A high rate and extent of germination are of primary importance in successful crop production. Incomplete germination of seeds brings about in its wake wide gaps in the field lessening the density of the crop and thereby the yield. Recent studies at Rothamsted have stressed the enormous importance of density of crop as one of the major factors affecting crop yields. The problem is all the more serious in a vegetatively propagated crop like Sugarcane. Consequently this phase of sugarcane culture has attracted the attention of a large number of workers throughout the country. The greater speed of germination helps the seedlings to make the maximum use of limited soil moisture, especially where germination phase is followed by a warm and dry period, as obtains in case of spring planting in Bihar and Uttar Pradesh. Besides, early sprouting of buds also hastens tiller production, and these tillers by making full use of the following grand period of growth, contribute to the ultimate yield. Further, average percentage germination of sugarcane buds under north Indian conditions, where the bulk of the Indian sugar industry is located, is as low as 30-35% as compared to 80-90% under south Indian conditions. As a result of this peculiar situation, there have been many attempts to find out the causes underlying this low germination with a view to enhance the same and thereby to improve yield.

Germination, as it is generally spoken of in sugarcane culture, comprises two distinct phases: (i) sprouting of the dormant bud and root primordia and (ii) establishment of the young sprout. The first phase is largely influenced by internal factors which relate to the nature of the eye-bud, type of sett, its physical and chemical composition, etc., while the external factors like the type of soil, its moisture and manurial status, general edaphic and climatic conditions of the locality, etc., have greater impress on the second phase. Pre-planting treatments, depending on their nature, influence the first or the second phase.

Varietal Differences

A wide varietal difference as regards rate and extent of germination has been observed. It is needless to state that varieties with higher percentage of germination are more economical to plant than low germinating varieties. The variability between varieties was thought to be due to the presence of different proportions of dry-scaled buds, which were slow to germinate\(^\text{e}\) and also due to the high fibre
content with hard rind, high wax deposit on the cane and thicker cane girth, which affect germination adversely. It may, however, be noted that causes of varietal difference are much more complex, involving the morphological characteristics as well as the dynamic of metabolic and enzymatic activities and consequently the genic base of the variety. Hence rigorous selection of seedlings in the breeding programme for high and rapid germination and rejection of shy and slow germinators is of paramount importance.

Moisture content of the setts is one of the important factors affecting germination. It becomes all the more important where sugarcane is grown under unirrigated conditions, the sett being forced to sustain on its own moisture content, coupled with traces of moisture in the soil, until the root system is sufficiently developed to tap the deeper soil layers. Under the conditions of Bihar, Khanna observed that higher moisture percentage in cane favourably influenced germination, 50-3% moisture being critical, below which very poor germination resulted. Further, desiccation of the setts was found connected with the form and shape of buds and also their position on the cane, the younger buds borne on the top desiccating quicker. The interval of time between cutting of setts and planting and method of preserving them was found to have a marked effect on moisture content of the sett. Under Bihar conditions, material left open in the sun for more than four days during the month of February resulted in very unsatisfactory germination. The poor germination in Bihar, of setts obtained from Coimbatore was also thought to be due to excessive desiccation which varied in different seedlings. When it was necessary to transport seed material over long distances, it was found best to keep it moist and well covered with trash. But under the conditions of Mysore, preservation of canes for a few days after cutting seemed to increase the germination percentage, particularly so, when they were kept in shade; however, this might have been due to some chemical changes in the sett, rather than to loss of moisture.

**EFFECT OF SOIL MOISTURE**

Apart from the moisture content of the sett, soil moisture also influences the germination percentage. It plays the dual role of keeping the buds moist and thus help sprouting and also keeping the young sprout well supplied with water. Too much water would clog the pore space and create an anaerobic condition unsuitable for plant growth, while too little would force the setts to sustain on their own. At Shahjahanpur all varieties gave lower germination under dry conditions as compared to the wet. Under the conditions of Bihar it was shown that soil moisture markedly influenced germination percentage, optimum moisture in the soil for high germination being 15% in the first 6" layer of the north Bihar alluvium. Further, high germination in low land was attributed in part to the high moisture content of the soil at planting. In general, percentage of germination increased with an increase in soil moisture. Fifteen per cent, or more of soil moisture induced more than 50% germination in Co, while that
GERMINATION OF SUGARCANE—A REVIEW

below 10% only 17.6%. At Anakapalle germination was less under rainfed conditions than under irrigated conditions, the average percentage being 45 and 57 respectively. Studies on buds kept in various humid ranges have shown that rapid germination and growth of buds were not limited by higher moisture uptake; it was also observed that the more frequent the irrigation, the better was the germination. In Punjab it was observed that irrigation applied to crops had a direct bearing on the germination capacity of the seed material. Higher moisture levels had an inhibiting effect on germination in the early stages. Later on, the differences were however made up. Variations in moisture under different levels of soil moisture appeared to be mainly responsible for lower germination in the earlier phase under high soil moisture levels.

EFFECT OF TEMPERATURE

In view of the varying temperature from one tract to another, as well as the multiple planting time recommended by some of the States, considerable work has been undertaken on the influence of temperature on germination of sugarcane setts.

At Shahjahanpur (U.P.) it appeared that late sowing (April), because of the high temperature, showed better germination in relation to both rapidity and extent which was further confirmed by delayed germination due to prevailing continued low temperatures during the season 1939-40 and again by earlier and quicker germination in 1940-41 and 1941-42 under higher atmospheric and soil temperatures. Under Bihar conditions, temperature in the range 40-55°F. was detrimental to germination. The lower limits reached in various months was observed to have a marked influence on germination, the temperature during November being more favourable than that during January. It was also suggested that quickness of germination could be achieved by applying warm water. On the other hand, in Madras, hottest, coldest as well as rainy periods lowered germination. Under the wide temperature range (3-4°F. below freezing point in winter to 116°F. in summer) as obtains in Punjab, it was observed that late plantings accompanied by higher temperatures resulted in gappy stands in view of the drying of buds before they could germinate. Plantings in the first and third week of March and first week of April gave significantly better germination than that in the third week of April or first week of May, the former in its turn being superior to the latter. It was concluded that sugarcane in Punjab should be sown as soon as the season in a little warmer. Singh and Gill found 75-85°F. soil temperature to be optimum for rapid germination. Later, Singh and Singh from a detailed study on the effect of soil temperature on germination reported that the minimum soil temperature from 62-3-83-4°F. was conducive to good germination, the higher and lower temperatures proving definitely deleterious.

In the winter (December)-planted crop, the buds did not germinate during December-January, when the minimum soil temperature was
between 49.7° F and 59.3° F. In Padegaon, Bombay, temperatures below 50° F. have been found to be definitely deleterious to germination. Increased rate of germination with minimum temperatures above 60° F. was quite evident, which was obtained even with the lowering of the glucose and amide content. Further, constant temperature as low as 35° F. was found not harmful, while fluctuating temperatures were observed to be definitely deleterious. However, alternating high and low temperatures around the mean temperature of 70° F. were found very satisfactory from the point of view of bud sprouting and ultimate stand in the field in the North-West Frontier Province.

**Effect of Nutritional Status of the Sett**

The energy required for sprouting of the bud and for growth and development of the young sprout, until the seedling is established, is drawn from the nutrients stored in the cane. In view of this the type of nutrients contained in the cane depending on the time of their being used as seed material and also the manurial treatment given during the normal course of growth, especially that given as a preharvest treatment, have a profound effect on germination.

As early as 1931, Viswanth and Suryanarayana obtained distinctly higher yields on unmanured fields when cane sets obtained from plots grown with different manures were used as against seed from unmanured plots. At Shahjahanpur, good seed material derived from canes well supplied with nitrogen and water gave 8% and 20% better germination in early and late March plantings respectively which was further substantiated by Mathur. At Ankapalle it was shown that seed obtained from an intensively fertilized plot germinated better than that obtained from a poorly fertilized one, the percentages being 64 and 34 respectively. Under the conditions of Bihar, Khanna from that high glucose ratio influenced germination favourably. Dutt and Narasimhan showed the importance of starch in the sets in improving germination. Outstanding and exhaustive studies in this subject were conducted by Rege and co-workers at Padegaon. Investigations at Padegaon suggested that nitrogen was the controlling factor in germination, glucose content being sufficiently high in all the cases under study; great variation was however found not only in amide nitrogen content but also in the enzymatic activity in the two varieties Pundia and P.O.J 2878 studied. This was further confirmed by the favourable effect of ammonium sulphate at the time of planting. It was concluded that the real criterion for the germination of sets was the chemical content and age, the latter having an indirect effect. Further chemical analysis showed a high positive correlation between germination and amide nitrogen, while little correlation was obtained with glucose. Of the two important chemical constituents required for germination, viz., carbohydrates (mainly glucose) and the soluble nitrogenous compounds, the latter appeared to be the more important. It was concluded that normal plantings which are heavily manured would supply suitable planting material from this point of view. Beneficial effect of nutrients stored in the sett has also been shown by Venkata-
raman who demonstrated the beneficial effect of long internodes connected with the bud for better germination. Subba Rao et al. also observed a positive correlation between average internode length at preharvest stage of different varieties and the germination percentage. Further, higher efficiency as regards sprouting was observed in the middle bud of a three-budded sett, which naturally has larger internodal tissue compared to the end buds. This observation presupposes that the bud can draw its nutritional requirement from the internodal tissue on either side of it. However, it does not agree with the conclusions derived from the studies at Padegaon that sprouting bud is served by a distinct current of food material from the internode immediately below the bud. Kale and Deshpande also opined that the higher percentage of mortality in single shoot (Rayangun) and seedling setts as compared to double shoot (Rajoong) and seedling setts was due to the insufficiency of plant food and water in the small portions of internodes attached to them.

However, nutritional status of the sett governs mainly the sprouting and the initial growth of the young sprout, and it is the elemental composition of the soil that governs the subsequent establishment of the young seedling and its growth. It logically follows that initial fertility level of the soil and manures and fertilizers applied before and at planting would have a major effect on the ultimate germination percentage. Thus various forms of fertilizer elements have been tried with a variety of results.

At Padegaon, it was observed that the utility of application of ammonium sulphate at the time of planting was more pronounced under adverse conditions of climate, soil or even planting material. On the other hand "no nitrogen" treatments showed lower rate and fall in germination percentage, though a basic dose of superphosphate was given; nor was there any variation in germination in treatments of 300 lb. N/acre with or without phosphate, proving thereby the more important role of nitrogen than of phosphorus. It was further observed that unfavourable effects of low temperature could be avoided to a great extent by applying nitrogen in the form of ammonium sulphate at planting. At Anakapalle, the response was erratic in that in one season, it was found that the application of a concentrated dose of nitrogenous manure (100 lb. N/acre) at the time of planting seemed to promote germination, while in the other season, in which 0, 50, 100, 150, 200 and 250 lb. N/acre were tried, the germination of buds seemed to be practically unaffected by the different treatments. Under the conditions of Punjab, higher nitrogen doses over 50 lb./acre affected germination adversely, more so in the case of higher doses. Under dry planting conditions, Khan and Agarwal found oilcakes and inorganic fertilizers, except superphosphate, to adversely affect the germination of setts. Thakur and Chatterjee observed that ammonium sulphate in combination with single superphosphate at planting had a greater stimulating effect on germination as compared to compost in normal soil conditions of north and south Bihar. However, in extremely sandy soils the use of ammonium sulphate and single super-
phosphate had a very significant deleterious effect. On the other hand, the application of compost in combination with single super phosphate had a very stimulating effect on germination. It seems that higher fertilizer doses under limited soil moisture conditions (which varies in different tracts) upset osmotic balance thereby affecting germination.

Germination has also been thought to be limited by the lack of one or the other of the minor elements, necessary for plant growth. Rege and Divekar have shown the beneficial effect of copper, boron, zinc and manganese on the rate of germination, copper and boron, in particular, giving the best results. Even soaking of setts in micro-element solutions has given desirable results. Dipping of setts (which were first desiccated for 48 hours in shade to ensure sufficient absorption) for 12 hours in solutions of micro-elements, viz., copper, boron, zinc and manganese, the concentration in case of copper being 30 p.p.m. and of other elements 50 p.p.m., showed improved germination. This effect was more pronounced in P.O.J. 2878 than in E.K. 28, showing differential varietal response. Zinc showed good effect on P.O.J. 2878, closely followed by manganese, while manganese was the only element which gave higher germination in E.K. 28. Further, in another series, copper at 10 p.p.m. gave the best germination closely followed by 50 p.p.m. dose of zinc. Soaking of setts for 12 hours in dilute solutions (1% and 0.5%) of manganese sulphate also improved germination very markedly.

**Effect of Growth-Regulating Substances**

The impress of apical dominance in the entire cane as well as in each section of the cut cane carrying more than one bud has been recognized for a long time. The scientific explanation of apical dominance appears to be that a bud germinates only when its auxin content is reduced below a critical level by "being pumped" downwards along the gradient. In this way the natural auxin is "pumped" from the topmost bud to the next one below so that the latter is kept in check until the former germinates. This phenomenon continues from one bud to the next. Investigations on the germinating capacity of the individual buds of three-budded setts have shown poor germination and also vigour of the shoot in the bottom eye bud irrespective of the position of the sett on the cane, but the basal bud was always seen to have more roots. Subba Rao et al. observed that in a three-bud sett, the top bud was the earliest to germinate, followed by the "middle" and "bottom" buds, although the ultimate germination percentage was highest with the "middle" bud. It was concluded that the "bottom" bud being situated lowest in the order of polarity is liable to rot with the greater time interval necessary for it to germinate under field conditions, thus providing small contribution to the total germination.

Although the role of natural auxin is well established in the case of apical dominance, investigations carried out with synthetic hormones have failed to indicate any systematic or consistent trend. Soaking of setts for 12 hours in dilute solutions of N.A.A. was found to improve
germination markedly. Treatment of setts with as low a concentra-
tion as 0·001 p.p.m. also improved germination very markedly. However, Subba Rao et al. did not find any improvement in germina-
tion with soaking of setts for 15 minutes in 100 p.p.m. of N.A.A. and I.A.A. It was concluded that the time allowed for soaking was not sufficient for the absorption of effective quantities of the hormones. However, there was some indication towards differential action of N.A.A. and I.A.A. Soaking in dilute solutions of 2, 4-D showed gradual fall in the percentage germination with increase in concentra-
tion, while concentrations of 0·01% and 0·1 p.p.m. improved germina-
tion markedly. Soaking of setts of variety Co. 419 for 24 hours in 100 p.p.m. and 1,000 p.p.m. of Agroson solution did not stimulate germination very much; but higher concentrations suppressed bud development, but did not affect sett-root development. Hormone A in dilutions of ½ c.c. in ½ pint and ½ c.c. in 2 pints of water, however sup-
pressed root growth.

Effect of Cultural Practices

Length of sett.—The most suitable length of sett (i.e., one bud, two buds, three buds or whole cane) for good germination and stand has been considered by workers from early days. This problem is quite complicated because it involves number of buds per sett and con-
sequently the phenomenon of apical dominance as well as the amount of internodal tissue.

At Shahjahanpur, one-bud sett gave the poorest germination, two-
bud setts four times better and buds from 3–18 were individually about six times better. At Padegaon, slightly superior germination was obtained in case of one-budded setts over that of the three-budded ones possibly due to better selection of the seed material. But it was also stated that under adverse climatic conditions, single-budded setts were likely to suffer more than three-budded setts, if proper precautions were not taken. In Punjab, the three-budded setts gave better germination than two-budded ones. The percentage germination, 45 days after planting, was 39·57 in the case of two-budded sets as against 46·12 in three-budded ones. It was further observed that the three-budded setts were the earliest to germinate with a higher percentage up to one month after planting but later two-budded setts seemed to catch up and the differences in the percentage germination practically disappeared 45 days after planting.

Mode of planting.—Mode of planting in relation to the position of the sett in the soil has also a lot to do with achievement of high germi-
nation. Change in the mode of planting has been found necessary with different soil types. In heavy soils (including alkaline soils) dry planting, with light irrigation later on, was found to be more useful as against the normal deep planting in shallow and medium soils where copious quantities of water was given along the rows immediately after planting. Depth of planting on this score needs to be carefully adjusted depending on the type of soil.
Position of the bud in the soil.—Position of the buds when planted also affects the amount and rate of germination, in view of the space to be traversed by the sprouting seedling. Under Uttar Pradesh conditions upward position of buds in the soil gave the best germination followed by buds placed sideways; the buds facing downwards showed the poorest germination. Further, Gashlot working with three-budded setts found that setts with all three buds on sides and with two buds up and one bud down gave almost similar germination percentage, but much higher than with two buds down and one bud up. However, Subba Rao et al., working under Bihar conditions, found that "up" buds gave the highest germination followed by "side" and "down" buds in decreasing order. The two buds up and one down (with reference to a three-budded sett) position gave about 10% higher germination over the position with all three buds on sides.

Stripped setts.—Setts which were stripped gave 6–10% better germination over unstripped ones and this effect was more marked in varieties Co. 313 and Co. 76, but not in Co. 421. Under the conditions obtainable in Punjab, unstripped cane also affected germination rather adversely.

Topped setts.—Setts from canes topped one week before planting, showed better germination initially, but ultimately germination percentage was almost equalised; but topping 3 weeks before did not show improvement in germination percentage. Under Bihar conditions also topped setts gave better germination than soaked ones. Further in low fibred varieties like Co. 308, topped setts proved better but in high fibred varieties like Co. 395, Co. 513 and Co. 508 topping was superseded by soaking in water for 48 hours.

Water suckers.—Water suckers or water sprouts have given satisfactory germination in moist soil bed and could be used for seed purposes provided one irrigation could be assured to establish them.

Rayungans.—Krishnamurthy Rao obtained better germination from Rayungans, while Agarwal also recommended Rayungans as a safeguard against the failure of some buds to germinate. Further Mukerji and Ram Krishan recorded approximately 50% better germination by Rayungan method over normal planting methods; number of millable canes also showed a very marked improvement. Jayaram, under South Indian conditions, also found Rayungans to give better germination but the chief disadvantage in their use in bulk was that their establishment was not good except in the months of December to February and required better climate, soil and irrigation. A modification of the Rayungan method, called "Rajoong" method, which involves planting of double shoot setts, as against single shoot setts of Rayungan, is being successfully followed on submerged lands in Kolhapur since 1938. Kale and Deshpande made a comparative study of Rayungan, Rajoong and normal (three-budded setts) methods of planting and found that while with three-budded setts average germination percentage was 55.7, the percentage survival of shoots was 78.3 and 53.8.
in dry soils and 95.5 and 95.8 in wet soils, for Rajong and Rayungan methods respectively. The method of planting single and double seedlings, yet another modification of Rayungan method, also gave better results than normal mode of planting, the percentage survival of seedlings being 63.7% and 74.7 in dry soils and 94.1 and 92.7 in wet soils for single and double seedlings respectively.

Part of the cane.—Top joints and immature parts of cane were considered to germinate better than the bottom and mature parts. However, observations showed that this did not hold good in all soil types, particularly in those where high moisture content prevailed during the germination stage. At Padegaon, top setts proved the best and the bottom setts the worst. The whole cane setts attained an intermediate position and gave germination equal to the middle setts.

PRE-PLANTING TREATMENT OF CUTTINGS

With a view to improve germination, both in speed and extent, different workers have tried several treatments with interesting results.

Soaking in water.—Water being of easiest availability from cultivator's point of view, many workers took recourse to it. Under the climatic conditions of Bihar, it was observed that quickness of germination could be achieved, by soaking the material before planting. Increased germination, high pre-monsoon tillering and yield were observed from setts soaked for 48 hours. Khanday found better results when canes were kept standing vertically, with their ends wholly immersed in water before planting, more so in case of middle and top setts. It was also pointed out that the improvement gained by water soaking treatments was due to the improved metabolic activity of the sett. At Shahjahapur in early sowings, soaking for 24 hours proved beneficial, but not so in case of late sowing, the germination later on being temperature bound: in another season, germination however increased at all the three dates of sowing, while in yet another season, February sowings failed to respond to water soaking. It was also found that best germinations resulted under late sowing by a combination of water soaking, irrigation after planting and increased seed rate. Singh et al. found that high water content of the cutting promoted the conversion of carbohydrates into reducing sugars, and concluded that the beneficial effect of soaking was partly at least due to a higher concentration of reducing sugars.

Soaking in aqueous solutions of chemical compounds.—At Shahjahapur soaking of setts in lime wash for 24 hours before planting improved germination in early sowings, the improvement being minimum with late sowings in the season 1938-39, but during 1940-41 and 1941-42, germination improved with all the dates of sowing. Mathur concluded on the basis of these data that setts pre-soaked in lime wash gave 18-20% better germination when planting was done early in the season. In Bihar, soaking for 6 hours in lime saturated solution gave very satisfactory results. At Padegaon soaking of setts with dry-
scaled buds in saturated lime solution for 24-48 hours was found to be beneficial giving 10% higher germination, but at lower temperatures, only soaking for 24 hours was more effective.\textsuperscript{21}

Khanna\textsuperscript{22} soaked setts for 24-48 hours in solutions of various materials among which extracts of ashes and saturated solution of lime-magnesium proved more beneficial particularly so for bottom setts. Vijayasaradhy \textit{et al.}\textsuperscript{23} tried soaking of setts in solutions of ammonium sulphate, potassium permanganate and potassium ferricyanide with no marked improvement in germination, the lower concentrations being slightly favourable and higher ones deleterious.

The optimum pH for good germination and subsequent growth of cane is between 6.0 and 7.2. Various hydrogen-ion concentrations indicated differential effects on germination of sugarcane. There is a positive correlation between germination energy and dry matter output by plants. It is maximum at 6.8 pH for 24 hours soaking. 96 hours soaking decreased germination.\textsuperscript{46}

Soaking in insecticides.—The clensol series of termite preventives showed stimulating effects on both germination energy and capacity.\textsuperscript{30} But soaking in solutions of aldrin, dialdrin and B.H.C. showed no improvement in germination.\textsuperscript{30}

Pre-treatment with fungicides.—At Shahjahanpur, dipping in Agroson did not improve germination, it being only slightly superior to control. On the other hand, dry application of Agroson was definitely superior. Hortoson was more promising, but dressing of R. 1104 did not prove useful.\textsuperscript{43} In recent years Aretan, an organomercurial fungicide, has given much promise. It is supposed to act by preventing the ingress of soil micro-organisms which constitutes a drain on the nutrients and moisture reserve of the sett and also produce toxicity conditions through incomplete fermentation. Subba Rao \textit{et al.}\textsuperscript{69} reported marked improvement in germination percentage with various Aretan pre-treatments; however, the speed of germination was adversely affected by Aretan. Singh, Gill and Singh\textsuperscript{67} also observed beneficial effect of Aretan on germination. Muthuswamy and Aravamudhan\textsuperscript{60} also found that treatment of setts before planting with Aretan/Dieldrin, Aretan/Aldrin, Aretan and Aretan/B.H.C. improved germination, in the order of the treatments. The studies conducted by Subba Rao \textit{et al.}\textsuperscript{71} at eleven locations in Bihar confirmed the beneficial effects of Aretan pre-treatment, 15 minutes soaking in $\frac{1}{2}$ lb. Aretan in 20 gallons of water giving 8.9% more germination over control.

Keeping setts under cowdung.—Although initially the canes kept under cowdung for 48 hours showed better germination than those kept for 24 hours, these effects were ultimately reversed—germination under 24 hours cowdung treatment and control was approximately equal and better than that under 48 hours pre-treatment.\textsuperscript{44-45}

Electroculture.—Electroculture treatment induced a rapid rate of germination during the first three weeks, but without any significant effect on final yield.\textsuperscript{39}
Germination of Sugarcane—A Review

Irradiation of setts.—Exposure to X-rays and ultra-violet rays did not help much except in the case of Co. 281 where stimulation was marked. Plant material grown under components of white light gave conflicting results, blue rays being slightly better in one case and green in other, with red, white and blue following in decreasing order.

Conclusions

The foregoing review reveals that, despite the wide diversity of observations and inferences, there prevails some agreement as regards the importance of several factors concerned with germination in sugarcane. Apart from genetic variation in respect of capacity for germination, moisture content, nutrient reserve mainly glucose and amide nitrogen, good undried buds, reduction of natural hormones, etc., are factors regarded as essential for good germination, thus most of the attempts to improve germination have centred around conserving or augmenting the moisture and nutrient reserve of the setts and soil as reflected in preference of immature parts over the mature parts of the cane and of fresh seed material over stale, methods of preserving the setts, pre-harvest application of manures and fertilizers, pre- and post-planting application of irrigation and fertilizers, preference of planting methods which allow of larger amounts of internodal tissue per bud and the least desiccation of buds and other pre-planting treatments such as soaking in water, in solution of inorganic and organic compounds, in solutions of fungicides and insecticides. Factors aiding or hastening the reduction of natural hormones either by aiding the action of natural I.A.A. oxidase system by providing a time lag or by some pre-planting treatment like soaking in hot water or by antagonistic action of synthetic hormones or by lessening or nullifying the effect of apical dominance by planting one-bud setts or by such cultural practices as topping have also been stressed. Selection of better seed material with good eye-buds, with less of waxy coating and low hardiness of rind have also been suggested.

Despite a general accord on these principles there is as yet much to be resolved as regards the relative role and importance of each of these factors in view of the immensely diverse edaphic and climatic zones and planting seasons under which sugarcane is grown in the Indian sub-continent. Sugarcane growing tracts of India fall under two distinct climatic zones, the southern tropical zone and the northern sub-tropical. Unlike its southern counterpart, where the climate is milder and more congenial for sugarcane culture, the northern region, where the bulk of the crop is sown in spring, temperature and moisture become the limiting factors, the dry and hot period following the spring planting coupled with the limited irrigational facilities being definitely detrimental to seeding establishment and to sprouting in case of later plantings. Longer and larger areas are being brought under autumn plantings in the northern sugarcane belt. In addition, individual factory farms have also successfully switched back the time of planting to the
monsoon period corresponding to the now well-known Adsali planting of the Deccan canal tract.

An ideal system for procuring high germination in the field would be to select undried fresh buds from cane which has been manured just before harvest for seed purposes, dry them in the field under shade for a period of 2-5 days allowing for destruction of the natural hormones and planting in a seed-bed with sufficient moisture. Where conditions of soil are adverse as regards soil microflora and termites and where temperature may be slightly adverse leading to prolonged germination, pre-planting treatments with organo-mercurial fungicides at the rate of ½ lb. in 20 gallons of water coupled with insecticidal treatment in the rows need to be employed. Such a procedure on the basis of the work so far done seems to be the most ideal.

With the rapidly advancing knowledge about growth regulators the day may not be far off when it may be possible to annul the effect of apical dominance enabling planting of complete sugarcane direct without cutting into setts and thus saving cost of labour. Suitable pre-harvesting treatments to seed canes may also be devised apart from those known so far so that the nutritional and hormonal balance is maintained and rapid, steady and sure germination of all the buds is ensured.

REFERENCES
2. Annual Report, Sugarcane Research Scheme, Anakapalle, 1933-34.
3. Ibid., 1934-35.
4. Ibid., 1935-36.
5. Ibid., 1938-39.
6. Ibid., 1939-40.
7. Ibid., 1940-41.
8. Ibid., 1945-46.
9. Ibid., 1946-47.
11. Ibid., 1951-52.
12. Ibid., Anakapalle and Gudiyatam, 1948-49.
15. Ibid., 1939-40.
18. Ibid., 1935-36.
19. Ibid., 1936-37.
21. Ibid., 1941-42.
22. Ibid., 1950-51.
23. Ibid., 1951-52.
27. Ibid., 1933-34.
28. Ibid., 1934-35.
29. Ibid., 1935-36.
31. Ibid., 1944-45.
32. Ibid., 1945-46.
33. Ibid., 1946-47.
34. Ibid., 1956-57.
36. Ibid., 1936-37.
37. Ibid., 1937-38.
38. Ibid., 1938-39.
39. Ibid., 1939-40.
40. Ibid., 1940-41.
41. Ibid., 1941-42.
42. Ibid., 1944-45.
43. Ibid., 1948-49.
44. Ibid., 1949-50.
45. Ibid., 1950-51.
48. Final Report, Sugarcane Research Scheme, Pusa (Bihar), 1932-44.
71. SUBBA RAO, M. S. et al., Unpublished.