EFFECT OF DATE OF SOWING

AND

COMBINATION OF NITROGEN, PHOSPHORIC ACID AND POTASH

ON

THE GROWTH AND YIELD OF SEA ISLAND COTTON

(*Gossypium barbadense*, Linn.)

By

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CERTIFICATE

This is to certify that the thesis herewith submitted contains the results of bonafide research work carried out by Sri. M. Abdul Kalam under my supervision. No part of the work embodied in this thesis has been submitted earlier for the award of any degree.

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C O N T E N T S

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INTRODUCTION

Exploratory trials for the introduction of Sea Island cotton in the west coast region of the Madras State were sponsored by the Madras Agricultural Department, as early as 1930. But it was only from 1949, that intensive trials on acclimatisation of Sea Island cotton were started at Pattambi, Nileshwar and Mangalore. The results of these trials confirmed that Sea Island cotton could be cultivated successfully under the conditions prevalent in the west coast regions. However, the cultivation of this crop was taken up on a commercial scale in the State of Kerala, only in 1957 (Anon.1959).

In Kerala, cultivation of Sea Island cotton is confined mostly to the District of Palghat. In view of the increasing demand for the extra long staple cotton, under which the Sea Island cotton is classified, it seemed worth trying the performance of this crop in other Districts also as a preliminary step to study the desirability of extending the area of its cultivation in the State. With this object in view, the present trial was taken up to explore the possibilities of introducing Sea Island cotton in the Vellayani region.

The red loamy soils of the Vellayani region of the Trivandrum District are of average fertility and sufficiently deep with good drainage. The area receives an average rainfall of more than 1750 mm. per annum. The average annual temperature is 81^{o}F with abundant sunshine throughout the year. These soil and climatic features favour the requirements of Sea Island cotton for its successful cultivation in the Vellayani region. Accordingly, preliminary trials were carried out by the Agricultural College and Research Institute at Vellayani during 1959-62 to study the performance of the crop in that locality. The crop was sown in the month of July in all the years. Though the vegetative growth and flowering of the crop were observed to be quite satisfactory, excessive precipitation during the month of October coincided with the flowering of the crop and resulted in a heavy shedding of the squares and flowers with a consequent reduction in the yield of kapas. This failure of the crop could be attributed to the unfavourable sowing date followed in all the years. Hence, it was also found necessary to determine in the present investigation the most favourable sowing date that would provide the crop the optimum climatic conditions during the season of its growth, especially at the time of flowering and boll bursting.

In regard to manurial requirements of Sea Island cotton, only a few trials have been reported. The results obtained by Ramaswamy and Vaman Bhatt (1957) showed good response to 60 lb. nitrogen, 30 lb. phosphoric acid and

50 lb. potash per acre. However, this recommendation could not be assumed to be applicable to the different regions of Kerala. Although, the trials conducted at Trichur by Kurup (1961 - unpublished) indicated the optimum dose of nitrogen, phosphoric acid and potash to be 40 lb., 30 lb. and 50 lb. per acre respectively, this could not be considered a suitable recommendation for the red loamy regions. The Fertilizer Workshop Seminar held in the Agricultural College and Research Institute at Vellayani in 1961 had also fixed a manurial schedule of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre for the Sea Island cotton crop. The proposed schedule in the Seminar could not be recommended as such without conducting further trials in specific areas, since it was only a tentative recommendation.

Hence, it was necessary to carry out the present investigation to determine the optimum sowing time for Sea Island cotton and a better manurial combination of nitrogen, phosphoric acid and potash for the red loamy soils of Vellayani.

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REVIEW OF LITERATURE

I. Effect of time of sowing on the growth and yield of cotton.

i. Effect of environment on cotton - rainfall, humidity and temperature.

It was reported by several workers that the yielding capacity and other economic characters of cotton were subjected to considerable variation according to environment. Balls (1915) observed that the fibre length was influenced by moisture available to the plants during their growth period. The longest lint was produced if enough moisture was available during the early stages of boll formation and development. More or less the same conclusions were obtained by Sen and Kar (1947) that fibre development did not depend on temperature but on the availability of moisture. It was shown by Lord (1948) that maturity of fibre was considerably affected by cultural and environmental conditions. Dastur (1949) observed that lower temperature was conducive to the development of vegetative branches. Dastur, later (1950), found that in the case of American cotton in the Punjab, minimum temperature in the latter half of the maturation period and low humidity at day time caused the first branch to appear at a higher node. Balasubramaniam and Kesava Iyengar (1953) observed accelerated fibre elongations in American cotton under congenial conditions of solar activity and adequate soil moisture, at Palur. Qureshi (1957) found that ginning out-turn was increased by atmospheric humidity and low temperature in September and October in Gaoroni-12 cotton at Lattur. Patel and Parmer (1958) found that high yield and superior fibre quality were associated with well distributed rainfall. The results of investigations carried out by Ramachandran et al. (1959) revealed that the mean fibre weight was the least variable and was not appreciably affected by a difference in the environment. In the case of Egyptian and Sea Island cotton, Dastur (1959) observed that the weight of kapas per boll increased as the temperature dropped. Sethi et al. (1960), while reviewing the results of experiments carried out by various authors like Pearson (1949), Lord (1948) and Evensen (1955), concluded that the fibre immaturity and formation of motes were influenced by environment. Muller (1962) found that, of the environmental factors influencing the growth and yield of cotton, climate was much more important than soil. He observed that the best sowing time depended on uniform temperature in tropical regions.

ii. Effect of time of sowing on the yield attributes of the cotton crop.

(1) Vegetative growth and flower and boll production.

Doyle (1941) observed retarded fruiting due to a wet summer during the growing period of the cotton crop. Dastur and Mukhtar Singh (1944) found that the delay in sowing beyond a given period did not cause an equivalent delay in the reproductive phase. It was reported by Vaidya (1953) that with Indore and Dhar 43 cottons, 90 to 95 percent increase in yield was contributed by boll number in the pre-monsoon sowing than monsoon sowing. Christidis and Harrison (1955) stated that early sown cotton might be able to develop a larger number of fair sized bolls. The same result was obtained by Bederker et al.(1958) It was also reported by Patel and Parmer (1958) that early sowing resulted in greater growth and fruiting of the plants. The same result was obtained for American cotton in Punjab by Gursham Singh and Kanwar Singh (1959). Dastur (1959), in his trials on American Upland cotton in Malwa tract, observed that the height of the main stem declined as the sowing date advanced from May to July. Early sowing also produced significantly greater number of bolls than the number of bolls produced by the later sown crop. Dastur et al. (1960) also got results in line with the above findings.

The results obtained by the above authors indicate that early sowings increased the rate of vegetative growth and produced greater number bolls when compared to the late sown crop.

(2) Earliness in flowering and maturity.

According to Dastur et al. (1960), earliness in flowering of the cotton crop could be regarded as one of the most important physiological characters as the maturity of the crop was determined to a very great extent by the date of first flowering. Christidis and Harrison (1955) reported that a delay in maturity became more pronounced with successively later sowings. The results obtained by Bederker _et al_. (1958) and Dastur (1959) also confirmed the above finding. Dastur _et al_ (1960) emphasised the importance of sowing time as a factor influencing the appearance of the first flower bud. These authors, while reviewing the experiments carried out on date of sowing in different countries had also reported that in Egypt the date of first flower bud formation was not much affected by different sowing dates.

It is thus clear that the above findings of Christidis and Harrison (1955), Bederker _et al_. (1958), Dustur (1959) and Dastur _et al_. (1960) indicate that earliness of the cotton crop is obviously a result of early sowing.

(3) Shedding percentage. It was reported by Doyle (1941) that 14 to 16 percent of shedding of flowers and bolls in cotton was found to occur even during seasons when soil and weather conditions were very favourable. But,according to Muller (1962), richly flowering varieties usually shed more fruits before ripening and frequently only 40 percent of the flowers reached maturity.

Joshi *et al.* (1941) reported that high temperature caused heavy shedding of squares, flowers and bolls in summer season crops. According to Christidis and Harrison (1955), lack or excess of moisture in the soil, strong winds and excessive heat were found to increase shedding. But, Gursham Singh *et al.* (1958) reported that, change in sowing date did not affect materially the setting percentage of bolls. However, it was found by Dastur *et al.* (1960), that late sowing increased the proportion of vegetative buds to flower buds and also the opening of flower buds into flowers. The findings of Allan Goodman (1955), as reviewed by Muller (1962), showed that light and cloudiness also played a role in the shedding of flowers.

(4) Ginning percentage. Varying results were reported by different authors on the effect of date of sowing on ginning outturn. Qureshi (1957) observed that a season of well distributed rainfall, high humidity and low temperature resulted in increased ginning percentage in Gaorani-12 cotton.

On the other hand, Bederker *et al.* (1958) found that ginning percentage was not affected by date of sowing. Similar results were also obtained by Ramachandran *et al.* (1959) in four hybrids they had studied at Palur and Srivalliputtur in Madras State. However, Christidis and

and Harrison(1955), while reviewing the experiments on time of sowing of cotton, conducted in various cotton growing regions of the world, concluded that early sowing increased ginning percentage. In M.C.U. 1 cotton, Kamalanathan and Ramachandran (1961) also got results in conformity with the above findings.

iii. Effect of time of sowing on the fibre characters.

Varying results were reported by several workers on the effect of time of sowing on the fibre properties, namely, fibre length, fibre weight, maturity co-efficient and fibre strength.

Investigations carried out by Rajaraman and Afzal (1943) revealed that the earliest sowing produced lint definitely inferior in quality than those from late sowing. Sen and Kar (1947) observed increased fibre length due to low moisture in the soil during the period of flowering and boll formation. Nayak (1956) reported no effect on fibre length due to early sowing. Trials carried out by Ramachandran et al.(1959) showed that the mean fibre weight was least variable and was not appreciably affected by the differences in the environment, in the six interspecific hybrids they studied. On the other hand, increased fibre length and fibre maturity were reported to be due to early sowing by Kanniyan and Balasubramanian (1952) and Jambunathan (1959) in Madras and Jullunder respectively. Deo (1955), Sivasubramanian (1957) and Jambunathan (1959) also observed superior fibre quali/ ties in the earlier sown crop of Jayadhar and Laxmi cottons, summer cotton strains, and 320 F cotton in Dharwar, Madras and Punjab respectively. Kamalanathan and Ramachandran (1961) reported increased fibre length in M.C.U. 1 cotton in the Bhavani Project area. Similar results were also observed at Nanded area.(Anon.1956) . Trials conducted by Kesava Iyengar (1960) in Sea Island cotton in West Bengal showed that out of the sowing dates tried from April to September, July sown crop gave the highest fibre length, while May sowings recorded low fibre weight and fairly good maturity percentage. August sowings gave the best Pressley strength and the best fibre length was reported in the July sown crop.

From the foregoing review,it can be concluded that majority of the authors reported superior fibre qualities due to early sowing. However, authors like Rajaraman and Afzal (1943) and Nayak (1956) got adverse results on the fibre properties due to early sowings.

iv. Effect of time of sowing on the yield of cotton.

The importance of time of sowing on the yield of cotton was stressed by various authors. Trought and Afzal (1931) reported that early June was the optimum time for sowing cotton in Lyallpur. Dastur (1944) and Afzal (1949), from exhaustive sowing date experiments conducted in the pre-partition Punjab since 1926, showed that sowing in the beginning of July, was found to give the highest yield. Vaidya (1953) found that in the case of cotton, pre-monsoon sowing gave increase in yield over monsoon sowings. More or less the same conclusions were obtained by Sardar Singh (1955) in the Black cotton soils of the Malwa tract of Madhya Pradesh. Ramachandran and Sethuraman (1955) observed that yield differences in cotton due to different dates of sowing were significant for all the hirsutum varieties tested. Gursham Singh and Atwal (1955) in the Patiala tract and Sivasubramanian (1957) at Srivalliputtur found that earlier sowing registered highest mean yields in both the tracts. Christidis and Harrison (1955), while reviewing the results of experiments on time of sowing as obtained by Fikry (1937) and Crowther _et al._(1937) in Egypt and Portsmouth (1937) and King (1952) in Sudan also came to similar conclusions. Moreover, Nayak (1956) obtained results that earlier sown crop gave more than double the yield when compared to normal sown crop. Studies made during 1957 at Gadag and Dharwar also indicated that earlier sowings produced higher yields.

So also, Bederker *et al*. (1958) found a trend towards higher yield due to early sowing in the case of Gaorani cotton in Bombay State. Neelakantan *et al*.(1958), while reviewing the results of various experiments conducted on cotton since 1920 in Madras State, also reported that early sowing in December instead of March tribled the yield in South Arcot. As reported by Gurham Singh and Kanwar Singh (1959) at Abohar, Jhansi and Jullunder in Punjab and Wahab and Ahmed (1960) in West Pakistan, early sowings were found to give higher yields. Kesava Iyengar (1960) got results showing that in Sea Island cotton, among the dates of sowing tried from April to September, May sowings recorded the highest yield in West Bengal.

It is evident from the foregoing review that earlier sowings always gave higher yield and sometimes upto three times higher than that obtained from a late sown crop. This favourable effect due to the early date of sowing is found in all types of cotton irrespective of the varieties and also of the tracts where they are grown.

II. Nutrition and its effect on the growth and yield of the cotton crop.

(i) Effect of nutrition on the yield attributes of the cotton crop.

(1) Vegetative growth, flowering and boll production.

The total number of flowers and bolls seemed to bear the closest relation to yield. According to Balls and Halton (1915) and Harland (1918), flower production depended on the number of sympodial branches per plant and the number of flowers per branch. It was reported by Christidis and Harrison (1955) that the height of the plant and the number of nodes increased due to application of nitrogen. Bederker and Shaligram (1958) observed significant increase in plant height from about one month after sowing, in the nitrogen manured plot. Dastur et al. (1960) also reported that nitrogen treated plants grew more vigorously during the early stages soon after sowing and after which showed a depression in the rate of growth. Dastur and Mukhtar Singh (1943), Christidis and Harrison (1955), and Dastur and Kanwar Singh (1956) found that nitrogen influenced the reproductive characters such as flower production, boll number per plant and boll weight with a consequent increase in yield. Bederkar and Shaligram (1958) also observed that increased production of flowers was also due to nitrogen application.

According to Christidis and Harrison (1955), one of the most striking effects of phosphoric acid on cotton was nastening maturity. Nelson (1949) reported increased boll size by the application of phosphorus. However, Christidis and Harrison (1955) reported that phosphorus had very little effect on the size of boll and the weight of seed. They also reported favourable root development due to the increased concentration of phorphorus. Superphosphate produced only slightly beneficial effect on the boll weight and was significant only in four out of nine experiments carried out in Malwa tract. However Dastur (1959) observed that the boll number increased by the application of superphosphate. Muller (1962) also reported that phosphoric acid had favourable effects on the development of flower buds and fruiting and also accelerated the ripening of bolls.

In Sea Island cotton, Harland (1921) showed that the size of the crop was limited to the supply of potash in the soil. According to Nelson and Ware (1932), the total number of flowers and bolls was found to increase by the application of 60 lb. potash per acre. So also, increased boll size was reported by Turner (1944) and Vaidya (1953) by the application of potash. However, Dastur (1959) reported that potash had no effect on the number of bolls, although it increased the boll weight. Muller (1962) observed that plants fertilized with potash produced seeds with higher percentage of germination.

Bederker and Shaligram (1958) reported that a combination of nitrogen and phosphoric acid gave an increased number of flowers. With regard to the effect of phosphoric acid or potash in combination with nitrogen, Dastur (1959) reported that potash and phosphoric acid, either singly or in combination with nitrogen increased the rate of flower production and boll number. Sreedharan (1962-unpublished) also got similar results in P.216 F cotton in rice fallows.

(2) Earliness in flowering and maturity.

Although, Christidis and Harrison (1955) reported that early flowering was a verietal characteristic, various experiments proved the beneficial effect of plant nutrients on earliness in flowering and maturity of the cotton crop.

According to Collings (1926) and Buie (1928), application of nitrogen delayed maturity of the crop. Similar results were also reported by Dastur and Mukhtar Singh (1944) in Punjab. But Christidis and Harrison (1955) and Bederker and Shaligram (1958) observed that early blooming, early production of bolls and early maturity were the results of nitrogen application. However, the former authors further reported negative response to nitrogenous fertilizers on boll formation and time of maturity as obtained by Russian workers and also in twelve years trials conducted in New Mexico.

Christidis and Harrison (1955) reported that hastening maturity was one of the most striking effects of phosphatic fertilizers. Williams *et al.* (1937) observed that, with 15 percent of phosphoric acid in a complete fertilizer added, resulted in obtaining more than 65 per-cent of the total produce of seed cottonin the first picking. Dastur (1959) also reported that application of phosphorus hastened earliness by inducing the formation of the first fruiting node.

With regard to the effect of potash on earliness in cotton, favourable results were reported by Nelson and Ware (1932). Sreedharan (1962-unpublished) observed that application of 30 lb. potash was found to hasten the flowering and maturity of the crop, whereas 60 lb. potash retarded the same. But, according to Kharkov et al.(1933), potash extended cotton flowering period. In conformity to this finding, Brown and Pope (1939) also showed ,in Lousiana, that potash retarded boll opening when compared to other nutrients.

Brown (1938) found that judicious application of fertilizers resulted in quickening the growth, earlier blooming and production of more earlier bolls. The same author also observed early bursting of the bolls due to application of fertilizers, which resulted in greater production of seed cotton at the first picking.

(3) Shedding of flowers and bolls.

Apart from hereditary factors, Christidis and Harrison (1955) also suggested inadequate supply of nutrients as one of the important factors affecting the shedding of flowers and bolls in cotton. It was reported by Dastur and Kanwar Singh (1956) that the application of nitrogen slightly increased the setting percentage. Brown (1958) observed that the increase in shedding was related to the lowering of food reserve. Wadleigh (1944), as reported by Brown (1958), found that plants grown relatively on a low supply of nitrogen, after setting a number of bolls sufficient to deplete the nitrogenous reserve within the plant, shed all young bolls formed subsequently. He also reported that the total boll number was further determined by carbohydrate supply. But, according to Eaton (1950), the unbalance of carbohydrate and nitrogen was the only reason for shedding of flowers and bolls. In addition, he considered plant composition including enzymes and hormones, as a factor influencing shedding.

On the other hand, Dastur and Mukhtar Singh (1944) and Dastur and Gopani (1952) reported that the setting percentage was found unaffected due to application of nitrogen. Eaton and Ergle (1953) also showed that percentage of bolls shed was not affected by nitrogen supply, although it affected the absolute number of bolls produced. Similar results were also observed by Negi and Kanwar Singh (1956) and Singh et al. (1959) that the applicaton of nitrogen did not affect the setting percentage of bolls. Moreover, the former authors also observed that nitrogen created a tendency towards more shedding, in higher doses. Shaligram (1957) also found no definite pattern of shedding as influenced by nitrogen or phosphoric acid. Nelson and Ware (1932) reported that shedding percentage was not affected by the application of potash.

(4) Boll bursting.

Boll bursting determined the quality of bolls whether good, medium or bad. The importance of boll bursting was pointed out by several authors. Dastur (1949,1959) correlated 'bad boll opening' due to nitrogen deficiency and presence of sodium salts in the soil. Bederker and Shaligram (1959) also reported that nitrogen application induced bursting of bolls. In South Carolina, Killinger (1941) found that bad opening of bolls was associated with potash deficiency. Improper development of bolls due to potash deficiency was also reported by Christidis and Harrison (1955). Sreedharan (1962-unpublished) also showed that the percentage of good bolls obtainedwas found to increase due to high doses of potash along with nitrogen andphosphoric acid.

(5) Ginning percentage,seed index and lint index.

According to Christidis and Harrison (1955) ginning outturn was considerably affected by the number of fibres per seed, seed weight and lint weight. Nelson and Ware (1932) observed that potash had only a slight effect on ginning percentage,lint index and seed index, whereas Christidis and Harrison (1955) reported that potash had no effect on these characters at all. Nayak (1937) found that the lint percentage decreased from 27.1 to 24.8 by the application of farm yard manure at the rate of 0 to 15 tons per acre. Nelson (1949) also showed that nutritional conditions favourable for high yield had the tendency to lower the ginning percentage. So also, Christidis and Harrison (1955) reported, as the results obtained at Greece,that ginning percentage was not affected by nitrogen supply. These workers also observed that phosphate had only little effect on ginning percentage. This was also in agreement with the results obtained by Ramaswamy and Vaman Bhatt (1957) in Sea Island cotton. Sreedharan (1962-unpublished) also observed that potash had no influence on ginning percentage, seed index and lint index on P.216 F. cotton in rice fallows. In contrary to these findings, Christidis and Harrison(1955) and Bhat and Gopani (1956) reported an increase in ginning percentage, lint index and seed index by the application of nitrogen and phosphoric acid.

(ii) Effect of nutrients on the fibre characters.

Christidis and Harrison (1955) reported that eventhough the fibre length varied considerably according to variety, it was also influenced by the conditions of growth, which had often a larger effect than genetical differences.

From the trials carried out by Ramaswamy and Vaman Bhatt (1957), it was reported that manuring had been more effective on the lengthening phase of the cotton fibre than its thickening phase. These authors further observed a significant increase of 14 percent and 16 percent of fully mature fibres at Pattambi and Mangalore respectively. Gulati and Nazir Ahmed (1947) reported that fibre length increased by the application of 60 lb. nitrogen per acre in Gaorani-6 and Gaorani-12 cotton. Christidis and Harrison (1955) also suggested that nitrogen exerted a large positive effect on the lint length.

Reynolds and Killough (1934) recorded increased fibre length due to phosphate application. According to Gulati and Nazir Ahmed (1946), the mean fibre maturity also was found to increase by a combination of 40 lb. nitrogen and 20 lb. phosphoric acid.

In contrary to the above findings on the effect of nutrients on the fibre properties, Iyengar (1941) reported that differences in nutrients supplied showed only negligible effects on fibre length, fibre weight and its intrinsic fineness in rich soils. In Gaorani-6 and Gaorani-12 cotton, Gulati and Nazir Ahmed (1946) observed that the mean fibre weight decreased with increase in the amount of nitrogen. Sen and Nazir Ahmed (1947) found that in the case of Combodia cotton in Coimbatore, fertilizer did not produce a significant change in fibre weight.

Nitrogenous fertilisers when applied in naturally fertile fields, the mean fibre length was slightly less than that of no treatment. Results obtained by Samson (1941), as reported by Deo (1955), also showed that difference in the amounts of nutrients supplied had only little effect on the fibre length and fibre weight. Lowered fibre weight, due to fertilizers, had also been observed by Deo (1955). So also, Sreedharan (1962-unpublished) showed that potash had no influence on fibre length, fibre weight and maturity co-efficient on P.216 F cotton in rice fallows.

iii. <u>Nitrogen, phosphoric acid and potash requirements of the cotton crop</u>.

(1) <u>Removal of nitrogen, phosphoric acid and potash nutrients</u>.

Widely varying amounts of nitrogen, phosphoric acid and potash were reported to be removed from the soil by the cotton crop. White (1914) and Olsen and Bledsoe (1942), after their pot culture experiments, concluded that for yielding 500 lb. of lint per acre, the cotton crop removed 35.8 lb. nitrogen, 14.8 lb. phosphoric acid and 15.1 lb. potash from the soil.

It was reported by Johnson (1920) that a cotton crop of average yield of 200 lb. lint took up 134 lb. nitrogen, 86 lb. phosphoric acid and 114 lb. potash per acre. Martin and Leonard (1950) found that a crop yielding 700 lb.of lint per acre, the nutrient removal amounted to 77 lb. nitrogen, 23 lb. phosphoric acid and 67 lb. potash. Christidis and Harrison (1955),while reviewing the results of experiments conducted in various cotton growing countries, concluded that a good yield of cotton rarely removed 35 lb. nitrogen, 14 lb.phosphoric acid and15 lb. potash per acre. According to Jacob and Vonvoxkull (1959), a cotton crop yielding 300 lb. lint, removed 50 to 60 lb. nitrogen, 20 to 24 lb. phosphoric acid and 40 to 48 lb. potash from an acre of land. However, Dastur (1959) brought out the correlation of the removal of the three different nutrients and found that they were removed at a definite ratio of 3.3 : 1 : 3.3 by the cotton crop. He concluded that the excess uptake of one of the nutrients indicated the deficiency of any of the other nutrients. Sawhney and Sikka (1960) suggested that an average cotton crop removed from the soil,about 23 lb. nitrogen, 18 lb. phosphoric acid and 78 lb. potash per acre.

From the above data, it is evident that the cotton crop removed the following amounts of nitrogen, phosphoric acid and potash from one acre of land:

Nitrogen	23 lb. to 134 lb.
Phosphoric acid	14 lb to 86 lb.
Potash	15 lb. to 114 lb.

(2) Optimum rates of nitrogen, phosphoric acid and potash for the cotton crop.

According to Muller (1962), a balanced application of all the important nutrients was necessary for a rapid, vigourous growth and healthy development of the cotton plant. With regard to the requirement of nitrogen, it was found by Nelson (1949), that a dose of 10 to 60 lb. nitrogen per acre increasedthe yield of cotton by 68.7 percent. But, Vaidya (1953) recommended 50 lb. nitrogen per acre to increase the yield of cotton upto 50 percent. For 'Surti' cotton, Bhatt and Gopani (1956) recommended 40 lb. nitrogen as the most remunerative dose. The results obtained by these authors were further confirmed by Kalyanaraman and Rangaswamy (1957) in the case of P.216 F cotton in rice fallows in Madras State. But, as reported by Muller (1962), 80 to 100 lb. nitrogen per acre was considered optimum in Punjab.

Brown and Pope (1939) reported that with heavy application of phosphoric acid, there was a large increase in the percentage of seed cotton gathered at the first picking. But, according to Panse (1953), Vaidya (1953) and Bederker *et al*. (1957), application of phosphoric acid alone had no effect on the yield of cotton. However, increase in yield by 23.3 percent was obtained by Nelson (1949) due to application of 50 lb. phosphoric acid in combination with other nutrients. So also, Christidis and Harrison (1955) reported that a dose ranging from 15 to 60 lb. phosphoric acid was observed to be optimum for high yields in most of the States in U.S.A.

Results of experiments conducted by various authors indicated that the yield response of cotton to potash application was lower than as in the case of nitrogen and phosphoric acid. Christidis and Harrison (1955) reported that, in Greece, 31 to 223 lb. potassium sulphate applied per acre failed to show any increase in yield. Dabral (1955) also reported no response for potash or phosphoric acid in Uttar Pradesh. Trials conducted by Dastur (1959) at Babur Farm, Rajapalayam and Srivallipu-ttur also showed a depressing effect due to application of potash. However, Bledsoe *et al*. (1937) found, in Georgia, that 32 lb. potash per acre in combination with equal amounts of nitrogen and phosphorous gave larger returns. So also, in West Carolina, as reported by Christidis and Harrison (1955), 48 lb. potash per acre was found to be efficient in increasing the yield. Experiments conducted by Dastur (1959) at V.C. Farm in

Mysore also showed an increase in yield by the application of potash. It was also observed by Sreedharan (1962-unpublished) that 30 lb. potash per acre was the most economic dose, in combination with 40 lb. nitrogen and 15 lb. phosphoric acid, for P. 216 F. cotton in rice fallows in Madras State.

From experiments conducted at V.C. Farm and Babur Farm, Dastur (1959) concluded that a combination of nitrogen and potash always gave good yield. So also, at V.C. Farm, the highest yield of 434 lb. kapas was recorded with 50 lb. nitrogen and 150 lb. phosphoric acid. However, he concluded that the interaction of nitrogen and phosphorous was not significant over application of either nitrogen or phosphorus alone.

Doraiswamy and Iyengar (1946) found that American cotton responded well to phosphoric acid and potash applications in the presence of nitrogen and gave higher yields. Nelson (1949) reported the optimum dose of nitrogen, phosphoric acid and potash for cotton as 60 lb., 50 lb. and 60 lb. respectively. According to Tag (1956), the optimum dose of nitrogen and potash remained the same, but an increased dose of 90 lb. phosphoric acid was found to be the optimum in Bombay. For doubling the yield of Egyptian cottons, Dastur(1959) recommended 50 lb. nitrogen, 100 lb. phosphoric acid and 100 lb. potash per acre. Recommendations for the optimum fertilizer for the irrigated cotton, as made by Pal and Sikka (1961), varied from 40 to 80 lb. nitrogen, 20 to 40 lb. phosphoric acid and 40 to 80 lb. potash per acre.

It is seen that only a few trials were carried out to fix a proper manurial dose for Sea Island cotton in India. Agronomical trials carried out under the Sea Island Cotton Scheme in the west coast regions revealed that 40 lb. nitrogen in combination with phosphoric acid and potash gave higher yields (Anon. 1956). But the results obtained by Ramaswamy and Vaman Bhatt (1957) in the west coast of Madras State indicated nitrogen, phosphoric acid and potash requirements, as 60 lb., 30 lb. and 50 lb. respectively. The Fertilizer Workshop Seminar held in the Agricultural College and Research Institute at Vellayani in 1961 also recommended the same phosphoric acid and potash doses, but the dose of nitrogen recommended was only 40 lb. per acre. Trials conducted by Kurup (1961-unpublished) also indicated the optimum dose of nitrogen, phosphoric acid and potash as 40 lb., 30 lb. and 50 lb. respectively.

III. Interaction between date of sowing and nitrogen, Phosphoric acid and potash.

According to Christidis and Harrison (1955) the effect of sowing date was not independent of the effect of other factors affecting the crop simultaneously.

Yield, for instance, was differently affected by sowing date, especially in the presence or absence of nitrogenous fertilisers. These authors also reported, such interaction between sowing date and other factors, often significant. Various experiments carried out to study the effect of interaction of fertilizers to the crops sown on different dates revealed that manuring with nitrogen in the early sown crop increased both vegetative and reproductive growth.

The results of the trials conducted by Gregory et al.(1931), as reported by Christidis and Harrison (1955), revealed that response of ammonium sulphate declined with advancing sowing date. Crowther et al. (1938) further supported the view that the returns in yield for nitrogen application were greatest in the early sowing in Egypt.

According to Dastur (1944), Dabral (1955) and Gursham Singh and Atwal (1955), increase in yield was the highest when nitrogen was applied to an early sown crop. Vaidya (1953) reported that nitrogen gave a better response in yield and number of bolls per plant with pre-monsoon than monsoon sowings. Dastur et. al.(1957) observed that manuring with ammonium sulphate produced a better response combined with early sowings. While reviewing the experiments carried out in cotton since 1920 in Madras State, Neelakantan et.al. (1958) reported that early sowing in September with manuring at 40 to 60 lb. nitrogen per acre was effective in enhancing the yield of the winter-sown irrigated Combodia. Increased vegetative growth and reproductive growth and increased rate of boll production and boll weight due to early sowing and manuring with nitrogen were also reported by Dastur (1959). Gursham Singh and Kanwar Singh (1959) observed that the percentage increase in yield over control per pound of nitrogen applied, and the net profit also were found to be the highest with earlier sowings.

Vaidya (1953) recorded that the interaction of either phosphoric acid alone or phosphoric acid in combination with nitrogen, with pre-monsoon date of sowing or sowing after the commencement of monsoon did not have any effect on cotton.

From the foregoing review, it can be seen that not much work has been done on the effect of sowing dates on the yield attributes, yield and fibre characters of Sea Island cotton. The optimum nutritional requirement of the crop has also not been studied in different regions. This investigation was initiated, therefore, to study the influence of different sowing dates in the Vellayani region and to determine the fertilizer requirement for Sea Island cotton in the red loamy soils of Vellayani.

MATERIALS AND METHODS.

(i) Materials.

Experimental site.

The study was carried out in the dry lands of the College Farm, Agricultural College and Research Institute at Vellayani. The site, where the experiment was carried out, was selected to have maximum uniformity in soil conditions, to avoid variations due to soil heterogenity.

The soil belongs to the group, red loam, with the following chemical composition:

Total nitrogen	0.0500 percent.
Total phosphoric acid	0.0430 ,,
Available phosphoric acid	0.0021 ,,
Total potash	0.0970 ,,
Available potash	0.0009 ,,

Sea Island cotton - variety 'Andrews'

Sea Island Andrews was the variety selected for the investigation. This cotton belongs to the species *Gossipium barbadense* . From comparative yield trials of different varieties of Sea Island Cotton, namely Monteserrat, St. Kitts, West Burry, St. Vincent, Andrews and Sea Island White, it was found that the variety Andrews could be grown successfully in Kerala under proper cultivation practices. According to Kesava Iyengar (1959), this variety was found to be earlier, more prolific and with a higher ginning percentage than the other Sea Island varieties. Kurup (1961-unpublished) also found the variety as the most hardy and heaviest yielder eventhough some of the other varieties had longer staple length. Sikka et al. (1961) reported that the 'Andrews' variety had a staple length of 1.25", ginning outturn of 33% and a spinning capacity of about 80's standard warp counts. It had a duration of about six and a half months. The average yield of kapas* ranged from 500-750 lb. per acre. Moreover, the work conducted during the year 1956 in Madras State also showed that the variety 'Andrews' was highly promising recording a phenominally high yield of 1614 lb. of kapas per acre.(Anon. 1956)

(ii) Methods.

It seemed that the discouraging results on the final yield of kapas per acre, obtained during 1959-'62 in the Vellayani area were due to late sowing in the month of July. The flowering period coincided with heavy showers in October and resulted in very low yield of kapas. Based on this finding, four early dates of sowing were selected in the present study, which would normally give a favourable period in this locality at the time of flowering of the crop during August - September. The dates fixed for sowing were of 15 days intervals from the first sowing date. The first sowing date was

* This term denotes seed-cotton and is approved by the Indian Central Cotton Committee.

fixed after receiving the summer showers during April. The four dates selected were as follows:-

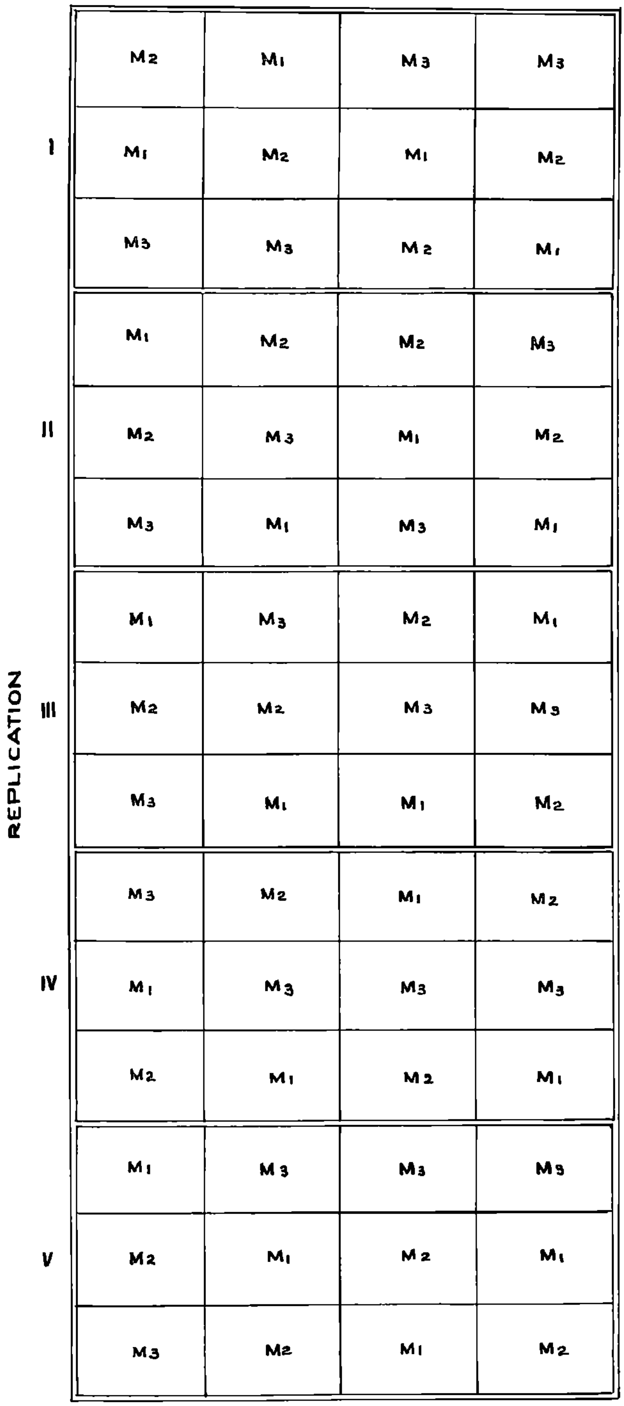
Date of first sowing	- 16-4-1962	..	D_1
Date of second sowing	- 2-5-1962	..	D_2
Date of third sowing	- 18-5-1962	..	D_3
Date of fourth sowing	- 3-6-1962	..	D_4

According to Kurup (1961-unpublished) and the recommendations of the Fertilizer Workshop Seminar held in 1961 at Vellayani, 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre was the optimum for Sea Island cotton in Kerala. Since this was only a tentative recommendation for the whole State of Kerala, three levels each of nitrogen, phosphoric acid and potash in combination were tried in the present study to determine the best combination of nitrogen, phosphoric acid and potash among the three levels tried, in the Vellayani region. The levels of nitrogen, phosphoric acid and potash in combination were fixed as one dose below and one dose above the recommended doses. The three levels of the NPK combination tried were as shown below:

40 lb. nitrogen, 30 lb. phosphoric acid 50 lb. potash	..	M_1
30 lb. nitrogen, 20 lb. phosphoric acid 40 lb. potash	..	M_2
50 lb. nitrogen, 40 lb. phosphoric acid 60 lb. potash	..	M_3

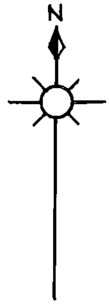
F I G U R E 1

Plan of the experimental layout.



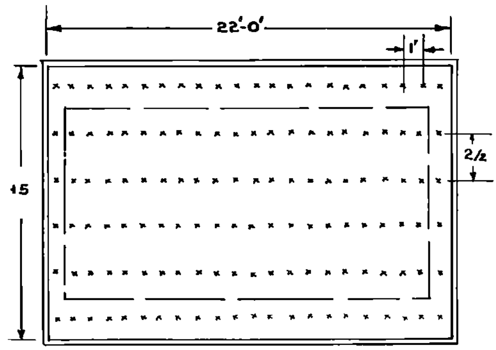
EXPERIMENTAL AREA

SCALE 1mm = 1'



LAYOUT

SPLIT PLOT DESIGN



SINGLE SUB-PLOT

(ENLARGED)

SCALE 3mm = 1'

FIG 1

Layout of the experiment.

The design adopted for the experiment was a split-plot design with date of sowing (cultural treatments) as main plot and levels of nitrogen, phosphoric acid and potash combination (manurial treatments) as the sub plot treatments. There were five replications with the net plot size 20' x 10'.

Application of fertilizers.

Nitrogen, phosphoric acid and potash were applied in the form of urea, superphosphate and muriate of potash, respectively. From the results of the earlier trials conducted at Trichur on the time of application of fertilizers to Sea Island cotton, Kurup (1961-unpublished) suggested application of the entire dose of superphosphate and muriate of potash and a small quantity of nitrogen as basal dressing at the time of preparing ridges and the rest of the nitrogen to be applied at intervals of a month. Crowther (1938) suggested application of one-fifth of the total quantity of nitrogen at the time of preparing ridges and the rest to be applied in two equal doses, first application four weeks after sowing and the second one month after the first top dressing. Based on the above recommendations, in the present study, the entire doses of phosphoric acid and potash and one-fifth of the total quantity of nitrogen for each plot were applied as basal dressing at the time of preparing ridges. The rest of the nitrogen was applied in two equal doses with one month interval after sowing.

As recommended from the results of the manurial trials conducted under the Sea Island Cotton Scheme (Kurup 1961-unpublished), all the plots in the present study received a basal dose of farm yard manure at the rate of 3 tons per acre.

Sowing.

The land was ploughed five times and weeds were removed. Plots were marked to a size of 22' x 15' and bunds separating the main and sub plots were taken. Farm yard manure and basal dose of fertilizers were applied to the plot and mixed well. Ridges and furrows were taken two and a half feet apart. Within each sub plot, one row was left as guard row. Two seeds each were sown one foot apart on the ridges. As it was proved by experiments conducted during 1960-'61 at Trichur that two plants per hole instead of one depressed the yield, a final thinning was given to get one plant per hole in all the treatments. According to the spacing adopted, the seed rate per acre was about 8 lbs. Before sowing, preliminary selection and treatment of seeds were done to eliminate defective seeds.

Plant protection.

Adequate plant protection measures were taken for the control of pests and diseases. Prophylactic spraying with D.D.T. at 0.2 percent strength was given two weeks after sowing for the control of Jassids and leaf rollers in all the treatments. Spraying was continued at fifteen days intervals. Spraying with Endrin at 0.03 percent strength was given from the square formation stage at fifteen days intervals till three weeks before harvest, for the control of boll worms. There was no incidence of pests as a result of spraying at regular intervals. Use of pre-treated seeds for sowing, and regular fungicidal spray prevented the crop from diseases.

Harvest.

As the variety had the peculiar habit of shedding *kapas* after complete bursting, the boll pickings were done at an interval of five days after the first picking.

The number of days taken to start the first picking and the total number of pickings in all the treatments are given below:

Treat-ment	Number of days taken from sowing to first picking	Number of days taken from first picking to last picking	Picking period	Total number of pic-kings.
D_1	128	49	Aug.23 to Oct.10	9
D_2	130	49	Sep.13 to Oct.31	9
D_3	132	49	Sep.28 to Nov.15	9
D_4	141	49	Oct.23 to Dec.10	9

Observations made and characters recorded.

Four plants were selected at random from each sub plot and studied throughout the life of the crop.

Christidis and Harrison (1955) found that one of the factors involved in the optimal planting date was largely determined by soil moisture. It was also reported by Patel and Parmer (1958) that the economic characters of cotton such as yield, ginning outturn, fibre length and fibre weight were also affected by variation in climatic conditions. Hence, detailed studies were made on both, climatic and plant characteristics.

(a) Climatic factors.

As suggested by Qureshi (1957), the climatic factors such as rainfall, temperature and relative humidity were recorded throughout the growing period of the crop to study their effects on the growth and yield of the crop:

(1) Rainfall.

(i) Rainfall during seven days prior to sowing.

The sowings were done only after receiving summer showers. Therefore, rainfall received during seven days prior to sowing was taken into account to study its effects on the germination percentage.

(ii) Rainfall during seven days after sowing.

(iii) Railfall during flowering and boll formation period.

Rainfall received during this period was recorded to find the effect of precipitation on shedding of squares, flowers and young bolls.

(iv) Total rainfall.

Total precipitation during the crop period in all the treatments was recorded and studied.

(2) Atmospheric temperature during flowering and boll formation period.

Minimum and maximum temperature during this period was recorded.

(3) Mean humidity percentage.

Mean humidity was recorded daily throughout the flowering and boll formation stage.

(b) Plant characters studied.

(1) Percentage of germination.

The sprouted seeds were counted and the germination percentage was calculated in all the treatments.

(2) Height of the plant at maturity.

According to Hutchinson and Ramiah (1938), the height of the plant was measured from the cotyledonary node to the apex of the plant, correct to a centimeter. The height was recorded on the day of the first picking.

(3) Date of first flowering.

As suggested by Christidis and Harrison (1955), in order to be on the safe side in assessing earliness, the dates of first flowering were recorded for all the four plants each in a plot and the average date of first flowering was finally determined.

(4) Number of flowers produced.

Daily flower counts of all the observational plants have shown conclusively the total number of flowers produced per plant as reported by Christidis and Harrison (1955) .

(5) Number of bolls produced per plant.

The number of bolls harvested in each picking was recorded and the total number of bolls was found out after the final picking.

(6) Percentage of shedding.

Like any other wild or cultivated plant, cotton produces flowers much in excess of those which develop imto fruit and eventually reach maturity. Hence, percentage of shedding is more important than flowering in determining the yield. As suggested by Christidis and Harrison (1955), shedding percentage was worked out by the difference in number of flowers produced and the number of bolls found on the first day of harvest.

(7) Percentage of good and medium bolls.

Good, medium and bad bolls were separated at the time of picking and their percentages were caluulated on the number of bolls harvested.

The boll bursting determined the quality of bolls whether good, medium or bad. A well developed boll in Sea Island cotton flare back on ripening, that the ripe cotton readily falls out. Such bolls were classified as 'good bolls' in the present study. The bolls in which the locks were moderately firm, the opening of bolls was not complete, assuming a cup-like form, were classified as 'medium bolls'. In other cases the bolls did not open wide enough for the cotton to project or the locks were lightly retained in the boll so that they could be pulled out of it, only in pieces. Such bolls were classified as 'bad bolls'. Hutchinson and Ramiah (1938) had also adopted this system of classification of bolls.

(8) Total yield of kapas and percentage of good kapas.

As *kapas* shed soon after bursting the bolls, picking was done at intervals of five days. The *kapas* collected from good and medium bolls were separated as 'good kapas' and weighed separately to find out its percentage.

(9) Bartlett's index.

Ramaswamy (1959) and Sethi *et al.* (1960) reported that this method was the most commonly applied for determining early picking.

The following formula was used for determining the rate index as reported by Sethi *et al.* (1960):

$$\frac{(P1)+(P1+P2)+\ldots\ldots\ldots+(P1+P2+\ldots\ldots\ldots+Pn)}{n(P1+P2+\ldots\ldots\ldots\ldots\ldots+Pn)}$$

where, P1, P2........Pn were the weights of seed cotton collected in the first, second........nth pickings and 'n' was the number of pickings taken.

(10) Seed index.

This is the weight of hundred seeds expressed in grams which was calculated from the weight of two hundred seeds obtained from each sample after ginning.

(11) Lint index.

According to Christidis and Harrison (1955), the lint index represented the absolute weight of lint borne by hundred seeds. While ginning, weight of kapas of two hundred seeds (lint and seeds) was recorded. After ginning, the weight of the lint borne by hundred seeds was calculated in milligrams.

(12) Ginning percentage.

Cotton picked from the plant is in the form of seed cotton (kapas), and before the fibres can be used for any purpose they have to be separated from the seed. The process of separation is called ginning.

Two hundred seeds with lint were collected from each treatment and ginned in a laboratory hand gin. The weight of seed and lint borne by hundred seeds, was determined separately for each treatment.

(13) Fibre characters.

The following fibre characters were studied:

(i) Fibre length
(ii) Fibre strength (Pressley strength)
(iii) Fibre weight
(iv) Maturity co-efficient.

Representative samples of kapas were collected from all the plots and analysed for the above characters, after ginning, in the Cotton Technological Laboratory, Agricultural College and Research Institute, Coimbatore.

The samples were taken at random from each lot of ginned lint from all the treatments.

Statistical analysis.

(i) Simple correlations.

Simple correlations were worked out relating to the effects of climatic factors on germination percentage and shedding percentage. The results of the analysis of the data obtained are given in Tables I to III in the succeeding section.

(ii) Plant characters and Yield.

Results of statistical analysis of the data recorded on each character studied are given in Tables IV to XIX in the succeeding section.

......

R E S U L T S

The various observations made on the climatic factors and plant characters at different growth phases of the crop, were statistically analysed.

The analysis of variance table is given in the Appendix.

The results observed are presented below:

I. Climatic factors.

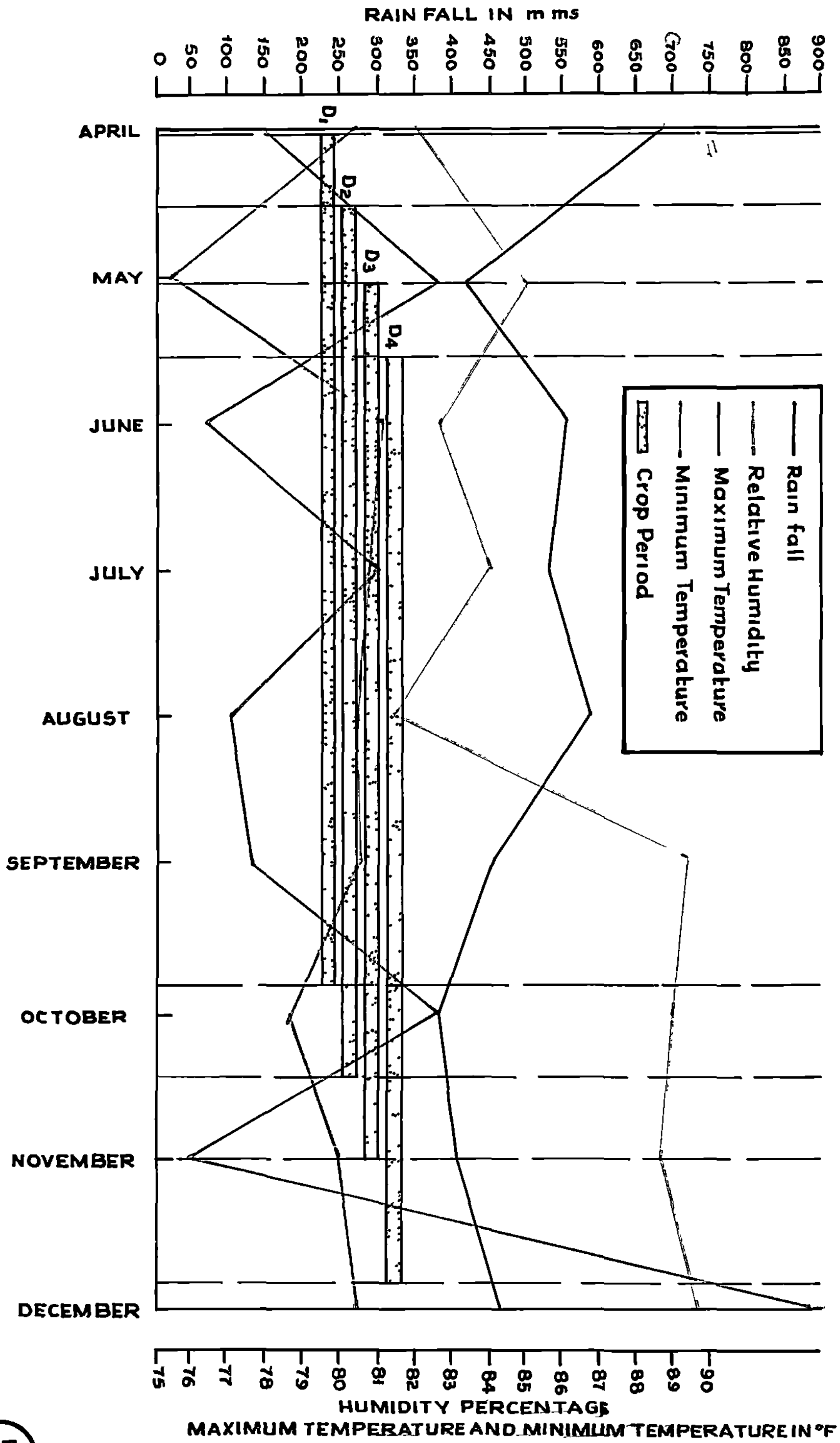
The climatological data recorded are given in the Appendix I. Rainfall, humidity and minimum and maximum temperatore are graphically represented in the figure 2.

A. Effect of rainfall on percentage of germination.

Rainfall during seven days prior to sowing and seven days after sowing was recorded to study its effects on the percentage of germination. The rainfall recorded during this period under each sowing date D_1, D_2,D_3 and D_4 was 62.23 mms. 42.17 mms., 35.56 mms, and 156.26 mms. respectively. (Appendix II). Accordingly, the mean percentages of germination recorded from D_1 to D_4 were in the order 43.45, 48.40, 63.21 and 68.70. They are presented in the Table I below.

F I G U R E 2

Rainfall, humidity percentage,
minimum temperature and maximum temperature
during the crop season.



RAIN FALL IN m ms
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
D1
D2
D3
D4
Rain fall
Relative Humidity
Maximum Temperature
Minimum Temperature
Crop Period
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
HUMIDITY PERCENTAGE
MAXIMUM TEMPERATURE AND MINIMUM TEMPERATURE IN °F

FIG 2

TABLE I

EFFECT OF RAINFALL ON GERMINATION PERCENTAGE RECORDED UNDER EACH DATE OF SOWING AND MANURIAL LEVELS

	Average percentage of germination				
D / M	D1	D_2	D_3	D_4	Mean
M_1	43.03	49.96	63.14	68.55	56.17
M_2	40.44	48.83	88.27	68.68	56.56
M_3	46.87	46.39	58.21	68.88	55.09
Mean	43.45	48.40	63.21	68.70	55.94

C.D. (at 5 percent) for date of sowing means: 5.75

Dates: $\underline{D_4\ D_3}$ $\underline{D_2\ D_1}$

The dates D_4 and D_3 recorded significantly higher percentage of germination than D_2 and D_1 dates of sowing. The maximum percentage of germination occurred in the D_4 date of sowing. However, the differences between D_4 and D_3 and also between D_2 and D_1 were not significant

B. Correlation studies:

(i) Effect of climatic factors on shedding percentage.

Simple correlations were worked out relating to the effects of rainfall, temperature and relative humidity during flowering and boll formation stage and the percentage of shedding of squares, flowers and bolls.

They are presented in table II below:

TABLE II

EFFECTS OF RAINFALL, RELATIVE HUMIDITY, MINIMUM TEMPERATURE AND MAXIMUM TEMPERATURE DURING FLOWERING AND BOLL FORMATION STAGE ON THE SHEDDING PERCENTAGE.

Date of sowing	Total rain fall in mms. (x)	Daily mean humidity percentage. (x)	Average daily maximum temperature in °F (x)	Average daily minimum temperature in °F (x)	Percentage of shedding (y)
D_1	670	80.1	83.0	80.9	43.66
D_2	872	88.3	83.3	79.9	41.81
D_3	652	89.1	84.7	80.2	48.65
D_4	1364	88.8	83.3	79.9	49.30
Correlation co-efficient.	..	..	0.5**	..	..

** indicates significance at 1 percent level.

1. <u>Correlation between rainfall during flowering and boll formation stage and percentage of shedding.</u>

No significant relationship, though not recorded, a high value of the correlation co-efficient indicated that the percentage of shedding increased with an increase in the precipitation.

2. Correlation between daily mean humidity percentage during flowering and boll formation stage and percentage of shedding.

No significant relationship was observed between the daily mean humidity percentage and the shedding of flowers and bolls.

3. Correlation between average daily maximum temperature during flowering and boll formation stage and the percentage of shedding.

The correlation co-efficient was significant. The percentage of shedding increased with an increase in the daily maximum temperature.

4. Correlation between average daily minimum temperature during flowering and boll formation stage and the percentage of shedding.

The correlation coefficient wasnot significant. The result indicated that thepercentage of shedding was not affected by daily minimum temperature during flowering and boll formation stage.

B. Effect of rainfall on the final yield of kapas.

The total rainfall received during the crop season under each date of sowing and the corresponding yieldsof kapas are given in Table III below:

TABLE III

RELATIONSHIP BETWEEN THE TOTAL RAINFALL DURING THE CROP SEASON AND YIELD OF KAPAS.

Date of sowing	Total rainfall in mms. (x)	Average yield in lb.per acre (y)	Correlation co-efficient
D_1	1165	1111.95	
D_2	1388	1184.25	0.28
D_3	1041	483.52	
D_4	1844	452.30	

The maximum yield of 1184.25 lb.kapas per acre was recorded in the D_2 sowing, which received a total rainfall of 1388 mms. during the crop season. Though the D_4 crop season received a total precipitation of 1844 mms.,the yield of kapas obtained was only 452.3 lb. per acre due to the maximum shedding of flowers and bolls occurred in the D_4 crop season (Table IX). Hence a correlation study between rainfall and total yield of kapas indicated no significant relationship.

II. Plant Characters and yield attributes.

1. Height of plants at maturity.

The average height of plants recorded is presented in the Table IV below:

F I G U R E   3

Height of plants at maturity

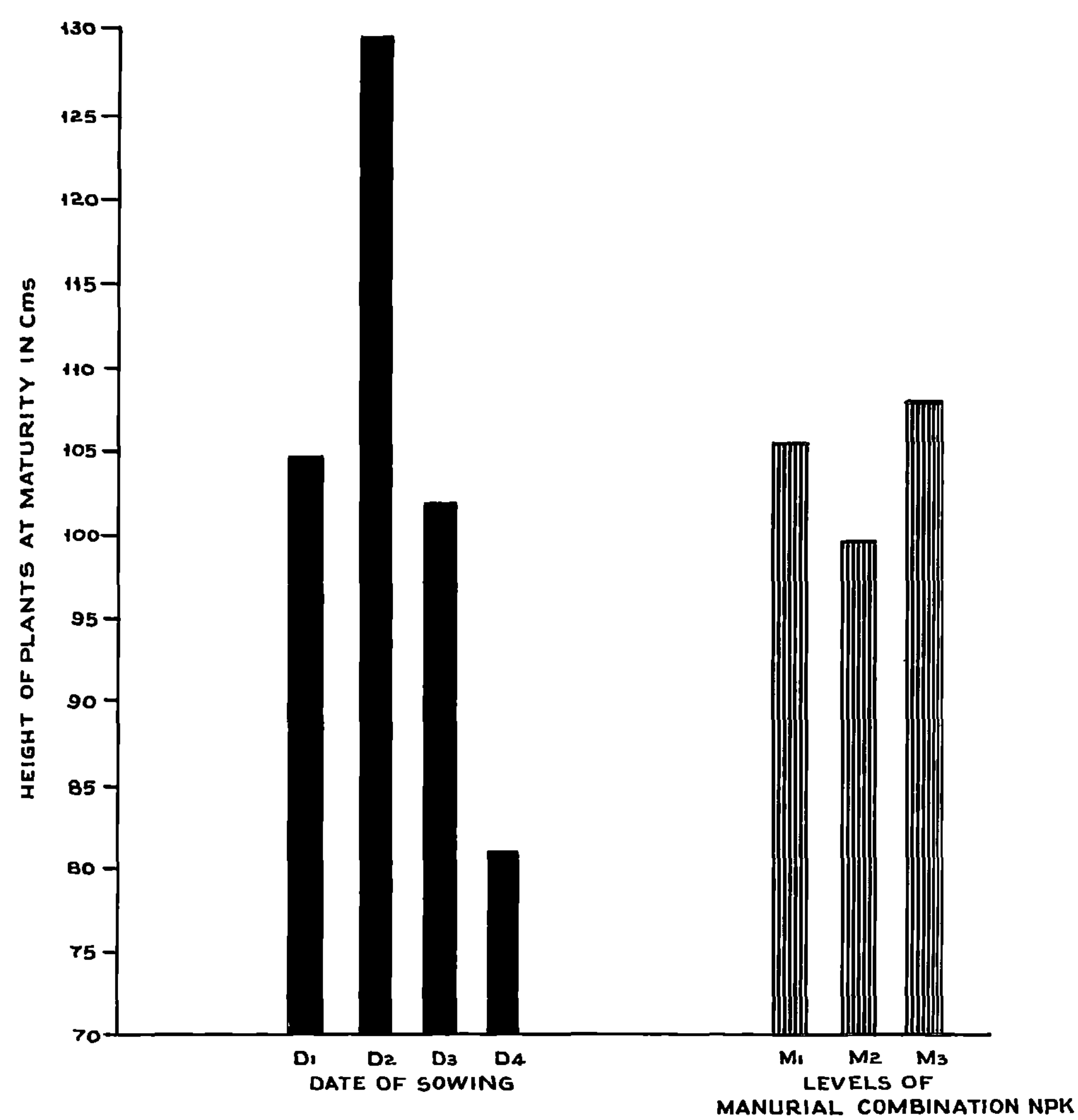

HEIGHT OF PLANTS AT MATURITY IN Cms
130
125
120
115
110
105
100
95
90
85
80
75
70
D1 D2 D3 D4
DATE OF SOWING
M1 M2 M3
LEVELS OF
MANURIAL COMBINATION NPK

FIG 3

TABLE IV

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE HEIGHT OF PLANTS AT MATURITY.

	Average height of plants at maturity in Cms.				
M \ D	D_1	D_2	D_3	D_4	Mean
M_1	104.80	129.40	100.40	82.00	104.15
M_2	100.80	123.40	97.80	77.20	99.80
M_3	106.00	135.60	102.80	85.20	107.40
Mean	103.87	129.47	100.33	81.47	103.78

C.D. (at 5 percent) for date of sowing means: 1.64

C.D. (at 5 percent) for manurial levels: 1.73

Dates: D_2 D_1 D_3 D_4

Manures: M_3 M_1 M_2

Effect of date of sowing. The effects of different sowing dates were satistically significant. D_2 recorded the maximum height of plants. A progressive increase in the height of plants was observed in the order D_4, D_3, D_1 and D_2.

Effect of manurial levels. The differences between the levels of the NPK combination were significant. M_3 recorded the maximum height of plants at maturity.

The height of plants is graphically represented in the figure 3.

2. Earliness in flowering. The average number of days taken for the first flower opening is presented in the Table V below:

TABLE V

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON EARLINESS IN FLOWERING.

	Average number of days taken for the first flower opening.				
M \ D	D_1	D_2	D_3	D_4	Mean
M_1	67.4	65.8	66.6	62.6	65.6
M_2	66.6	67.4	67.4	60.3	65.4
M_3	65.8	66.0	66.2	64.0	65.5
Mean	66.5	66.4	66.7	62.6	65.5

C.D.(at 5 percent) for date of sowing means: 1.48

Dates: $\underline{D_3 \quad D_1 \quad D_2}$ D_4

Effect of date of sowing. The fourth date of sowing (D_4) was significantly earlier for the first flower opening. There were no significant differences in earliness between D_1, D_2 and D_3. However, D_2 was found to be slightly earlier than D_3 or D_1.

F I G U R E   4

Earliness in flowering and in maturity.

F I G U R E   5

Number of flowers, number of bolls
and shedding percentage.

LEVELS OF NPK COMBINATION

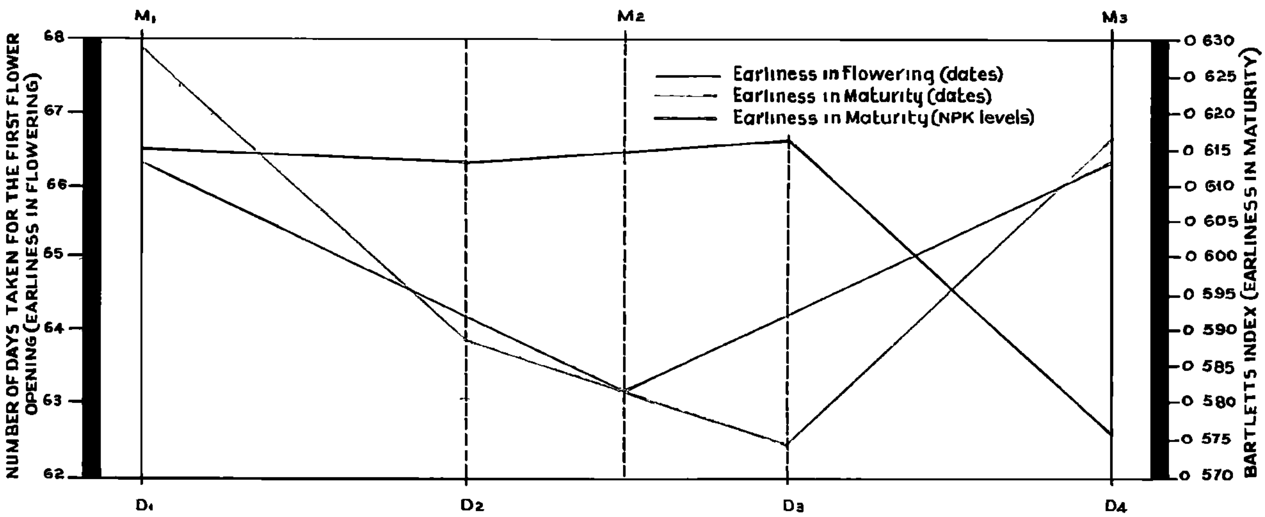


FIG 4

LEVELS OF NPK COMBINATION

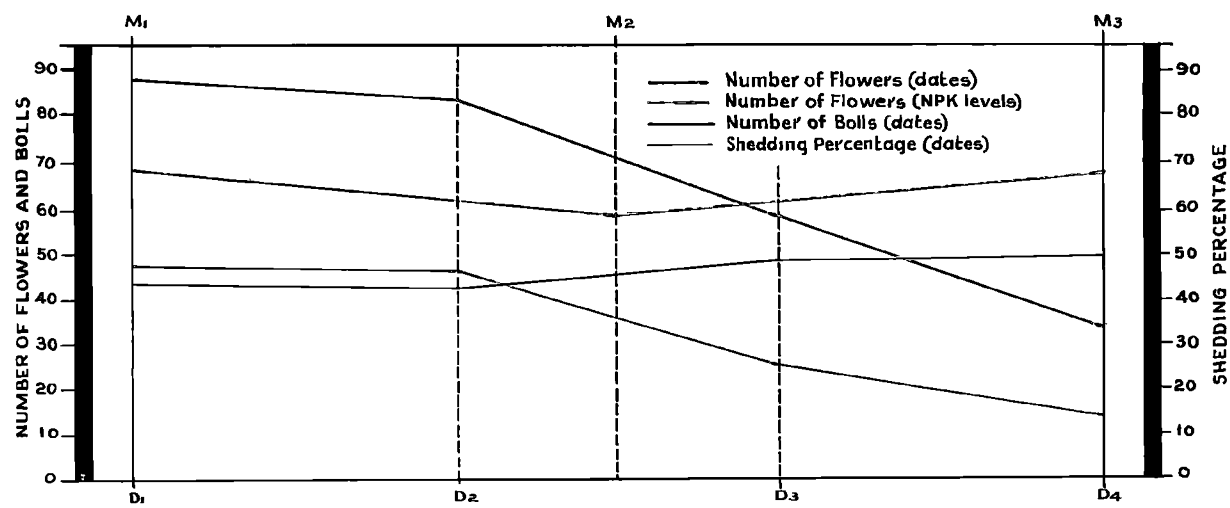


FIG 5

Different levels of the NPK combination did not show any significant effect on earliness in flowering.

3. Earliness in maturity. The average Bartlett's Index values are presented in the Table VI below:

TABLE VI

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON EARLINESS IN MATURITY

	Average Bartlett's index values				
D / M	D_1	D_2	D_3	D_4	Mean
M_1	0.6768	0.5908	0.5716	0.6160	0.6138
M_2	0.5710	0.5568	0.5392	0.6588	0.5815
M_3	0.6408	0.6210	0.6126	0.5794	0.6135
Mean	0.6295	0.5895	0.5745	0.6181	0.6029

C.D. (at 5 percent) for date of sowing means: 0.0296

C.D. (at 5 percent) for manurial levels: 0.0225

Dates: $\underline{D_1 \quad D_4} \quad D_2 \quad D_3$ (underlined: D_1 D_4; D_4 D_2; D_2 D_3)

Manures: $\underline{M_1 \quad M_3} \quad M_2$

The high value of the index indicated the earliness of the crop.

The results showed that there was no significant difference on earliness in maturity between D_1 and D_4, D_4 and D_2 and D_2 and D_3 . But D_1 date of sowing matured, significantly, earlier than D_2 and D_3. Similarly, D_4 date of sowing also matured, significantly, earlier than D_3.

Effect of manurial levels. The manurial levels M_1 and M_3 recorded significantly early maturity to that recorded in the M_2 level. The difference between M_1 and M_3 was not significant.

The effects of sowing dates and the fertilizer levels on earliness in flowering and maturity are graphically represented in the figure 4.

4. Number of flowers produced. The average number of flowers produced per plant is presented in the Table VII below:

TABLE VII
EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE NUMBER OF FLOWERS PRODUCED PER PLANT

Average number of flowers per plant.					
M \ D	D1	D_2	D_3	D_4	Mean
M_1	91.80	87.80	60.80	36.60	69.25
M_2	87.60	71.80	48.80	26.40	58.65
M_3	88.80	88.00	60.60	30.20	66.90
Mean	89.40	82.53	56.73	31.07	64.93

C.D. (at 5 percent) for date of sowing means: 7.84

C.D. (at 5 percent) for manurial levels: 5.61

Dates: $\underline{D_1\ D_2}\ D_3\ D_4$

Manures: $\underline{M_1\ M_3}\ M_2$

Effect of date of sowing. The earlier sowing dates D_1 and D_2 recorded maximum number of flowers per plant than those of D_3 and D_4 . The difference between D_1 and D_2 was not significant. Similarly, D_3 date of sowing showed, significantly, higher number of flowers than that of D_4.

Effect of manurial levels. The M_1 and M_3 levels of the NPK combination recorded significantly maximum number of flowers than in the M_2 level. The difference between M_1 and M_3 was not significant.

5. Number of bolls per plant at maturity.

The average number of matured bolls per plant is presented in the Table VIII below:

TABLE VIII
EFFECT OF SOWING DATES AND MANURIAL LE VELS ON THE NUMBER OF MATURED BOLLS PER PLANT.

	Average number of matured bolls per plant.				
D / M	D_1	D_2	D_3	D_4	Mean
M_1	46.80	53.60	25.60	14.00	35.00
M_2	46.20	37.60	22.00	10.80	29.15
M_3	47.20	46.60	25.80	13.60	33.30
Mean	46.73	45.93	24.47	12.80	32.48

C.D.(at 5 percent) for date of sowing means: 4.14

Date $\underline{D_1 \quad D_2}$ D_3 D_4

Effect of date of sowing. The two earlier sowing dates

(D_1 and D_2) produced the maximum number of matured bolls per plant than those obtained from the later sowings (D_3 and D_4).

The results indicated that the number of matured bolls produced was in the trend as that of flowers.

6. Percentage of shedding of squares, flowers and bolls.

The average shedding percentages are presented in the Table IX below:

TABLE IX

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE PERCENTAGE OF SHEDDING OF SQUARES, FLOWERS AND BOLLS.

Average shedding percentage.

D / M	D_1	D_2	D_3	D_4	Mean
M_1	44.252	38.612	47.302	51.952	45.530
M_2	43.520	43.550	47.662	49.998	46.183
M_3	43.152	43.274	50.976	45.956	45.840
Mean	43.641	41.812	48.647	49.302	45.851

C.D.(at 5 percent) for date of sowing means: 2.179

C.D. (at 5 percent) for manurial levels within the same date: 3.324

C.D. (at 5 percent) for manurial levels not within the same date: 2.860

Dates: $\underline{D_4 \quad D_3} \quad \underline{D_1 \quad D_2}$

Effect of date of sowing. Significantly minimum percentage of shedding had occurred in the D_1 and D_2 sowing dates when compared to D_3 and D_4. The sowing date D_2 recorded the lowest percentage , though the difference between D_1 and D_2 was not significant. Almost equal amounts of shedding had occurred in D_3 and D_4 and there was no significant difference between them.

Different levels of the NPK combination did not show any significant response on the shedding percentage.

In the D_2 date of sowing, the combinations D_2M_2 and D_2M_3 recorded significantly higher percentage of shedding than in D_2M_1 though the differences between these two combinations werenot significant. In the D_4, the combination $D_4 M_3$ was found to be significantly lower than D_4M_1 or $D_4 M_2$. These two combinations recorded almost equal shedding percentages. The D_2M_1 combination was found to be significantly superior to all the other combinations tried in the experiment. It recorded the minimum percentage of shedding.

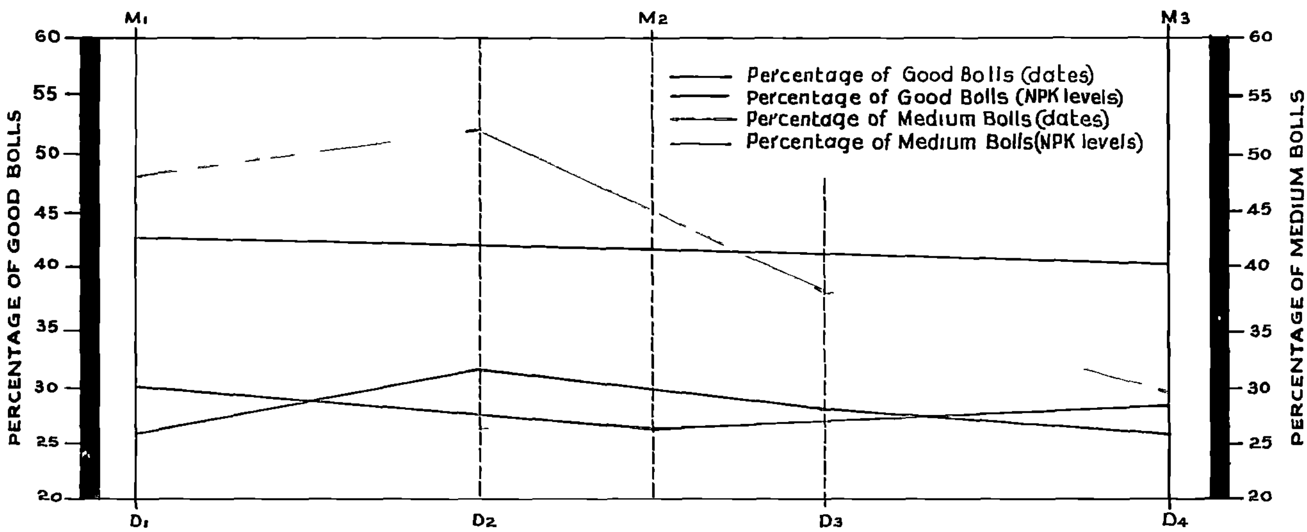
. The results obtained on the number of flowers, number of bolls and shedding percentage are represented in the figure 5.

7. Percentage of good bolls and medium bolls. The average percentages of good bolls and medium bolls are presented in

F I G U R E 6

Percentage of good bolls and medium bolls.

LEVELS OF NPK COMBINATION



DATE OF SOWING

FIG 6

the Table X below:

TABLE X

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE PERCENTAGE OF GOOD BOLLS AND MEDIUM BOLLS

Average percentage of good bolls and medium bolls.

M \ D	D_1 Good bolls	D_1 Medium bolls	D_2 Good bolls	D_2 Medium bolls	D_3 Good bolls	D_3 Medium bolls	D_4 Good bolls	D_4 Medium bolls	Mean Good bolls	Mean Mddium bolls
M_1	26.80	45.42	32.56	54.76	29.40	38.28	29.42	32.16	29.55	42.67
M_2	24.28	49.74	29.98	52.70	24.30	37.80	24.12	27.96	25.69	42.05
M_3	25.70	48.44	33.08	49.06	28.54	37.20	25.80	26.92	27.79	40.40
Mean	25.60	47.87	31.87	52.17	27.44	37.76	25.76	29.01	27.68	41.71

Good bolls

C.D.(at 5 percent) for date of sowing means: 3.05

C.D.(at 5 percent) for manurial levels: 1.75

Dates: D_2 D_3 D_4 D_1

Manures: M_1 M_3 M_2

Medium bolls

C.D.(at 5 percent) for date of sowing means: 2.00

C.D.(at 5 percent) for manurial levels: 1.64

D_2 D_1 D_3 D_4

M_1 M_2 M_3

Percentage of good bolls.

Effect of date of sowing. The second sowing date (D_2) recorded significantly maximum percentage of good bolls. The dates D1, D_3 and D_4 showed significantly minimum percentages of good bolls. They were equally effective.

Effect of manurial levels.

The differences between the percentages obtained in M_1, M_2 and M_3 were significant. M_1 had given significantly higher percentage of good bolls than M_2 and M_3, while M_3 was also significantly superior to M_2.

Percentage of medium bolls.

Effect of date of sowing.

There was a trend of progressive increase in the percentages of medium bolls in the order D_4, D_3 D_1 and D_2. The differences between the dates were significant.

Effect of manurial levels.

The M_1 and M_2 levels of the NPK combination recorded significantly higher percentages of medium bolls, than M_3. The effects of M_1 and M_2 were almost equal.

The results are represented in the figure 6.

8. Percentage of good kapas. The average percentages of good *kapas* are presented in the Table XI below:

TABLE XI

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE PERCENTAGE OF GOOD KAPAS

	Average percentage of good kapas				
D / M	D_1	D_2	D_3	D_4	Mean
M_1	50.28	51.66	45.80	39.88	46.91
M_2	50.64	50.88	40.72	41.38	45.91
M_3	49.26	51.16	45.96	40.30	46.67
Mean	50.06	51.23	44.16	40.52	46.49

C.D. (at 5 percent) for date of sowing means: 2.31

C.D. (at 5 percent) for manurial levels within the same date: 2.90

C.D. (at 5 percent) for manurial levels not within the same date: 2.80

Dates: $\underline{D_2 \quad D_1}$ D_3 D_4

Effect of date of sowing. The earlier dates D_1 and D_2 recorded significantly higher percentages of good kapas. The difference between D_1 and D_2 was not significant. D_3 and D_4 recorded significantly minimum percentages of good kapas. The differences between D_1 and D_3 and also between D_3 and D_4 were significant.

M_1 was found to be slightly superior over M_2 and M_3.

The interaction between date of sowing and manurial levels was significant. In the D_3 sowing date, the combinations $D_3 M_1$ and $D_3 M_3$ had given significantly higher percentages of good <u>kapas</u> than that was recorded in the D_3M_2 combination. The combinations D_3M_1 and $D_3 M_3$ gave almost equal percentages. The D_2M_1 combination recorded significantly maximum percentage of good <u>kapas</u> when compared to the percentages given by all the combinations in D_3 and D_4 sowing dates.

The results are represented in the figure 8.

9. <u>Ginning percentage</u>. The average ginning percentages are presented in the Table XII below:

TABLE XII
EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE GINNING PERCENTAGE

Average ginning percentage.					
D / M	D_1	D_2	D_3	D_4	Mean
M_1	35.00	35.00	34.60	33.20	34.50
M_2	34.30	34.60	34.40	33.30	34.13
M_3	35.00	35.30	35.00	34.40	34.93
Mean	34.77	35.03	34.67	33.60	34.52

C.D.(at 5 percent) for date of sowing means: 0.95

C.D.(at 5 percent) for manurial levels within the same date: 0.65

C.D.(at 5 percent) for manurial levels not within the same date: 0.97

Dates: <u>D_2 D_1</u> D_3 D_4

Effect of date of sowing. The sowing date D_4 gave significantly minimum ginning percentage. Though the sowing dates D_1, D_2 and D_3 gave significantly higher ginning percentages, the differences between them were not significant.

Different levels of the NPK combination did not show any significant effect on the ginning percentage.

The interaction between date of sowing and manurial levels was significant. In the D_1 date of sowing, the combinations D_1M_1 and D_1M_3 recorded significantly higher ginning percentages though the difference between D_1M_1 and $D_1 M_3$ was not significant. In the D_4, the combinations $D_4 M_1$ and $D_4 M_2$ recorded significantly higher percentages.

The highest ginning percentage recorded in the $D_2 M_3$ combination was found to be significantly superior over the percentages recorded in the combinations $D_1 M_2$, $D_4 M_1$ and $D_4 M_2$.

10. Lint index. The average weights of lint in miligrams,borne by hundred seeds are presented in the Table XIII below:

TABLE XIII

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON LINT INDEX

Average weight of lint in milligrams					
M \ D	D_1	D_2	D_3	D_4	Mean
M_1	56.00	58.40	57.60	60.30	58.75
M_2	55.00	56.40	52.20	58.80	55.65
M_3	59.60	59.60	59.60	61.80	60.15
Mean	56.93	58.13	56.46	61.20	58.18

C.D.(at 5 percent) for manurial levels: 1.61

Manures: $\underline{M_3 \quad M_1}$ M_2

Date of sowing had no significant effect on the lint index.

Effect of manurial levels. M_1 and M_3 levels of the NPK combination had given the highest lint index. The difference between M_1 and M_3 was not significant.

11. Seed index. The average weight of hundred seeds

each is presented in the Table XIV below:

TABLE XIV

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON SEED INDEX

	Average weight of 100 seeds in grams.				
M \ D	D_1	D_2	D_3	D_4	Mean
M_1	100.60	105.70	108.00	112.70	106.75
M_2	105.10	103.70	105.40	109.80	106.00
M_3	110.20	106.60	113.30	114.20	111.08
Mean	105.30	105.33	108.90	112.23	107.94

The effects of neither the sowing dates nor the manurial levels of the NPK combination were found to be significant. However, a slightly minimum index value was observed in the first and the second sowing dates. Similarly, the manurial levels M_1 and M_2 also recorded slightly minimum index values.

12. Fibre characters.

(a) Mean fibre length. The average values of the mean fibre length are presented in the Table XV below:

F I G U R E 7

Mean fibre length, mean fibre weight
and maturity coefficient.

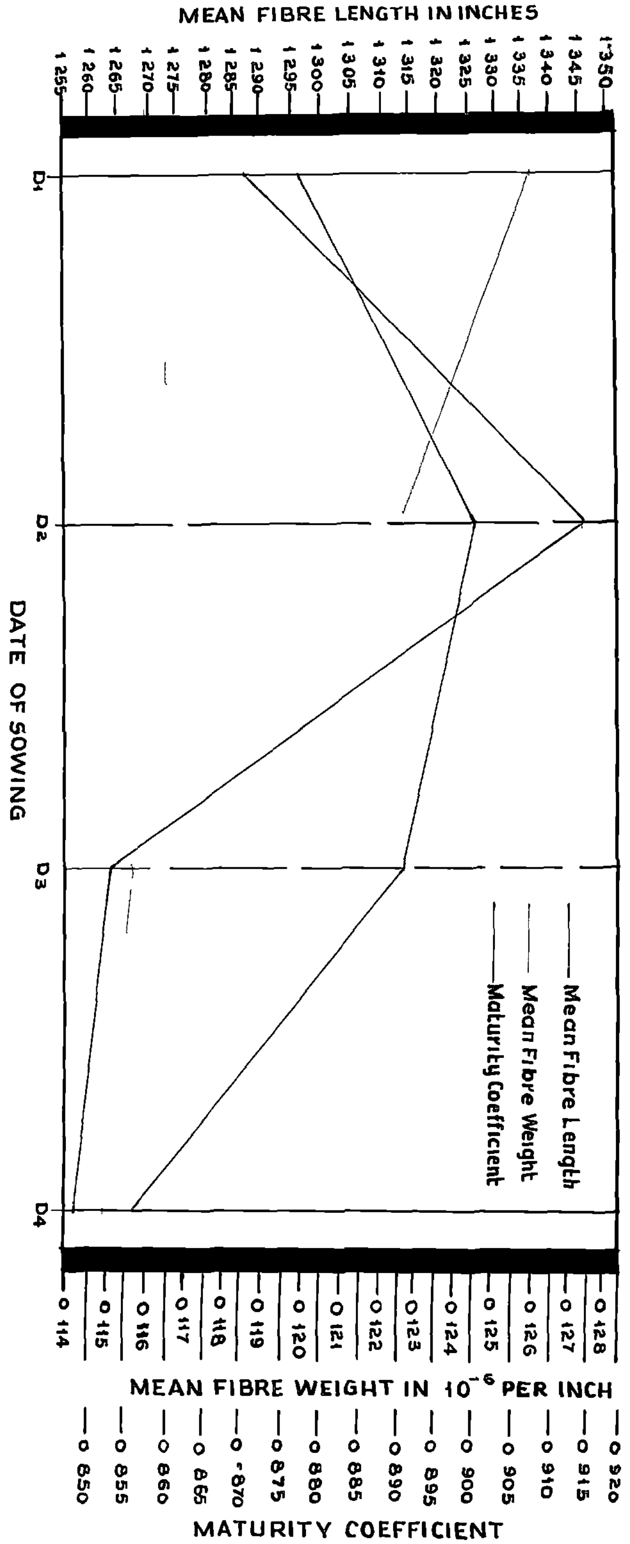

MEAN FIBRE LENGTH IN INCHES
1·255
1·260
1·265
1·270
1·275
1·280
1·285
1·290
1·295
1·300
1·305
1·310
1·315
1·320
1·325
1·330
1·335
1·340
1·345
1·350
D1
D2
D3
D4
DATE OF SOWING
Mean Fibre Length
Mean Fibre Weight
Maturity Coefficient
0·114
0·115
0·116
0·117
0·118
0·119
0·120
0·121
0·122
0·123
0·124
0·125
0·126
0·127
0·128
MEAN FIBRE WEIGHT IN 10^{-6} PER INCH
0·850
0·855
0·860
0·865
0·870
0·875
0·880
0·885
0·890
0·895
0·900
0·905
0·910
0·915
0·920
MATURITY COEFFICIENT

FIG 7

TABLE XV

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE MEAN FIBRE LENGTH

	Mean fibre length in inches.				
M \ D	D1	D_2	D_3	D_4	Mean
M_1	1.2820	1.3520	1.2660	1.2580	1.2895
M_2	1.0840	1.3420	1.2460	1.2540	1.2815
M_3	1.2940	1.3400	1.2740	1.2600	1.2920
Mean	1.2870	1.3450	1.2620	1.2570	1.2877

C.D.(at 5 percent) for date of sowing means: 0.0209

Dates: D_2 D_1 $\underline{D_3\ D_4}$

Effect of date of sowing. The sowing date D_2 recorded significantly longer fibres than sowing date D_1. D_3 and D_4 were almost equall~~y~~ ~~effective~~ in their effects on fibre length. Significantly minimum fibre length was observed in these two sowing dates.

The effects of manurial levels of the NPK combination were not significant.

(b) Mean fibre weight The average values of the mean fibre weight are presented in the Table XVI below:

TABLE XVI

EFFECT OF SOWING DATES AND MANURIAL LEAVES ON THE MEAN FIBRE WEIGHT

	Mean fibre weight in 10^{-6} oz. per inch				
M \ D	D1	D_2	D_3	D_4	Mean
M_1	0.1270	0.1274	0.1144	0.1160	0.1212
M_2	0.1248	0.1194	0.1148	0.1152	0.1186
M_3	0.1268	0.1216	0.1180	0.1140	0.1201
Mean	0.1262	0.1228	0.1157	0.1150	0.1199

C.D. (at 5 percent) for date of sowing means: 0.0038

Dates: $\underline{D_1 \quad D_2}$ $\underline{D_3 \quad D_4}$

Effect of date of sowing. Early sowings (D_1 and D_2) recorded, significantly, maximum fibre weight. The differences between D1 and D_2 and D_3 and D_4 were not significant.

The different levels of the NPK combination did not show any significant effect on the fibre weight.

(c) Pressley strength index. The average index values are presented in the Table XVII.below:

TABLE XVII

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE PRESSLEY STRENGTH INDEX.

Average Pressley strength index in lb.per mgm.					
D / M	D_1	D_2	D_3	D_4	Mean
M_1	6.606	6.790	6.482	6.396	6.569
M_2	6.496	6.482	6.414	6.526	6.480
M_3	6.406	6.442	6.402	6.418	6.417
Mean	6.503	6.571	6.433	6.447	6.489

The sowing dates and also the different levels of the NPK combination did not show any influence on the fibre strength.

(d) Maturity coefficient. The average maturity coefficients are presented in the Table XVIII below:

TABLE XVIII

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE MATURITY COEFFICIENT

Average maturity coefficient					
M \ D	D_1	D_2	D_4	D_4	Mean
M_1	0.8740	0.9290	0.8996	0.8506	0.8817
M_2	0.8760	0.8970	0.8876	0.8574	0.8795
M_3	0.8846	0.9040	0.8878	0.8622	0.8847
Mean	0.8782	0.9011	0.8917	0.8567	0.8820

C.D.(at 5 percent) for date of sowing means: 0.0198

Dates: $\underline{D_2\ D_3\ D_1}$ D_4

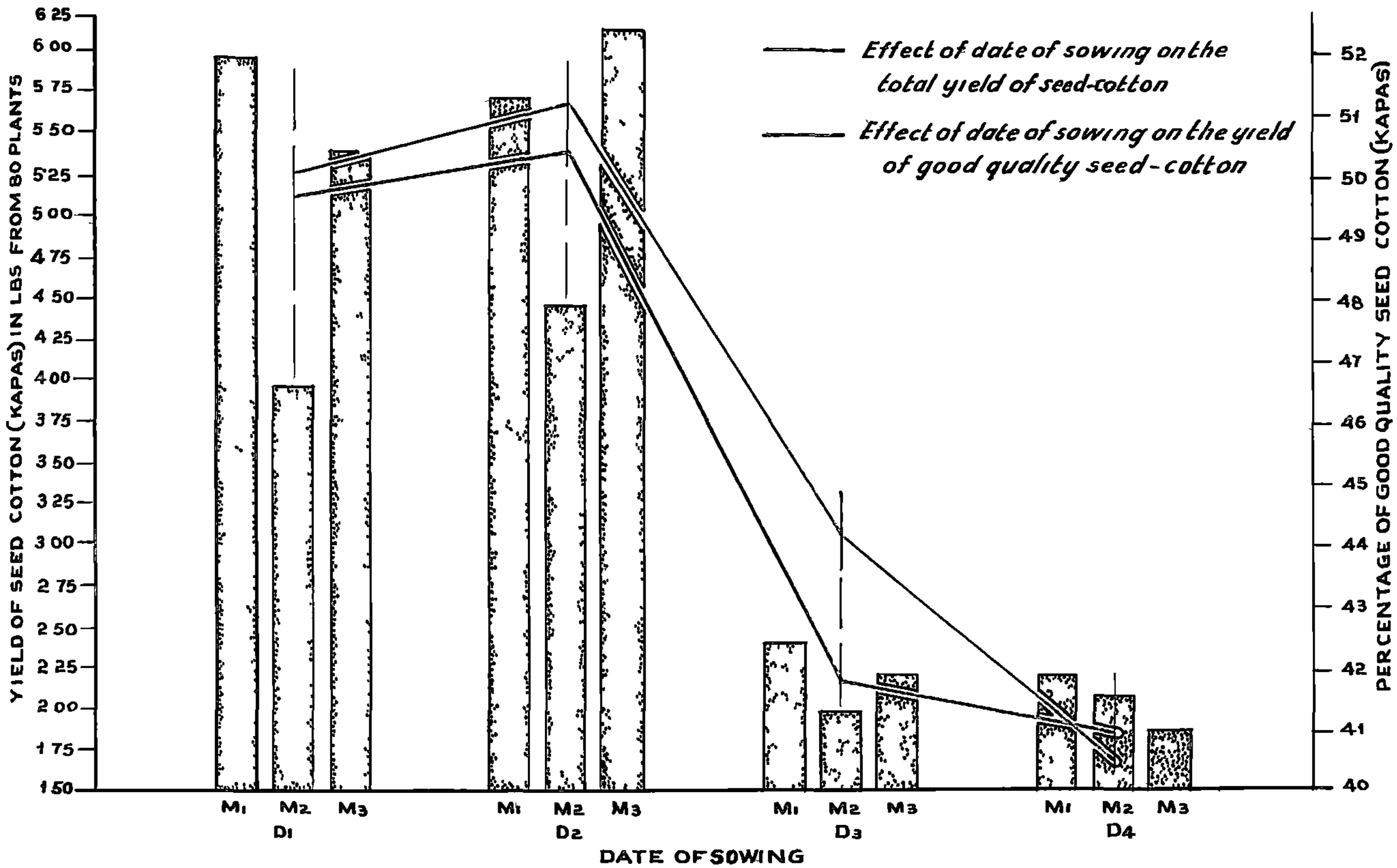
Effect of date of sowing. The first three sowing dates showed significantly higher coefficients. The difference between them was not significant.(Fig 7)

The different levels of the NPK combination did not show any significant effect on the maturity coefficient.

III. Yield of kapas. A preliminary analysis of the yield data indicated that the analysis of covariance technique was not necessary and that the yield could be adjusted for the number of plants, for statistical analysis.

F I G U R E   8

Yield of kapas and percentage of good kapas.



YIELD OF SEED COTTON (KAPAS) IN LBS FROM 80 PLANTS
6 25
6 00
5 75
5 50
5 25
5 00
4 75
4 50
4 25
4 00
3 75
3 50
3 25
3 00
2 75
2 50
2 25
2 00
1 75
1 50
Effect of date of sowing on the total yield of seed-cotton
Effect of date of sowing on the yield of good quality seed-cotton
52
51
50
49
48
47
46
45
44
43
42
41
40
PERCENTAGE OF GOOD QUALITY SEED COTTON (KAPAS)
M1 M2 M3
D1
M1 M2 M3
D2
M1 M2 M3
D3
M1 M2 M3
D4
DATE OF SOWING

FIG 8

The average values of the adjusted yields of kapas per net plot are presented in the Table XIX below:

TABLE XIX

EFFECT OF SOWING DATES AND MANURIAL LEVELS ON THE FINAL YIELD OF KAPAS

	Average yield of kapas in lb. from 80 plants				
M \ D	D_1	D_2	D_3	D_4	Mean
M_1	5.940	5.734	2.414	2.238	4.081
M_2	3.964	4.440	2.006	2.104	3.129
M_3	5.412	6.140	2.236	1.870	3.915
Mean	5.105	5.438	2.219	2.071	3.708

C.D. (at 5 percent) for date of sowing means: 1.717

C.D. (at 5 percent) for manurial levels within the same date: 0.550

C.D. (at 5 percent) for manurial levels not within the same date: 0.620

C.D. (at 5 percent) for manurial levels: 0.864

Dates: $\underline{D_2\ D_1}$ $\underline{D_3\ D_4}$

Manures: $\underline{M_1\ M_3}$ M_2

Effect of date of sowing. The two earlier sowings (D_1 and D_2) gave significantly maximum yield of kapas, when compared to D_3 and D_4. These sowing dates were almost equally effective. There were no significant differences in the yield of kapas between D_2 and D_1 and also between D_3 and D_4.

Effect of manurial levels. The M_1 level of NPK combination followed by the next higher level M_3, recorded significantly maximum yields. However, these two manurial levels were equally effective in increasing the yields. The lowest level M_2 gave significantly lower yield when compared to the higher levels M_1 and M_3.

The interaction between date of sowing and manurial levels was significant. The D_2M_1 and D_2M_3 combinations gave significantly higher yields than the yield obtained from the other manurial combinations in D_3 and D_4. The combination D_2 M_1 was also significantly higher to D_2 M_2 and on a par with D_2 M_3. The D_2 M_1 combination was also found to be significantly superior to D_1 M_2 though it was on a par with D_1 M_1 and D_1 M_3.

The average yield per acre was worked out. It is presented in the Appendix IV.

The total yield of kapas and the percentage of good kapas are represented in the figure 8.

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D I S C U S S I O N

The present investigation was taken up with a view to determine the favourable time for cultivation of Sea Island cotton, to explore the possibilities of expanding the area under this crop in the Vellayani region and also to find a suitable fertilizer combination of nitrogen, phosphoric acid and potash. The variety 'Andrews', which proved to be successful in the west coast regions of Kerala, was selected for the study. The climatic factors and the plant characters at different growth phases were studied to ascertain their magnitude of response on the growth and yield and also on the quality of kapas obtained, under the varying environmental conditions provided by different sowing dates.

The data were analysed statistically and the analysis of variance tables are furnished in the Appendices.

i. Climatic factors.

A. Effect of rainfall on the germination percentage.

The analysis of the data on the germination percentage (Table I) indicated that the sowing dates D_3 and D_4 (18th May and 3rd June) gave significantly higher percentages and D_4 recorded the maximum percentage.

The basal dose of the different levels of the NPK combination tried in any of the sowing dates was not found to influence the germination percentage.

Sowing dates D_1 (16th April) recorded 43.45 percent germination, D_2 (2nd May) 48.40 percent, D_3 63.21 percent and D_4 68.70 percent. In the D_1 sowing date, about 54 mms. of rain was received on the sixth day prior to sowing (Appendix II). The rainless period of five days before sowing and seven days after sowing resulted in a low germination percentage in D_1. In D_2, though there was continuous showers for four days previous to the third day prior to sowing, the total rainfall recorded during this period was only 22.87 mms. when compared to 62.23 mms. in D_1. That D_2 recorded a high percentage of germination than D_1, may be due to the fact that the rainfall was distributed evenly before sowing and also due to moderate showers of 19.30 mms. on the sixth and the seventh day after sowing. In the case of D_3, there was a total of 28.45 mms. of rainfall on the fifth and the sixth day prior to sowing. Thus the total precipitation recorded during these two days was 22.86 mms. greater than that recorded during the fifth and the sixth day prior to D_2 sowing. In the D_2 sowing, there was a rainless dry period of fourteen days previous to the eighth day prior to sowing. But in D_3, there were continuous showers even before seven days prior to sowing. This might have also resulted in a higher percentage of germination observed in D_3.

Qureshi (1957) also found that the rainfall received during a period of fifteen days prior to sowing influenced the germination percentage. According to him, either heavy showers during a period of seven days after sowing or long breaks of monsoon during that period were detrimental for a high percentage of germination. Christidis and Harrison (1955) also suggested that the soil must contain a considerable amount of moisture to obtain a high percentage of germination. This was confirmed from the observed germination percentage in D_4 and D_3.

B.(i) Shedding percentage.

The correlation studies made under the present investigation (Table II) revealed the influence of climatic factors during flowering and boll formation stage on the shedding percentage of squares, flowers and bolls.

(a) Rainfall and shedding percentage. Though the percentage of shedding was not significantly affected by the rainfall, there was a slight increase in the shedding percentage as the precipitation increased. Crowther (1934) found that heavy irrigations caused a high percentage of shedding. Christidis and Harrison (1955) also reported the results as obtained by Albert and Armstrong (1931) that cotton grown under high soil moisture conditions shed a larger percentage of fruit bud than under moisture near the optimum. In the present investigation also, the greater percentage of shedding might have been due to a high soil moisture condition which resulted from an increased precipitation. It could also be attributed to the interruption of sun light due to cloudy sky which might have resulted in a reduction in the rate of carbohydrate synthesis by the plant. The direct effect of raindrops might have also played a role in increasing the shedding.

(b) Effect of temperature and humidity on shedding Percentage. The daily minimum temperature had no influence on the shedding percentage. But a significant positive correlation was obtained between the daily maximum temperature and the percentage of shedding. Joshi *et al*.(1941) and Christidis and Harrison (1955) also reported that high temperature caused heavy shedding of squares,flowers and bolls.

The shedding percentage was not influenced by the mean relative humidity.

(ii) Effect of rainfall on the final yield of kapas.

Though the fourth sowing date (D_4)had received the maximum rainfall during the crop season, the yield of kapas was minimum (Table III) when compared to those obtained from the other sowing dates. The lowest yield recorded was mainly due to the highest percentage of shedding which occurred as a result of heavy and distributed showers throughout the flowering and boll formation stage. The sowing date D_2, which recorded the highest yield had received only a low rainfall when compared to the D_4. The increased yield obtained in D_2 was due to the minimum percentage of shedding which was significantly lower than that recorded in the D_4. Thus, it can be concluded from the present study that the percentage of shedding is a more important factor than the total rainfall in determining the yield. This finding is in partial agreement with the results obtained by Crowther (1934) in Sudan, where he found that excessive soil moisture increased the shedding percentage with a consequent reduction in the yield.

II. Plant characters and yield attributes.

1. Height of plants at maturity.

The sowing dates D_1 and D_2 recorded significant increase in the height of plants than in D_3 and D_4 (Table IV, Fig.3). The earlier work done by Patel and Parmer (1958) and Dastur (1959) had also revealed that early sowing resulted in an increased vegetative growth of the plants. Dastur in 1960 again confirmed that early sowing of Sea Island cotton under Punjab conditions also resulted in a vigourous vegetative growth, which declined as the sowing date advanced. The increased vegetative growth observed in the early sown crop may be attributed to a longer growing period enjoyed by the crop than that was obtained for a late sown crop.

Effect of different levels of the NPK combination.

The height of the plants recorded was significantly higher in the case of application of 50 lb. nitrogen, 40 lb. phosphoric acid and 60 lb. potash per acre (Fig.3). Harland (1921) showed in West Indies that for Sea Island cotton, the size of the crop was positively influenced by the application of potash. Dastur(1959) also pointed out that for the full manifestations of the functions of nitrogen, potash was necessary. But the present finding revealed that for maximum vegetative growth, increased doses of nitrogen and phosphoric acid were also found necessary together with a higher quantity of potash. Thus the increase in the height of the plant observed due to application of the M_3 fertilizer level may be possibly due to the higher quantity of potash together with the increased quantities of nitrogen and phosphoric acid when compared to the lower quantities of all the three nutrients applied in the M_1 and M_2 levels. Dastur (1959) from sowing cum manurial experiments conducted at the V.C. Farm and at the Babur farm in

Mysore and Sreedharan (1962 - unpublished), from an experiment conducted in rice fallows, also concluded that the best growth of the plants was observed by the application of all the three plant nutrients together.

2. Earliness in flowering and maturity.

Earliness was determined by the number of days taken for the first flower opening and also by the Bartlett's index (Tables V and VI).

Effect of date of sowing.

The fourth date of sowing (D_4) recorded significant earliness in flowering. The other three earlier sowing dates D_1, D_2 and D_3 were almost similar in their effects for the first flower opening. However, Bartlett's index indicated that D_1 followed by D_4 matured earlier (Fig.4) though there was no significant difference between them. The earliness in flowering and in maturity of the late sown crop (D_4) was due to shortened vegetative and reproductive phases when compared to a long period which was available for the early sown crop. Earlier work of Dastur and Mukhtar Singh (1944) also revealed that a delay in the sowing of cotton by a given period did not cause an equivalent delay in the reproductive phase.

The D_1 crop also matured earlier as the D_4 crop. This could have been due to the inadequate soil moisture conditions which prevailed as a result of only very low rainfall received after flowering. These adverse conditions affected the proper development of bolls in the D_1 crop, which resulted in an early maturity. The crops from sowing dates D_2 and D_3 received moderate showers after the flowering of the crop and hence could have maintained an optimum moisture level in the soil for the full development of bolls. Consequently, D_2 and D_3 sowings matured only later when compared to the D_1 and D_4 crop. Christidis and Harrison (1955) and Bederker *et al.*(1958) also observed that a delay in sowing date resulted in a consequent delay in maturity. However, Dastur (1960) reported that in Egypt, the date of first flower bud formation was not much affected by different sowing dates.

Though the present study indicates that the late sown crop (D_4) was earlier in maturity as the early sown crop (D_1), the yield (Table XIX) obtained from the late sown crop was significantly lower than that obtained from the early sown crop. Similarly, the percentage of good *kapas* (Table XI) harvested from the late sown crop was also significantly minimum when compared to that recorded in the early sown crop. Thus the total yield of *kapas* and its quality were affected to a very great extent by late sowing.

From these results it is seen that the earliness in maturity due to late sowing could not be considered a favourable factor in Sea Island cotton under Vellayani conditions.

Effect of fertilizer levels. Earliness in flowering was not affected by differant levels of NPK combinations carried in the experiment (Table V). This indicated that the levels of the NPK combination, varying from 30 to 50 lb. nitrogen, 20 to 40 lb. phosphoric acid and 40 to 60 lb. potash per acre did not show any significant variation in their effects on earliness in flowering. Bartlett's index (Table VI) showed that the medium level of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre exhibited significant earliness in maturity (Fig.4). than the lowest level of 30 lb.nitrogen, 20 lb.phosphoric acid and 40 lb. potash per acre. But there was no difference on earliness in maturity, between the levels of 40 and 50 lb. nitrogen, 30 and 40 lb.phosphoric acid and 50 and 60 lb. potash per acre. Williams et al.(1937) obtained similar results wherein it was found that the application of 15 percent phosphoric acid in a complete fertilizer helped in increasing the earliness. But from the present study it was seen that at least 25 percent of phosphoric acid was found necessary for a significant increase on earliness in maturity for Sea Island cotton in the Vellayani region.

3. Number of flowers and bolls.

Effect of date of sowing. The data given in the Table VII indicate that the first and the second sowing dates (D_1 and D_2) recorded significantly higher number of flowers. The percentages of shedding of squares flowers and bolls (Table IX) were significantly lower in the D_1 and D_2 sowings (Fig. 5). Hence these two earlier sowings recorded more number of bolls than in D_3 and D_4 (Table X VIII). A decreasing trend in the number of boll production due to late sowing was also reported by authors like Christidis and Harrison (1955), Bederker et al.(1958) Patel and Parmer (1958) and Gursham Singh and Kanwar Singh (1959). In the present study also, the results showed that the number of flowers and the number of bolls were found to decrease as the sowing date advanced from April to June.

The increased number of flowers recorded in the D_1 and D_2 sowings might have been due to the maximum height the plants attained, by early sowings (Table IV). As the plant height increased the number of sympodial branches also increased, which resulted in more flowers. This is also in agreement with the findings of Balls and Halton (1915) and Harland (1918).

According to Afzal (1941), the percentage of shedding was more important than flower production in determining the yield, as a correlation between the number of flowers and the final number of bolls produced was not generally significant. However in the present study, D_1 and D_2, which recorded a significantly high percentage of flower production, only a minimum percentage of shedding was observed. As a result, the number of bolls developed and harvested was higher and hence the yield was also maximum. Hence the present study also confirmed the results obtained by Balls and Halton (1915) that the yield primarily depended upon the number of flowers per plant.

Effect of fertilizer levels. Bederker and Shaligram (1958) reported that a combination of nitrogen and phosphoric acid was found to give increased number of flowers. According to Dastur (1959) also, phosphoric acid and potash, either alone or in combination with nitrogen increased the rate of flower production.

The present investigation revealed that the higher levels of NPK combination (M_1 and M_3) produced significantly greater number of flowers (Fig. 5). However, with regard to the rate of boll production, the different levels of NPK combination did not show any significant effect.

4. Shedding percentage.

Effect of date of sowing. The results presented in Table IX showed that the maximum shedding of squares, flowers and bolls occurred in the late sowings (D_3 and D_4), eventhough there was no significant difference between them. The highest percentage of shedding recorded in the D_4 sowing date could be attributed to the maximum rainfall which occurred during the flowering and boll formation stage. The earlier sowings (D_1 and D_2) recorded significantly lower percentage of shedding. But Gurshun Singh et al.(1958) found that a change in sowing date did not affect materially the setting percentage of bolls. In the present trial, it was seen that there was a progressive increase in the shedding percentage as the sowing date advanced from April to June. Christidis and Harrison (1955) also reported similar findings in several experiments.

Effect of fertilizer levels. The different levels of the NPK combination did not show any significant variation in the shedding percentage. The results thus indicated that the levels varying from 30 to 50 lb. nitrogen, 20 to 40 lb.phosphoric acid and 40 to 60 lb. potash per acre had no influence on the percentage of shedding. Dastur and Mukhtar Singh (1953) and Singh et al. (1958) also observed similar results with regard to nitrogen application. Shaligram (1957) concluded that the shedding percentage was not affected by the application of nitrogen and phosphoric acid in combination. According to Nelson and

Ware (1932), potash also had no effect on shedding percentage.

Thus the present finding confirmed that shedding was not affected by the application of fertilizers, but mainly depended on the hereditary and environmental factors. Christidis and Harrison (1955) also brought out similar conclusions.

The interaction between the date of sowing and fertilizer levels was significant. In the D_4 date of sowing, the combination D_4 M_3 resulted in a significantly lower shedding percentage than those observed in D_4 M_1 and D_4 M_2 combinations, though the difference between the latter two combinations was not significant. The lower percentage of shedding observed in the D_4 M_3 can be attributed to the higher doses of fertilizers given along with the high rainfall enjoyed by that treatment whereas in D_4 M_1 and D_4 M_2, the absence of a higher dose of fertilizers had actually pushed up the shedding percentage to a higher degree. Christidis and Harrison (1955) also reported similar results wherein they stated that irrigation or high rainfall helped to reduce the shedding percentage in a fertile field or in a field where a fairly high dose of nitrogen fertilizers was applied. The present finding is in partial agreement with these results.

In the D_2 date of sowing, the combination D_2 M_2 and D_2 M_3 were on a par, though D_2 M_1 recorded a lower shedding percentage. The rainfall received during the flowering and boll formation stage of the D_2 sown crop was only 872 mms. when compared to 1364 mms. in the D_4 This low rainfall would have acted adversely on the $D_2 M_2$ and $D_2 M_3$ combinations, which received the lowest and the highest levels of fertilizers, respectively. Thus, it could be seen that M_1, which was the medium level of the NPK combination recorded the minimum shedding percentage. The M_1 fertilizer combination seemed to be the optimum even in the case of other yield attributes.

5. Percentage of good bolls and medium bolls.

Effect of date of sowing. The sowing date D_2 recorded significantly higher percentage of good bolls and medium bolls than those in the other three sowing dates (Table X, Fig. 6). The rainfall data indicated (Appendix III) that during the boll bursting stage of the early May sown crop (D_2), only minimum showers were received when compared to the rainfall recorded in the later sowings. This very low rainfall contributed for the good bursting of the bolls in D_2. Thus, thepresent study seemed to indicate that sowing in the first week of May enables maturation and harvesting time with a period of bright sunshine to coincide, resulting in good boll bursting.

Effect of fertilizer levels. The M_1 level of the NPK combination recorded the highest percentages of both good and medium bolls. This was significantly higher than M_3 and on a par with M_2 in the case of medium bolls and with regard to good bolls, the M_1 level was significantly superior to both M_2 and M_3 levels. Earlier workers like Dastur and Samant (1942) observed that 48 lb. nitrogen increased the rate of production of good bolls in the Punjab. Dastur (1949, 1959) correlated bad boll opening ('Tirak') in the Punjab American cotton with nitrogen deficiency and presence of sodium salts in the soil. Christidis and Harrison (1955) also reported increased production of good bolls due to application of nitrogen. In South Carolina, Killinger (1941) found that bad opening of bolls was associated with potash deficiency. Sreedharan (1962 - unpublished) showed that the percentage of good bolls obtained was found to increase upto 60 lb. potash along with 40 lb. nitrogen and 15 lb. phosphoric acid per acre. The results obtained by these authors also indicated the need for a balanced application of nitrogen and potash for an increased rate of production of good bolls. From the three levels of the fertilizer combination tried in the present study, 30 lb. phosphoric acid and 50 lb. potash per acre along with 40 lb. nitrogen was found to be the optimum dose for Sea Island cotton in the Vellayani region.

6. Percentage of good *kapas*. The good *kapas* constitute

the *kapas* obtained from both good and medium bolls.

Effect of date of sowing. The present study indicated that the percentage of good *kapas* (Table XI) was maximum in D_2. Thus it could be seen that sowing in the first week of May was found to be definitely favourable for obtaining a high percentage of good *kapas* (Fig.8). Here also the absence of rainfall at boll bursting stage might have helped in obtaining the highest quantity of good *kapas*.

Though the effect of different levels of NPK combination was not found to be significant, M_1 level was found to be slightly superior than M_3 and M_2.

From the interaction studies also, it was seen that $D_2 M_1$ combination recorded significantly higher percentage of good *kapas* over the percentages recorded in all the combinations in D_3 and D_4 sowing dates. The combination $D_2 M_1$ was also found to be slightly superior over all the combinations in D_1 and the combinations $D_2 M_2$ and $D_2 M_3$. From these results it can be seen that the application of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre to the crop sown in the first week of May (D_2) seemed to be the most favourable dose of the NPK combination for obtaining the highest quality *kapas*.

7. Ginning percentage, seed index and lint index. The yield of cotton is indirectly influenced by the above

factors. High ginning percentage, low seed index and high lint index are favourable characters which have got some effect in determining the yield, though they are mostly varietal. The results obtained in the present investigation are presented in Tables XII, XIII and XIV.

Effect of date of sowing. The present work showed that the higher ginning percentage observed in sowing dates D_1, D_2 and D_3 were almost equal. The latest date of sowing (D_4) recorded significantly minimum ginning outturn. Christidis and Harrison (1955) reported that early sowing increased the ginning percentage. In M.C.U. I cotton, Kamalanathan and Ramachandran (1961) also got similar results. However, Bederker *et al.* (1958) found that ginning percentage was not affected by date of sowing. The present work indicated that ginning percentage was not much affected by date of sowing since the last sowing only recorded a variation. This result is in partial agreement with the results reported by the above authors.

Both lint index and seed index did not show any significant response due to different sowing dates. Christidis and Harrison (1955) also reported that the lint percentage was less affected by a variation in environment than other quantitative or physiological characteristics.

Effect of fertilizer levels. Different levels of the NPK combination tried in the present investigation did not show any significant effect on the ginning percentage and seed index. Though the authors like Christidis and Harrison (1955) and Bhatt and Gopani (1956) observed an increase in ginning percentage and seed index, manurial trials conducted by Ramaswamy and Vaman Bhatt (1957) on Sea Island cotton indicated that fertilizers had no response on both these characters. The present finding is also in conformity with the results obtained by the above workers, in Sea Island cotton.

With regard to lint index, M_1 and M_3 levels of the NPK combination were found to be significantly superior over M_2. Earlier works reported by Christidis and Harrison (1955) and Bhat and Gopani (1956) also indicated an increase in the lint index due to application of nitrogen and phosphoric acid, with potash having no influence. In Sea Island cotton, Ramaswamy and Vaman Bhatt (1957) also found that the lint index increased due to application of 60 lb. nitrogen, 30 lb. phosphoric acid and 50 lb.potash per acre. The present study indicated that for a significant response on the lint index, only 40 lb. nitrogen seemed to be sufficient along with 30 lb. phosphoric acid and 50 lb.

potash per acre.

Interaction between date of sowing and fertilizer levels was significant. In regard to ginning percentage the fertilizer combination $D_2 M_3$ showed significantly higher ginning outturn than that recorded in the $D_2 M_2$ combination. The $D_2 M_3$ was also on a par with $D_2 M_1$. This indicated that the lower level of the NPK combination (M_1) was equally effective as the highest level (M_3) in increasing ginning percentage. Thus the present study revealed that for high ginning outturn, sowing in the first week of May along with the application of 40 lb. nitrogen 30 lb. phosphoric acid and 50 lb. potash per acre was the optimum for Sea Island cotton.

8. Fibre characters: Fibre length, fibre weight, Pressley strength and maturity coefficient.

The fibre characters determine the quality and market value of the cotton lint. Though they are purely varietal characters, they are reported to be influenced by environmental conditions and manuring.

Effect of date of sowing. Results obtained in the present investigation (Tables XV, XVI, XVII, and XVIII) revealed that the different environmental conditions provided by sowing in different dates resulted in significant variation in fibre length, fibre weight and maturity coefficient (Fig.7). The earlier sowings

(D_1 and D_2) recorded significantly longer fibres. Increased fibre weight was also observed in the earlier sowings. The data on maturity coefficient revealed that the sowing dates D_2, D_3 and D_1 were significantly superior to the sowing date D_4. Date of sowing had no influence on the Pressley strength index.

The increased fibre length in D_1 and D_2 may be attributed to the well distributed light showers received during the period of flowering and boll formation. A more favourable soil moisture due to light showers during this stage, might have increased the fibre length since the formation of the primary wall of the cotton fibre is complete during a period of sixteen days after flowering. Sen and Kar (1947) also observed similar results. The decrease in fibre length recorded in the late sowings (D_3 and D_4) might have been due to excessive rainfall received during flowering and boll formation periods. This resulted in a water logged condition around the roots of the plants which might have checked the lint development. Christidis and Harrison (1955), while reviewing several studies on the relation between lint length and water supply, had also brought out similar conclusions. Kanniyan and Balasubramanian (1952) and Jambunathan (1955) also observed increased fibre length and fibre maturity due to early sowing. According to Deo (1955), Sivasubramanian (1957) and Jambunathan (1959), early sowings recorded superior fibre qualities.

Effect of fertilizer levels. In the present investigation, different levels of the NPK combination did not show any significant response on the fibre characters. Levels varying from 30 to 50 lb. nitrogen, 20 to 40 lb. phosphoric acid and 40 to 60 lb. potash per acre showed almost the same effect. However Gulati and Nazir Ahmed (1946) reported that increased application of nitrogen influenced the lengthening of the cotton fibre. On the other hand, Iyengar (1941) Samson 1941, Sen and Ahmed(1947) and Deo (1955) all observed no effect on fibre characters due to fertilizers. The present study also confirmed these findings.

III. Yield of kapas.

Effect of date of sowing. The present study showed that early sowing had a significant effect in increasing the yield of *kapas* in Sea Island cotton (Table XIX) . The earlier sowing D_2 recorded a significant higher yield than that obtained from late sowings D_3 and D_4 (Fig.8) though D_2 was on a par with D_1. Crowther *et al.*(1937), Afzal (1949), Nayak (1956) and Sivasubramanian (1957) also observed similar trend in their findings with regard to the effect of fertilizers. In Sea Island cotton also, Kesava Iyengar (1960) reported that early sowing recorded the highest yield. Thus in the present investigation it is confirmed that an early sown crop in the first week of May was found to be superior than the late sown crop in the third week of May or in the first week of June, in the Vellayani region.

Effect of fertilizer levels. The NPK level M_1 had given significantly higher yield than that recorded in M_2, though the difference between M_1 and M_3 was not significant. This indicated that the medium level M_1 was equally effective as the highest level M_3 in increasing the yield. The earlier agronomical trials carried out under the Sea Island Cotton Scheme in the west coast regions revealed that 40 lb.nitrogen in combination with phosphoric acid and potash gave higher yields. (Anon.1956). In the present study, it was observed that the NPK combination of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre was better for the Vellayani region.

The results obtained by Ramaswamy and Vaman Bhatt (1957) showed that 60 lb. nitrogen was a better level than 40 lb. nitrogen as observed in the present study. This difference in response of nitrogen might have been due to the difference in the soil types. The laterite soils which are comparatively poorer in nitrogen responded to a higher dose of nitrogen, whereas for the red loamy soils of Vellayani, which contain a fairly high percentage of this nutrient when compared to laterite soils, showed no response beyond 40 lb. nitrogen per acre.

Interaction between date of sowing and fertilizer levels was significant. The D_2M_1 and D_2M_3 combinations had given significantly higher yield than the yield obtained from the other fertilizer combinations in D_3 and D_4. The combination D_2M_1 was on a par with D_2M_3. The combination $D_2 M_1$ was found to be significantly superior to $D_1 M_2$, though it was on a par with $D_1 M_1$ and $D_1 M_3$. Earlier workers like Crowther et al. (1937), Dastur (1944), Dabral (1955), Christidis and Harrison (1955), Dastur et. al.(1957) and Gursham Singh and Kanwar Singh (1959) had studied the interaction of sowing date with nitrogen only. But in the present investigation, the interaction of date of sowing with all the three major nutrients in combination was studied. The results obtained showed that early sowing in the first week of May in combination with fertilizer dose of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre was found to be superior to all the fertilizer combinations tried in the later sown crops either in the third week of May or in the first week of June.

SUMMARY AND CONCLUSIONS

The present investigation was undertaken at the Agricultural College and Research Institute at Vellayani to determine the favourable time for the cultivation of Sea Island cotton to explore the possibilities of expanding the area under this crop in the Vellayani region. This work also envisaged the study of fertilizer requirements of the crop for this region.

Four sowing dates were tried in the present study with fifteen days intervals. The first date of sowing was fixed on the 16th of April,1962, after receiving summer showers. Three levels of the fertilizer combination, NPK, varying from 30 to 50 lb. nitrogen, 20 to 40 lb. phosphoric acid and 40 to 60 lb. potash per acre were also tried to determine a suitable combination of these nutrients for the Vellayani region.

The different climatic factors in relation to the different growth phases and yield of the crop were studied. Germination percentage, height of plants at maturity, earliness, shedding percentage, fibre characters, yield attributes namely number flowers and bolls, seed and lint indices and yield were investigated.

The results can be summarised as follows:

1. The germination percentage was found to be significantly higher in the late sowings, either in the third week of May or in the first week of June.

2. Sowing in the first week of May was found to increase the height of the plants when compared to later sowings.

A combination of 50 lb. nitrogen, 40 lb.phosphoric acid and 60 lb. potash per acre was found to give the maximum height for the plants when compared to the lowest level of the fertilizer combination tried in the study.

3. Early sowings upto to the first week of May was conducive to the production of a greater number of flowers and bolls.

The NPK combination of 40 lb. nitrogen, 30 lb.phosphoric acid and 50 lb. potash per acre was found to produce a greater number of flowers and bolls than the other two combinations.

4. The early sown crop matured earlier.

Early maturity of the crop was also found to be influenced by the application of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre than the other two levels tried.

5. Rainfall during flowering and boll formation stage increased the percentage of shedding with a consequent reduction in the yield of kapas. The daily minimum temperature and mean humidity during flowering and boll formation stage did not show any effect on the shedding percentage. However, a rise in the daily maximum temperature was found to increase the shedding of squares, flowers and bolls.

6. Maximum shedding of flowers and bolls had occurred in the late sowings from the second week of May onwards.

The different levels of nitrogen, phosphoric acid and potash , varying from 30 to 50 lb., 20 to 40 lb., and 40 to 60 lb. per acre respectively had no effect on the shedding percentage.

7. Sowing in the first week of May recorded maximum percentage of good bolls, medium bolls and good kapas . The NPK level of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash was found to be the optimum dose for good and medium boll production.

8. Both lint index and seed index were not affected by the date of sowing. The fertilizer level of 50 lb.

nitrogen, 40 lb. phosphoric acid and 60 lb. potash per acre was found to give a high lint index.

9. Late sowing in the first week of June resulted in a significant reduction in ginning percentage.

The different levels of the fertilizer combination of NPK tried, did not have any effect on the ginning percentage.

10.Sowing in the first week of May was found to increase the fibre length, fibre weight and maturity coefficient.

The fibre characters were not found to be influenced by the application of fertilizers.

11. Sowing in the second week of May gave the highest yield of kapas.

The NPK level of 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre was found to give the maximum yields.

CONCLUSION.

The results of the present study on Sea Island cotton in the Vellayani region, revealed that both high yield and good quality kapas may be obtained by sowing the crop in the first week of May, provided there are adequate showers prior to the date of sowing for obtaining a high percentage of germination. If there are no adequate showers, a soaking irrigation can be given either just before sowing or immediately afterwards, so as to enable the maximum number of seeds to germinate . The fertilizer combination of 40 lb. nitrogen, 30 lb. phosphoric acid, and 50 lb. potash per acre was found to be a suitable dose to increase the per acre yield of Sea Island cotton in the Vellayani region.

R E F E R E N C E S

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* Original not seen.

A P P E N D I C E S

A P P E N D I X I

Climatological data from April 1962 to December 1962.

Months	Rainfall in mms.	Relative humidity percentage	Maximum temperature in ^{o}F	Minimum temperature in^{o}F
April	135.4	82.0	88.7	80.4
May	385.3	85.0	83.4	75.2
June	63.3	82.6	86.0	81.0
July	298.0	84.1	85.5	80.7
August	98.6	81.3	86.8	80.3
September	125.5	89.3	84.0	80.5
October	378.7	88.9	82.5	78.6
November	42.9	88.7	83.1	80.0
December	889.0	89.7	84.4	80.3

A P P E N D I X II

Rainfall in mms. during 7 days prior to sowing and

7 days after sowing.

D_1		D_2		D_3		D_4	
April	Rainfall in mms.	April-May	Rainfall in mms.	May	Rainfall in mms.	May-June	Rainfall in mms.
9	8.38	25	12.45	11	0.00	27	0.00
10	53.85	26	3.05	12	12.70	28	0.00
11	00.00	27	2.54	13	15.75	29	0.00
12	00.00	28	4.83	14	0.00	30	0.00
13	00.00	29	0.00	15	0.00	31	0.00
14	00.00	30	0.00	16	0.00	1	0.00
15	00.00	1	0.00	17	0.00	2	0.00
16*	00.00	2*	0.00	18*	0.00	3*	21.59
17	00.00	3	0.00	19	0.00	4	15.24
18	00.00	4	0.00	20	0.00	5	3.40
19	00.00	5	0.00	21	0.00	6	10.82
20	00.00	6	0.00	22	0.00	7	10.16
21	00.00	7	0.00	23	0.00	8	31.24
22	00.00	8	4.06	24	3.81	9	31.75
23	00.00	9	15.24	25	3.30	10	32.00
Total	62.23	Total	42.17	Total	35.56	Total	156.26

* indicates sowing dates.

A P P E N D I X III

Rainfall data during boll bursting stage.

Date of sowing		Period of boll bursting	Rainfall in mms.
16-4-62	(D_1)	Aug.23 to Oct.10	280.1
2-5-62	(D_2)	Sep.13 to Oct.31	378.7
18-5-62	(D_3)	Sep.28 to Nov.15	416.6
3-6-62	(D_4)	Oct.23 to Dec.10	897.1

A P P E N D I X IV

Yield of kapas per acre.

	Average yield per acre.				
D / M	D_1	D_2	D_3	D_4	Mean
M_1	1301.2	1256.0	528.8	490.2	894.1
M_2	863.4	972.6	439.4	460.9	684.1
M_3	1185.5	1345.0	489.8	409.6	857.5
Mean	1111.9	1194.2	486.5	452.3	811.9

APPENDIX V (a)

Analysis of variance for germination percentage, plant height, number of days taken for the first flower opening and shedding percentage.

		Variance			
Source of variation	D.F.	Germination percentage.	Plant height at matutity	No. of days taken for the first flower opening.	Shedding percentage.
Replication	4	15.48	10.1500	1.46	3.4876
Dates	3	2143.29*	5847.8800**	41.39**	204.5337
Whole plot error	12	50.33	4.2170	3.44	7.5090
Manures	2	11.61	305.8150**	2.46	2.0247
Interaction	6	61.33	9.9000	2.96	35.1012**
Subplot error	32	23.34	7.2600	1.73	6.6564
Total	59				

* Significant at 5 percent level.

** Significant at 1 percent level.

A P P E N D I X   V (b)

Analyais of variance for number of flowers, Bartlett's index, number of bolls at maturity and percentage of medium bolls.

		Variance			
Source of variation	D.F.	Number of flowers	Bartlett's index	Number of bolls at maturity	Percentage of medium bolls
Replication	4	463.31*	0.0034	110.100*	13.5225
Dates	3	10612.84**	0.0096**	844.960**	1620.9660**
Whole plot error	12	96.89	0.0014	27.130	21.7225
Manures	2	619.82**	0.0069	181.115	27.1150*
Interaction	6	68.19	0.0091	59.96*	26.3500*
Subplot error	32	75.36	0.0051	335.70	6.4700
Total	59				

* Significant at 5 percent level.

** Significant at 1 percent level.

A P P E N D I X V (c)

Analysis of variance for percentage of good bolls, good kapas, ginning percentage and lint index.

		Variance			
Source of variation	D.F.	Percentage of good bolls	Percentage of good kapas	ginning percentage	Lint index.
Replication	4	65.400**	7.365	0.4425	13.18
Dates	3	127.750**	381.157**	4.793	68.06
Whole plot error	12	14.790	8.417	1.416	60.78
Manures	2	74.500**	5.470	3.205**	106.07**
Interaction	6	11.047	15.091*	0.981**	10.38
Subplot error	32	7.350	5.060	0.255	6.32
Total	59				

* Significant at 5 percent level.

** Significant at 1 percent level.

APPENDIX V (d)

Analysis of variance for seed index, fibre length and fibre weight.

		Variance		
Source of variation	D.F.	Seed index	Fibre length	Fibre weight.
Replication	4	124.78	0.000325	0.00002425
Dates	3	165.59	0.024167**	0.00044400**
Whole plot error	12	114.77	0.000700	0.00002250
Manures	2	150.08	0.000600	0.00003550
Interaction	6	27.45	0.000300	0.00002733
Subplot error	32	52.57	0.003750	0.00001590
Total	59			

* Significant at 5 percent level.

** Significant at 1 percent level.

A P P E N D I X V (e)

Analysis of variance for Pressley strength, maturity coefficient and yield of kapas.

		Variance		
Source of variation	D.F	Pressley strength	Maturity coefficient	Yield of kapas
Replication	4	0.082975	0.0006115	00.240
Dates	3	0.041266	0.0055618**	49.223**
Whole plot error	12	0.061020	0.0006236	00.466
Manures	2	0.115900**	0.0001339	05.180**
Interaction	6	0.037200	0.0001660	01.460**
Subplot error	32	0.019160	0.0002384	00.180
Total	59			

* Significant at 5 percent level.

** Significant at 5 percent level.

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P L A T E S

P L A T E   I

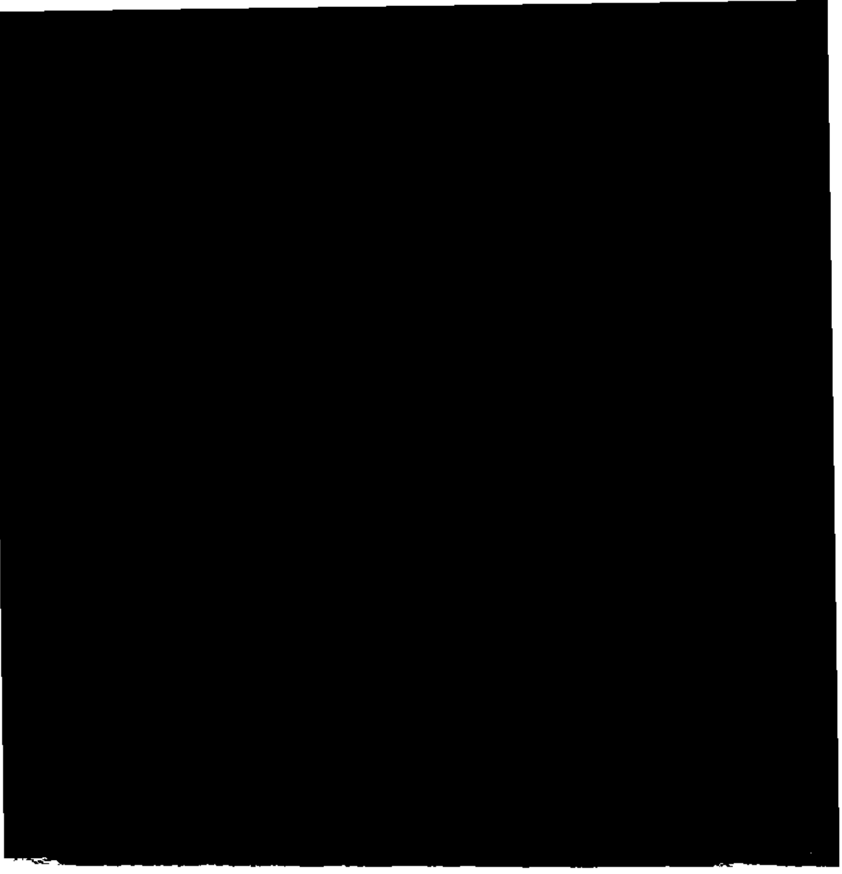
A view of the crop sown on the 2nd May (treatment D_2), during its flowering stage.

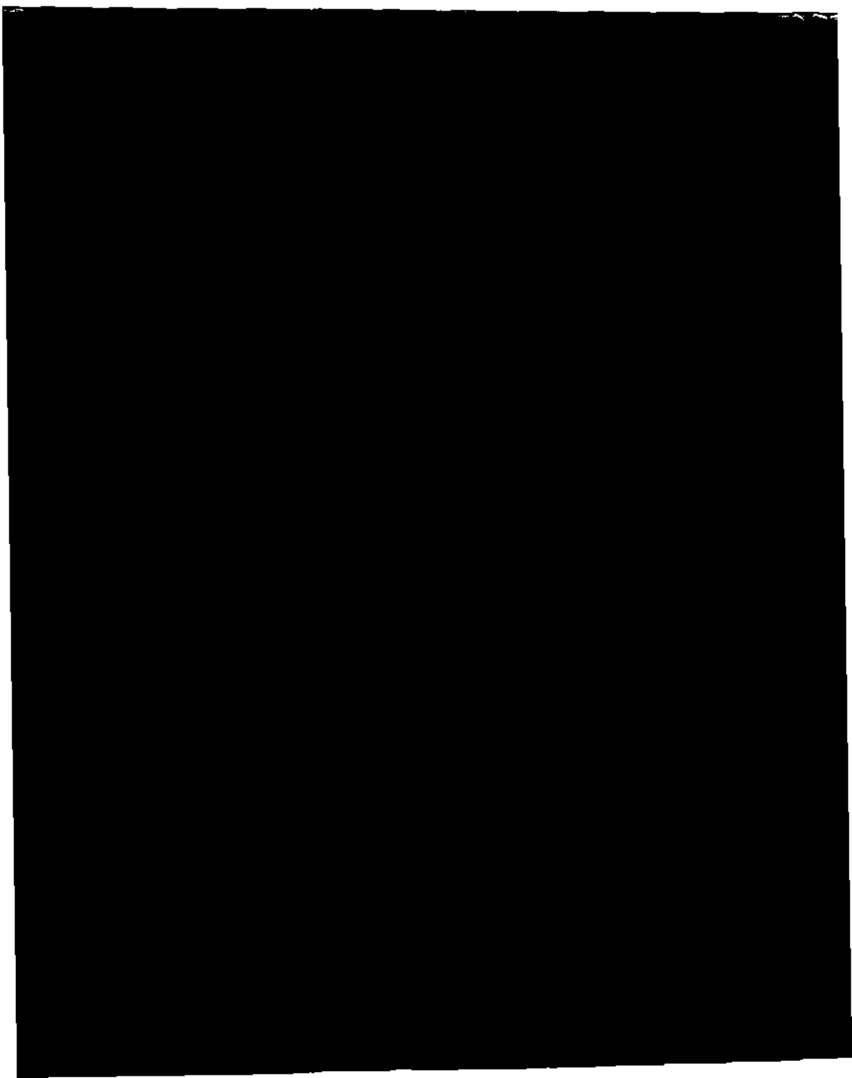
P L A T E II

An average plant from the crop sown on the 16th April (Treatment D_1)

P L A T E   III

An average plant from the crop sown on the 2nd May (Treatment D_2)





P L A T E IV

An average plant from the crop
sown on the 18th May
(Treatment D_3)

P L A T E V

An average plant from the
crop sown on the 3rd June
(Treatment D_4).

P L A T E   VI

An average plant at 40 lb. nitrogen, 30 lb. phosphoric acid and 50 lb. potash per acre.

P L A T E VII

An average plant at 30 lb. nitrogen, 20 lb. phosphoric acid and 40 lb. potash per acre.

P L A T E VIII

An average plant at 50 lb. nitrogen, 40 lb. phosphoric acid and 60 lb. potash per acre.