presence of a tough lemma and palea which enclose the caryopsis and prevent the maximum expansion of the embryo and the seed, or imprison the young embryo if it has started to grow. Work in Hawaii and in America indicates that this period of dormancy can be reduced by acid scarification or by the removal of the lemma and the palea. Matthews (1947) found that gentle stirring of the seeds in concentrated sulphuric acid for six minutes followed by blowing the seeds violently against a rough surface gave sixty-four per cent germination. In Hawaii (1944) maximum germination was obtained by heating the seed with concentrated sulphuric acid for thirty to forty minutes. Subsequent drying of the acid-treated seeds did not affect the germinative capacity.

**Paspalum notatum** can also be propagated by planting short pieces of the thick stolons but this is a laborious and expensive method on a large scale.

**Recommendations:**

The performance of **Paspalum notatum** in the present trial was rather disappointing. Its development throughout the period was extremely slow although the plant remained green in the dry season.

It is felt however that full justice was not done to this grass, as, being a naturally slow grower, the plant was not sufficiently established when the dry season started and was consequently unfavourably affected.

At this stage, therefore, it is unsafe to generalise about the behaviour of **Paspalum notatum**. It is suggested that it is retained for further experiments and observations.

The habit of growth makes it an excellent grass for sowing on slopes, embankments and other places where the surface soil needs to be held in position. It also appears to be able to withstand constant treading.
Many strains of this plant occur and it would appear to offer considerable scope to the plant selector. The numerous forms offer promising material for selection or breeding of types more suitable than existing ones.
**PASPALUM PILOSUM** Lam.

**Taxonomy:**

Paspalum pilosum Lam. is a member of the family Gramineae, sub-family Panicoideae and the tribe Paniceae.

**Morphological description:**

Paspalum pilosum Lam. is a tufted perennial, 30 to 100 cm. tall.

The culms are ascending and flattened; the nodes are white and shortly hairy.

The leaf blades are flat, 10 to 40 cm. long and 3 to 8 mm. wide, pointed with rough margins, harshly pubescent above and much less so beneath.

The leaf sheaths are compressed, hairy at the upper end and along the margins.

The ligule is membranous, 1 mm. long and backed by long hairs.

The inflorescence is a solitary raceme, 6 to 17 cm. long, and arcuate. The spikelets are 2.5 to 3 mm. long, elliptic and borne in pairs. The outer glume of the primary or pedicelled spikelet is minute and membranous and that of the secondary or sessile spikelet is about half the length of the spikelet and eccentric. The sterile lemma is leathery and encloses three purple stamens. The fertile palea is hony and longitudinally striated.

**Ecology and economic value:**

Paspalum pilosum is indigenous to tropical America and Trinidad. It occurs commonly on open sparsely wooded slopes, and bushy savannahs, mostly in rather moist soil, in the lowlands and up to 1,500 metres in Costa Rica, Bolivia and Southern Brazil (Hitchcock, 1936). Hinds (1940), in his report on the grasses of Trinidad, noted that Paspalum pilosum appeared to withstand both drought and severe handling but at low altitudes the leaves are frequently blotched, possibly by a Helminthosporium.

**Experimental observations:**

Off-setts of *Paspalum pilosum* were planted on the 27th
PASPALUM PILOSUM. Lam. (x ½)
A. Spikelet (x 10); B. Floret (x 10); C. Raceme (x 1).
October, 1958, in a small plot measuring 14 ft. long by 14 ft. wide. The planting material was obtained from the roadside near the "Old Block" of the I.C.T.A. Hostel. Each off-sett consisted of three rooted tillers and was planted at a distance of 1 ft. apart in the row and 2 ft. apart between the rows.

During the first few weeks after planting, there was very little vegetative growth and after three weeks, the majority of the plants began to flower. It was apparent that this flower formation was at the expense of vegetative growth and therefore, the early flowers were removed, but the effect on the vegetative growth appeared to be negligible.

The number of off-setts that "took" was extremely small and it appears that this grass is very sensitive to "planting shock" which makes its vegetative establishment rather difficult.

The development of intra-vaginal tillers was very slow and the grass did not appear to be able to withstand competition from weeds. Consequently, weeding of the plot had to be frequent, otherwise the grass would have been completely smothered out.

At the beginning of January, the grass failed to make any appreciable growth and became very coarse and fibrous. In an attempt to stimulate tiller production, half the plot was cut during early January and the whole plot was dressed with a fertiliser mixture (4:0:1) at the equivalent rate of 2 hundredweights per acre. Response to cutting and fertiliser application was very poor and flowering commenced again within ten days of cutting.

Later in the year, the plants began to make better vegetative growth but they remained tufted and afforded very poor ground cover.

The following table shows the chemical composition of the grass in the wet and in the dry season:

<table>
<thead>
<tr>
<th>Time of cutting</th>
<th>Crude protein</th>
<th>Fat</th>
<th>Fibre</th>
<th>Ash</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet season</td>
<td>14.42</td>
<td>1.53</td>
<td>25.86</td>
<td>16.66</td>
<td>90.80</td>
</tr>
<tr>
<td>Dry season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This grass was taken for analysis while in full bloom and no
Average number of tillers per plant.

--- Number of panicles per plot.

Average height of plant in inches.

Nov. 23rd.  Weeks  Jan. 25th.
reasonable account can be made of the unusually high protein content.

**Propagation and seed setting ability:**

Flowering in this grass commenced three weeks after planting, and rose to a peak about the middle of December. Thereafter, flowering decreased rapidly and by the middle of January, no further flowering occurred.

The inflorescence was found to be covered with the mycelium of a fungus. The seeds contained no caryopsis and a germination test was not considered worthwhile.

**Recommendations:**

*Paspalum pilosum* is a grass which from its performance in small plots appears to form very little herbage under Trinidad conditions. Its establishment and development are extremely poor and it forms large coarse tufts which do not cover the ground evenly. The stems are hard and fibrous and being very shallow rooted it does not appear to withstand drought. For this reason, as well as its comparatively small yield, it cannot be recommended for use in general agriculture.
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