The Flowering and the Production of True Seed of Sugarcane in Louisiana.

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THE FLOWERING AND THE PRODUCTION OF TRUE
SEED OF SUGARCANE IN LOUISIANA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Botany, Bacteriology,
and Plant Pathology

by
Elias D. Paliatseas
M.S., Louisiana State University, 1951
August, 1954
MANUSCRIPT THESES

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ABSTRACT

A study on the flowering and the production of true seed of sugarcane was undertaken at Grand Isle, Louisiana, during 1950, 1951, 1952 and 1953.

Floral initiation and flowering in sugarcane occurred each year under the conditions existing at Grand Isle, provided that freezing temperatures during the winter did not occur. Low temperatures prevailing in late fall and early winter prevented the production of viable pollen. Higher temperatures in the greenhouse were necessary for viable pollen production and anther dehiscence. Most varieties which were examined produced viable pollen. Differences in the percentage of viable pollen grains were noted in the various varieties.

Flowering of sugarcane in the greenhouse was affected by the time of transfer of rooted stalks to the greenhouse and by exposure to sunlight.

A suppression in the flowering of sugarcane appeared to occur in the greenhouse when the transfer of rooted stalks took place at an early stage of flower development, or when a North or East exposure was given to the plants.

An acceleration in flowering occurred in the greenhouse when the transfer of rooted stalks took place at an advanced stage of flower development, or when the rooted stalks were given a South or West exposure in the greenhouse.

The time of flowering of sugarcane coincided for most of the varieties, making possible a large number of crosses. These crosses would be difficult to make under tropical conditions in other sugarcane
countries where the period of flowering time is short and a steady sequence in flowering of the varieties is the rule.

Seedlings from selves and crosses were produced in 1951 and 1952. In 1953, seedlings from crosses only were produced. There was an increase in the percentage of flowering of sugarcane in the greenhouse each year. Also there was a steady increase in the number of seedlings from crosses produced every year.

The bi-parental crossing method was used, with either parental arrows rooted or the male arrow rooted and the female arrow preserved in Hawaiian solution, or by placing their roots in nutrient solution or water.

Differences in the number of seedlings produced by selfing between varieties were found.

Differences in the number of seedlings produced by different crosses were also found.

In all 219,597 sugarcane seedlings were produced at Grand Isle, La., in the four years from 1950 through 1953. These included 164,526 seedlings from the crosses made and 55,071 seedlings from selfing.
INTRODUCTION

The improvement of sugarcane, an outstanding world crop, known since the early records of history, 5000 B.C. (44), for a long time was entirely dependent on mutations or natural selection. As a result, progress was slow. Sexual reproduction as a means of breeding came into use only recently, as the opinion prevailed that sugarcane was incapable of producing viable seed. The fact that Creole, a noble variety, generally cultivated in past centuries did not flower, is likely to have led to this opinion (36). It is remarkable how this fallacy was accepted and endorsed with authority for so long, since Rumph (33) a Dutch Botanist of the seventeenth century made a definite statement to the contrary and cane seedlings were obtained in Barbados in 1858, in Java in 1862, and in Reunion in 1871 (33).

Nevertheless, when Soliwedel in Java and Harrison and Bovell in Barbados in 1889 (60) announced the fertility of sugarcane, their observations were received with some degree of suspicion and were not at once accepted. However, this discovery came at an opportune moment. A disease known as Sereh was going such great damage in Java that the industry was brought near ruin about 1880, and it became imperative that new sugarcane varieties be introduced. At the outset, attempts were made, through the importation of noble varieties from the Malay Archipelago, to find a variety immune to Sereh. This venture, however, was not successful. The subsequent discovery that cane produced viable seed stimulated cane breeding aimed at the production of varieties resistant to Sereh.
The ensuing activity in the hybridization of sugarcane may be classed in the following periods:

1. Channe mobilization: Varieties of *S. barberi* were imported from India and one of them, *Channe*, was crossed with the noble varieties, Striped Preanger and Black Cheribon. From these crosses a number of seedlings resulted (P.O.J. 33, 36, 105, 139, 213, 234) which were resistant to Sereh, but susceptible to mosaic.

2. Crosses between noble varieties which failed to produce resistance to Sereh.

3. Glagah mobilization: Kassoer was found to be a natural hybrid of Black Cheribon x *S. spontaneum*. By crossing the variety P.O.J. 2364 (P.O.J. 100 x Kassoer) with another noble variety (P.O.J. 2364 x EK.28), Jeswiet obtained a number of valuable varieties. Among these were P.O.J. 2714, 2722, 2725, 2878, and 2883, in which resistance to Sereh, mosaic and root rot were combined with the high sugar yield. Though further mobilization was continued, it was thought that disease resistance would decrease since seedlings of the fourth mobilization (P.O.J. 2929 and P.O.J. 2940) exhibited Sereh symptoms (72).

Although the initial work in cane breeding was directed towards resistance to the various diseases, the main object of all the sugarcane breeding stations has been to develop sugarcane varieties combining desirable agronomic characters, such as high yield, a high sucrose content, low fiber content, resistance to cold and drought, adaptability to mechanical harvesting and resistance to diseases.

Hybridization experiments were laid out on definite lines in which the different characteristics of the several varieties were carefully considered. The knowledge of the characteristics of the different
varieties was of the utmost importance, since with such knowledge it was often possible to continue the work with a small number of varieties possessing the desired qualities which were not found in others. The sugarcane breeders knew what characteristics they wanted in a variety and went after them through the careful selection of parent canes.

Proven parental varieties now enter largely into the breeding programs of the different countries, together with experimental crosses made with the object of proving other varieties as desirable parents. But the raising of large populations of seedlings of known parentage introduces a problem of selection among the varied assortment of combinations of characters present in these seedlings. Using a relatively small number of proved parental varieties, a large number of new varieties have been produced and have spread all over the world. Within a little more than fifty years of cane breeding, the original varieties that had been grown in the East throughout recorded history and carried to the New World at the end of the fifteenth century, have in most part assumed the role of museum specimens. Though still grown to some extent on a commercial scale, their place is, to an ever increasing degree, being taken by varieties raised from seed and selected by sugarcane breeders.

Sugarcane (Noble) was originally confined to the moist tropics, with only a few varieties being grown in the subtropical areas of Northern India, South Africa, Egypt, and Louisiana. With the development of new seeding varieties, derived from crossing Noble sugarcanes with more hardy wild species and forms, it became evident that a number of those varieties could be grown further into subtropical areas and could be subjected to a considerable degree of frost. From a commercial standpoint,
the sugarcane industries established in subtropical areas have thereby derived much benefit from the breeding programs, but had the disadvantage of depending on importations from other countries for their supply of varieties. This was because sugarcane, while giving adequate vegetative growth for commercial cultivation, was not sufficiently adapted to these climatic conditions to complete the life cycle by flowering and producing viable seed.

Under these subtropical conditions, sugarcane varieties may or may not flower naturally, and when they do, they fail to produce viable seed, a failure which in the majority of cases is due to the lack of viable pollen.

That low temperature was responsible for the lack of viable pollen in sugarcane was recognized first by Khanna (57). This was a major difficulty in the breeding of sugarcane in Northern India. It was overcome by transferring the breeding program to southern India (Coimbatore) where milder conditions for breeding prevailed.

Natal (South Africa) is another example of a subtropical country, where it was thought that sugarcane (commercial varieties) did not set seed, and was thus dependent upon other countries for its supply of improved varieties. In 1944, however, seed was obtained from commercial varieties for the first time (22). This stimulated an investigation of the factors responsible for viable seed production and by 1950, the information obtained resulted in the solution of the problem of hybrid sugarcane seed production from local sources.

In Louisiana, the problem of hybrid sugarcane seed production locally was more difficult than in Northern India and South Africa. First of all, sugarcane flowered in Louisiana only occasionally, and
when it did flower, the cold weather prevented the production of viable seed. Sporadic attempts, which were made in the past, to raise seed from flowering canes failed. Abbott (1) reports the production of a few hundred seedlings in Louisiana from a commercial variety late in March of 1949, a year in which sugarcane flowered in Louisiana.

The primary objective of the present paper is to summarize methods and techniques as well as results obtained during 1950, 1951, 1952 and 1953 by which it was proved that the production of hybrid sugarcane seed in Louisiana under controlled conditions was commercially feasible. This investigation was initiated by the Plant Pathology Department of the Louisiana Agricultural Experiment Station as a part of the sugarcane breeding project undertaken in 1948.
HISTORICAL REVIEW

The discovery that sugarcane can produce viable seed, although little more than fifty years old, has led to a line of research that has enabled the development of new varieties of sugarcane and revolutionized the sugarcane industry in every cane-growing country.

From the outset of this discovery, it became obvious that the study of the problem of flowering was of utmost importance, since flowering supplied the material for breeding: the flowers, carrying the gametes with chromosomes and genes, the correct random assortment of which could result in a variety superior in agronomic characters to all existing ones to the great benefit of the world's sugarcane industries.

Nevertheless flowering in general is a physiologic response which is one of the least understood of all responses. The reason no doubt is the complexity of the subject. The various factors that affect flowering are apparently not only numerous but interlinked. There are, in the first place, hereditary factors and environmental factors. Each species and even each variety has a given span of life, and at a certain stage the plant attains maturity and flowers. In the majority of cases, the response is closely linked with environmental and especially climatic conditions. This is most clearly seen in annuals and perennials in their seasonal progression of flowering of different species.

In sugarcane the term maturity has a special significance and refers to the period at which the juice reaches its maximum richness in sucrose. Maturity in this accepted sense is not linked with flowering, because some early maturing varieties rarely flower, while late
maturing ones may flower profusely.

Some plants retain the power to respond to their environment in the matter of flowering; notably there is a response to length of day which has been shown to characterize many plants. Sugarcane seems to belong to this group. In other plants, particularly perennials there is a further response to the carbon/nitrogen ratio in the plant tissue.

Agricultural plants have in many cases for years been subjected to a selective process which largely ignores those characters which have a natural survival value. Where the economic value of the plant lies in the fruit, human selection will control flowering, as in the production of early and late maturing varieties, but when the economic product is derived from tissues of the plant other than the fruit or associated organs, and this is the case with sugarcane, only minor attention is paid to the question of flowering.

Sometimes flowering in sugarcane has an economic aspect, which is opposed to its usefulness in breeding. It affects the weights and quality of juice and the loss of sugar sometimes may amount to 46 per cent.

Since the discovery in the eighties that sugarcane was capable of producing viable seed (33) the desirability of the knowledge of the factors controlling flowering has been unquestioned. Length of day seems to be one of the most important factors. Allard (2) in his day length experiments with a form of S. spontaneum 28 NG 292, introduced from New Guinea, induced it to flower in Washington, D. C. when he exposed it to a 13 hour day length. Similar results were obtained by Sartoris (76) in Arlington, Virginia. Sartoris observed that the range of day length under which this variety flowered was narrow; between
12 and 14 hours. Allard and Evans (3) stated that this form belonged to the intermediate class of plants, the members of which are unable to flower when the day length is too short or too long. McMartin (65) states that sugarcane, at least the cultivated varieties, require about a 12 hour day light period to respond to flowering and that this light period occurs in March, in Natal (South Africa), while apparent flower primordia can be found in April. Brett (27) expressed the suggestion that at least in cultivated varieties the light period over which they respond to flowering is longer than that found for S. spontaneum 28 NG 292, and that hybrids between officinarum and spontaneum may flower somewhere between the time of flowering of their parents.

Brandes had already confirmed that the time of flowering of hybrids of S. spontaneum x S. officinarum was intermediate. (17, 18, 19, 20). He applied photoperiodism to induce flowering in noble varieties grown at Canal Point in his attempt to transfer cold resistance found in a form of S. spontaneum introduced from Turkestan.

The time of flowering of S. spontaneum (Turkestan) which is in July in Washington, D.C. did not coincide with the time of flowering of noble types, S. officinarum, in midwinter at Canal Point, Florida. To bridge that difference Brandes transferred pollen of S. spontaneum by airplane to South America where noble types flower in July, and he made a successful cross. He raised the F₁ hybrid which bloomed in October at Canal Point, Fla. To backcross it with noble types and transfer cold resistance to them he applied photoperiodism to hasten flowering in them. He was successful in inducing a Co. 281 to flower in October, simultaneously with the F₁ plant, so that the backcross could be made.
In Southern Formosa (56), differentiation in the flower bud of sugarcane occurs about the end of September. The day length there at that time is about 12 hours. However, there is a slight variation in the differentiation date of the flower buds, depending on the variety, the date of planting and certain seasonal conditions.

In Hawaii (5), the first flag appears in the last week of October and the first flower in the first week of November. It appears that differentiation in the growing point of sugarcane occurs around the first week of September. The day length at that time is about 12 hours.

Some rather interesting cases are given in Hawaii (5) which would seem to support the reduced day length theory. At Kahuku, the first arrows appear in the field which are shadowed in the afternoons by cliffs to the west. Similarly, at the Manoa sugarcane substation, which lies at the foot of a thousand foot cliff, flowering commences before it does at Makini, where presumably this condition is absent. The local variation in the time of flowering may be influenced by the prevalence of the cloudy days which occur during September.

Because of the two year cropping system, flowering in Hawaii has an economic aspect. It affects the weight and juice quality, causing a loss which sometimes exceeds 46 per cent. To avoid these economic losses accompanying flowering in Hawaii, they either select canes which are light arrowers (61) or illuminate the fields with electric lights at night in September, to stop flowering (17, 28).

In India the problem of the flowering of sugarcane has received great attention at the Coimbatore Sugarcane Breeding Institute. The first experiments on flowering were by Dutt in 1932-33 and 1933-34 (40, 41). According to these experiments, sugarcane flowering was
hastened by eleven and fourteen days as a result of exposure to day light of six and four hours for 35 and 45 days respectively. A variety, Co. 290, flowered 26 days earlier than the control due to a six hour day treatment, but it was found that only one per cent, of the pollen produced germinated. In another experiment, Dutt (42) studied the effect of the long day. The additional light that was given was eight hours for 30 days with 60 watt bulbs. Sugarcane plants treated were at the fifth month of their growth. The vigorous variety, Co. 285, that ordinarily flowered at Coimbatore very early in the season, with the application of the long-day treatment had its flowering delayed so it became possible to cross it with thick canes (Noble) and to transmit hardiness. Co. 421, which flowered early under natural conditions, also was delayed by long day treatments and this enabled it to be crossed with Co. 290 and Co. 446, valuable late flowering canes. The long day treatment delayed flowering by about a fortnight.

These experiments though yielding very good results, did not afford positive means of regulating the processes associated with flowering.

A reexamination of the problem of flowering was made recently by Visarasaradhy and Narasimhan (99) with the object of gaining precise knowledge and understanding of the experimental induction and control of flowering of sugarcane.

[These experiments revealed that normal day length is critical for normal growth and flowering of the cane plant and that deviations of one or two hours in day length in either direction greatly inhibited and suppressed flowering. As brought to light by these experiments, sugarcane]
is not a short day plant as classified by others, but, as Allard and Evans suggested belongs to the intermediate group of plants. Lee and Lin (58), in 1950, studying the photoperiodic effect on some characters of S. spontaneum found that flowering was inhibited by six hours exposure to daylight and was delayed by exposures to light of nine and 15 hours.

That day length is one of the most important factors that control flowering is indicated by an experiment conducted by Hussainy (54). He collected a type of spontaneum near Lahore, North India with good agricultural characteristics. He transferred it to Coimbatore to be utilized for breeding. At Coimbatore, it did not flower. When he transferred it again to its original habitat it bloomed. Examining the factors that might have caused the failure to bloom, he found that the amount of light the plant received at Lahore from April to July exceeded that which the same plant received at Coimbatore during the same period by about 100 hours. S. spontaneum being a long day plant and receiving a prolonged duration of light at Lahore, flowered. Chilton and Moreland (28) working on the control of flowering of sugarcane, treated cane varieties with photoperiod treatments of gradually diminishing day lengths. They started on May 17 with a day length of 12 hours and 44 minutes plus the time to sunset and this was diminished a minute a day for 30 days and 1-1/2 minutes a day for the rest of the time until August 7th.

They observed the first response 26 days from the beginning of the experiment. After 44 days five varieties had floral initials. A sixth variety, Co. 290, formed initials early in August. They repeated the same experiment beginning in August and obtained similar results. They indicated that the response was due to the shortening of the day and
not to the lengthening.

Though day length is the most important factor in the flowering of sugarcane and thereby flowering is controlled by latitude, being profuse in the tropics and gradually diminishing away from the tropics, there are exceptions to the general rule depending on other environmental factors. First of all, most varieties of sugarcane do not flower every year. There are some which flower profusely in one country and scarcely or seldom in another. Moreover, the very same varieties flower differently in each country.

These exceptions (or divergencies) reflect difficulties in the breeding programs of the different countries and a knowledge of the particular behavior of the flowering of each cane variety in each country would be of help when coordination in a breeding program is needed (17, 18, 19, 20, 35).

Not only within different countries do the varieties behave differently as to flowering, but the same holds true for different regions within the same country.

For instance, variety H. 109 flowers profusely in Coimbatore and Hawaii but never in Java. P.O.J. 2727 flowers profusely in Coimbatore and never in Florida (90). Louisiana Stripe while never flowering in Louisiana, flower profusely in the Philippines (52).

In Java, in a moist cool climate in the hills, both arrowing and seed setting are better than in the warm dry lowland (90, 55).

In Mauritius, flowering is more profuse on the edge of the field than in the center (90). It is more profuse in mountains than in plains (34, 35). In India, arrowing of sugarcane is more profuse in Coimbatore than in Northern India. Barber and Venkatarma (9, 86) in
their pioneer work on sugarcane in India, made careful notices as to flowering in different sugarcane regions. Taking India as a whole, it was observed that flowering of sugarcane was profuse in the Southern part of the country but gradually decreased toward the Northwest. The time of planting and the type of soil were factors important to flowering (9, 10, 86). By planting sugarcane varieties in a wet environment a drop in the total solids occurred which seemed to favor flowering (91).

Ordinarily, sugarcane does not flower in North India, but heavy rainfall in the summer and fall, preceded by low humidity in the spring and summer, combined with high temperature throughout the year has caused flowering (13). It was found further in India that the free arrowing of sugarcane was associated with comparatively light soils and heavy rainfall during the growing season followed by a pronounced drought previous to the arrowing season (90).

On the basis of their flowering tendencies, the sugarcane types in India appear broadly divided into three categories, viz. (a) those whose original habitat is in the peninsular areas, south of the 18th parallel (North), (b) those belonging to the peninsular areas between the 18th and 20th parallels and (c) those belonging to the continental areas north of the 20th parallel. The number of cane types flowering at Coimbatore expressed as a percentage of the number of types collected from each area is very high for (a) 85.6 per cent, low for (c) 24.3 per cent and intermediate for (b) 66.7 per cent (45).

Arrowing of cane in Hawaii (5), varies with climatic conditions, elevation has a decided influence on arrowing. As has been observed, there is no arrowing less than 50 feet above sea level but a steady
increase from this to 600 feet beyond which few canes flower. As to the influence of moisture and soil fertility, it is impossible to judge exactly. However there is a difference in arrowing in irrigated and un-irrigated fields. The frequency of arrowing in plant canes and ratoons is about the same (5).

Markwell (62) observed that arrowing of sugarcane in Hawaii was favored by an irregular environment. A low phosphorous content favored flowering. Barnum (12) reported that flowering was dependent upon a high relative humidity (80 per cent to 90 per cent). Rainfall did not hinder flowering, but did inhibit the discharge of pollen.

In Natal (South Africa) (27, 65), the flowering of canes is determined by climatic conditions. The amount and distribution of flowering is governed by weather conditions of which the temperature and the rainfall preceding the flowering months appear important. According to DeAlmeida (32), flowering of sugarcane in São Paulo, Brazil, is more free than in any other country and many of the old varieties, which rarely flower in their country of origin flower freely in São Paulo. There is a seasonal variation in flowering and large varietal differences. P.O.J. 2725 and C. P. 27-139 annually flower up to 100, per cent, while Co. 281, Co. 290 and P.O.J. 213 rarely flower. Among other factors, age of the plants is important, flowering being more abundant in old canes. It is generally considered that canes infected with mosaic or other diseases have a predisposition to flower.

May is the month when the cane in São Paulo commences to mature, when the rains cease at the end of April and the temperature remains high, flowering is abundant. The sudden cutting off of moisture and minerals accompanying active photosynthesis in the leaves, appears
to be a condition favorable to flowering. This is in agreement with the carbon/nitrogen relationship.

The character of the soil, the fertility and the cultural methods adopted appear to influence flowering. Of the plant foods, nitrogen in the form of nitrate or sulphate of ammonia impedes and even prevents flowering, a fact which appears to be linked with the association between flowering and the carbon/nitrogen ratio.

In experiments (32) attempting to show the effect of nitrogen applications on the flowering of sugarcane, unfertilized plots showed 74 per cent flowering. One hundred Kgs. of sulphate of ammonia per acre, applied a month before the flowering season, reduced flowering to 54 per cent. Two hundred Kgs. of sulphate of ammonia reduced flowering to 11 per cent.

One of the greatest difficulties in crossing canes is that the different varieties do not flower simultaneously. In Coimbatore for instance, the noble varieties *S. officinarum* flower first, and varieties of the Indian species *S. barberi* later (89).

In Java, Glagah, Kassoer and Kassoer derivatives flower in that order while the noble varieties follow some weeks afterward. Further, it is a well known phenomenon in Java that canes flower sooner in high-lying regions than in the plains. It has been a common practice to synchronize crossing among early and late blooming varieties by the planting of cane varieties at higher elevations. On the Malay plateau some 1200 to 1600 feet high, with different rainfall and lower temperatures, the time of flowering of the different varieties shows a tendency to overlap, with some varieties continuing to flower for one and a half to two months (8).
Another means to bridge the difference between the flowering time of early and late blooming varieties, is the preservation of pollen of the early flowering variety until the late blooming one comes to bloom. Dutt (38, 39) succeeded in preserving pollen of the variety Maur 131 for 13 days in a desiccator in which the relative humidity was kept constant at 85 per cent and the temperature adjusted between 5°C. and 13°C.

Venkatraman (83), to bridge the 15 to 20 days difference in flowering between early thick canes (noble) and late thin ones (S. barberr), described a method in which the cut off tassels were packed in moist paper and straw. In this way he was able to preserve pollen for eleven days.

By preservation of pollen, it became possible for the cane breeders not only to bridge differences in flowering between early and late blooming varieties in a country, but also to transfer pollen from one location to the other or even from one country to the other (17, 18, 19, 20, 25, 35).

Sartoris (76) succeeded in bridging differences of about a month in early and late blooming varieties by planting them in muck and sand respectively. When a mixture of both were used the range of arrewing of the different varieties was extended to two-three months. Venkatraman (86, 87) using different kinds of soil was able to bridge differences in the flowering time of sugarcane varieties of 26 days.

Fertilizers may have some influence in flowering. It seems that the application of phosphate fertilizer hastens the time of flowering, whereas the application of nitrate fertilizers has a retarding influence (88).
DeAlmeida (32) reports that the application of phosphate had no effect on blooming; the application of potash led to an acceleration of flowering, while the application of nitrates either impeded or prevented flowering.

Bourne (15), studying the flowering behaviour of P.O.I. 2725 at Canal Point, Florida, dug up some stools in the field in October, divided each stool and replanted half in the field, the other half in the greenhouse. The former soon flowered, whereas the latter failed to flower. In March he moved it to the outside and noticed that it flowered. It seems that there was a suppression of flowering under greenhouse conditions.

Sartoris et al (78) report that an acceleration of natural flowering of sugarcane at Canal Point, Florida in the fall of 1947 was a result of fall high temperatures and flooding of the sugarcane area. The flowering was earlier than normal and more profuse. Late flowering varieties like C. P. 34-79 and F. 31-962 flowered earlier and more profusely in flooded spots than they did generally over the Everglades area. The flowering was more profuse for clones which produced roots on the submerged nodes as a result of flooding.

At Coimbatore (89), it has been possible to bridge differences in flowering time by a fortnight by planting the varieties at different times under different conditions; but these results by no means have been uniform or certain. Also, in India, smoking the sugarcane was found to hasten arrowing by about four days.

In the Philippines the disparity in flowering times of sugarcane is said to have been overcome by planting the parent varieties at
at different elevations. Cross pollination between Badila and Hind's special, previously not possible, was achieved by such a method (89).

Recently, in India, extensive studies were conducted on the control of flowering with the possible view of suitting it to their breeding program. For the first time since the foundation of the Coimbatore Cane Breeding Institute the non-blooming varieties, Co. 442 and Co. 439 bloomed in September and October, 1950 respectively (45). These varieties had been subjected to different manurial, irrigation, and photoperiod treatments (45).

Also late blooming varieties, Co. 290, Co. 440 and Co. 443 flowered a month earlier. Co. 290 and Co. 443 were subjected to 24 hours of complete darkness at the fifth month stage for nine and 12 days and received 17½/2 and 75 lbs. of nitrogen and three levels of irrigation, viz., normal, daily and twice daily until September 26, 1950. Co. 440 received different photoperiod, manurial, and irrigation treatments under pot culture until January, 1950 and were later transplanted in the field (45).

In another experiment (46), continuous darkness given at the 7½/2 month stage of growth made the early flowering varieties, Co. 285 and Co. 421 flower as late as November 9 and November 27, respectively, along with the late flowering varieties Uba Marot and Co. 290 and enabled crosses to be made between the two groups. On the other hand, at no stage of growth of the late flowering varieties did the seven and 15 day dark treatments induce any earliness, although, flowering was delayed under certain treatments.

The flowering behavior of early and late flowering varieties was found to be more markedly influenced by irrigation than by manure.
Under daily irrigation and manuring, an early blooming variety flowered until November 3. Under daily and normal irrigation, but with no manure, it flowered until as late as December 3. The variety Co. 421 continued to produce flowers until November 14 with daily irrigation and no manure, but with normal irrigation and manure (100 lbs. nitrogen) it continued to produce flowers until as late as December 10.

The late flowering variety Co. 290 started flowering as early as October 30 under daily irrigation and manuring.

Rasm(73) by means of x-rays was able to induce non-flowering varieties to flower and to delay the flowering of early flowering varieties.

For crossing it is significant to know the behavior of the parental varieties with respect to their fertility or sterility. Normally the flowers of sugarcane are hermaphroditic. However, some varieties do not produce fertile pollen. On the other hand, female sterility is rare. According to Stevenson (81), male sterility can be attributed to two causes: (1) genetic, due to a breakdown in meiosis and (2) environmental, due to a suppression of anthesis. Some varieties shed pollen freely, and some do not shed at all, where the cause is genetic.

In between there is a range in which shedding is affected by environmental conditions, and might be improved experimentally. Mangelsdorf and Lennox (59) pointed out that sterility in both sexes in sugarcane often occurs in the offspring of widely differing parents. For example, S. officinarum × S. barbati progeny, P.O.J. 36 is pollen and ovule sterile. In the majority of the cases, in Hawaii, only male sterile cane varieties which cannot fertilize themselves even though their ovules are functional are used as females. Examples of this condition are
Both the ovules and the pollen may be viable and the cane remain self sterile, due to self-incompatibility. Information as to the degree of self sterility of sugarcane varieties is useful in planning crosses with them. For example, Badila and H. 109 are self-sterile, while H. 456 is self-fertile (59).

It is essential to note that only male sterile varieties are used as female parents, while pollen producing ones are used as male parents.

According to Venkatraman (90), the behavior of varieties as to male sterility or fertility is different in the different sugarcane countries. For instance, Co. 281 in Coimbatore and Porto Rico produces pollen but in Florida is very inconsistent in pollen production. On the other hand, Co. 213 which in Queensland and Coimbatore is reported as male sterile produces fertile pollen in Mauritius.

To have an estimate of what proportion of the pollen produced by one variety is fertile or viable, staining with potassium iodine is used. The fertile pollen grains will stain blue because of the presence of starch. Better results were obtained when a propiono-carmine stain was used (103). Fertile pollen with this stain appear deep-red while the infertile ones appear light red. This method affords good results even when the pollen examined is taken two days before the anthers open.

However, neither the potassium iodine nor propiono-carmine stains, though they afford a good estimate of the viability of pollen, provide evidence on the germinative power of the pollen. Smith (79) reported that pollen viability tests are of little value. Commenting on the JJK (potassium iodide) test, he stated this method would demonstrate
only the presence of starch which indicates a well-developed pollen
grain and not the germinability.

A pollen germination test would be better. Dutt (38, 39) obtained
the best germinations of sugarcane pollen on agar containing 26 per cent
saccharose. Results of lesser degree were obtained with sugar concen-
tration varying from 0 and 30 per cent.

Bouras (16), in Florida, found, that 34 per cent saccharose
in agar gave the best germination. Weller (101, 102), in Hawaii, re-
ported the best germination of pollen grains in a 34 per cent saccharose
concentration. Sartoris (77) reported that sugarcane pollen retained its
viability for 10 days when stored under low temperature at 4°C. and
high relative humidities of 90-100 per cent.

Vyasasradhy (98) recommends a method for the preservation
of pollen during transport consisting of an ordinary, thermos flask in
which a test tube with the pollen is suspended. The thermos flask is
filled with water at the required temperature. The temperature of the
water in the thermos flask kept constant for two days. By changing the
water he could preserve pollen for several days.

It seems that the production of fertile pollen is strongly in-
fluenced by various environmental factors. Jeswiet (55) observed that
in the same field, the first arrows of EK.28 developed under humid
conditions, produced fertile pollen; the later ones that developed in a
drier period showed varying degrees of male fertility.

Venkatsraman (99) observed that cane varieties grown in sub-
tropical areas do not produce fertile pollen in the first year after their
introduction into the tropics.

Khanne (57) reported the effect of low temperature on the
viability of pollen of sugarcane in the subtropical regions of Northern India. Brett (22, 24), examining the pollen production and fertility under natural conditions in Natal during 1944-45, noticed that at the beginning of the flowering season in July, the pollen fertility was very low and tended to increase as the season advanced. At the beginning of the season only a few varieties produced viable pollen and these were the hardy types of *S. spontaneum*. In November and December, however, fertile pollen occurred in a considerably higher proportion of flowering varieties, including some of those released for commercial cultivation. In some of the varieties which flowered over a long period, it was found that viable pollen was not produced until some months after the commencement of flowering. The variety Co. 301, for example, was completely male sterile in July of both 1944 and 1945, whereas by October of both years it had started to produce much fertile pollen and seedlings were produced by using this variety as a male parent (24).

It was thought, therefore, that if during the earlier part of the flowering season canes were subjected to conditions approaching those naturally occurring later in the year, fertile pollen might be produced in some varieties that had previously been male sterile. The conditions in October and November in Natal are characterized by higher temperatures and longer days, than those prevailing in July. Using a combination of the Hawaiian and the Indian method, Brett (23, 24) was able to move canes that showed advanced signs of future flowering to the greenhouse and treat them with high temperatures (above 70° F.) and longer day lengths. He observed that when the stalks of some varieties flowered viable pollen was produced.

Further work, on the effect of different factors upon sugarcane
pollen fertility, indicated that the usual male sterility of tassels under the conditions existing in the field in Natal was due to one major factor, the low temperatures in the field (25, 26).

In Louisiana during 1949, a year of profuse natural sugarcane flowering, attempts made to obtain seed from tassels that were collected failed due to lack of viable pollen. However, late in March when the temperature increased, a few hundred seedlings were produced (1) from seed collected in the field.

During the 1951-52 flowering season at Grand Isle, La., periodic examinations of tassels produced in the open, showed no viable pollen. However, under greenhouse conditions (temperatures above 70° F.) viable pollen was observed in 14 varieties. The viable pollen varied from 40 to 92 per cent (71).

When the viability of sugarcane seed was demonstrated by Soltwedel in Java 1887, and Harrison and Bovell in Barbados (33), programs of breeding for new varieties of sugarcane were undertaken in both Java and Barbados. Other countries followed, Mauritius in 1891, India, 1912. Cane breeding stations were also established in numerous other countries notably Hawaii, Queensland, Porto Rico, Argentina, British Guiana, Florida, and etc.

The earlier work mainly consisted in collecting seed from wind-pollinated arrows, raising seedlings from these and testing them for desirable characters. Many valuable varieties were produced by this method among them H. 109 and C. P. 807, but the method was entirely empirical and depended for success on chance.

When Mendel discovered the laws of inheritance, it was surprising that his ideas took so long to be appreciated. First Bovell (80)
in Barbados conducted emasculation and artificial insemination ex-
periments with sugarcane flowers and produced the famous BH 10/12.
Practical difficulties of manipulation however, made this method un-
suited for raising the large number of seedlings required for a breed-
ing program. When it was recognized that partial or complete male
sterility characterized certain varieties, it became possible to use such
arrows in conjunction with male fertile arrows to produce seed from
crosses in adequate quantity and of a known parentage. This was the
first major advance in cane breeding, for it enabled parental value
to be assessed, through the average quality of seedling populations.

The techniques used to bring tassels together for pollination
may be classified in several ways. For instance, when the tassels are not
covered to exclude contamination from foreign pollen the crossing
method is designated as open crossing. When the tassels are covered
with bags, glass or celluloid so that foreign pollen is excluded, the cross-
ing is designated as covered crossing. Covered crossing was widely
used in Java and Hawaii at one time. But it was found that tassels en-
closed in lanterns yielded fewer seedlings than did those ripened in the
open. This method however, is still used in Formosa, Barbados and
Mauritius (61). In Java the covered crossing method was restricted to
crosses in which the certainty of parentage was of particular importance
(61). In Australia the lantern method is also used to some extent. Open
crossing is used in Java, Hawaii, Porto Rico and Florida.

Another difference in the technique used in crossing sugarcane
is whether or not parental tassels remain part of the plant during
crossing. Where the tassels remain part of the plant during crossing,
the type of crossing may be designated as field crossing or row cross-
ing. Where the parental tassels are separated from the plant the type
of crossing is designated as the rooting crossing system, free crossing
The row crossing system or field crossing system is an old one used to raise seedlings in Java and Hawaii (8), in which both parental tassels, male and female, are grown near each other in adjacent rows in the field. The two tassels are bent toward one another and the male is fastened over the female. Pollination occurs through the agency of the wind.

Rooting crossing method: This method, developed in India by Venkatraman (84) is used to make it possible to transfer arrows to isolated areas and thus prevent contamination from wind born pollen. The principle is based on the fact that root primordia are present at the base of the internodes and these are allowed to grow and develop roots by fastening a container full of compost around the middle of the stalk covering two joints. After sufficient roots are formed, the stalk shortly before emergence of the flower is cut and transferred to an isolated place for crossings. To protect the rooted arrows from unfavorable weather they are transferred to sheds (85).

Free crossings: This is open crossing, used mostly in Java and Hawaii, before the development of the Hawaiian crossing method in which sulphurous acid to maintain the arrows is used. In this method the female arrows remain attached to the plant while the male arrows are cut and placed in vases of water and fastened in position around the female arrow. The male arrows are replaced daily. Pollination occurs through the agency of the wind.

Evelyn (48) reported another method of producing rooted tassels for breeding purposes which has proved successful in Barbados. By this method, cuttings of cane varieties which are intended for use in
crossing are planted in cement barrels filled with ordinary soil and watered daily for the first few months. Grown in this manner, arrows are produced freely from the varieties tested. Crosses are made between the arrows produced by varieties grown in different barrels.

The Indian method of rooting arrows has been applied with slight modifications at both the Louisiana and Florida cane breeding stations (90, 70, 71). South Africa has reported and uses a method of rooting sugarcane stalks combining the Indian and the Hawaiian methods (23, 24, 25, 26).

The Hawaiian Method: It was recognized that crossing would be greatly expedited if some means could be found to prolong the life of the cut male tassels, thereby eliminating the necessity of replacing these tassels each day. Verret and his associates after conducting a large number of experiments with various chemicals found that cane stalks with or without a tassel in a solution of sulphurous acid at a dilution of one part of sulphurous acid to 2000 parts of water, would remain alive in normal condition for several weeks (4, 74, 93, 94, 95). The sulphurous acid method, permitted the cane breeder to make his crosses in isolated locations well removed from the danger of contamination by wind born pollen.

Das and Wilder (31) reported on their use of concentrations of three parts of sulphurous acid to 10,000 parts of water. The solution was changed every three days, and the ends of the sugarcane stalks were cut off at each change of solution. Verret (97) observed that the great advantage of the sulphurous acid method was that the cane breeder was not faced with the problem of synchronizing the period of receptivity of the stigma with the dehiscence of the anthers. The breeder
was using two normal tassels in a manner making it possible to mini-
mize contamination with foreign pollen.

The Hawaiian method is based on the fact that the microorgan-
isms responsible for the clogging of the vascular system of sugarcane
arrows when placed in water, are inhibited so that the normal uptake
of water by the plant is possible.

Agee suggested that the antiseptic used for this purpose should
be lethal to the microorganisms and non-injurious to the arrow (4).

Although some varieties did quite well in the sulphurous acid
solutions used other varieties tended to die prematurely. From 1928
to 1931, further work was conducted in Hawaii with the object of finding
a means of enhancing the effectiveness of the SO₂ solution.

The modified sulphurous acid solution at present employed con-
tains 150 ppm of SO₂ and 85 ppm of H₃PO₄ (61).

The importance to Hawaii of this development can be appre-
ciated from the fact that, since 1931 every seedling of commercial
value has been derived from crosses of which one or both parents was
kept alive by means of the modified sulphurous acid solution (61).

The Hawaiian method has also been tried in most of the other
cane breeding countries and has generally replaced other methods.

In Mauritius, the Hawaiian solution method was modified by
adding 0.01 per cent of calcium sulphite, which is supposed to change
the sulphuric acid produced in the solution back to sulphurous acid.
This method appears to have given better results (47).

In Australia, the Hawaiian method has given good results.

Further experimentation showed that a solution containing 0.01 per
cent of SO₂ and 0.01 per cent of H₃PO₄ gave the best results under
Australian conditions (6, 53).

In Barbados, the solution method proved unsuccessful and the seed did not germinate (64).

In Florida, the Hawaiian method used mostly under field conditions to preserve male tassels only for pollination has given good results. Its application under greenhouse conditions was not too successful and most of the tassels died prematurely, perhaps due to liberation of SO\textsubscript{2} gas in the air (50).

Favorable results were obtained by Bourne, (14) with the sulphurous acid-phosphoric acid solution in Florida. He used a rack having 12 containers for the solution. The rack afforded protection of the solution against light, dilution by rain and foreign matter, also the stalks were easy to handle in the rack.

At present the Hawaiian methods for crossing sugarcane include the conventional "bi-parental crossing" in which the crossing of two parents takes place in isolation, the "melting pot" technique and the "area cross technique". The term melting pot as used in Hawaii refers to an area to which is brought a wide diversity of carefully selected female varieties. In this area interspersed among the female arrows, arrows of a number of selected male varieties are placed. The arrows used in the melting pot are moved around periodically to increase the diversity of cross-pollination. Only the female parent of seedlings produced in the melting pot is known.

The "area cross" is one method in which a single outstanding male parent is used to pollinate a number of female varieties. Both parents of the progeny are known. Both "melting pot" and "area cross" methods were developed during the war, when labor was restricted,
with the object of producing seedlings from a large number of combinations at a minimum expense (100). Since the war with increased facilities for "bi-parental crossing", it is felt still in Hawaii that the melting pot procedure has a definite place in the breeding program. A recent study of the 1949 and 1950 seedlings, which appeared outstanding in 1952, shows that 86.5 per cent were derived from the melting pot crossing with only 13.5 per cent of these select seedlings coming from bi-parental crosses (100).

Another distinction in the methods used in crossing cane is whether the crossing is natural or artificial. Under natural crossing the shedding of the pollen from the anthers of the male arrow on the stigmas of the female arrows occurs naturally. Under artificial crossing, the collected pollen from male arrows is brought to the stigmas of female arrows artificially.

Artificial pollination was first employed in Java (8) toward the end of the crossing season when only a few male tassels were available. This method has never attained practical importance and it is resorted to only in special circumstances (17, 18, 19).

Recently in Porto Rico (51), artificial pollination by means of a small hand sprayer was used to increase the efficiency of natural crossing and seed setting during the rainy season in which natural shedding of pollen was limited. The pollen in the sprayer was suspended in water.

The ripening of sugarcane seed takes two to four weeks after pollination and there are certain signs when it is completed. The top portion of the arrow begins to fall apart, and the small leaflet under the arrow dries up. At this time the arrow should be cut and placed in
a bag to dry. In many sugarcane breeding stations where the Hawaiian method is used, the male arrows are thrown away after pollination and a cover is placed over the female arrows to protect them from birds and from the chance of seed becoming mixed by the blowing about of parts of ripe arrows (8, 53).

In Hawaii (61), when the arrows in various isolation racks and in melting pot areas have finished their pollination, they are transported to a central ripening area where they can be watched closely so that they may be harvested at the proper stage of maturity. Upon removal of the female tassels from the bi-parental crosses and "area crosses" to the ripening area the male tassels are discarded. All tassels in the melting pot areas, both male and female, are transported to the ripening area and are harvested for subsequent sowing (61).

In Australia (53), after all flowers have opened and pollination is completed, the female arrows are removed to the ripening rack. This is merely a stand to which the females may be tied while the seed ripens.

Since there is no pollen present in these female arrows and the stigmas are past the receptive stage, arrows from the different crosses can be placed very close together. It takes 14 to 28 days from the completion of pollination to the ripening of seed.

In Florida at the Canal Point Station, after pollination, the female arrows are moved outside the greenhouse to save space in the greenhouse for other crosses. Male arrows are discarded after pollination (50).

Sugarcane seed can germinate soon after ripening if conditions
are favorable. It is possible to preserve seed for a short time without the use of any special technique. Seed of *S. spontaneum* for instance remains viable from three to eight months but the viability gradually decreases.

In some cases it is desirable to preserve sugarcane seed longer than usual if planting cannot be done until several months after harvest.

Several investigators (29, 63, 75, 96) have shown that *Saccharum* seed can be preserved dry over CaCl$_2$ at a low temperature (about the freezing point) or in a CO$_2$ atmosphere.

Sartoris (75) stored cane seed in the presence of carbon dioxide and calcium chloride for eight months and obtained germination comparable to fresh seed.
MATERIALS AND METHODS


In the second half of October 1950, 90 stalks of sugarcane, (six each of 15 varieties) were selected on the basis of possible future blooming and were rooted with stove pipes which were filled with muck soil, using a modification of the method reported by Venkatraman (84). After sufficient roots were formed, at about the end of November these canes were severed beneath the stovepipes and were transferred into a 9' x 15' x 13'1/2' greenhouse heated by a butane gas heater with an automatic temperature control. The sugarcane stalks in the greenhouse were watered daily and attention was given to prevent the temperature in the greenhouse during the day from rising above 90° F. The temperature was kept between 75° F. and 80° F.1 An examination of pollen

\[1\] For temperature recording, thermographs placed at an eight foot height were used.
production and pollen fertility in the sugarcanes that flowered was made.
To test the viability of the pollen the potassium iodine method was used.
About 30 days after blooming the fuzz was collected in paper bags, dried
for one day in a shaded part of the greenhouse and then mailed to Baton
Rouge for planting. The planting was done in flats in a greenhouse in
Baton Rouge in sterilized soil and at temperatures of 85° to 92° F.

When the flowering season was over in early March, 1951, and
no signs of flowering were observed in the majority of the marcotted
canes in the greenhouse, they were transferred outside the greenhouse
and planted in the nearby field in two rows. Apparently these canes
did not have floral initials and failed to bloom, but were kept for the
second flowering season. No natural flowering occurred in the 1950-51
season because outside temperatures dropped below freezing twice and
all the sugarcane stalks growing in the field were damaged.

During the 1951-52 season about fifteen more varieties selected
from those used as parents at the Canal Point Breeding Station in
Florida, were sent to Grand Isle and planted in single row plots as done
previously. Another greenhouse 12' x 12' x 15', was built in the summer
of 1951 and was also heated with butane gas. Organic fertilizer (shrimp
bean) at the rate of 1500 pounds per acre and chemical fertilizer (8-8-8)
at the rate of 400 pounds per acre were applied to the sugarcane during
the spring. The cane breeding plots were irrigated during the summer
months with well water using two gasoline powered pumps. The canes
were dusted weekly from April to the end of October with cryolite for
the control of the sugarcane borer.

In the first week of October periodic examinations for floral
initials were made. Cane tops were dissected longitudinally and the
growing point was examined with a hand lens for floral differentiation. To detect differentiation at the very earliest stage a microscope was used.

The time of floral initiation and the percentage of stalks showing this were determined by random sampling.

Upon the completion of floral initiation in the various sugarcane varieties which occurred from about the end of October until the 15th of November, 500 canes that showed the characteristics indicating future flowering, and including 28 varieties, were rooted using stove-pipes as in the previous year. These were divided into three groups of about 166 canes each. The first group of 180 was moved to the greenhouse November 15, the second group on November 30 and the third group on December 15, 1951. The transfer to the greenhouse was expected to produce flowering and to increase pollen fertility. The time when the sugarcane stalks were transferred to the greenhouse was found to affect blooming. In 1951-52 the cane stalks in the greenhouse were handled in the same manner as the previous year as far as maintaining temperature and watering were concerned. They were arranged in rows in such a way as to give the maximum exposure to sunlight. Additional light was given in the afternoon between 4 p.m. and sunset using four fluorescent units of 100 watts each in each of the two greenhouses. When the stalks began flowering about the middle of December, and male and female arrows were available, crossing work was started. Priority was given to crosses between those varieties which had given the maximum percentage of initial seedling selections when used in crosses made at Canal Point, Florida in previous years. When proven parent varieties were not available, other varieties were used in the crosses in order to
explore the capabilities of these as parents. The system of crossing that was used was bi-parental. Both male and female arrows rooted in stovepipes were tied together with the male arrow extending about six inches above that of the female. Pollination of the female arrow was done by tapping the stalks in the morning between 8 and 9 a.m. Complete genetic male sterility was not observed in the varieties grown at Grand Isle. Partially male sterile arrows due to lack of dehiscence of the anthers were used as female parents. Pollen viability tests between and within male fertile varieties were made using the propionic-carmine stain (103).

Sometimes male sterile arrows grown in the field were used in crosses in the greenhouse. These arrows exhibited complete male sterility due to the low temperatures present in the field during the development of the arrows. The number of male and female arrows in the greenhouse when increased by female arrows taken from the field made possible combinations not made at other sugarcane breeding stations in tropical countries, where dependence is supposedly placed only on genetically male sterile varieties for use as females in the crosses made. The seed or fuzz was harvested in paper bags separately from male and female arrows three to four weeks after the last florets in an arrow had opened. In ripe arrows secondary spikelets are blown away by the wind unless seed are collected immediately upon ripening. The fuzz was taken to a shaded part of the greenhouse for drying for one day and were then shipped to Baton Rouge for planting. During the 1951–52 breeding season, natural flowering occurred in the field at Grand Isle. The number of varieties that flowered naturally and the percentage of blooming per variety was determined. Periodic
examinations for possible viable pollen production under natural conditions were made and ripe arrows from a few varieties were collected to determine if viable seed were produced.

1952-53 Breeding Season

The program was expanded in 1952-53. The number of sugarcane varieties in the field was increased to approximately fifty and the greenhouse space available was expanded to 630 square feet. The detection of flower primordia was begun as usual on October 1, 1952. The number of sugarcane stalks selected for rooting was about one thousand, and included twenty-eight parental varieties. Four dates of rooting corresponding to four dates for transferring canes to the greenhouse were used. The number of new leaves developed from the time of transfer until the boenting stage was determined for each of ten varieties in each of the four transfer groups. The number of flowers per variety and per group were also determined.

To determine whether exposure of sugarcane stalks in the greenhouse had any effect on emergence of the arrows five varieties were chosen, including 20 stalks each with five stalks of each variety facing East, South, West and North respectively. The number of emerged arrows per variety and exposure was recorded.

During the 1952-53 breeding season the number of cane stalks in the greenhouse was very large and many did not receive the amount of light usually considered necessary for flower emergence. It was interesting to note, however, that some canes reached the boenting (preflower) stage but the arrows did not emerge. Though such arrows stayed alive for some time inside the sheath of the last leaf they
ultimately died.

The following technique was developed to prevent the death of the arrows and to enhance their emergence. The sheath of the flag leaf was lightly scored 2” to 4” below the ligule, carefully split and removed, exposing the top part of the inflorescence or arrow. The exposed part of the arrow turned pink and in three or four days began to slowly emerge. When the subsequent development of the arrow was restricted, the above was again done, to permit further growth of the arrow. If necessary, this process was continued at three to four day intervals until emergence of the arrow was completed.

When applied, this technique gave very good results with some varieties and poor results with others.² Crosses of sugarcane were made in 1952 by the bi-parental crossing method, and a large number of seedlings were produced.

1953-54 Breeding Season

During 1953-54 the number of varieties grown at Grand Isle, in the breeding plots was increased to approximately 80. The dates when floral initiation was first observed in each variety were recorded as usual. Muck soil and sand, 3/4 to 1/4 respectively, were used to root canes in 24’’ stovepipes. Most canes rooted in this manner were used as male-fertile parents after transfer to the greenhouse. Male-sterile arrows were used as females and were transferred to the greenhouse from the field at the time of emergence of the arrow. The transfer was made either after marcelsetting or in a modified Hawaiian solution of 150

² Some natural flowering occurred in the field during the 1952-53 season and the dates of flowering as well as percentage was determined for each variety.
ppm $\text{SO}_2 + 85$ ppm $\text{H}_3\text{PO}_4$, as described by Mangelsdorf (61). For rooting, either 12" long stovepipes filled with the muck-soil mixture and covering only two joints, or plastic films 18" x 18" fastened around two joints and filled with wet sphagnum moss were used. After enough roots were produced by the stalks, usually about two to three weeks after marcotting, the cane plant with the arrow about to emerge was severed below the rooted joints and transferred to the greenhouse and either planted in a crock or placed in nutrient solution or water. The nutrient solution was prepared by adding 2 gm. potassium sulphate, 2 gm. Mg. phosphate and 4 gms. Calcium Nitrate to one gallon of water.

The nutrient solution or water was aerated, using a small air pump. Antibiotics such as penicillin, streptomycin, aureomycin and chloromycetin were used at concentrations of 50 ppm, 100 ppm, 150 ppm, and 200 ppm, as arrow preservatives. None of these approached the efficiency of the Hawaiian solution, although most of them were good for inducing roots.

Most of the crosses made during the 1953-54 breeding season involved parentages whose value was proven from previous years, and from which a maximum percentage of select seedlings had been obtained in the past. Sometimes such crosses were difficult to make, because of differences in the flowering time among the varieties involved. However, at Grand Isle, most of the useful combinations in crosses were obtained because the flowering season was long, extending from November through June, and there was an overlapping in the sequence of flowering of the different varieties. Such an overlapping is unknown in tropical countries and may perhaps be attributed at Grand Isle to the differential effect of low temperatures in suppressing flowering. Under
greenhouse conditions the flowering also was extended from November to June, with overlapping in the sequence of flowering of the different varieties and this made possible, a number of desirable combinations between parents that would have been difficult to obtain under natural conditions in other areas.

The long duration of the flowering season of sugarcane at Grand Isle, Louisiana under natural and controlled conditions would make possible the carrying out of a cane breeding program based on outside crosses, provided a protected area be found in which male-sterile arrows from the field and male fertile ones from the greenhouse could be used for crossing.

Such a possibility was investigated during the 1953-54 breeding season. A few crosses were made in the middle of May in an area protected from the wind between two greenhouses, using male sterile arrows from the field and male fertile ones from the greenhouse. When the seed was ripe in the middle of June, samples were taken from both male and female arrows and checked for germination.

Periodic examination for pollen production and viability under natural conditions was made from November until the middle of May. The system of crossing used during the 1953-54 breeding season was bi-parental, with both parental arrows rooted or with only male arrows rooted and female arrows preserved in the Hawaiian solution.

Upon ripening of the seed, only fuzz from female arrows was collected. Fuzz from male arrows was discarded. The germination of the seed per cross was made either by planting all the fuzz, or by using a representative sample, with the remainder of the fuzz being stored in a freezer at 0°F. for use the next year.
EXPERIMENTAL RESULTS

1950 Season — Floral Initiation

The dates and percentages of floral initials found at Grand Isle are given in Table 1. Of twenty-five varieties of sugarcane grown in the field at Grand Isle during the fall of 1950, six formed floral initials between October 12 and October 24. The percentage of floral initials found was very low and varied, according to the variety, from eight to 18 per cent.

Flowering

The results on the production of flowers and seedlings at Grand Isle in 1950 are shown in Table 2. Of ninety stalks, including fifteen varieties which were marcotted and brought into the greenhouse, only two, C.P. 44-101 and C.P. 44-155 flowered. Pollen produced by C.P. 44-101 was examined using the iodine test and ninety per cent full grains were found. Although C.P. 44-155 produced some viable pollen, the anthers did not show good dehiscence. Thirty days after the last florets had opened, seed from both arrows were collected and planted in flats in sterilized soil. Seed from the variety C.P. 44-101 were germinated and produced sixty-seven seedlings and from C.P. 44-155 eight seedlings. These were the first sugarcane seedlings produced in Louisiana under controlled conditions.

Natural flowering of sugarcane did not occur in 1950.
Table 1. Time of Floral Initiation for some Varieties Tested at Grand Isle During 1950.

<table>
<thead>
<tr>
<th>Test NO.</th>
<th>Variety</th>
<th>Floral Initiation Date</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C. P. 29=103</td>
<td>10/17/50</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>C. P. 29=116</td>
<td>10/15/50</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>C. P. 34=120</td>
<td>10/22/50</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>C. P. 36=13</td>
<td>10/12/50</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>C. P. 36=105</td>
<td>10/24/50</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>C. P. 44=101</td>
<td>10/14/50</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>C. P. 44=155</td>
<td>10/21/50</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2. Data on Sugarcane Flowers and Seedlings Production in the Greenhouse at Grand Isle, Louisiana in 1950.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>No. stalks Rooted</th>
<th>No. Arrows Produced</th>
<th>No. Seedlings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>C. P. 29=103</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>C. P. 29=116</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>C. P. 29=120</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>C. P. 29=320</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>6</td>
<td>C. P. 30=24</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>7</td>
<td>C. P. 34=120</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>8</td>
<td>C. P. 36=13</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>9</td>
<td>C. P. 36=105</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>10</td>
<td>C. P. 36=203</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>11</td>
<td>C. P. 43=3</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>12</td>
<td>C. P. 43=9</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>13</td>
<td>C. P. 44=101</td>
<td>6</td>
<td>1</td>
<td>67</td>
</tr>
<tr>
<td>14</td>
<td>C. P. 44=155</td>
<td>6</td>
<td>1-</td>
<td>8</td>
</tr>
<tr>
<td>15</td>
<td>C. P. 45=155</td>
<td>6</td>
<td>2</td>
<td>75</td>
</tr>
</tbody>
</table>

**TOTAL 90**
1951 Season — Floral Initiation

Forty varieties of sugarcane were grown at Grand Isle during the 1951-52 season. Of these, twenty-five were available as plant cane and fifteen as first stubble. Observations for the occurrence of floral initials were started the second week of October and records of the date and percentage of floral initials found were made for each variety and type of planting.

Floral initials were found in eleven varieties in plant cane, in seven varieties in first year stubble, and in seven varieties were found both in plant cane and in first year stubble. Floral initials were formed at practically the same time, regardless of the variety or type of planting, e.g. plant cane or first stubble. The dates and percentages of floral initiation are shown for each variety and type of planting in Table 3. With the exception of two varieties, Co. 290 and F. 36-819, the percentage of floral initials found was very high, and varied with the variety from forty-eight to ninety-eight per cent. Differences in the percentage of floral initials found, although existing between the different varieties, were not for the type of plantings within varieties. Only in one variety, C. P. 36-105, were found large differences in percentage of initials between plant cane and first year stubble.

Flowering

A total of five hundred and twenty stalks of cane from twenty-two sugarcane varieties were rooted in the field from October 20th to November 15, 1951. These were divided into three groups of 180, 180, and 160 stalks, which were transferred to the greenhouse on November 15, November 30, and December 15, respectively. Some of the cane stalks after growing in the greenhouse at temperatures
Table 3. Summary of data on floral initiation and natural flowering in some varieties of sugarcane observed at Grand Isle, La., in 1951.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>Plant 1st. found</th>
<th>Percentage of initiating</th>
<th>Plant 1st. found</th>
<th>Percentage of natural flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>10/20</td>
<td>45</td>
<td>11/14</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Co. 290</td>
<td>10/20</td>
<td>44</td>
<td>11/14</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>C. P. 27-108</td>
<td>10/20</td>
<td>92</td>
<td>10/19</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>C. P. 29-103</td>
<td>10/20</td>
<td>85</td>
<td>10/19</td>
<td>51</td>
</tr>
<tr>
<td>5</td>
<td>C. P. 29-116</td>
<td>10/20</td>
<td>85</td>
<td>10/19</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>C. P. 29-120</td>
<td>10/20</td>
<td>75</td>
<td>10/19</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>C. P. 30-24</td>
<td>10/20</td>
<td>75</td>
<td>10/19</td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>C. P. 30-224</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>9</td>
<td>C. P. 33-229</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>10</td>
<td>C. P. 34-120</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>11</td>
<td>C. P. 36-103</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>12</td>
<td>C. P. 36-103</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>13</td>
<td>C. P. 38-34</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>14</td>
<td>C. P. 43-3</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>15</td>
<td>C. P. 45-9</td>
<td>10/20</td>
<td>45</td>
<td>10/19</td>
<td>55</td>
</tr>
<tr>
<td>16</td>
<td>C. P. 43-28</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>17</td>
<td>C. P. 43-64</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>18</td>
<td>C. P. 43-74</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>19</td>
<td>C. P. 44-101</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>20</td>
<td>C. P. 44-155</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>21</td>
<td>C. P. 44-186</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>22</td>
<td>C. P. 45-155</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>23</td>
<td>C. P. 48-106</td>
<td>10/20</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
<tr>
<td>24</td>
<td>F. 36-319</td>
<td>11/11</td>
<td>45</td>
<td>10/24</td>
<td>55</td>
</tr>
</tbody>
</table>
of between 75°F and 80°F. for approximately a month began flowering. The number of arrows emerged per variety and date when brought into the greenhouse were recorded from the beginning of the flowering season to the end. The results are shown in Table 4. Of the 22 varieties transferred to the greenhouse, 18 flowered. The percentage of flowering in the varieties varied from three to 66 per cent, with varieties Co. 281, C.P. 27-108, C.P. 30-24, and C.P. 48-106 having the highest number flowering and F. 36-819, C. P. 33-224, and C.P. 33-229 having the lowest number producing flowers. The average percentage for the varieties flowering in the greenhouse was 28.4; however, for all varieties observed the percentage of flowering was 23.6.

In the first group of stalks which was transferred to the greenhouse, 33 plants, or 18 per cent of the total, produced arrows; of the 180 plants in the second group, 40 or 22 per cent formed arrows; of the 160 plants in the third group; 49, or 32.6 per cent of the total produced arrows.

The dates when the first and last arrows emerged in the greenhouse, and the duration of flowering in days for each variety of sugar-cane observed are shown in Table 5. C.P. 48-106 flowered first in the greenhouse on December 28, 1951, C.P. 29-116, C. P. 36-105, and C.P. 34-120 flowered a few days later in the order given. These varieties are members of the so-called early flowering group. F. 36-819 flowered three months later and, together with C. P. 29-103, C. P. 33-229, and C.P. 43-64 belong to the group considered as late flowering varieties. For crossing, not only the date when the first flower emerged but also the date the last flower emerged for each variety is important; the difference between the two gives the duration of flowering
Table 4. Effect of time of transferring of sugarcane to the greenhouse on flowering at Grand Isle, La. in 1951.

<table>
<thead>
<tr>
<th>No.</th>
<th>Varieties</th>
<th>No. rooted stalks transferred to greenhouse</th>
<th>No. arrows emerged from stalks transferred</th>
<th>% flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>11/1 11/15 11/30 Total 11/1 11/15 11/30 Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>5     5     5     15     0     2     4     6     40.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>C.P. 27-108</td>
<td>11    14    10    35     6     7     8     21     60.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>C.P. 29-103</td>
<td>10    10     5    25     1     2     3     6     24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>C.P. 29-116</td>
<td>10    10     10    30     6     7     7     20     66.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>C.P. 30-24</td>
<td>10    15     5    30     4     4     5     13     42.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>C.P. 33-224</td>
<td>10    10     10    30     0     0     0     1     2       6.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>C.P. 33-229</td>
<td>10     5     5    20     0     0     0     1     1       5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>C.P. 34-120</td>
<td>10    15     10    35     4     5     4     13     37.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>C.P. 36-120</td>
<td>10     5     5    20     1     2     3     6     30.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>C.P. 38-34</td>
<td>10    10     10    30     2     2     2     6     20.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>C.P. 38-7</td>
<td>2     2     1     5     0     0     1     1     20.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>C.P. 42-64</td>
<td>10    15     10    35     1     1     2     4     11.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>C.P. 43-74</td>
<td>5     10     10    25     3     2     3     8     32.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>C.P. 44-101</td>
<td>10     5     5    20     0     1     2     3     15.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>C.P. 44-105</td>
<td>10     5     5    20     0     0     0     1     10.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>C.P. 44-156</td>
<td>2     2     1     5     1     0     0     1     20.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>C.P. 48-106</td>
<td>5     5     10    20     3     3     2     8     40.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>F. 36-819</td>
<td>10    10     10    30     0     0     0     3     3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>450    35    40    49    122</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nonflowering

<table>
<thead>
<tr>
<th></th>
<th>No.</th>
<th>11/1 11/15 11/30 Total</th>
<th>11/1 11/15 11/30 Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Co. 290</td>
<td>13         15          22</td>
<td>50          0          0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 29-120</td>
<td>4          3           3</td>
<td>10          0          0</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 29-320</td>
<td>10         5           5</td>
<td>20          0          0</td>
<td>0</td>
</tr>
<tr>
<td>22</td>
<td>C.P. 36-183</td>
<td>3          9           3</td>
<td>10          0          0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>180         180         160</td>
<td>520         35          40</td>
<td>49</td>
</tr>
</tbody>
</table>
Table 5. The date of first and last arrow emerged and the duration of flowering for the varieties of sugarcane tested in the greenhouse at Grand Isle, Louisiana, in 1951.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>Date of first arrow emergence</th>
<th>Date of last arrow emergence</th>
<th>Duration of flowering (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>1/4/52</td>
<td>3/9/52</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>C.P. 27-103</td>
<td>1/15/52</td>
<td>3/15/52</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>C.P. 29-116</td>
<td>2/28/52</td>
<td>3/16/52</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 30-24</td>
<td>1/15/52</td>
<td>3/1/52</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 33-229</td>
<td>1/26/52</td>
<td>3/1/52</td>
<td>57</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 34-120</td>
<td>1/5/52</td>
<td>3/1/52</td>
<td>57</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 36-105</td>
<td>1/2/52</td>
<td>3/12/52</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 38-34</td>
<td>2/2/52</td>
<td>3/12/52</td>
<td>38</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 43-9</td>
<td>1/8/52</td>
<td>2/15/52</td>
<td>37</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 43-6</td>
<td>2/20/52</td>
<td>3/11/52</td>
<td>29</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 43-74</td>
<td>1/8/52</td>
<td>3/21/52</td>
<td>51</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 44-101</td>
<td>1/16/52</td>
<td>3/9/52</td>
<td>51</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 44-155</td>
<td>2/20/52</td>
<td>3/4/52</td>
<td>22</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 44-156</td>
<td>2/3/52</td>
<td>3/12/52</td>
<td>37</td>
</tr>
<tr>
<td>15</td>
<td>C.P. 48-106</td>
<td>3/4/52</td>
<td>3/20/52</td>
<td>16</td>
</tr>
<tr>
<td>16</td>
<td>C.P. 56-819</td>
<td>3/4/52</td>
<td>3/20/52</td>
<td>16</td>
</tr>
</tbody>
</table>
or the number of days in which flowers of each variety are available for crossing, provided that there is no interruption in the sequence of flowering in the interim between the earliest and latest emergence.

As was shown in Table 5, varieties with a long period of flowering, 50 days or over, were Co. 281, C. P. 27-108, C. P. 29-103, C. P. 29-116, C. P. 30-24, C. P. 34-120, C. P. 43-74, and C. P. 44-101. Varieties with a short period of flowering were F. 36-819, and C. P. 33-229, with a duration of about two weeks. All the rest of the varieties were intermediate in the length of time flowers emerged.

**Natural Flowering of Sugarcane**

Most of the varieties which formed floral initials in October started flowering when the temperature conditions on the outside were favorable for the gradual development of the floral primordia. When the arrow inside the boot reached full development it emerged. The number of varieties of sugarcane which flowered naturally during 1951 and the percentage of flowering in each variety are shown in Table 3. Nineteen varieties flowered that year and the percentage of flowering was variable with the different varieties.

**Production of Pollen and Dehiscence of Anthers.** Eighteen varieties were examined during 1951 for pollen production and for the condition of the anthers. Fourteen of these varieties produced viable pollen. Although four other varieties produced some viable pollen, their anthers did not dehisc and release the pollen. The data on pollen production and anther condition are shown in Table 6. There was a highly significant difference between varieties in the per cent of full pollen grains produced. Analysis given in Table 6a. The highest
Table 6. Per cent of full pollen produced, color and dehiscence of anthers of sugarcane varieties under greenhouse conditions at Grand Isle, Louisiana, in 1951.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>Pollen abundance</th>
<th>Full pollen per cent</th>
<th>Anthers Color</th>
<th>Dehiscence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>abundant</td>
<td>71</td>
<td>pink</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>C.P. 27-108</td>
<td>&quot;</td>
<td>87</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>3</td>
<td>C.P. 29-116</td>
<td>variable</td>
<td>80</td>
<td>yellow</td>
<td>&quot;</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 30-24</td>
<td>&quot;</td>
<td>45</td>
<td>pink</td>
<td>&quot;</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 33-224</td>
<td>abundant</td>
<td>90</td>
<td>pale</td>
<td>&quot;</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 36-105</td>
<td>&quot;</td>
<td>75</td>
<td>pink</td>
<td>&quot;</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 38-34</td>
<td>&quot;</td>
<td>39</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 43-9</td>
<td>&quot;</td>
<td>35</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 43-64</td>
<td>&quot;</td>
<td>44</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 43-74</td>
<td>&quot;</td>
<td>70</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 44-101</td>
<td>&quot;</td>
<td>90</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 44-156</td>
<td>&quot;</td>
<td>65</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 48-106</td>
<td>variable</td>
<td>60</td>
<td>&quot;</td>
<td>poor</td>
</tr>
<tr>
<td>14</td>
<td>F. 36-819</td>
<td>abundant</td>
<td>45</td>
<td>&quot;</td>
<td>good</td>
</tr>
</tbody>
</table>

Table 6a. Summary of analysis of variance on the production of full pollen of sugarcane.

<table>
<thead>
<tr>
<th>Variance due to</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean squares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varieties</td>
<td>13</td>
<td>16,045.72</td>
<td>1,234.28**</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>8,98.00</td>
<td>21.38</td>
</tr>
<tr>
<td>TOTAL</td>
<td>55</td>
<td>16,943.72</td>
<td></td>
</tr>
</tbody>
</table>

** Highly significant differences.
percentage of full pollen grains in 1951 were shown by the varieties C.P. 44-101, C.P. 27-108, and C.P. 36-105 and the lowest percentages by the varieties C.P. 43-64, C.P. 30-24, and F-36-819.

In the greenhouse, the color of the anthers of the cane flowers was pink for all varieties except C.P. 29-116 and C.P. 33-224, which had pale, yellowish anthers.

In thirteen of the fourteen varieties producing full pollen grains, dehiscence of the anthers was good, while in the other it was poor.

**Production of Seedlings**

Data regarding the production of sugarcane seedlings from seed produced at Grand Isle, La., in the 1951 season are shown in Table 7. Both seedlings produced from selfing and from crossing were grown. Seedlings from selfing, because of their lack of vigor, are not usually used in the breeding programs at other sugarcane stations. In the Louisiana program a limited number of selfed seedlings, produced in 1951 were planted in the field either for breeding purposes, or to establish a number of selfed lines for future genetic studies. Male fertile arrows were not used exclusively to produce selfed seedlings, but were also utilized as the male parent in crossing. Upon maturity of the seed, fans from both male and female arrows was collected separately and planted at Baton Rouge, La. By this method, information concerning the self-fertility or self-sterility of male arrows was obtained. Arrows with both pollen and ovules functional, but which are self-incompatible, are of some importance in sugarcane breeding because these arrows can be used, together with male sterile ones as female parents. Conditions of self-sterility or self-incompatibility among male fertile arrows were not found at Grand Isle, where all male arrows which were selfed set
viable seed.

The largest number of seedlings produced by one arrow was obtained from the varieties C.P. 27-108 and C.P. 44-101, which produced 1,568 and 1,552 respectively. These varieties had also been found to have the highest percentage of full pollen grains. The smallest number of seedlings produced by one arrow was obtained from F. 36-819, with only 100 seedlings. The average number of seedlings produced from selfed arrows was 844. This number was higher than the average of seedlings produced by arrows used as female parents in the crosses made, which was 388. Crosses were made in the greenhouse when two or more arrows emerged in the greenhouse at the same time. Arrows of both sexes were necessary. When male sterile arrows were not present in the greenhouse and were available in the field, the latter were rooted and transferred to the greenhouse. At times male fertile arrows, when these were abundant in the greenhouse, were transferred, before emergence of the arrow, to the outside and subjected to the effect of low temperatures for five to six days. They were then returned to the greenhouse and utilized as male sterile, or female parental arrows. The limited number of arrows present in the greenhouse or outside in 1951 made it difficult to carry out a planned crossing program based on progeny performance. A list of elite parental varieties, based on progeny performance from crosses made at Canal Point, Florida in previous years, was available and when arrows of these varieties were also available, they were used in crosses. Otherwise, other crosses were made to explore the performance as parents of the many Minute varieties available. The number of different crosses made at Grand Isle in the greenhouse in 1951, the number of seedlings
Table 7. Summary of sugarcane seedlings obtained in 1951-52 season from different sugarcane varieties selfed and crossed at Grand Isle, La.

<table>
<thead>
<tr>
<th>No.</th>
<th>Parentage</th>
<th>No. of arrows</th>
<th>No. seedlings</th>
<th>No. seedlings per arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Selfs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>3</td>
<td>1,494</td>
<td>498</td>
</tr>
<tr>
<td>2</td>
<td>C.P. 27-108</td>
<td>12</td>
<td>18,812</td>
<td>1,568</td>
</tr>
<tr>
<td>3</td>
<td>C.P. 29-116</td>
<td>6</td>
<td>4,530</td>
<td>755</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 30-34</td>
<td>2</td>
<td>564</td>
<td>282</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 33-224</td>
<td>1</td>
<td>314</td>
<td>314</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 36-105</td>
<td>5</td>
<td>4,646</td>
<td>929</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 38-34</td>
<td>1</td>
<td>218</td>
<td>218</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 39-9</td>
<td>1</td>
<td>893</td>
<td>892</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 43-64</td>
<td>3</td>
<td>675</td>
<td>225</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 48-74</td>
<td>8</td>
<td>4,202</td>
<td>525</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 44-101</td>
<td>1</td>
<td>1,552</td>
<td>1,552</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 44-156</td>
<td>1</td>
<td>270</td>
<td>270</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 46-106</td>
<td>1</td>
<td>471</td>
<td>471</td>
</tr>
<tr>
<td>14</td>
<td>F. 36-819</td>
<td>1</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Total Selfs</td>
<td>46</td>
<td>38,851</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crosses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Co. 281 x C.P. 27-108</td>
<td>1</td>
<td>421</td>
<td>421</td>
</tr>
<tr>
<td>2</td>
<td>Co. 281 x C.P. 36-105</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Co. 281 x F. 36-819</td>
<td>1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 27-108 x C.P. 33-224</td>
<td>1</td>
<td>1,102</td>
<td>1,102</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 27-108 x C.P. 38-34</td>
<td>1</td>
<td>2,353</td>
<td>2,353</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 27-108 x C.P. 43-74</td>
<td>3</td>
<td>3,442</td>
<td>1,147</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 27-108 x C.P. 44-101</td>
<td>3</td>
<td>1,381</td>
<td>460</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 27-108 x F. 36-819</td>
<td>1</td>
<td>149</td>
<td>149</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 29-103 x Co. 281</td>
<td>1</td>
<td>195</td>
<td>195</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 29-103 x C.P. 36-105</td>
<td>1</td>
<td>1,039</td>
<td>1,039</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 29-103 x C.P. 38-34</td>
<td>2</td>
<td>1,187</td>
<td>594</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 29-103 x C.P. 48-106</td>
<td>2</td>
<td>320</td>
<td>160</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 29-116 x Co. 281</td>
<td>5</td>
<td>417</td>
<td>83</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 29-116 x C.P. 27-108</td>
<td>2</td>
<td>1,321</td>
<td>661</td>
</tr>
<tr>
<td>15</td>
<td>C.P. 29-116 x C.P. 30-24</td>
<td>1</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>16</td>
<td>C.P. 29-116 x C.P. 36-105</td>
<td>2</td>
<td>544</td>
<td>272</td>
</tr>
<tr>
<td>17</td>
<td>C.P. 29-116 x C.P. 43-79</td>
<td>2</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>18</td>
<td>C.P. 29-116 x C.P. 43-74</td>
<td>1</td>
<td>203</td>
<td>203</td>
</tr>
<tr>
<td>19</td>
<td>C.P. 29-116 x C.P. 44-101</td>
<td>1</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 30-24 x C.P. 27-108</td>
<td>5</td>
<td>2,534</td>
<td>507</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 30-24 x C.P. 29-116</td>
<td>1</td>
<td>52</td>
<td>52</td>
</tr>
<tr>
<td>22</td>
<td>C.P. 30-24 x C.P. 43-74</td>
<td>5</td>
<td>1,500</td>
<td>300</td>
</tr>
<tr>
<td>23</td>
<td>C.P. 33-224 x C.P. 43-74</td>
<td>1</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>24</td>
<td>C.P. 33-229 x Co. 281</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 7. (Cont'd.)

<table>
<thead>
<tr>
<th>No.</th>
<th>Parentage</th>
<th>No. male arrows</th>
<th>No. seedlings</th>
<th>No. seedlings per arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>C.P. 34-120 x C.P. 27-108</td>
<td>4</td>
<td>364</td>
<td>91</td>
</tr>
<tr>
<td>26</td>
<td>C.P. 34-120 x C.P. 29-116</td>
<td>1</td>
<td>1,701</td>
<td>1,701</td>
</tr>
<tr>
<td>27</td>
<td>C.P. 34-120 x C.P. 36-105</td>
<td>3</td>
<td>713</td>
<td>38</td>
</tr>
<tr>
<td>28</td>
<td>C.P. 34-120 x C.P. 43-9</td>
<td>2</td>
<td>1,592</td>
<td>796</td>
</tr>
<tr>
<td>29</td>
<td>C.P. 34-120 x C.P. 43-64</td>
<td>1</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>30</td>
<td>C.P. 34-120 x C.P. 43-74</td>
<td>1</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>31</td>
<td>C.P. 34-120 x C.P. 44-101</td>
<td>1</td>
<td>394</td>
<td>394</td>
</tr>
<tr>
<td>32</td>
<td>C.P. 36-105 x C.P. 43-74</td>
<td>1</td>
<td>1,068</td>
<td>1,068</td>
</tr>
<tr>
<td>33</td>
<td>C.P. 38-34 x C.P. 27-108</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>34</td>
<td>C.P. 38-34 x C.P. 43-74</td>
<td>3</td>
<td>1,569</td>
<td>523</td>
</tr>
<tr>
<td>35</td>
<td>C.P. 38-34 x F. 36-813</td>
<td>1</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>36</td>
<td>C.P. 43-64 x C.P. 48-106</td>
<td>1</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>37</td>
<td>C.P. 44-101 x C.P. 43-9</td>
<td>1</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>38</td>
<td>C.P. 44-101 x Co. 281</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>39</td>
<td>C.P. 44-155 x Co. 281</td>
<td>1</td>
<td>346</td>
<td>346</td>
</tr>
<tr>
<td>40</td>
<td>C.P. 44-155 x C.P. 36-105</td>
<td>1</td>
<td>753</td>
<td>753</td>
</tr>
<tr>
<td>41</td>
<td>C.P. 48-106 x C.P. 27-108</td>
<td>1</td>
<td>71</td>
<td>71</td>
</tr>
<tr>
<td>42</td>
<td>C.P. 48-106 x C.P. 29-124</td>
<td>1</td>
<td>735</td>
<td>735</td>
</tr>
<tr>
<td>43</td>
<td>C.P. 48-106 x C.P. 36-105</td>
<td>1</td>
<td>315</td>
<td>315</td>
</tr>
<tr>
<td>44</td>
<td>C.P. 48-106 x C.P. 43-9</td>
<td>1</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>45</td>
<td>C.P. 48-106 x C.P. 43-74</td>
<td>3</td>
<td>1,790</td>
<td>597</td>
</tr>
</tbody>
</table>

**TOTAL CROSSES 76**

**29,512**
produced, the number of female arrows used, and other data are shown in Table 7. Forty-five different crosses were made and 29,512 seedlings were produced from these crosses. The number of female arrows used was 76. The average number of seedlings produced by one female arrow was 388.

Among the crosses of sugarcane varieties made in 1951, the following were considered as among the more promising ones.

- C.P. 27-108 x C.P. 33-224
- C.P. 27-108 x C.P. 43-74
- C.P. 27-108 x C.P. 44-101
- C.P. 39-116 x C.P. 43-74
- C.P. 29-116 x C.P. 44-101
- C.P. 34-120 x C.P. 27-108

1952 Season — Floral Initiation

The time when floral initials were first found and the percentage found in the sugarcane varieties at Grand Isle during the 1952 season are given in Table 8. The number of varieties grown in the field in that year was fifty. The number of varieties that formed floral initials was thirty-seven. Floral initials were first found in 1952 on October 3 for the early blooming varieties and from that time to November 27 depending on the variety. In the majority of Canal Point varieties floral initials were first found between October 3 and October 15. With Co. 290, a late flowering Indian cane, floral initials were first found on November 17. With F. 36-819, an elite Florida variety, floral initials were first observed on November 25.

Natural Flowering

The winter was mild in 1952 and no freezing temperatures occurred in the field at Grand Isle. The development of the floral primordia inside the sheath of the top leaf of the cane stalk was normal under natural conditions. Flowering in the field occurred. The number
Table 8. Summary of time of floral initiation and natural flowering in sugarcane varieties at Grand Isle, La. in 1952-53 season.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>Floral Initiation</th>
<th>Natural Flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Date</td>
<td>Per cent</td>
</tr>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>10/8/52</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>Co. 290</td>
<td>11/17/52</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Co. 356</td>
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<td>84</td>
</tr>
<tr>
<td>4</td>
<td>NCo. 310</td>
<td>10/8/52</td>
<td>92</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 27-108</td>
<td>10/8/52</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 28-19</td>
<td>10/13/52</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 29-103</td>
<td>10/3/52</td>
<td>85</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 29-116</td>
<td>10/3/52</td>
<td>95</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 29-220</td>
<td>10/8/52</td>
<td>41</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 30-24</td>
<td>10/8/52</td>
<td>95</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 33-29</td>
<td>10/13/52</td>
<td>28</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 33-224</td>
<td>10/3/52</td>
<td>75</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 33-229</td>
<td>10/8/52</td>
<td>21</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 33-372</td>
<td>10/13/52</td>
<td>75</td>
</tr>
<tr>
<td>15</td>
<td>C.P. 34-120</td>
<td>10/3/52</td>
<td>97</td>
</tr>
<tr>
<td>16</td>
<td>C.P. 36-105</td>
<td>10/13/52</td>
<td>81</td>
</tr>
<tr>
<td>17</td>
<td>C.P. 36-156</td>
<td>10/8/52</td>
<td>90</td>
</tr>
<tr>
<td>18</td>
<td>C.P. 36-183</td>
<td>10/8/52</td>
<td>95</td>
</tr>
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<td>C.P. 36-187</td>
<td>10/15/52</td>
<td>82</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 38-34</td>
<td>10/13/52</td>
<td>94</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 38-41</td>
<td>10/13/52</td>
<td>73</td>
</tr>
<tr>
<td>22</td>
<td>C.P. 43-64</td>
<td>10/15/52</td>
<td>70</td>
</tr>
<tr>
<td>23</td>
<td>C.P. 43-74</td>
<td>10/8/52</td>
<td>91</td>
</tr>
<tr>
<td>24</td>
<td>C.P. 44-101</td>
<td>10/3/52</td>
<td>96</td>
</tr>
<tr>
<td>25</td>
<td>C.P. 44-126</td>
<td>10/16/52</td>
<td>78</td>
</tr>
<tr>
<td>26</td>
<td>C.P. 44-155</td>
<td>10/3/52</td>
<td>96</td>
</tr>
<tr>
<td>27</td>
<td>C.P. 44-156</td>
<td>10/8/52</td>
<td>75</td>
</tr>
<tr>
<td>28</td>
<td>C.P. 45-155</td>
<td>10/3/52</td>
<td>80</td>
</tr>
<tr>
<td>29</td>
<td>C.P. 48-106</td>
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</tr>
<tr>
<td>30</td>
<td>C.P. 48-136</td>
<td>10/13/52</td>
<td>89</td>
</tr>
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<td>31</td>
<td>L.S.U. 48-82</td>
<td>11/1/52</td>
<td>25</td>
</tr>
<tr>
<td>32</td>
<td>CI. 41-142</td>
<td>10/13/52</td>
<td>95</td>
</tr>
<tr>
<td>33</td>
<td>F. 31-762</td>
<td>11/15/52</td>
<td>24</td>
</tr>
<tr>
<td>34</td>
<td>F. 36-819</td>
<td>11/25/52</td>
<td>18</td>
</tr>
<tr>
<td>35</td>
<td>P.O.J.2725</td>
<td>10/15/52</td>
<td>85</td>
</tr>
<tr>
<td>36</td>
<td>Q. 28</td>
<td>11/15/52</td>
<td>32</td>
</tr>
<tr>
<td>37</td>
<td>Ajax</td>
<td>11/27/52</td>
<td>15</td>
</tr>
</tbody>
</table>
of varieties flowering naturally, and the date of flowering for each
variety are shown in Table 8. Twenty-four varieties of sugarcane
flowered naturally during the winter of 1952 and early spring of 1953.

Flowering Under Controlled Conditions

The number of sugarcane stalks per variety rooted and trans-
ferred to the greenhouse, the number of arrows emerged, and the per-
centage of flowering for each variety in the greenhouse are shown in
Table 9. Approximately a thousand sugarcane stalks of 28 varieties
were rooted and transferred to the greenhouse. Only 294 arrows
emerged from 31 varieties. The average percentage of flowering
was 2/3 of the total number of cane stalks rooted. On the basis of
the number of rooted stalks of the varieties which flowered, the average
percentage of flowering was 36. The percentage of flowering per
variety is shown in Table 9. Large variations in the flowering per-
centage of the different varieties are shown in this table. The lowest
percentages of flowering were shown by the varieties C.P. 43-64, C.P.
29-103, and C.P. 33-224. The highest percentages of flowering were
shown by the varieties C.P. 29-116, C.P. 34-120, C.P. 36-105, Co. 281,
and C.P. 33-372. The varieties, Co. 290, P.O.J. 2725, and F. 36-819
although they formed floral initials in adequate numbers, did not
flower in the greenhouse in the winter of 1952, or in the early spring
of 1953. The dates of first and last arrow emergence and the duration
of flowering in days for each variety are shown in Table 10. The
earliest flowering varieties were C.P. 44-101, C.P. 30-24, C.P. 36-105,
and C.P. 29-116 and the latest flowering ones were C.P. 44-155,
C.P. 36-156, C.P. 27-100, C.P. 43-64 and C.P. 33-224. The longest
periods of flowering under greenhouse conditions in 1952 were observed
Table 9. Summary of the number of sugarcane stalks marcotted, number of arrows emerged in the greenhouse and percentage of flowering for sugarcane varieties at Grand Isle, La. in the 1952-53 season.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>No. cane stalks rooted</th>
<th>No. male sterile arrows</th>
<th>No. male fertile arrows</th>
<th>Total arrows</th>
<th>% flowering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>65</td>
<td>17</td>
<td>21</td>
<td>38</td>
<td>58.5</td>
</tr>
<tr>
<td>2</td>
<td>Co. 386</td>
<td>20</td>
<td>-</td>
<td>6</td>
<td>6</td>
<td>30.0</td>
</tr>
<tr>
<td>3</td>
<td>N.C.O. 310</td>
<td>15</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>46.6</td>
</tr>
<tr>
<td>4</td>
<td>Cl. 41-142</td>
<td>25</td>
<td>6</td>
<td>-</td>
<td>6</td>
<td>24.0</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 27-108</td>
<td>40</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>10.0</td>
</tr>
<tr>
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<td>C.P. 29-103</td>
<td>50</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>6.0</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 29-116</td>
<td>40</td>
<td>28</td>
<td>11</td>
<td>29</td>
<td>72.5</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 29-320</td>
<td>55</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>12.7</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 30-24</td>
<td>30</td>
<td>12</td>
<td>4</td>
<td>16</td>
<td>53.3</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 33-224</td>
<td>45</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>4.4</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 33-372</td>
<td>25</td>
<td>-</td>
<td>13</td>
<td>13</td>
<td>52.0</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 34-120</td>
<td>100</td>
<td>65</td>
<td>0</td>
<td>65</td>
<td>65.0</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 36-105</td>
<td>75</td>
<td>30</td>
<td>14</td>
<td>44</td>
<td>58.8</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 36-156</td>
<td>10</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>30.0</td>
</tr>
<tr>
<td>15</td>
<td>C.P. 38-34</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>22.2</td>
</tr>
<tr>
<td>16</td>
<td>C.P. 43-64</td>
<td>55</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>17</td>
<td>C.P. 43-74</td>
<td>35</td>
<td>2</td>
<td>2</td>
<td>12</td>
<td>34.3</td>
</tr>
<tr>
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<td>C.P. 44-101</td>
<td>40</td>
<td>12</td>
<td>2</td>
<td>14</td>
<td>35.0</td>
</tr>
<tr>
<td>19</td>
<td>C.P. 44-155</td>
<td>30</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>23.3</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 45-155</td>
<td>5</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>40.0</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 48-106</td>
<td>10</td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>40.0</td>
</tr>
</tbody>
</table>

Total: 815 213 81 294 36.1

Nonflowered:

| No. | Variety | No. cane stalks rooted | No. male sterile arrows | No. male fertile arrows | Total arrows | |
|-----|---------|------------------------|-------------------------|------------------------|-------------||
| 22  | C.P. 38-41 | 10                 | 0                       | 0                      | 0           | 0          |
| 23  | C.P. 44-156 | 10                | 0                       | 0                      | 0           | 0          |
| 24  | C.P. 51-33 | 10                 | 0                       | 0                      | 0           | 0          |
| 25  | C.P. 33-229 | 20                | 0                       | 0                      | 0           | 0          |
| 26  | Co. 290   | 60                 | 0                       | 0                      | 0           | 0          |
| 27  | P.O.J. 2725 | 20               | 0                       | 0                      | 0           | 0          |
| 28  | F. 36-819 | 60                 | 0                       | 0                      | 0           | 0          |

Total: 1005 213 81 294 29.2
<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>Date first arrow emerged</th>
<th>Date last arrow emerged</th>
<th>Duration of flowering in days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>1/10/53</td>
<td>4/1/53</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>Co. 356</td>
<td>2/12/53</td>
<td>3/18/53</td>
<td>34</td>
</tr>
<tr>
<td>3</td>
<td>NCo. 310</td>
<td>1/20/53</td>
<td>3/28/53</td>
<td>66</td>
</tr>
<tr>
<td>4</td>
<td>CI. 41-142</td>
<td>1/11/53</td>
<td>2/28/53</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 29-103</td>
<td>2/2/53</td>
<td>3/1/53</td>
<td>27</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 29-116</td>
<td>12/27/52</td>
<td>3/14/53</td>
<td>76</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 29-320</td>
<td>2/13/53</td>
<td>3/8/53</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 30-24</td>
<td>12/22/52</td>
<td>2/27/53</td>
<td>56</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 33-224</td>
<td>2/13/53</td>
<td>3/22/53</td>
<td>37</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 33-372</td>
<td>2/8/53</td>
<td>4/2/53</td>
<td>53</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 34-120</td>
<td>1/11/53</td>
<td>3/10/53</td>
<td>57</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 36-105</td>
<td>12/19/52</td>
<td>3/5/53</td>
<td>75</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 36-156</td>
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<td>3/1/53</td>
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<td>C.P. 43-64</td>
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<td>3/22/53</td>
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<tr>
<td>17</td>
<td>C.P. 43-74</td>
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<td>3/28/53</td>
<td>64</td>
</tr>
<tr>
<td>18</td>
<td>C.P. 44-101</td>
<td>12/17/52</td>
<td>1/6/52</td>
<td>20</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 45-155</td>
<td>2/18/53</td>
<td>3/1/53</td>
<td>11</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 48-106</td>
<td>1/26/53</td>
<td>2/20/53</td>
<td>24</td>
</tr>
</tbody>
</table>
The shortest periods of flowering were observed in the varieties C. P. 36-156, and C. P. 44+155. The rest of the varieties were intermediate in the length of time flowers emerged.

Effect of Date of Rooting and Transfer of Sugarcane Stalks to the Greenhouse on Flowering

The effects of early or late rooting and the transfer of these rooted stalks of sugarcane to the greenhouse on flowering are shown in Table 11. Eight hundred and fifteen sugarcane stalks involving 21 varieties were rooted in four groups at four different dates. The first group of 173 cane stalks was rooted on October 1, the second group of 158 cane stalks was rooted October 15, the third group of 183 stalks was rooted on November 1, and the last group of 301 stalks was rooted on November 15. The above groups of cane stalks were transferred to the greenhouse on November 1, November 15, December 1, and December 15, respectively. The number of arrows emerging, and the percentage of flowering per variety and group are shown in Table 11. The total number of arrows emerging in the first and second groups was low, while in the third and fourth groups it was higher. The percentages of flowering in the first, second, third, and fourth groups were 15.6, 21.5, 38.7, and 53.8 respectively. When the varieties are taken as a whole, they show few or no arrows in the first and second groups and an increased number of arrows in the third and fourth groups. These results indicate clearly that there is a relationship between the time of rooting and transplanting to the greenhouse and the percentage of arrows emerging.
Table 11. Effect of date of transferring into the greenhouse of early intermediate and late rooted sugarcane stalks on flowering in some varieties tested at Grand Isle, La., in 1952.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>No. of cane stalks * rooted and transferred</th>
<th>Total No. transferred</th>
<th>No. of arrows</th>
<th>Total No. flowered</th>
<th>Percentage of flowering</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td>Group 1 2 3 4</td>
<td>Group 1 2 3 4</td>
<td></td>
<td>Group 1 2 3 4</td>
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</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Co: 356</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NCs. 310</td>
<td>3 3 3 3 15 9 2 1 4 7 0.0 66.6 33.3 66.6</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CL 41-142</td>
<td>5 5 5 10 25 1 0 1 4 6 20.0 6.0 20.0 40.0</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>C.P. 27-108</td>
<td>10 10 10 10 40 0 0 1 3 4 0.0 0.0 10.0 30.0</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>C.P. 29-103</td>
<td>10 10 15 15 50 0 0 1 2 3 0.0 0.0 6.6 13.6</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>C.P. 29-116</td>
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<td></td>
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</tr>
<tr>
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<td>C.P. 29-320</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>C.P. 30-24</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>C.P. 33-224</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>C.P. 33-372</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>C.P. 34-120</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>C.P. 36-105</td>
<td>15 15 20 25 75 5 2 15 22 44 33.3 13.3 75.0 88.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>C.P. 36-156</td>
<td>2 2 2 4 10 0 0 1 2 3 0.0 0.0 50.0 50.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>C.P. 38-34</td>
<td>10 10 10 15 45 2 2 1 5 10 20.0 20.0 10.0 33.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>C.P. 43-64</td>
<td>15 15 15 15 55 0 0 0 2 2 0.0 0.0 60.0 60.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>C.P. 43-74</td>
<td>10 5 5 15 35 0 0 3 9 12 0.0 0.0 60.0 60.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>C.P. 44-101</td>
<td>10 10 10 10 40 6 8 0 0 14 60.0 80.0 0.0 0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>C.P. 44-155</td>
<td>5 5 5 15 30 0 0 0 7 7 0.0 0.0 0.0 46.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>C.P. 45-155</td>
<td>1 1 1 2 5 0 0 0 2 2 0.0 0.0 0.0 100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>C.P. 48-106</td>
<td>2 2 2 4 10 0 0 1 3 4 0.0 0.0 50.0 75.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Group 1 was rooted Oct. 1, transferred Nov. 1; Group 2, rooted Oct. 15, transferred Nov. 15; Group 3, rooted Nov. 1, transferred Dec. 1; Group 4, rooted Nov. 15, transferred Dec. 15.
Relationship Between Number of Leaves and Emergence of Flowers

The relationship of the time of transfer of the sugarcane stalks to the greenhouse and the percentage of flowering was indicated above. Another relationship seemed to exist between the number of new leaves present inside the top of the cane stalk at the time of transfer to the greenhouse and flowering. Two hundred cane stalks, involving ten varieties, were rooted in the field, divided into four groups of 50 stalks, five of each variety, and each of the four groups were transferred to the greenhouse at a different date. The number of new leaves inside the top of the cane stalk at the time of transfer to the greenhouse was recorded. The number of arrows produced per variety per group was also recorded. Data on the number of new leaves of sugarcane present at the time of the transfer of each group to the greenhouse and the number of arrows emerged per variety and per group are shown in Table 12. The first group of sugarcane varieties which was transferred early to the greenhouse had 300 new leaves. The second group of canes transferred to the greenhouse two weeks later, had 263 new leaves, the third group of canes transferred to the greenhouse two weeks after the second group, had 235 new leaves, and the fourth group of canes transferred to the greenhouse two weeks after the third group, had 216 new leaves. The corresponding number of cane arrows which emerged in each group of transferred canes was 10, 12, 23, and 28 respectively. According to these results, the larger the number of new leaves in the groups of sugarcane at the time of transfer to the greenhouse, the smaller the number of arrows emerging in the group; the smaller the number of the new leaves in the group of sugarcane at the time of transfer, the larger the number of cane arrows emerging in the group. Highly
Table 12. Relationship of the number of new leaves developed and number of flowers emerged by four groups of ten varieties of sugarcane transferred to the greenhouse at four different dates at Grand Isle, La. in 1952.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>No. cane stalks transferred to greenhouse at four dates</th>
<th>No. of new leaves developed</th>
<th>Corresponding No. of flowers emerged</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 3</td>
</tr>
<tr>
<td>1</td>
<td>Co. 281</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>C.P. 27-108</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>C.P. 29-103</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 29-116</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 29-320</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 30-24</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 34-120</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 36-105</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 43-74</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 44-101</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

TOTAL 50 50 50 50 300 263 235 216 1,014 10 12 23 28 73

* Group 1 = transferred November 1, Group 2 = transferred November 15, Group 3 = transferred December 1, Group 4 = transferred December 15.
significant differences were found in the number of new leaves of sugarcane at the time of transfer to the greenhouse between the different varieties and dates of transfer. Analysis of variance on the number of new leaves is shown in Table 13.

Also differences were observed in the number of arrows which emerged between varieties as well as between dates of transfer to the greenhouse. Data are given in Table 12.

Table 13. Summary of analysis of variance in the number of new leaves of sugarcane at the time of transfer to the greenhouse.

<table>
<thead>
<tr>
<th>Variance due to</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varieties</td>
<td>9</td>
<td>291.52</td>
<td>32.39**</td>
</tr>
<tr>
<td>Dates of Transfer</td>
<td>3</td>
<td>80.02</td>
<td>26.67**</td>
</tr>
<tr>
<td>Varieties x Dates of transfer</td>
<td>27</td>
<td>19.88</td>
<td>.74</td>
</tr>
<tr>
<td>Error</td>
<td>160</td>
<td>155.60</td>
<td>.97</td>
</tr>
<tr>
<td>TOTAL</td>
<td>199</td>
<td>547.02</td>
<td></td>
</tr>
</tbody>
</table>

** Significant one per cent.

Effect of Exposure to Sunlight Inside the Greenhouse on Flowering of Sugarcane

Twenty sugarcane stalks each, of five varieties were used in four exposures inside the greenhouse. The number of arrows from stalks at each exposure was recorded. These data are shown in Table 14. Sugarcane stalks facing South and West produced more arrows than those facing East and North. Highly significant differences were found in the number of arrows emerged from cane stalks of different varieties and different exposures. Analysis of variance is given in Table 15.
Table 14. Effect of the exposure to sunlight on flowering of sugarcane stalks of five varieties inside the greenhouse at Grand Isle, La. in 1952.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>No. of sugarcane stalks facing</th>
<th>No. arrows emerged from stalks facing:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>North</td>
<td>East</td>
</tr>
<tr>
<td>1</td>
<td>C.P. 29-116</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>C.P. 30-24</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>C.P. 34-120</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 36-105</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 44-101</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 15. Summary of Analysis of variance of the number of sugarcane arrows emerged from canes in the greenhouse at different exposures to sunlight.

<table>
<thead>
<tr>
<th>Variance due to</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varieties</td>
<td>4</td>
<td>4.8</td>
<td>1.2 **</td>
</tr>
<tr>
<td>Exposures</td>
<td>3</td>
<td>30.0</td>
<td>10.00 **</td>
</tr>
<tr>
<td>Error</td>
<td>12</td>
<td>2.0</td>
<td>.16</td>
</tr>
<tr>
<td>TOTAL</td>
<td>19</td>
<td>36.8</td>
<td></td>
</tr>
</tbody>
</table>

** Significant one per cent.
Seedling Production

Seedlings from selfs and crosses were produced in 1952. Stress was placed on the production of seedlings from crosses which show much more vigor than the seedlings from self. The number of crosses made in 1952, the parentage, the number of seedlings produced from each cross and other data are given in Table 16. The number of sugarcane seedlings from selfs amounted to 16,245. There were 55,442 sugarcane seedlings produced from crosses. Forty-two different crosses were made in the greenhouse. There were 109 female arrows involved in these crosses. The average number of seedlings per female arrow was 508. Great differences were found in the number of seedlings produced per arrow between and within crosses. Among crosses which were made at Grand Isle in 1952, the following ones were of considerable importance, due to the fact that high percentages of seedlings in the first selection were produced when such crosses were made in Canal Point, Florida recently.

1) Co. 281 x C.P. 33-224
2) C.P. 29-103 x C.P. 33-372
3) C.P. 29-116 x C.P. 43-74
4) C.P. 30-24 x C.P. 36-105
5) C.P. 34-120 x C.P. 36-105
6) C.P. 34-120 x C.P. 38-34
7) C.P. 36-105 x C.P. 30-24
8) C.P. 36-105 x C.P. 38-34
9) C.P. 44-101 x Co. 356
10) Cl. 41-142 x C.P. 43-74

1953 Season -- Floral Initiation

Data on time floral initiation was first found and the natural flowering in the open of the sugarcane varieties at Grand Isle in the 1953 season are given in Table 17. The number of varieties showing floral initials in 1953 increased to fifty-one. The dates when floral initials were first found in Canal Point varieties varied from October 6
Table 16. Summary of sugarcane seedlings produced at Grand Isle, Louisiana in the 1952-53 season.

<table>
<thead>
<tr>
<th>No.</th>
<th>Parentage</th>
<th>No. of arrows</th>
<th>No. of seedlings produced</th>
<th>No. seedlings per arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Selfs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Co. 281</td>
<td></td>
<td>5,073</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Co. 356</td>
<td></td>
<td>658</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>C.P. 27-108</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>C.P. 29-116</td>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>C.P. 30-24</td>
<td></td>
<td>2,554</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>C.P. 33-224</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>C.P. 33-372</td>
<td></td>
<td>2,319</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>C.P. 36-105</td>
<td></td>
<td>3,635</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>C.P. 38-34</td>
<td></td>
<td>1,305</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>C.P. 43-74</td>
<td></td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>C.P. 44-101</td>
<td></td>
<td>354</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Selfs</strong></td>
<td></td>
<td>16,245</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Crosses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Co. 281 x Co. 356</td>
<td>3</td>
<td>913</td>
<td>304</td>
</tr>
<tr>
<td>2</td>
<td>Co. 281 x C.P. 30-24</td>
<td>1</td>
<td>429</td>
<td>429</td>
</tr>
<tr>
<td>3</td>
<td>Co. 281 x C.P. 33-224</td>
<td>1</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Co. 281 x C.P. 33-372</td>
<td>1</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>5</td>
<td>Co. 281 x C.P. 36-105</td>
<td>1</td>
<td>273</td>
<td>273</td>
</tr>
<tr>
<td>6</td>
<td>Co. 281 x C.P. 38-34</td>
<td>1</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 27-108 x C.P. 33-372</td>
<td>3</td>
<td>4,486</td>
<td>1,495</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 29-103 x C.P. 33-372</td>
<td>1</td>
<td>276</td>
<td>276</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 29-103 x C.P. 38-34</td>
<td>1</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 29-116 x Co. 281</td>
<td>2</td>
<td>554</td>
<td>277</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 29-116 x Co. 356</td>
<td>5</td>
<td>580</td>
<td>116</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 29-116 x C.P. 33-372</td>
<td>3</td>
<td>467</td>
<td>156</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 29-116 x C.P. 43-74</td>
<td>3</td>
<td>1,212</td>
<td>404</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 29-116 x C.P. 44-101</td>
<td>1</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>15</td>
<td>C.P. 29-320 x C.P. 27-108</td>
<td>3</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>C.P. 29-320 x C.P. 33-224</td>
<td>3</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>17</td>
<td>C.P. 30-24 x Co. 281</td>
<td>1</td>
<td>69</td>
<td>69</td>
</tr>
<tr>
<td>18</td>
<td>C.P. 30-24 x Co. 356</td>
<td>1</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>19</td>
<td>C.P. 30-24 x C.P. 36-105</td>
<td>3</td>
<td>2,652</td>
<td>884</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 34-120 x Co. 281</td>
<td>7</td>
<td>3,373</td>
<td>482</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 34-120 x C.P. 29-116</td>
<td>1</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>22</td>
<td>C.P. 34-120 x C.P. 33-372</td>
<td>1</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>23</td>
<td>C.P. 34-120 x C.P. 36-105</td>
<td>5</td>
<td>474</td>
<td>95</td>
</tr>
<tr>
<td>24</td>
<td>C.P. 34-120 x C.P. 38-34</td>
<td>5</td>
<td>779</td>
<td>156</td>
</tr>
<tr>
<td>25</td>
<td>C.P. 34-120 x C.P. 43-74</td>
<td>4</td>
<td>147</td>
<td>37</td>
</tr>
<tr>
<td>No.</td>
<td>Parentage</td>
<td>No. of arrows</td>
<td>No. seedlings produced</td>
<td>No. seedlings per arrow</td>
</tr>
<tr>
<td>-----</td>
<td>-----------</td>
<td>---------------</td>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>26</td>
<td>C.P. 36-105 x Co. 281</td>
<td>1</td>
<td>458</td>
<td>458</td>
</tr>
<tr>
<td>27</td>
<td>C.P. 36-105 x Co. 356</td>
<td>2</td>
<td>126</td>
<td>63</td>
</tr>
<tr>
<td>28</td>
<td>C.P. 36-105 x C.P. 30-24</td>
<td>3</td>
<td>1,585</td>
<td>528</td>
</tr>
<tr>
<td>29</td>
<td>C.P. 36-105 x C.P. 33-372</td>
<td>9</td>
<td>9,453</td>
<td>1,050</td>
</tr>
<tr>
<td>30</td>
<td>C.P. 36-105 x C.P. 38-34</td>
<td>8</td>
<td>9,607</td>
<td>1,201</td>
</tr>
<tr>
<td>31</td>
<td>C.P. 36-156 x Co. 356</td>
<td>2</td>
<td>29</td>
<td>14</td>
</tr>
<tr>
<td>32</td>
<td>C.P. 36-156 x C.P. 33-372</td>
<td>2</td>
<td>264</td>
<td>182</td>
</tr>
<tr>
<td>33</td>
<td>C.P. 38-34 x C.P. 33-372</td>
<td>2</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>34</td>
<td>C.P. 33-101 x Co. 356</td>
<td>1</td>
<td>149</td>
<td>149</td>
</tr>
<tr>
<td>35</td>
<td>C.P. 44-101 x C.P. 30-24</td>
<td>4</td>
<td>3,921</td>
<td>980</td>
</tr>
<tr>
<td>36</td>
<td>C.P. 44-101 x C.P. 36-105</td>
<td>8</td>
<td>10,006</td>
<td>1,251</td>
</tr>
<tr>
<td>37</td>
<td>C.P. 45-155 x C.P. 33-172</td>
<td>1</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>38</td>
<td>C.P. 48-106 x C.P. 36-105</td>
<td>1</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>39</td>
<td>Cl. 41-142 x C.P. 44-101</td>
<td>1</td>
<td>1,339</td>
<td>1,339</td>
</tr>
<tr>
<td>40</td>
<td>Cl. 41-142 x C.P. 43-74</td>
<td>1</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td>41</td>
<td>NCo. 310 x C.P. 33-372</td>
<td>1</td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td>42</td>
<td>NCo. 310 x C.P. 36-105</td>
<td>1</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>109</td>
<td>55,442</td>
<td></td>
</tr>
</tbody>
</table>
to October 27. In the Florida varieties floral primordia were found later with F. 36-819 not showing floral initials before November 21. The percentage of floral initials found being somewhat higher than in 1951 and 1952. C. P. 30-24 showed the highest percentage of floral initials while the varieties F. 36-819 and Co. 290 showed the lowest.

**Natural Flowering**

At Grand Isle in 1953 some varieties of sugarcane started flowering in early November. Forty-one varieties of sugarcane flowered naturally in the open in 1953. The dates, duration and percentage of flowering are given in Table 17. The earliest to flower were Glagah and NCo. 310 which flowered on November 6 and 12 respectively. The latest canes to flower were F. 31-762, P. 33-32, and Co. 453, which flowered on March 29, March 28 and March 31 respectively. The varieties which exhibited the longest periods of flowering were Glagah, 118 days, C. P. 34-120, 100 days, C. P. 38-34, 97 days and C. P. 29-116, 93 days.

**Flowering Under Controlled Conditions**

At Grand Isle in 1953 flowering of sugarcane under controlled conditions was more successful than in previous years, reaching 54.1 per cent. The number of stalks rooted, the number of arrows which emerged and the percentage of flowering for each variety are given in Table 18. The same number of varieties that flowered under natural conditions flowered under controlled conditions when stalks of each variety were rooted at an early stage of floral development and transferred to the greenhouse. Few varieties showed exceptions to this, such as P. 33-32 which flowered only under natural conditions, C. P. 43-64 which flowered only under greenhouse conditions, and P.O.J. 2725, Co. 290, and F. 36-819 which flowered only sparsely in the
Table 17. Summary of data on floral initiation and flowering under natural conditions for some sugarcane varieties at Grand Isle, Louisiana in the 1953-54 season.

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<th>Date of last flower</th>
<th>Duration of flowering (days)</th>
<th>% flowering</th>
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<th>Duration of flowering (days)</th>
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<td>4/17</td>
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Table 18. Number of sugarcane stalks rooted, number of arrows emerged in the greenhouse and percentage of flowering at Grand Isle, La. in the 1953-54 season.

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<th>No. of arrows emerged</th>
<th>No. sterile arrows</th>
<th>No. fertile arrows</th>
<th>Total flowering</th>
<th>%</th>
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TOTALS 728 266 126 392 54.1
greenhouse. Data on the time of flowering of each variety under greenhouse conditions are given in Table 19. The sequence of flowering of the varieties of sugarcane in the greenhouse followed closely the sequence of flowering of the same varieties under natural conditions in the open. However, the duration of flowering under greenhouse conditions was a little longer than under natural conditions.

**Seedling Production**

Seedlings from crosses only, were produced at Grand Isle in 1953. The largest number of seedlings was produced by bi-parental crosses where both parental stalks were rooted and transferred to the greenhouse. Male parental stalks were transferred to the greenhouse at an early stage of floral development to induce the production of viable pollen. Parental stalks used as females, when they were genetically male sterile or their anthers had showed a lack of dehiscence, were transferred to the greenhouse two to three weeks prior to arrow emergence. When male fertile arrows were to be used as female parents the transfer to the greenhouse was made upon or a few days after the emergence of their arrows. With this method male fertile arrows could be used as female parents when necessary. The number of crosses made by this method, the number of seedlings produced and other data pertaining to seedling production are given in Table 20. In Table 21 the results are given of sugarcane seedling production from bi-parental crosses, where the female arrows were transferred from the field and preserved in the "Hawaiian Solution" and the stalks for producing male parental arrows were rooted and transferred to the greenhouse long before the emergence of the arrow. Table 22 gives the results of seedling production by bi-parental crosses in which the
Table 19. Date of the first and last arrow emergence and the duration of flowering under greenhouse conditions in each variety tested at Grand Isle, Louisiana in 1953-54 season.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variety</th>
<th>Date of first flower</th>
<th>Date of last flower</th>
<th>Duration of flowering (days)</th>
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<td>5/9/54</td>
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</tr>
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<td>15</td>
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<td>3/4/54</td>
<td>43</td>
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<td>5/2/54</td>
<td>91</td>
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<td>4/15/54</td>
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<td>4/5/54</td>
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<td>3/2/54</td>
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<tr>
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<td>3/25/54</td>
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<td>2/20/54</td>
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Table 20. Summary of sugarcane seedlings produced from bi-parental crosses when both parental stalks were rooted and transferred to the greenhouse at Grand Isle, La. in 1953.

<table>
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<tr>
<th>No.</th>
<th>Parentage</th>
<th>No. of male sterile arrows used</th>
<th>No. of seedlings produced</th>
<th>Est. No. seedlings stored</th>
<th>Total No. seedlings</th>
<th>No. seedlings produced by one female arrow</th>
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</thead>
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<th>No. of seedlings produced</th>
<th>Est. No. seedlings stored</th>
<th>Total No. of seedlings produced by one female arrow</th>
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<th>No.</th>
<th>Parentage</th>
<th>No. of male arrows used</th>
<th>No. sterile seedlings produced</th>
<th>Est. No. seedlings stored</th>
<th>Total No. seedlings produced by one female arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>74</td>
<td>C.P. 48-106 x C.P. 30-24</td>
<td>1</td>
<td>162</td>
<td></td>
<td>162</td>
</tr>
<tr>
<td>75</td>
<td>C.P. 48-126 x C.P. 29-116</td>
<td>2</td>
<td>108</td>
<td></td>
<td>108</td>
</tr>
<tr>
<td>76</td>
<td>C.P. 48-126 x C.P. 30-24</td>
<td>1</td>
<td>28</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>77</td>
<td>C.P. 48-126 x C.P. 33-372</td>
<td>1</td>
<td>101</td>
<td></td>
<td>101</td>
</tr>
<tr>
<td>78</td>
<td>17-6-46 x C.P. 43-64</td>
<td>2</td>
<td>92</td>
<td></td>
<td>92</td>
</tr>
<tr>
<td>79</td>
<td>17-6-46 x C.P. 43-74</td>
<td>1</td>
<td>178</td>
<td></td>
<td>178</td>
</tr>
<tr>
<td>80</td>
<td>Cl. 41-142 x C.P. 1165</td>
<td>1</td>
<td>680</td>
<td></td>
<td>680</td>
</tr>
<tr>
<td>81</td>
<td>Cl. 41-142 x C.P. 33-372</td>
<td>1</td>
<td>1518</td>
<td></td>
<td>1518</td>
</tr>
<tr>
<td>82</td>
<td>Cl. 41-142 x C.P. 43-74</td>
<td>8</td>
<td>3748</td>
<td></td>
<td>3748</td>
</tr>
<tr>
<td>83</td>
<td>P.O.J. 2725 x C.P. 43-24</td>
<td>1</td>
<td>15</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><strong>TOTALS</strong></td>
<td></td>
<td>178</td>
<td>28,122</td>
<td>32,208</td>
</tr>
<tr>
<td>No.</td>
<td>Parentage</td>
<td>No. of male sterile arrows</td>
<td>No. of seedings produced</td>
<td>Est. No. of seedlings as seed stored</td>
<td>Total</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------</td>
<td>----------------------------</td>
<td>--------------------------</td>
<td>-------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>1</td>
<td>Co. 281 x C.P. 27-108</td>
<td>1</td>
<td>-</td>
<td>180</td>
<td>180</td>
</tr>
<tr>
<td>2</td>
<td>Co. 281 x C.P. 38-34</td>
<td>1</td>
<td>-</td>
<td>740</td>
<td>740</td>
</tr>
<tr>
<td>3</td>
<td>Co. 356 x C.P. 27-108</td>
<td>2</td>
<td>-</td>
<td>848</td>
<td>848</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 1161 x Co. 281</td>
<td>1</td>
<td>59</td>
<td>-</td>
<td>59</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 27-108 x Co. 281</td>
<td>2</td>
<td>-</td>
<td>828</td>
<td>828</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 27-108 x C.P. 1165</td>
<td>3</td>
<td>-</td>
<td>2076</td>
<td>2076</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 27-108 x C.P. 38-41</td>
<td>1</td>
<td>-</td>
<td>484</td>
<td>484</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 27-108 x C.P. 43-74</td>
<td>1</td>
<td>874</td>
<td>-</td>
<td>874</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 29-103 x C.P. 36-105</td>
<td>1</td>
<td>-</td>
<td>216</td>
<td>216</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 29-116 x C.P. 36-105</td>
<td>1</td>
<td>197</td>
<td>-</td>
<td>197</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 29-320 x C.P. 27-108</td>
<td>1</td>
<td>-</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>12</td>
<td>C.P. 29-320 x C.P. 33-372</td>
<td>1</td>
<td>-</td>
<td>380</td>
<td>380</td>
</tr>
<tr>
<td>13</td>
<td>C.P. 29-320 x F- 36-819</td>
<td>1</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>C.P. 30-24 x C.P. 36-105</td>
<td>1</td>
<td>96</td>
<td>-</td>
<td>96</td>
</tr>
<tr>
<td>15</td>
<td>C.P. 33-372 x C.P. 1165</td>
<td>1</td>
<td>-</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>16</td>
<td>C.P. 33-372 x C.P. 43-64</td>
<td>1</td>
<td>-</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td>17</td>
<td>C.P. 34-120 x Co. 356</td>
<td>1</td>
<td>42</td>
<td>-</td>
<td>42</td>
</tr>
<tr>
<td>18</td>
<td>C.P. 34-120 x C.P. 1165</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>C.P. 34-120 x C.P. 27-108</td>
<td>1</td>
<td>-</td>
<td>448</td>
<td>448</td>
</tr>
<tr>
<td>20</td>
<td>C.P. 34-120 x C.P. 33-372</td>
<td>1</td>
<td>72</td>
<td>-</td>
<td>72</td>
</tr>
<tr>
<td>21</td>
<td>C.P. 34-120 x F. 36-819</td>
<td>1</td>
<td>26</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td>No.</td>
<td>Parentage</td>
<td>No. of sterile arrows</td>
<td>No. sterile arrows produced</td>
<td>Est. No. sterile arrows as seed stored</td>
<td>Total</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------</td>
<td>-----------------------</td>
<td>----------------------------</td>
<td>---------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>22</td>
<td>C.P. 36-105 x Co. 281</td>
<td>1</td>
<td>289</td>
<td>-</td>
<td>209</td>
</tr>
<tr>
<td>23</td>
<td>C.P. 36-105 x C.P. 33-372</td>
<td>5</td>
<td>1127</td>
<td>-</td>
<td>1127</td>
</tr>
<tr>
<td>24</td>
<td>C.P. 36-105 x 17-6-46</td>
<td>3</td>
<td>-</td>
<td>1520</td>
<td>1520</td>
</tr>
<tr>
<td>25</td>
<td>C.P. 36-211 x C.P. 33-372</td>
<td>1</td>
<td>15</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>26</td>
<td>C.P. 36-211 x C.P. 36-105</td>
<td>1</td>
<td>4</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>27</td>
<td>C.P. 38-34 x C.P. 27-108</td>
<td>1</td>
<td>-</td>
<td>104</td>
<td>104</td>
</tr>
<tr>
<td>28</td>
<td>C.P. 38-34 x C.P. 29-116</td>
<td>1</td>
<td>4</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>29</td>
<td>C.P. 38-34 x C.P. 36-105</td>
<td>2</td>
<td>201</td>
<td>-</td>
<td>201</td>
</tr>
<tr>
<td>30</td>
<td>C.P. 38-34 x C.P. 44-156</td>
<td>1</td>
<td>-</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>31</td>
<td>C.P. 38-34 x F. 36-819</td>
<td>1</td>
<td>47</td>
<td>12</td>
<td>59</td>
</tr>
<tr>
<td>32</td>
<td>C.P. 44-101 x C.P. 1165</td>
<td>1</td>
<td>-</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>33</td>
<td>C.P. 44-101 x C.P. 27-108</td>
<td>2</td>
<td>-</td>
<td>1176</td>
<td>1176</td>
</tr>
<tr>
<td>34</td>
<td>C.P. 48-126 x Co. 281</td>
<td>1</td>
<td>43</td>
<td>-</td>
<td>43</td>
</tr>
<tr>
<td>35</td>
<td>C.P. 48-126 x C.P. 1165</td>
<td>1</td>
<td>80</td>
<td>-</td>
<td>80</td>
</tr>
<tr>
<td>36</td>
<td>C.P. 48-126 x F. 36-819</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>TOTALS</strong></td>
<td><strong>48</strong></td>
<td><strong>3105</strong></td>
<td><strong>9380</strong></td>
<td><strong>12485</strong></td>
</tr>
</tbody>
</table>
Table 22. Summary of sugarcane seedlings produced from bi-parental crosses with the male arrows rooted in stovepipes and the female arrows preserved in nutrient solution. (Grand Isle, La. 1953 season)

<table>
<thead>
<tr>
<th>No.</th>
<th>Parentage</th>
<th>No. of arrows</th>
<th>No. seedlings produced</th>
<th>Est. No. seedlings from stored seed</th>
<th>Total No. seedlings</th>
<th>No. seedlings per arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281 x C.P. 43-64</td>
<td>1</td>
<td>-</td>
<td>448</td>
<td>448</td>
<td>448</td>
</tr>
<tr>
<td>2</td>
<td>Co. 356 x C.P. 43-64</td>
<td>1</td>
<td>195</td>
<td>148</td>
<td>343</td>
<td>343</td>
</tr>
<tr>
<td>3</td>
<td>Co. 453 x C.P. 43-64</td>
<td>1</td>
<td>-</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>C.P. 29-103 x C.P. 33-372</td>
<td>3</td>
<td>-</td>
<td>2432</td>
<td>2432</td>
<td>811</td>
</tr>
<tr>
<td>5</td>
<td>C.P. 30-24 x F. 36-819</td>
<td>2</td>
<td>-</td>
<td>184</td>
<td>184</td>
<td>92</td>
</tr>
<tr>
<td>6</td>
<td>C.P. 34-120 x C.P. 43-64</td>
<td>1</td>
<td>-</td>
<td>168</td>
<td>168</td>
<td>168</td>
</tr>
<tr>
<td>7</td>
<td>C.P. 36-105 x C.P. 1165</td>
<td>1</td>
<td>45</td>
<td>-</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>C.P. 36-105 x C.P. 33-372</td>
<td>2</td>
<td>-</td>
<td>1024</td>
<td>1024</td>
<td>512</td>
</tr>
<tr>
<td>9</td>
<td>C.P. 38-34 x C.P. 33-372</td>
<td>1</td>
<td>113</td>
<td>-</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>C.P. 44-155 x C.P. 27-108</td>
<td>1</td>
<td>264</td>
<td>-</td>
<td>264</td>
<td>264</td>
</tr>
<tr>
<td>11</td>
<td>C.P. 48-106 x C.P. 27-108</td>
<td>1</td>
<td>-</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>12</td>
<td>17-6-46 x Co. 356</td>
<td>1</td>
<td>-</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td><strong>TOTALS</strong></td>
<td><strong>16</strong></td>
<td><strong>517</strong></td>
<td><strong>4560</strong></td>
<td><strong>5077</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>
female or male sterile parental arrows were preserved by placing their roots in water or a nutrient solution. In Table 23 the data on seedlings produced are given from crosses made under natural conditions utilizing female arrows rooted in the field and transferred to an isolated location where male arrows were then transferred to them from the greenhouse.

Table 23. Summary of sugarcane seedlings produced from bi-parental crosses carried out under natural conditions in which only the male arrow was grown in the greenhouse and the female arrows were transferred from the field at Grand Isle, La. in 1953.

<table>
<thead>
<tr>
<th>No.</th>
<th>Parentage</th>
<th>No. of arrows</th>
<th>No. of seedlings produced</th>
<th>No. of seedlings per arrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co. 281 x C.P. 27-108</td>
<td>1</td>
<td>480</td>
<td>480</td>
</tr>
<tr>
<td>2</td>
<td>Co. 356 x C.P. 43-64</td>
<td>1</td>
<td>168</td>
<td>168</td>
</tr>
<tr>
<td>3</td>
<td>C.P. 33-372 x Co. 281</td>
<td>1</td>
<td>296</td>
<td>296</td>
</tr>
<tr>
<td>4</td>
<td>P. 33-32 x C.P. 27-108</td>
<td>1</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>F. 31-762 x C.P. 27-108</td>
<td>1</td>
<td>728</td>
<td>728</td>
</tr>
<tr>
<td></td>
<td>TOTALS</td>
<td>5</td>
<td>1680</td>
<td>1680</td>
</tr>
</tbody>
</table>
DISCUSSION

Floral initiation is the most fundamental step in the flowering of sugarcane, for this marks the actual change of the growing point from the vegetative to the reproductive stage.

The time at which this starts seems to depend on the rate of the preceding vegetative growth; therefore, the conditions which influence the rate of vegetative growth may cause differences in the time of floral initiation, their occurrence in various varieties and differences in the number present in each variety.

Floral initiation was lacking for most of the sugarcane varieties grown at Grand Isle in 1950. Only a small number of varieties produced floral initials.

Photoperiodic conditions at Grand Isle seem favorable for sugarcane flower induction, provided that other environmental factors are satisfied. One of the factors influencing floral initiation is the rate of preceding vegetative growth, and conditions which influence the rate of growth may inhibit floral induction, cause differences in the time of floral development and in the amount and distribution among the different varieties. In 1950 the vegetative growth of sugarcane plants at Grand Isle was not normal. The weather conditions during the three months preceding floral induction were dry. The amount of rainfall was only about two inches and infestation by the sugarcane borer was heavy.

Under these conditions, the growth of the sugarcane was poor. Therefore, the response to the photoperiod by floral initiation was not normal. Some varieties did not respond at all, and in others only a small
percentage formed initials.

Another reason why natural flowering of sugarcane did not occur in 1950, was because of the freezing temperatures which occurred twice in December and destroyed the small number of floral primordia present in the few varieties which had produced them and prevented further floral organization and emergence of the arrow.

Floral development and arrow emergence under greenhouse conditions occurred through the effect of higher temperatures. High temperature (between 70° F. and 80° F.) was responsible for pollen production and viability and anther dehiscence. The effect of temperature on pollen viability was recognized first by Khanna in India (57). Ten years later Brett (23) reported that the only factor responsible for low pollen viability in sugarcane in South Africa was the low temperature. He was the first to make an evaluation of this observation by initiating a breeding program in sugarcane based on increased pollen production and viability through subjecting sugarcane arrows to the effect of higher temperatures in the greenhouse.

The time of floral initiation of sugarcane varieties did not vary much in 1951. This indicated that early and late flowering varieties formed their floral initials at practically the same time. However, Co. 290 formed floral initials about two weeks later than the Canal Point varieties. This variety, perhaps because of more of the noble sugarcane characteristics than the Canal Point varieties, required a shorter day length to respond than the day length required for Canal Point varieties. This shorter day length occurred later in the season. The cause for the large difference in the percentage of floral initiation between the different varieties of sugarcane was
probably due to environmental conditions.

The selection of the rooted sugarcane stalks of each variety of sugarcane which were transferred after rooting, to the greenhouse, was made on the basis of all having floral initials inside the top of the cane stalk. If the environmental conditions inside the greenhouse were ideal a very high percentage of arrow emergence was expected. However, this was not the case, the percentage of arrow emergence being low.

The low percentage of arrow emergence of sugarcane varieties under greenhouse conditions may be the result of the effect of the greenhouse environment, characterized by high temperatures, low relative humidity, low intensity of sunlight and the exclusion of ultraviolet light. These artificial conditions in the greenhouse had a suppressing effect on flowering which was different among the different varieties. The differential flower suppression may account for the differences in the percentage of flowering under greenhouse conditions. An improvement of the low percentage of arrow emergence of sugarcane could be made by manipulating the canes in the greenhouse in such a way as to take advantage of conditions existing in the greenhouse (exposure to sunlight, and additional electric light in the afternoon).

The time of transfer of rooted sugarcane stalks to the greenhouse was found to influence flowering. The earlier the time of transfer, the lower the percentage of flowers obtained. The later the time of transfer of sugarcane to the greenhouse, the higher the percentage of flowering obtained. An explanation of this effect which may be given, and in agreement with the previous hypothesis, is that there is a suppression of flowering under greenhouse conditions. This suppression
may be greater at the early stage of organization of the floral primordia
than later in the season when such an organization had already started
in the field, before transfer to the greenhouse, and therefore, when the
transfer of sugarcane stalks to the greenhouse was made late in the
season with an advanced organization of floral primordia, the suppressing
effect of the greenhouse conditions on sugarcane flowering was dimin-
ished.

The differences in the time of flowering of the sugarcane
varieties under greenhouse conditions may be attributed to the dif-
ferent rate of growth of the floral primordia.

The natural flowering of sugarcane that occurred in 1951 may
be attributed to the favorable weather conditions that existed during the
1951 season. Temperature, the most important factor for the emergence
of the sugarcane arrow was normal. Only once during the season did
the temperature drop to 33°F. The rainfall during the three month
period preceding the time of floral initiation was 21.41". This, to-
gether with the normal day length conditions for flowering of sugarcane,
existing at Grand Isle, enabled a high percentage of the stalks to form
floral initials. Favorable temperature conditions prevailing during the
winter enabled the development and organization of the floral primordia
into arrows that emerged when they reached full development.

In the production of seedlings, differences were found in the
amount of seedlings produced on the average by one self-fertilized
arrow and one cross-fertilized arrow. The number of seedlings pro-
duced by one self-fertilized arrow was larger than the number of seed-
lings produced by one cross-fertilized arrow. This may possibly be
attributed to the higher pollination and higher degree of pollen growth
in the stigma of the same arrow than on the stigma of a different arrow.

The differences, between varieties of sugarcane, in the number of seedlings produced by one self-fertilized arrow and the number of seedlings produced by one cross-fertilized arrow may be attributed to differences in the percentage of pollen viability and the degree of anther dehiscence of the male arrows involved, the size of the arrow, the differences in the amount of pollen received by each arrow and the differences in the degree of anther dehiscence in the male arrows of the variety involved.

The percentage of floral initiation in the sugarcane at Grand Isle was about the same in 1952 as it was in 1951, but the time of occurrence was about two weeks earlier in the Canal Point canes in 1952 than in 1951. In the varieties F. 36-819 and Co. 290, the time of initiation was later in 1952. The differences in the time of floral initiation from year to year may be due to differences in the weather conditions from year to year which influence the growth of the sugarcane plants. Variation in the growth of sugarcane plants of the same variety from year to year may cause variation in the time of floral initiation.

The late time of floral initiation of the few noble sugarcane types grown at Grand Isle may be attributed to the shorter day length requirements for floral induction in these types.

The effect of the early or late transfer of rooted sugarcane stalks to the greenhouse on flowering was discussed previously. The same effect was shown under experimental conditions in 1952 when an experiment was carried out in a larger scale. The relationship between the time of transfer of the sugarcane stalks to the greenhouse and flowering was shown by another approach; the relationship of the
number of new leaves to the number of arrows produced. It was found that the number of new leaves present inside of the spindle was higher at the time of the first transfer of the sugarcane to the greenhouse than at the time of the last transfer. At the same time, the number of arrows emerging from the group of canes which was transferred to the greenhouse at the first date of transfer was lower than the number from the group which was transferred to the greenhouse at the last date.

This relationship may be explained by assuming that some pressure is applied on the young developing arrow by the surrounding leaves of the spindle. The higher the number of leaves around the developing arrow, the greater will be the pressure exerted. When the development of the arrow is normal the pressure of the leaves is counter-balanced by the pressure of the developing arrow. When the development of the young arrow inside the top of the cane stalk for one reason or the other is interrupted, the pressure of the surrounding leaves stops further development of this arrow. When the number of young leaves surrounding the developing arrow is small, their pressure on the arrow is lower and it is counter-balanced by the pressure of the developing arrow. Interruption in the growth of the young arrow is less affected by leaf pressure and the young arrow may continue to develop and emerge. The effect of exposure to sunlight on the development and emergence of the flowers of the sugarcane stalks inside the greenhouse was demonstrated. Sugarcane stalks having a West or South exposure produced more arrows than sugarcanes having an East or North exposure.

These results may be explained by the assumption that sunlight is required for the emergence of the arrow of sugarcane. The amount
of sunlight received by the cane stalks was greater in the South and
West exposure than in the East and North one.

In 1953, variations in the time of floral initiation shown by the
different varieties was greater than in 1951 or 1952. These differences
may be attributed to differences in the environmental conditions. The
duration of flowering of sugarcane varieties under greenhouse and
natural conditions was higher in 1953 than in 1951 and 1952. The per-
centage of flowering under natural conditions was higher in 1953 than
in 1951. The percentage of flowering under greenhouse conditions was
also higher than in 1951 and 1952. This may be due to the fact that the
transfer of the sugarcane stalks of the different varieties to the green-
house was made later in the season in 1953 than in 1951 and 1952 and
therefore the suppression of flowering in the greenhouse was less than
in 1951 and 1952. Varieties, such as Co. 290, F-36-819, and P.O.J.
2725, in which it is difficult to obtain emerged flowers, flowered in
the greenhouse in 1953.

In 1953, crosses of four different types were made to deter-
mine which one would result in the highest seed set per arrow, and the
highest seedling production.

The number of seedlings produced from crosses in which
both parental arrows were rooted in stovepipes amounted to 60,330.
The number of seedlings per arrow was 338.

The number of seedlings produced by the Hawaiian method was
12,485 and the average number of seedlings produced per arrow was 260.

The number of seedlings produced from crosses in which fe-
male arrows were preserved in water or nutrient solution was 5,077
and the number of seedlings produced per arrow was 317.
The number of seedlings from crosses made outside the greenhouse was 1,680 and the number of seedlings produced by one arrow was 336.

The method of crossing with both parental arrows rooted was the more promising one. An improvement in the other methods, especially the Hawaiian method may enable an increase in the number of crosses made each year with less labor involved.
SUMMARY

The flowering of sugarcane and the production of true seed of sugarcane at Grand Isle, La. were investigated during the years 1950, 1951, 1952 and 1953. The number of sugarcane varieties used during this investigation varied from 25 in 1950 to about 80 in 1953. Studies on floral initiation, natural flowering and flowering in sugarcane under controlled conditions were made in 1950, 1951, 1952, and 1953. In 1950, only a few varieties formed floral initials. Variations in the time and percentage of floral initiation and flowering were found under natural conditions between varieties in all years tested. Variations in time and percentage of flowering were observed between varieties under controlled conditions. Variations in the time of floral initiation were small, whereas variation in the time of flowering between varieties under both conditions were large.

The time of transfer to the greenhouse of rooted sugarcane stalks was found to influence flowering.

In greenhouse experiments in 1952, there appeared to exist a relationship between flowering and the number of new leaves inside the spindle at the time of transfer of sugarcane stalks to the greenhouse.

The exposure of sugarcane to sunlight in the greenhouse seemed to influence flowering.

Temperature appeared to affect the viability of the pollen of sugarcane. Under natural conditions, temperatures below 65°F prevented the production of viable pollen. Under controlled conditions with temperatures between 70°F and 80°F, viable pollen was
produced by most varieties.

Highly significant differences in the production of good pollen were found between varieties.

Sugarcane seedlings were produced under controlled conditions in 1950, 1951, 1952, and 1953. In 1950 only seedlings from selfing were produced. In 1953 seedlings from crosses only were produced.

In the production of seedlings of sugarcane from crosses the rooting method of bi-parental crossing was used in 1951, 1952, and 1953. In 1953 several methods of arrow preservation were tested. These included the Hawaiian method of maintaining the female arrows in sulphurous and phosphoric acid solution, the method of preservation of the female arrows by placing their roots in antibiotic solutions, nutrient solutions, and water. The effect of different methods on seed setting was tested.

Differences were found in the number of seedlings produced by male fertile varieties. Differences were found in the number of seedlings produced by different crosses. A small number of seedlings were produced from crosses which were carried out under natural conditions by using female arrows from the field and male arrows from the greenhouse.

In all an estimated 164,526 seedlings from crossing and 55,071 seedlings from selfing were produced at Grand Isle, La. in the four seasons from 1950 through 1953.


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AUTOBIOGRAPHY

Elias D. Paliatseas was born at Exohorion, Messinia, Greece; on December 25, 1911. He was graduated from the Exohorion public school in June 1925 and registered at the Kalamata High School in September 1925. He was graduated from Kalamata High School in June 1931. He was admitted at the Salonika University School of Agriculture in October 1931 and received the Bachelor of Science degree in Agriculture in December 1936.

He was employed by the plant breeding institute of Salonika Department of seed production from April 1936 to December 1936.

He served in the army at the R.O.T.C., Athens from January 1937 through September 1937. He was nominated and served as Lieutenant from September 1937 through April 1938.

He was employed as Assistant Agronomist at the Salonika Cotton Research Institute in May 1938. In October 1940 he was called to the Army and served on the war front from November 1940 to June 1941. He then returned to the Salonika Cotton Research Institute until 1947.

In September 1947 he was called to the Army again and served until December 1948.

In February 1950 he was admitted to the Louisiana State University and registered in the Agronomy Department. He received his Master of Science degree in August 1951.

He is at present a candidate for the degree of Doctor of Philosophy in August 1954.
List of Publications


EXAMINATION AND THESIS REPORT

Candidate:  **Elias D. Paliatseas**

Major Field:  **Plant Pathology**

Title of Thesis:  *The Flowering and the Production of True Seed of Sugarcane in Louisiana*

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:  **July 27, 1954**