https://doi.org/10.29321/MAJ.10.A03602

A Study on Flowering and Fruiting in *Hirsutum* Varieties of Cotton

by
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Introduction: The yield of cotton is dependent on many factors of which the rate of flowering, the length of flowering period, the percentage of setting, and the size of bolls are important. Not only do these variables change from variety to variety, but also are known to be influenced by environmental conditions such as season of crop growth, cultural operations, plant protection measures *etc*. Hence the study of relation of varietal and environmental factors to flowering and fruiting is of perennial interest to cotton breeders.

This report embraces the results obtained from a comparative study of sixteen *hirsutum* varieties raised under irrigated condition at Coimbatore in 1966–67 winter season extending from August to February and in 1967 summer extending from March to August.

Materials and Methods: Sixteen *hirsutum* varieties, MCU 1, MCU 2, MCU 3, P 216 F, K 3400, CS 72/2, CS 84/4, B 59–1678, B 15–1679, Bar 7/8–1, Acala 41–2, JR 23, JR 52, RH 5/1, 108 F and 37–61, representing the types under collection at the Cotton Breeding Station, Coimbatore were raised in Winter (August to February) season in 1966–67 and Summer (March to August) season in 1967 under irrigated condition adopting a spacing of 70 cm × 30 cm. The planting was done in ridges. A fertilizer mixture to supply nitrogen, phosphoric acid and potash at 50, 20 and 20 kg/ha respectively was applied in two split doses, the entire quantity of phosphoric acid and potash and two fifths of N being supplied at the time of last flowering and remaining three fifths of N, when the crop was 45 days old. The crop was given adquate protection throughout its life cycle.

Lay-out and experimental procedure: The lay-out was of simple randomised block design with each variety replicated twice. In each plot there were four rows, each of 20 feet length. Ten normal plants, five from each of the two central rows, were selected from each plot and thus there were twenty plants for each variety. The number of flowers appearing each day on these selected plants was recorded. Further, the flowers were marked on the day of blooming with dated and serially numbered tags. Towards the end of the season the bolls with tags were examined daily and picked with the tag at the first sign of dehiscence. The date of picking was noted on the tag.

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The picked bolls were dried and seed-cotton from each boll was removed and placed in separate envelopes on which the weight of *Kapas*, the date of flowering, and the date of picking were recorded.

Fertilization takes place in cotton within a few hours of the opening of the flowers and hence the date of opening of the flower may be taken as the date of formation of the boll from which that boll was formed. Thus the maturation period from a boll is the number of days from the date of opening of a flower to the date of dehiscence of the boll which formed from that flower.

From the flower-count record, the mean number of flowers produced per plant per fortnight was calculated for each variety so as to make the flowering curve smooth. The percentage of setting occurring during each period was also worked out.

Results: (a) *Flowering:* The data showing the interval of time between the planting and the appearance of the first flowering, the number of days for which the flowering continued and the rate of flowering have been presented in Table 1.

TABLE 1. *Showing (A) the interval of time between the planting and the date of first flowering in days, (B) the period of flowering in days and (C) the rate of flowering per plant per day*

Varieties	A		B		C	
	Winter	Summer	Winter	Summer	Winter	Summer
1	2	3	4	5	6	7
MCU 3	68	59	94	60	0.60	0.65
MCU 2	67	61	95	55	0.53	0.60
MCU 1	66	60	95	64	0.50	0.72
RH. 5/1	64	58	92	52	0.27	0.46
B. 59-1679	63	52	92	56	0.33	0.70
P. 216F	50	53	96	70	0.42	0.44
CS. 84/4	59	52	97	63	0.27	0.33
Acala 4-42	59	54	105	55	0.22	0.50
JR 23	59	54	90	61	0.42	0.50
B. 59-1678	59	52	89	55	0.52	0.60
37-61	59	53	102	71	0.42	0.44
JR 52	59	52	83	77	0.36	0.40
Bat. 7/8-1	58	52	103	84	0.41	0.50
108. F	57	61	91	54	0.20	0.31
K. 3400	57	50	92	56	0.30	0.50
C.S. 72/2	56	54	93	66	0.18	0.24
Mean	61	54	94	62	0.37	0.45

(i) *First flowering:* It may be evident from the above figures furnished in columns 2 and 3 that the interval of time between planting and first flowering with different varieties varies with the seasons of cultivation. The number of days ranged from 56 for CS 72/2 to 68 for MCU 3, and all the varieties without exception were brought into flowering condition earlier in summer than in winter. On an average, the varieties took 54 and 61 days to come to flower in summer and winter respectively. The difference between these two means was statistically significant.

(ii) *Period of flowering:* Figures in columns 4 and 5 show that the varieties differed from one another in the length of the period for which they continued to flower. In winter, the variety with the shortest span of flowering period was JR 52. It continued to flower for 83 days. The variety with the longest span was Acala 4-42 which continued to flower for 105 days. RH 5/1 with a period of 52 days and Bar 7/8-1 with 84 days were the varieties having the shortest and the longest period of flowering respectively in summer. The flowering periods for all the varieties were shorter in summer than in winter. The mean period of flowering for all the varieties in winter was 94 days, whereas in summer it was only 62 days. The difference was statistically significant.

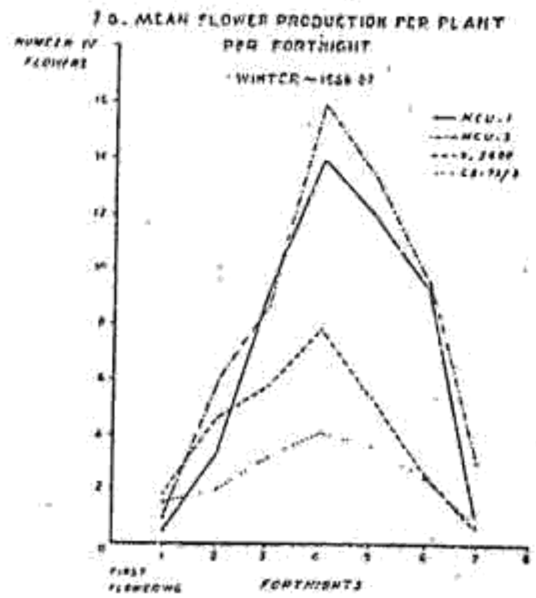
(iii) *Rate of flowering:* The data in columns 6 and 7 indicate that the production of flowers proceeded at different rates in different varieties and that the rate registered by each variety was invariably higher in summer than in winter. The mean rate of flower production per plant per day was 0.37 in winter and 0.49 in summer.

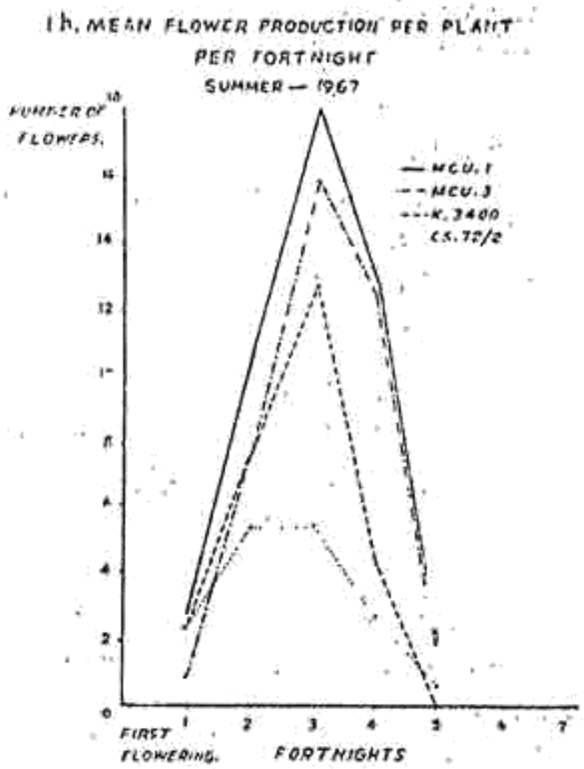
The number of flowers produced during each fortnightly period into which the flowering period had been divided and the cumulative percentage of flowers produced upto and inclusive of each fortnightly period have been represented graphically. *Vide* figs. 1(a) and 1(b).

In winter flowering continued for seven fortnights in many of the varieties and for eight in a few varieties, and in summer for five fortnights in most of the varieties and for six in a few varieties.

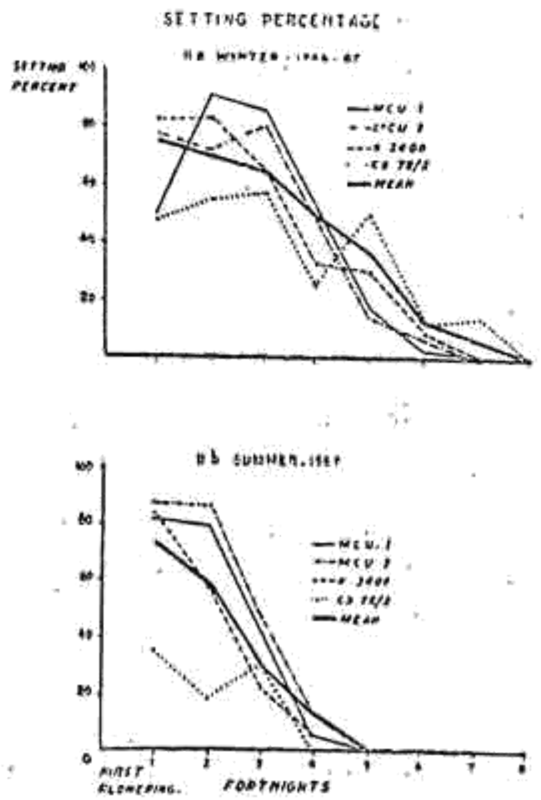
Since the flowering trends were essentially similar in all the varieties, graphs of four varieties alone have been given in figures I(a) and I(b), as the presentation of all graphs in the figures, it was felt, would lead to unnecessary cluttering.

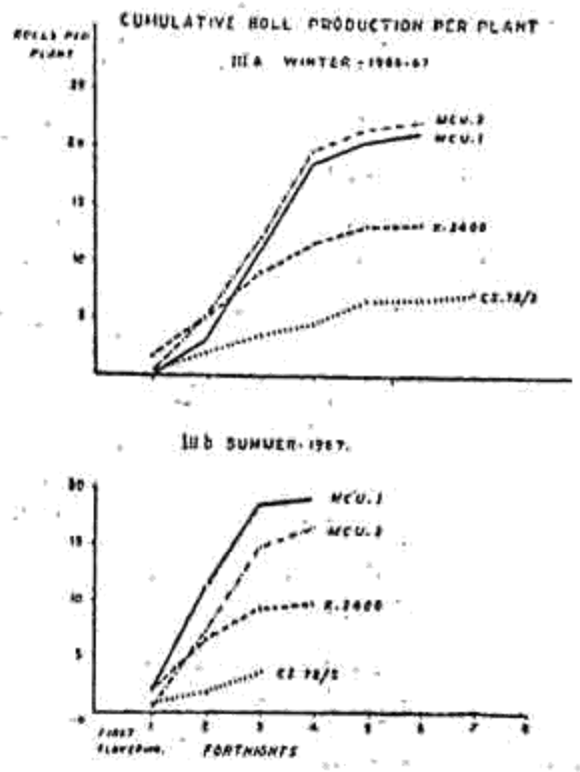
The steady increase in the rate of flowering for the first few fortnights and the retardation thenceforth was a common feature of flowering trend in all the varieties and in both the seasons, and curiously enough, the increasing phase in the rate of flowering lasted for the first four fortnights of flowering in winter and the first three fortnights in the summer uniformly in





all the sixteen varieties. Of the total production, 54.6 % in winter and 76.7 % in summer were produced during that period of flowering when the rate of flowering was increasing.





(b) *Bolling:* (i) *Boll-setting:* The mean setting percentages at different periods of flowering have been furnished in Table 2.

TABLE 2. *Setting Percentage*

Variety		1966—67 Winter Season								1967 Summer Season				
		Fortnightly periods reckoned from the date of first flowering								Fortnightly periods reckoned from the date of first flowering				
		1	2	3	4	5	6	7	Mean	1	2	3	4	Mean
MCU. 1	....	50	91	86	53	18	2	0	42	82	80	42	5	41
MCU. 3	....	78	73	81	48	14	6	0	39	88	87	47	14	43
P. 216F	....	71	77	65	41	29	10	0	42	58	58	39	18	35
K. 3400	....	83	84	65	33	30	8	0	47	83	58	23	5	35
C.S. 72/2	....	47	55	58	25	50	12	14	39	35	19	30	0	21
C.S. 84/4	....	58	55	59	50	46	25	21	43	69	48	23	13	30
J.R. 52	....	100	62	67	49	45	8	0	47	100	69	27	5	32
R.H. 5/1	....	80	75	73	70	45	15	14	49	67	56	37	11	39
Acala 4-42	....	79	64	50	47	49	11	8	43	76	43	22	15	36
J.R. 23	....	100	79	72	44	50	35	8	54	75	41	21	11	33
B. 59-1679	....	75	52	47	53	28	5	0	31	53	46	26	24	29
MCU. 2	....	80	94	68	52	18	4	0	42	86	63	16	0	38
B. 59-1678	....	46	76	59	43	16	7	6	33	100	100	46	42	68
37-61	....	100	52	70	57	53	8	21	43	85	68	27	9	41
108.F	....	75	65	58	50	50	17	0	51	65	37	20	14	29
Bar. 7/8-1	....	78	85	69	66	47	25	8	45	50	64	33	20	36
Mean	....	75	71	65	49	37	12	6	43	73	59	30	13	37

The setting percentage started high in the early part of the flowering period and declined gradually as the flowering period proceeded. On an average, the setting in winter season was nearly 70 % in the first fortnight; but by the time the flowering period reached the seventh fortnight, it declined to 6 %. In summer, the average setting was as high as 73 % in the first fortnight but by the fourth fortnight it declined to 12 %. The graphs in the figures II(a) and II(b) show the trends of setting in the four representative varieties.

(ii) *Number of bolls:* The number of bolls formed during each fortnight and the cumulative percentage of bolls formed upto and inclusive of each fortnight have been indicated graphically in Figs. III(a) and III(b) in respect of four representative varieties.

Of the average number of bolls produced, 75.5 % was produced during the first four fortnights of flowering in winter and 92.3 % during the first three fortnights of flowering in summer.

The curves were flattened or tended to flatten after the fifth fortnight in winter and the third in summer.

(iii) *Production of seed-cotton:* The weight of seed coton produced from the bolls formed in each fortnight and the cumulative percentage of seed cotton produced from the bolls formed up to and inclusive of each fortnight have been indicated in Table 3.

Of the average weight of kapas produced, 80.6 % was produced from the bolls formed from flowers appearing during the first four fortnights of flowering in winter and 93.0 % from flowers appearing from bolls formed during the first three fortnights of flowering in summer.

Discussion: It was seen that the rate of flowering was increasing during the first four fortnights of flowering in winter and the first three in summer. The over all average percentages of flowers, bolls and weight of *kapas* produced in winter and summer during these periods, it may be recalled, were as follows:

	Percentage	
	Winter	*Summer*
Flower	54.6	75.4
Bolls	75.5	92.3
Seed-cotton	80.6	93.0

The interesting and important point to note here is that, eventhough the flowering continued for a period of eight weeks in winter and six weeks in summer, the flowers produced during the period when the rate of flowering

TABLE 3. *The mean weight (g) and the cumulative percentage of seed-cotton obtained from bolls formed in the different periods of flowering*

Variety	1966—67 Winter Season								1967 Summer Season				
	Fortnightly periods reckoned from the date of first flowering								Fortnightly periods reckoned from the date of first flowering				
	1	2	3	4	5	6	7	Total	1	2	3	4	Total
MCU. 1	1.2 1.3	16.1 18.7	37.9 59.7	30.3 92.5	6.4 99.5	0.5 100		92.4	9.3 11.3	43.3 60.5	32.1 87.0	2.6 100	87.9
MCU. 3.	4.5 4.4	25.2 28.9	33.2 61.1	30.7 91.0	7.3 98.1	2.0 100		102.9	3.2 4.7	30.5 49.6	28.8 92.0	5.4 100	67.9
P. 216F	5.8 8.6	18.6 36.2	16.7 61.0	16.1 84.9	8.1 96.9	2.1 100		67.6	2.0 4.9	15.0 41.6	18.6 87.0	5.3 100	40.9
K. 3400	7.7 15.0	16.0 46.3	14.7 75.0	8.7 92.0	3.5 98.8	0.6 100		51.2	6.0 22.7	12.2 68.9	7.6 97.7	0.6 100	26.4
C.S. 72/2	3.3 9.9	6.6 29.6	10.0 59.6	5.1 74.9	6.8 95.2	1.2 98.9	0.4 100	33.4	3.1 20.7	4.8 52.2	7.1 100		15.0
C.S. 84/4	8.3 12.9	10.5 29.3	13.2 49.9	18.1 78.2	9.7 93.3	3.6 98.9	0.7 100	64.1	3.7 13.0	12.5 58.9	8.7 90.5	2.6 100	27.5
JR. 52	4.3 7.0	10.9 24.8	18.3 54.6	16.7 81.8	10.3 98.5	0.0 100		61.4	5.3 14.8	15.8 59.6	12.0 94.3	2.0 100	34.9
RH. 5/1	1.7 3.3	4.1 11.2	10.4 31.4	22.2 74.4	9.7 93.2	3.0 99.0	0.5 100	51.6	4.1 10.2	18.0 55.0	16.5 96.0	1.6 100	40.2
Akala 4-42	7.1 11.4	9.5 26.6	13.9 49.0	15.5 73.8	14.0 96.3	1.7 99.0	0.6 100	62.3	10.2 23.6	18.4 65.3	9.2 86.3	6.0 100	43.8
JR. 23	5.6 7.4	14.5 26.6	24.0 58.4	14.2 77.2	11.8 92.8	5.1 99.6	0.3 100	75.5	9.8 27.5	14.6 68.3	9.8 95.8	1.5 100	35.7
B. 59-1679	2.3 7.2	4.6 21.6	7.1 43.9	10.7 77.4	5.8 95.6	1.4 100		31.9	3.5 8.4	12.2 39.4	15.8 79.6	8.0 100	39.3
MCU. 2	4.5 4.8	24.4 31.0	30.1 63.2	26.7 91.9	6.4 98.7	1.2 100		93.3	13.9 27.1	30.2 86.0	7.2 100		51.3
B. 59-1678	5.3 11.4	9.3 31.5	12.6 58.6	13.2 87.1	4.5 96.8	1.2 99.4	0.3 100	46.4	6.2 13.1	21.8 59.2	14.6 90.1	4.7 100	47.3
37-61	1.6 2.4	5.1 10.0	17.5 36.0	20.4 66.4	18.8 94.3	2.6 98.2	1.2 100	67.2	8.4 17.5	24.5 68.7	13.7 97.3	1.3 100	47.9
108.F	5.3 10.6	10.5 31.5	13.3 58.0	12.2 82.3	7.0 96.2	1.9 100		50.2	4.4 21.6	8.1 61.3	6.7 94.1	1.2 100	10.4
Bar. 7/8-1	2.3 2.8	9.7 14.4	21.2 39.7	20.9 64.7	19.8 88.4	7.9 97.8	1.8 100	83.6	7.3 12.3	26.6 57.0	20.1 90.8	5.5 100	59.5
Mean	4.4 7.5	12.2 26.1	18.4 53.7	17.6 80.6	9.4 95.8	2.3 99.4	0.4 100	64.7	6.3 15.8	19.3 59.5	14.3 93.0	3.0 100	42.9

was increasing, that is, the first four fortnights of flowering in winter and the first three in summer accounted for over 80% of the seed-cotton yield in winter and very nearly the entire yield in summer. Importance of the first four fortnights of flowering in winter crop and three fortnights in summer crop for obtaining good yield is, therefore, obvious.

The fruit setting was high in the beginning of flowering period but it progressively decreased with the progress of flowering period. The setting of fruits was considerably reduced during the period when the rate of flowering was declining. This period extended from the fifth fortnight of flowering in winter and the third fortnight in summer. Mason and Maskell (1938) were inclined to attribute this deterioration to nutritive limitations. Since the foliar application of organic nutrients is reported to have attended with no improvement in fruit set, it is considered by Eaton and Ergle (1953) that inadequacy of nutrients to sustain the development of later formed flowers may not be the real cause for the impairment of setting. While the techniques of foliar applications of nutrients generally do not improve fruit set, several lines of evidence support the concept of nutritive limitations. Murneck (1927) established that the presence of fruits in *cleome* effectively limited further fruit set. Van Steveninck (1957) found that the deterioration of fruit set with time in *Lupinus luteus* could be averted by removal of the fruits which had already been set. A similar competition for nutrients seems to be responsible for the abortion of ovules in the stylar end of bean pods (Gableman and Williams, 1962), a condition which becomes more severe under conditions of water stress. In cotton itself, when the early formed bolls are lost due to insect injury or other causes, the later formed flowers in the upper parts of the plants do give rise to plenty of bolls.

Flower abscission also may to some extent be the cause for poor setting. Application of auxin such as naphthalene acetic acid during the phase of flowering when decline in the rate of flowering occurs may increase fruit setting (El Murabaa, 1957) and this requires investigation.

The results obtained from this study have further indicated the powerful influence which the season is capable of exerting on the flowering and the fruiting of *hirsutum* cotton. Plants begin to flower definitely earlier in summer than in winter. The length of flowering period is also significantly reduced. But, in contrast, the rate of flowering is increased. In some of the varieties, the rate in summer as compared to that in winter is so great as to compensate fully for the reduction in the span of flowering. For example, MCU 1, P.216F, JR.52, RH.5/1, JR.23 and Bar.7/8-1 produced about the same number of flowers in both the seasons, eventhough the lengths of flowering periods differed significantly. Obviously, the physiological activities in relation to flowering and fruiting are stimulated to a greater degree in summer than in winter. Comparison of the meteorological data recorded for both the seasons has revealed that the cotton plants are exposed at every stage of its development to higher temperature in summer than in winter. In this connection it may perhaps be pertinent to refer to the findings of Price (1911) that the velocity of development of flower buds of branches from fruit trees gathered in winter and subjected to various constant temperatures in the laboratory increases with rise in temperature, the rise being to some extent in accordance with the law of Vant Hoff and Arrhenius. If this finding be true generally of flowering activity, it serves to explain that the greater stimulation of flowering processess in summer than in winter was in all probability be due to the higher temperature prevailing throughout the life of the crop in summer than in winter, the comperative meterological data for 1966–67 winter season and 1967 summer season being as follows :

Season	Bright sun shine (Hours)	Temperature°C Maximum	Temperature°C Minimum	Humidity at 14.22 hours %	Rain-fall (mm)	Rainy days	Average for 43 years ending 1966–67 Rain (mm)	Average for 43 years ending 1966–67 Rainy days
1966–67 Winter	222	29.9	19.1	54	578.8	34	390.2	26
1967 Summer	217	32.6	22.4	52	170.0	17	280.4	26

Summary : A comparative study of the flowering and fruiting in sixteen *hirsutum* varieties of cotton was made during two seasons 1966–67 winter and 1967 summer. The flower initiation period. the length of flowering period and the rate of flowering were found to vary with varieties and seasons. The summer season having higher temperature than winter was observed to exert much influence on the flowering activity. In summer, the on-set of flowering was earlier and the length of flowering period was shorter but the rate of flowering was higher—so high in some varieties as to compensate fully for the decrease in the span of flowering period. The study has further revealed that the ascending phase of flowering extending over the first four fortnights of flowering in winter and the first three fortnights in summer are probably the most critical period from the point of view of yields and during this period, the crop presumably will need careful tending with suitable nutrients, proper irrigation, adequate plant protection, *etc.*

Acknowledgements : The authors are grateful to Mr. T. G. Balasubramanium and Mr. V. Krishnan for the valuable help rendered by them in taking field observations.

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Madras agric. J. 1969 (56) 400-405

Studies on the Application of Organic and Inorganic Forms of Phosphorus in Paddy Culture-II-Variation in Organic Carbon and Available Nitrogen Status

by

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The chemical study of submerged soil is of great importance and its practical significance hardly needs any emphasis. Much work has been done on the decomposition of green manure in paddy soils (Acharya, 1935; Tenny Waksman, 1930 and Harrison and Aiyer, 1916). However, the N regime under water-logged condition characteristic of the virtual absence of nitrates and accumulation of ammoniacal N has not been fully worked out and particularly under condition of application of organic and inorganic forms of phosphorus.

Though the response of paddy to the application of phosphorus in general has not been as large as in the case of nitrogen, significant yield increases in certain pockets of the major rice growing states of India have been reported, (Mukherji, 1955; and Ray Chaudhuri, 1953). Ghose *et al.* (1960) have found that the addition of phosphorus both in soluble and insoluble forms stimulated the fixation of nitrogen by algae under submerged conditions. Govindarajan and Venkatarao (1952) have shown that yield

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