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The Madras Agricultural Journal

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Editorial 98

Post-graduate Courses in Agriculture: To improve the efficiency of the scientific personnel engaged in Agricultural Research, teaching and extension, the institution of post-graduate studies is an important step and the Planning Commission has made provision for such courses in the National Plans. The TCM particularly has been interesting itself in establishment of post-graduate courses in Agricultural and Veterinary Colleges. Post-graduate studies in several fields of Agriculture in various forms existed for a long time in India especially the post-graduate diplomas at Indian Agricultural Research Institute. At the Agricultural College and Research Institute, post-graduate degrees leading to M. Sc., and Ph. D. by research were in vogue even from 1930. Post-graduate degree courses for M. Sc., (Ag.), existed at Banares, Nagpur and Agra for fairly long periods. But the rapid expansion of Agricultural Departments due to food shortage after world War II brought the need for post-graduate courses to the forefront and TCM particularly took the lead in advising and helping to establish the post-graduate courses at several Agricultural Institutes and Colleges. With the co-operation of half a dozen Universities in U. S. A., the required personnel were trained, the needed equipment and books were supplied and guidance of technicians were made available. This impetus for post-graduate degrees by courses resulted in the establishment of M. Sc., and Ph. D. courses at the Indian Agricultural Research Institute, Delhi, and the Agricultural College and Research Institute, Coimbatore through the aid of the Government of India. Several other states as Punjab, Bihar, Andhra Pradesh, also organised post-graduate degree courses. Due to the rapid organisation of these post-graduate courses in a few years it looks as though a proper consideration for teaching and training of a high order in these institutions, has not been given for obvious reasons. In several cases greater numbers than those that could be properly trained and guided were admitted; facilities for farm, laboratory and library were inadequate. The duration of the courses varied; teaching methods adopted differed in the different institutes and sufficient record of research work, quite essential for post-graduate courses, has not also been developed in some Institutes. Though there is justification for the institution of post-graduate courses, yet, unless these are properly managed, the result will not be upto expectation. In this context, it is very opportune that the Indian Council of Agricultural Education organised a teaching seminar in March 1960 at Bombay particularly with reference to post-graduate courses. Subjects pertaining to teaching methods, qualification for admissions, standards for post-graduate Institutions, supporting courses to level up students, were dealt with and the post-graduate courses received attention also at the meetings of the I.C.A.E. It is hoped that as a result of these deliberations, the post-graduate courses in Agriculture in this country will be reorganised to turn out post-graduates trained for independent thinking and leadership in the field of Agricultural Sciences, so that there are no complaints that there are no suitably trained or qualified men in the several fields of specialisation. The post-graduates should be capable of applying the basic principles of sciences to the solution of problems which will contribute to better crop production and prosperous Agriculture.

Copper Nutrition of Millets (Part II)

by

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Effect of copper on foliar symptoms in Cumbu: At a higher concentration of copper about 20 ppm, chlorotic striations in the leaves were developed to a marked degree when the experiment was conducted in sand cultures. Similar striations were noted at 5 ppm. concentration in solution cultures. This chlorotic pattern, resembling iron deficiency was characteristic which was studied by Chapman et al (1939) elsewhere while studying antagonism between iron and copper. The observations fall in line with those of Willis and Pilland (1934) on corn.

In view of the striations and chlorosis, chlorophyll estimation of leaf samples obtained from plants growing in sand cultures having 20 ppm and 50 ppm concentration was done and the mean data expressed as a ratio over control were as follows.

Control = 1.	Cholam Co. 12.	Ragi Co. 1.	Cumbu Co. 4.
20 ppm Cu	0·63	1·38	0·91
50 ppm Cu	0·72	0·94	0·74

With increasing concentrations of copper, 20 ppm and above, chlorophyll content is decreased in Cholam and Cumbu. In Ragi too 50 ppm. effected a decrease. Copper in very low concentrations is considered to increase the chlorophyll content. In chemical studies magnesium content of the leaves under copper treatment was found to be lower than control. Since the inter veinal chloratic symptoms appear to be closely similar to those induced by Magnesium deficiency. It is not unlikely that an inter-relation might exist between copper and magnesium an excess of one leading to deficiency levels in another. Observations of Okuntsov (1946) and Chuard and Porchet (1900) were that addition of copper increased chlorophyll content. The observations in this study are not in line with those above but it is possible that the apparent difference is due to higher concentrations of copper employed in the study.

Chemical Studies: The data on chemical analysis are presented in the appendix. Chemical analysis of the leaves of plant samples indicate that in the same group of plants, viz., millets, the plants do not respond in the same way with regard to intake of macro-nutrients at different levels of copper nutrition.

Low concentrations of copper at 10 and 20 ppm results in a higher percentage of Nitrogen in the leaves in all the three crops. This increase persists till the flowering stage, whereafter the difference is not perceptible. Findings are similar to Lipman and Burgess who found the stimulating effect of copper on nitrifying flora and doubling the nitrate yield. Various other works lend support to this observation — Suisen Dyo (1938) — on Nitrogen nutrition of Paddy, Trumble (1950) — on copper on increased production of plant protein, Kwiscinski (1930) — on mobilisation of ammonia and role of Tyrosinase and Ascorbic acid oxidase in plant body, Girst, (1953)/on the effect of copper on growth, maturation and yield and also increased Nitrogen intake. At higher levels of copper, Jensen (1926) found a reduction in the amounts of nitrate due to the destruction of nitrifying organism.

As for Phosphoric acid similar trend is seen in Cholam and Cumbu but not Ragi within the same range.

A slight increase of Potash intake between 10 and 50 parts per million copper levels is noted in all the three crops till about the flowering stage. Thereafter Potash content goes down.

In the case of lime there is very little variation till about the flowering stage. Only at higher concentrations of fifty and hundred parts per million of copper, the lime content was reduced in Cholam.

The effect of added copper to the intake of Magnesium seems to be inversely related, the magnesium content decreasing as the concentration of copper increased in the growing medium. This effect is noticeable in all the three crops studied.

Observations on variations in the chemical constituents in the earhead show that Nitrogen content is not increased in Cholam and Cumbu as a result of adding copper in the growing medium. In Ragi earheads, there is a small increase. Phosphoric acid and lime content decrease to a small extent due to added copper. Magnesium intake was increased in Ragi and Cumbu due to copper but not in Cholam. Little variation is noticed in potassium intake in all the three crops due to added copper.

Copper, Iron, and Magnesium are said to produce a series of inter-dependent catalytic reactions in the development of photo-synthetic system of the green leaf. Hill (1949) has pointed out similarities of the structure of chlorophyll and iron porphyrin of

haemoglobin. Considerable studies on structural similarities are in progress which would through enough information as to the possibility of copper replacing Magnesium in the porphyrin structure of the chlorophyll molecule.

Effect of Copper on the intake of iron: In all the three millets, Copper was found to increase in the leaves, stems, and earheads according to increasing concentrations in the growing medium. Apart from the visual symptoms of chlorotic striations increasing with higher levels of copper, the data of chemical analysis show that there appears to exist an inverse relationship between iron and copper in the leaves. The observations on antagonism are in line with those of Willis and Pilland (1934). Iron assimilation was found to be depressed by copper suggesting the possibility of copper replacing iron in chlorophyll formation (Densch and Hunnius) (1924). The findings of Mader and Mary Mader (1937) that the cooking quality of Potato tubers that had received a spray of copper sulphate was superior to tubers from unsprayed controls and that the former contained less iron than the latter lend to support to this view. Jorma Erkama's (1947) study on the effect of copper and manganese on iron status and Delf's (1946) studies on the channels of transloca-tion of copper within the plant body go to show the ready action of copper in oxidising ferrous into ferric state. Kliman (1937) is of the view that iron is taken in within the plant in the ferrous state. The oxidation of iron within the plant results in its precipitation, as evidenced by the increased concentration at the root zone.

Effect of copper on the content of reducing sugars:

Reducing sugars (mg/gm in fresh leaves)

Crop	Control	10 ppm.	20 ppm.	50 ppm.	100 ppm.
Cholam Co. 12	3·25	3·60	4·10	1·20	0·30
Ragi Co. 1	3·08	3·40	4·18	3·82	2·86
Cumbu Co. 4	4·36	4·51	4·63	4·25	3·15

In the three crop plants a slight increase in reducing sugars at lower concentrations of copper is noticed and at higher concentrations it was reduced. Chuard and Porchet's (1900) observations on the slight increase in sugar in fruit of grapes and gooseberries consequent to Bordeaux Mixture application lend support to this response. The increased catalase activity in the leaves rather than roots produced by boron in rice seedlings, is an instant in point (Pattanaik) (1950) and as Copper along with Manganese, Zinc and Boron froms a group having similar physiological functions (Thatcher) (1934), it may be considered to play a similar role in effecting increased sugar content, within an optimum range.

Summary and conclusion: Studies on copper nutrition of millets formed part of the study in this article. The effect of copper on different plant attributes like height, leaf area, flowering, dry matter production and yield were studied in detail. Chemical analysis of leaves were carried out to have an idea of any inter-relationship between added copper and other nutrients. Its effect on germination, chlorophyll content and reducing sugars was observed. Copper in low concentrations stimulates growth in millets and eventhough it modifies growth rate at about the post-vegetative stage, improves dry matter productions and also increases the final yield. Nitrogen intake is improved at low concentrations of copper but there is an inverse correlation between Copper and Magnesium intake. A similar antagonism is also apparant between Copper and Iron.

Acknowledgment: The author is indebted to the University of Madras for granting permission to publish this paper which forms one of the aspects in "Studies on Copper in Cereals" — a thesis submitted for the award of M. Sc. degree.

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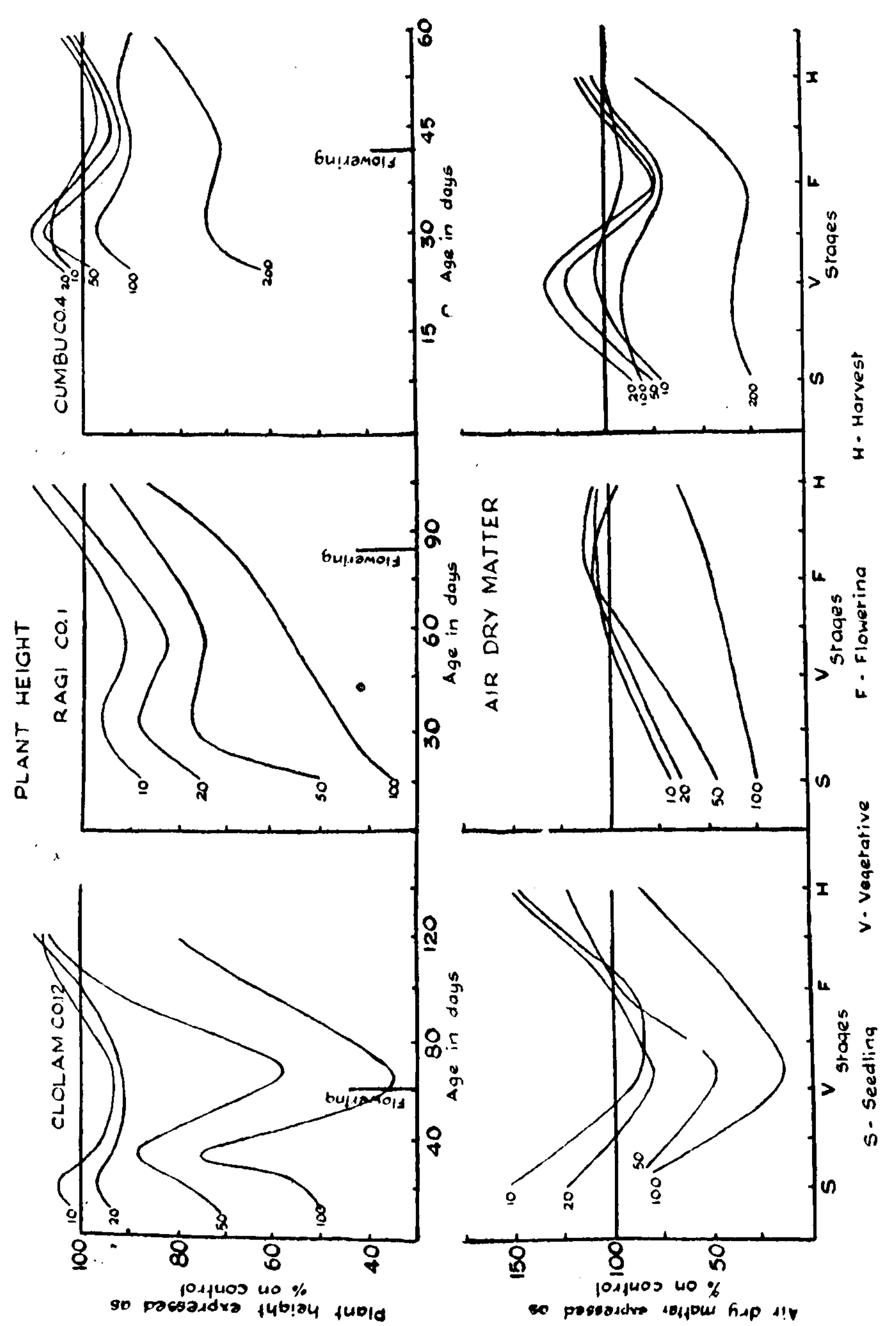
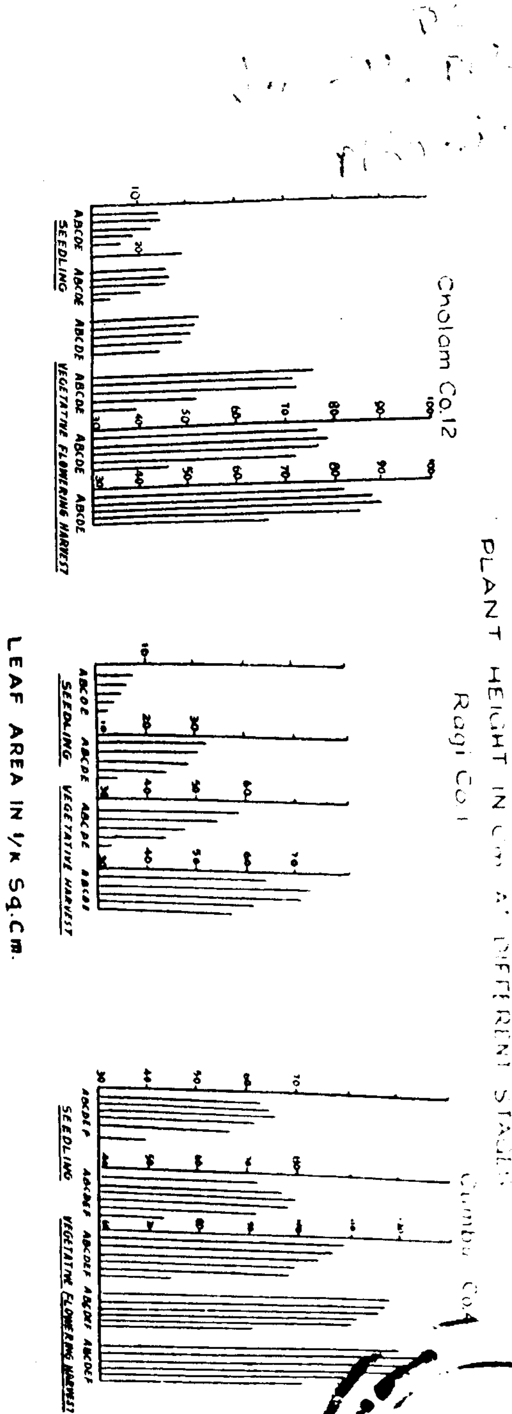
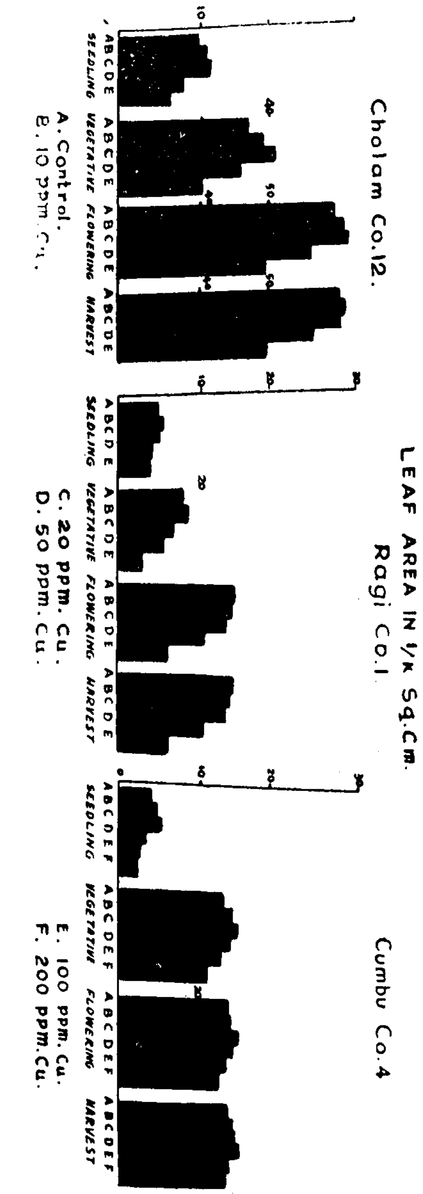

PLANT HEIGHT
CHOLAM CO.12
RAGI CO.1
CUMBU CO.4
AIR DRY MATTER
Plant height expressed as % on control
Air dry matter expressed as % on control
Age in days
Stages
Flowering
S - Seedling
V - Vegetative
F - Flowering
H - Harvest


Cholam Co.12
Ragi Co.1
SEEDLING
VEGETATIVE
FLOWERING
HARVEST


LEAF AREA IN 1/K Sq.Cm.
Cholam Co.12.
Ragi Co.1
Cumbu Co.4
SEEDLING
VEGETATIVE
FLOWERING
HARVEST
A. Control.
B. 10 ppm. Cu.
C. 20 ppm. Cu.
D. 50 ppm. Cu.
E. 100 ppm. Cu.
F. 200 ppm. Cu.

APPENDIX

Effect of Copper on the intake of Macro-nutrients.
Cholam Co. 12.
Leaves (at various stages)

	Seedling	Vegetative	Flowering	Harvest	Earhead
Moisture %					
Control	8·73	8·66	8·58	8·50	8·88
10 ppm. Cu	8·68	8·64	8·56	8·54	9·10
20 ppm. Cu	8·74	8·66	8·60	8·48	9·06
50 ppm. Cu	8·70	8·60	8·56	8·50	8·98
100 ppm. Cu	8·66	8·62	8·58	8·54	9·06
Nitrogen % (moisture-free)					
Control	2·792	1·288	1·119	0·933	1·290
10 ppm. Cu	2·944	1.379	1·225	0·918	1·263
20 ppm. Cu	2·976	1.410	1·256	0·918	1·262
50 ppm. Cu	2·760	1.256	1·072	0·826	1·200
100 ppm. Cu	2·500	1.073	1·041	0·765	1·078
Phosphoric acid P_2O_5% (moisture-free)					
Control	0·590	0·449	0·328	0·284	0·615
10 ppm. Cu	0·613	0·471	0·339	0·273	0·605
20 ppm. Cu	0·603	0·460	0·339	0·273	0·605
50 ppm. Cu	0·482	0·372	0·279	0·251	0·511
100 ppm. Cu	0·438	0·334	0·252	0·219	0·484
Lime (Ca O) % (moisture-free)					
Control	0·368	0·553	0·613	0·765	0·123
10 ppm. Cu	0·399	0·490	0·612	0·735	0·123
20 ppm. Cu	0·339	0·491	0·613	0·734	0·123
50 ppm. Cu	0·276	0·337	0·459	0·551	0·092
100 ppm. Cu	0·270	0·245	0·276	0·467	0·062
Magnesia (Mg O)% (moisture-free)					
Control	0·656	0·762	0·881	0·979	0·329
10 ppm. Cu	0·635	0·705	0·773	0·833	0·310
20 ppm. Cu	0·621	0·677	0·726	0·838	0·304
50 ppm. Cu	0·621	0·564	0·599	0·669	0·283
100 ppm. Cu	0·529	0·564	0·571	0·599	0·283

	Seedling	Vegetative	Flowering	Harvest	Earhead
Potash (K_2O)% (moisture-free)					
Control	2·612	2·100	1·344	1·241	1·093
10 ppm. Cu	2·725	2·226	1·356	1·216	1·066
20 ppm. Cu	2·709	2·122	1·349	1·215	0·823
50 ppm. Cu	2·615	2·095	1·314	1·144	1·014
100 ppm. Cu	2·601	1·709	1·238	1·059	0·955

Effect of Copper on the intake of Macro-nutrients.
Ragi Co. 1.
Leaves (at various stages)

	Seedling	Vegetative	Flowering	Harvest	Earhead
Moisture %					
Control	7·65	7·70	7·43	7·21	7·84
10 ppm. Cu	7·69	7·84	7·54	7·33	7·92
20 ppm. Cu	7·70	7·69	7·58	7 39	7·78
50 ppm. Cu	7·68	7·65	7·44	7·29	7·86
100 ppm. Cu	7·80	7·84	7·54	7·35	7·74
Nitrogen % (moisture-free)					
Control	1·774	1·774	1·694	1·509	1·458
10 ppm. Cu	1·896	1·762	1·620	1·481	1·688
20 ppm. Cu	3·049	1·790	1·379	1·300	1·518
50 ppm. Cu	2·917	1·668	1·225	1·178	1·504
100 ppm. Cu	2·032	1·519	1·090	0·907	1·426
Phosphoric acid (P_2O_5)% (moisture-free)					
Control	1·722	1·273	1·186	1·067	0·825
10 ppm. Cu	1·300	0·949	0·860	0·853	0·792
20 ppm. Cu	1·278	0·922	0·849	0·826	0·786
50 ppm. Cu	1·106	0·888	0·832	0·798	0·760
100 ppm. Cu	0·981	0·828	0·800	0·783	0·737

	Seedling	Vegetative	Flowering	Harvest	Earhead
Lime (Ca O) % (moisture-free)					
Control	...	...	...	...	0·638
10 ppm. Cu	...	...	...	...	0·305
20 ppm. Cu	...	...	...	...	0·304
50 ppm. Cu	...	...	...	...	0·304
100 ppm. Cu	...	...	...	...	0·229
Magnesia (Mg O) % (moisture-free)					
Control	0·882	1·054	1·176	1·222	0·329
10 ppm. Cu	0·844	0·999	1·052	1·203	0·336
20 ppm. Cu	0·838	0·977	1·059	1·183	0·321
50 ppm. Cu	0·578	0·712	0·880	1·049	0·289
100 ppm. Cu	0·392	0·572	0·732	0·918	0·255
Potash (K_2 O) % (moisture-free)					
Control	4·701	4·359	4·110	3·826	2·120
10 ppm. Cu	4·870	4·580	4·280	3·910	2·126
20 ppm. Cu	5·115	4·535	4·211	3·814	2·187
50 ppm. Cu	4·778	4·478	4·194	3·830	2·074
100 ppm. Cu	4·633	4·479	4·158	3·782	2·025

Effect of Copper on the intake of Macro-nutrients.
Cumbu Co. 4
Leaves (at various stages).

	Seedling	Vegetative	Flowering	Harvest	Earhead
Moisture %					
Control	8·85	8·58	8·73	8·32	9·03
10 ppm. Cu	8·78	8·62	8·80	8·40	8·98
20 ppm. Cu	8·75	8·64	8·78	8·36	9·02
50 ppm. Cu	8·80	8·50	8·65	8·44	9·02
100 ppm. Cu	8·82	8·50	8·72	8·36	8·96
200 ppm. Cu	8·90	8·54	8·81	8·40	9·06

	Seedling	Vegetative	Flowering	Harvest	Earhead
Nitrogen % (moisture-free)					
Control	..	2·262	1·948	1·558	3·755
10 ppm. Cu	...	2·664	2·522	1·452	3·692
20 ppm. Cu	...	2·651	2·466	1·406	2·493
50 ppm. Cu	...	2·569	2·253	1·376	2·370
100 ppm. Cu	...	2·540	2·255	1·258	2·307
200 ppm. Cu	...	2·394	2·182	1·070	2·125
Phosphoric acid (P_2O_5) % (moisture-free)					
Control	1·103	0·874	0·762	0·529	0·995
10 ppm. Cu	1·132	0·908	0·822	0·459	0·945
20 ppm. Cu	1·205	0·799	0·778	0·437	0·939
50 ppm. Cu	1·151	0·654	0·640	0·409	0·890
100 ppm. Cu	1·051	0·601	0·592	0·398	0·818
200 ppm. Cu	...	0·481	0·417	0·327	0·786
Lime (Ca O) % (moisture-free)					
Control	1·091	0·780	0·828	1·771	0·154
10 ppm. Cu	0·989	0·858	1·013	1·865	0·215
20 ppm. Cu	1·074	0·858	1·166	1·925	0·185
50 ppm. Cu	1·176	0·826	1·379	1·701	0·185
100 ppm. Cu	1·177	0·826	1·166	2·230	0·185
200 ppm. Cu	...	0·765	1·075	2·598	0·185
Magnesia (Mg O) % (moisture-free)					
Control	1·138	1·211	1·511	1·609	0·361
10 ppm. Cu	1·031	0·987	1·183	1·505	0·563
20 ppm. Cu	0·984	0·836	0·876	1·487	0·336
50 ppm. Cu	0·853	0·855	0·864	1·460	0·188
100 ppm. Cu	0·283	0·774	0·801	1·086	0·170
200 ppm. Cu	...	0·539	0·738	3·774	0·149
Potash (K_2 O) % (moisture-free)					
Control	6·046	4·783	4·306	3·887	2·215
10 ppm. Cu	6·267	4·778	4·718	4·210	2·223
20 ppm. Cu	7·097	5·054	4·924	4·219	2·223
50 ppm. Cu	9·277	4·982	4·709	4·008	2·210
100 ppm. Cu	8·267	4·490	4·306	3·878	2·219
200 ppm. Cu	...	4·229	4·080	3·787	2·208

COPPER - IRON RELATIONSHIP

Cholam Co. 12.

	Seedling L	Seedling S	Seedling R	Vegetative L	Vegetative S	Vegetative R	Flowering L	Flowering S	Flowering R	Harvest L	Harvest S	Harvest R	Harvest E
Copper (Expressed in Parts Per Million)													
Control ...	0·18	0·06	0·20	0·47	0·08	0·24	0·31	0·05	0·30	0·27	0·04	0·30	0·94
10 ppm. Cu ...	0·30	0·14	0·84	0·70	0·16	1·02	0·55	0·20	1·63	0·50	0·20	2·60	2·07
20 ppm. Cu ...	0·73	0·24	1·00	1·32	0·30	1·28	1·04	0·22	1·81	1·00	0·20	3·00	2·62
50 ppm. Cu ...	1·23	1·43	2·83	2·90	0·50	5·66	1·27	0·48	2·06	1·20	0·44	3·40	3·78
100 ppm. Cu ...	2·12	0·58	4·44	4·75	0·78	8·28	2·62	0·70	3·63	2·58	0·66	4·20	5·84
Iron (Expressed in Parts Per Million)													
Control ...	130	19	393	126	17	382	108	13	314	106	12	302	47
10 ppm. ...	124	21	395	116	18	386	105	15	342	105	15	314	42
20 ppm. ...	101	23	410	103	21	392	86	16	351	77	15	347	40
50 ppm. ...	67	29	473	61	25	448	57	20	401	52	19	367	33
100 ppm. ...	57	36	505	56	33	464	43	29	425	44	29	410	27

L — Leaf; S — Stem; R — Root; E — Earhead.

COPPER - IRON RELATIONSHIP

Ragi Co. 1.

	Seedling L	Seedling S	Seedling R	Vegetative L	Vegetative S	Vegetative R	Flowering L	Flowering S	Flowering R	Harvest L	Harvest S	Harvest R	Harvest E
Copper (Expressed in Parts Per Million)													
Control ...	0·18	0·05	0·18	0·33	0·06	0·20	0·24	0·04	0·20	0·20	0·04	0·18	1·90
10 ppm. Cu ...	0·28	0·08	0·38	0·42	0·14	0·42	0·35	0·14	0·40	0·30	0·12	0·38	2·14
20 ppm. Cu ...	0·37	0·18	0·54	0·68	0·22	0·50	0·48	0·18	0·52	0·38	0·20	0·66	2·52
50 ppm. Cu ...	0·82	0·20	1·00	0·96	0·34	1·25	0·63	0·30	1·06	0·44	0·26	1·14	3·85
100 ppm. Cu ...	0·72	0·24	1·80	1·24	0·40	2·14	0·84	0·36	1·80	0·73	0·33	1·86	5·12
Iron (Expressed in Parts Per Million)													
Control ...	126	18	382	117	17	377	99	14	303	92	13	294	58
10 ppm. Cu ...	120	21	390	112	19	382	89	16	320	88	15	313	51
20 ppm. Cu ...	116	22	405	111	22	405	81	17	429	77	16	325	49
50 ppm. Cu ...	86	57	433	81	24	422	72	23	380	64	21	363	48
ˈ00 ppm. Cu ...	69	32	492	63	30	448	41	27	449	35	25	430	43

L — Leaf; S — Stem; R — Root; E — Earhead.

COPPER-IRON RELATIONSHIP

Cumbu Co. 4.

	Seedling L	Seedling S	Seedling R	Vegetative L	Vegetative S	Vegetative R	Flowering L	Flowering S	Flowering R	Harvest L	Harvest S	Harvest R	Harvest E
Copper (Expressed in Parts Per Million)													
Control ...	0·44	0·08	0·26	1·14	0·12	0·38	0·74	0·12	0·38	0·58	0·10	0·30	1·04
10 ppm. Cu ...	0·52	0·18	0·48	1·38	0·38	0·58	1·06	0·32	1·86	0·92	0·24	1·84	2·02
20 ppm. Cu ...	1·10	0·22	1·20	2·84	0·55	1·63	1·42	0·54	2·14	1·30	0·38	2·00	2·86
50 ppm. Cu ...	1·66	0·46	2·82	3·97	0·64	3·74	1·88	0·66	4·27	1·68	0·60	4·20	4·22
100 ppm. Cu ...	2·50	0·63	5·30	5·40	1·18	5·88	3·46	1·24	6·10	3·14	1·18	5·93	6·24
200 ppm. Cu ...	3·46	0·88	6·52	6·82	1·42	8·43	5·02	1·46	7·14	4·55	1·24	6·86	8·14
Iron (Expressed in Parts Per Million)													
Control ...	165	23	430	142	18	426	112	15	342	97	14	368	60
10 ppm. Cu ...	114	23	440	105	19	430	96	17	347	85	15	312	57
20 ppm. Cu ...	89	24	493	96	23	460	71	21	349	68	22	329	54
50 ppm. Cu ...	62	32	550	56	29	480	44	28	380	41	25	362	49
100 ppm. Çu ...	41	38	553	38	33	510	55	30	422	34	27	403	37
200 ppm. Cu ...	25	44	650	25	37	643	22	30	525	21	28	510	34

L — Leaf; S — Stem: R — Rooting; E — Earhead.

Cytoplasmic inheritance of variegation in bajara, the pearl millet *(Pennisetum Typhoides Stapf and Hubbard)*

by

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Introduction: In the course of field studies on pearl millet (*Pennisetum typhoides* Stapf and Hubbard) an interesting morphological variation viz., white striping of leaves in some plants was observed. Plants with albinotic stripes with varying intensities were observed in three inbred lines. Similar variegation has been studied in Gramineae in the genus *Zea* (Anderson, 1923; Demerec, 1927), *Sorghum* (Karper, 1934), *Hordeum* (Imai, 1936), *Avena* (Love *et al*, 1936), *Oryza* (Pal *et al* 1941) and *Triticum* (Pao *et al*, 1946). The occurrence and inheritance of variegation in the pearl millet has not been reported so far, though chlorophyll deficiencies as albinos and albino-stripes have been recorded (Krishnaswamy *et al*, 1942). Detailed studies of variegation in pearl millet have been made and presented in this paper.

Previous Work: The discovery of cytoplasmic inheritance in 1909 by Correns (1909) in Mirabilis and by Baur (1909) in Pelargonium evoked considerable interest in different aspects of heredity and the years that followed witnessed a large number of such instances in various crops. In maize, Anderson (1923) and Demerec (1927) have described four cases of cytoplasmically inherited chlorophyll variegation. Karper (1934) has described in detail a case of cytoplasmic inheritance of variegation in sorghum. He has traced striping upto the panicle and has shown evidence that the pattern of striping in the panicle determines the type of progeny. A definite non-randomised occurrence of the white and green spikelets in the panicle has been observed. The white spikelets in the striped area produce white plants only, even when fertilised with pollen from normal green plants and that normal green plants pollinated with pollen from white spikelets produce green plants only. Imai (1936) has recorded in barley an instance of maternal inheritance of yellow and white plastids which arose by the mutation of green plastids through genic action. Love *et al* (1936) in their studies on the variegation of Oats, have observed that the behaviour of chlorophyll deficiency was apparently cytoplasmic in nature. In rice, Pal *et al* (1941) have recorded that variegation is a mendelian recessive to green and that albinism is transmitted through the mother only. Pao *et al* (1946) have noted an instance of material inheritance of yellow-striped plant in wheat. They have recorded that pure breeding, truly variegated lines were not isolated.

Material and methods: Over three hundred pure lines isolated from varieties of different geographical origin are maintained at the Millets Breeding Station, Coimbatore. Out of them, the striped plants were noted in the following three inbred lines.

S. No.	Number of inbreds		Place of origin
1.	P. T. 827/2	...	Kottapuli Cumbu, Salem
2.	P. T. 826/4	...	Kullan Cumbu, Salem
3.	M. S. 6356/12	...	A variety of Bajri, Madhya Pradesh

The details of stripes were studied in these lines.

Another set of three inbred lines which were found to be pure for green progenies during five generations of selfing were chosen and were hybridised with the striped plants to study the inheritance of this character. The details of these inbreds are as below :—

S. No.	Number of inbreds		Place of origin
1.	P. T. 820/6	...	Emari sajja, Chittoor
2.	P. T. 829/5	...	Arisi Cumbu, Coimbatore
3.	P. T. 841/9	...	Bajiri, Sind

FIG. 1.
A striped and a normal green plant of the pearl millet.

The striped and green plants from the segregating lines were selfed and the behaviour of the progenies were observed. Reciprocal crossess of striped plants with green plants (both homozygous and heterozygous parents) were made and the inheritance of the striping was studied in the F_1 and F_2 generations.

Further, white spikelets of the striped panicle and green spikelets of pure green panicle were hybridised, reciprocally and the behaviour of striping was studied in the subsequent generations.

Transverse section of the striped leaf was taken and the arrangement of chloroplast was also studied.

Experimental data: *Experiment No. 1. Study of the striping charactor.* The striping is marked as white longitudinal lines along the entire leaf blade and sheath also (Photographs). Stripes have been found to occur even in the seedling (first) leaf itself. It is more marked in the later formed leaves where the width of the stripes vary from 0·01 cm. to the entire breadth (4·5 cms) of the leaf. The white stripe takes it origin from each node near the axillary bud and runs along the groove in the internode. On the leaf sheath it takes the route along the margins and finally travels along the leaf blade. In heavily striped plants, the stripes travel up to the panicle along the peduncle and all the spikelets arising from the stripes are completely white. Transverse section of the striped leaf, when examined shows that the white stripe is completely dèvoid of green plastids, although the cells are packed with colourless bodies.

Regarding tillers many of them were found to be striped, few of them green and still fewer completely white (Table–I).

TABLE I

Striped Plants Sl. No.	Total No. of Tillers.	Nature of Tillers		
		Green	Striped	Albino
1.	5	1	3	1
2.	3	...	3	...
3.	3	1	2	...
4.	4	...	3	1
5.	4	1	3	...
6.	3	...	3	...
7.	3	...	2	1
8.	3	1	2	...
9.	5	...	5	...
10.	2	...	2	...
Total	35	4	28	3

The striped plant shows poor development and a heavily striped plant seldom reaches half the normal height. In such cases the tillers do not produce any panicle. The white stripes continue to remain so and they do not turn green later on. Some of the striped plants expressed definite demarcation between the white and the green patches. This demarcation was seen in the panicle also. Seeds collected from the spikelets marked at the time of flowering as green, striped and albino based on the appearance of the maternal tissue in the spikelets, were sown and the behaviour of the progenies was observed. It was seen that the type of seedlings produced agreed with the expression of the parental tissue. The data are presented in Table–II.

TABLE II.

S. No.	Panicle Number	Seeds taken from the type of spikelets	Character of seedlings obtained
1.	P. T. 827/2	(i) 6 green 5 striped 5 white	6 green one green + 4 striped 5 white
2.	P. T. 827/2	(ii) 5 green 7 striped 4 white	5 green 5 striped, one green + one white 4 white
3.	„	(iii) 5 green 4 striped 4 white	5 green 4 striped 4 white
4.	P. T. 826/4	(i) 6 green 5 striped 4 white	6 green 3 striped, one green + one white 4 white
5.	P. T. 826/4	(ii) 5 green 6 striped 5 white	5 green 6 striped 5 white

Experiment No. II. During the year the striping was noted, striped and green plants in P. T. 826/4 and P. T. 827/2 were selfed and the segregation noted in the subsequent generations are presented in Table III.

TABLE III.

S. No.	No. of the inbreds	Character of the tiller	Character expressed by the progeny			Total
			Green	Striped	Albino	
1.	P. T. 827/2 a	Green	283	...	...	283
2.	„ 827/2-1	Green	312	...	...	312
3.	„ 826/4-4	Green	359	...	...	359
4.	„ 827/2 b	Green	398	129	10	537
5.	„ 827/2 c	Green	265	79	13	357
6.	„ 826/4 a	Green	122	37	9	168
7.	„ 826/4 b	Green	166	47	2	215
8.	„ 827/2-1	Striped	85	15	29	129
9.	„ 826/4-2	Striped	161	27	24	212
10.	„ 826/4-3	Striped	84	23	17	124
11.	„ 826/4-4	Striped	67	44	14	125
12.	„ 826/4-5	Striped	53	45	11	109
13.	„ 827/2-3	Striped	25	24	4	53
14.	„ 826/4-1	Striped	15	6	5	26
15.	„ 827/2-2	Striped	15	20	2	37
16.	„ 826/4-6	Striped	18	6	...	24
17.	„ 827/2-2	Striped tiller with white panicle	No germination		...	...
18.	„ 826/4-6	do.	No germination		...	...

Experiment No. III. In the following seasons reciprocal crosses between plants with different genotypes were made. In each of the crosses two F_1 plants were selected, selfed and the behaviour of the F_2 populations was studied. The data is presented in Table IV. In each plant that was involved in the crosses, a tiller was always selfed and its progenies were studied to know whether it was homozygous or heterozygous.

TABLE IV.

Cross Nos.	Crosses ♀ Parent	x	♂ Parent	F_1	P_2 Green	Striped	Albino
1.	MS. 6356/1 Homozygous green	x	P. T. 827/2 Heterozygous green	c (1) green	101	28	5
				(2) green	236	...	...
2.	P. T. 826/4 Heterozygous striped		P. T. 820/6 Homozygous green	(1) green	63	23	...
				(2) green	38	12	...
3.	Reciprocal of Cross No. 2		. ...	(1) green	48	18	...
				(2) green	43	13	...
4.	P. T. 841/9 Homozygous green	x	P. T. 827/2 Heterozygous striped	(1) green	110	34	4
				(2) green	37	13	...
5.	Reciprocal of Cross No. 4		...	(1) green	63	20	...
				(2) green	55	13	4

Experiment No. IV. Plants with heavy striping were crossed reciprocally with green plants and the results obtained in the F_1 and F_2 populations are presented in Table V.

TABLE V.

Cross Nos.	Crosses ♀ Parent	x ♂ Parent	F_1	F_2 Green	Striped	Albino
6	P. T. 827/2-4 Plant and panicle striped	x P. T. 841/9 Homozygous green	1 green 15 striped 4 albino	* % @		
7	Reciprocal of cross Nos. 6		(1) green	112	30	7
			(2) green	99	28	6

TABLE V *(Contd.)*

Cross Nos.	Crosses ♀ Parent	x ♂ Parent	F_2	F_1 Green	Striped	Albino
8	M S. 6356/12-2 Plant and panicle striped	x MS.6356/12-4 Homozygous green	3 green 13 striped 5 albino	* % @		
9	Reciprocal cross No. 8		(1) green	115	31	7
			(2) green	62	17	5
10	M S. 6356/12-2 Plant and panicle striped	x P. T. 829/5 Homozygous green	3 green 23 striped 17 albino	* % @		
11	Reciprocal of cross No. 10		(1) green	153	46	12
			(2) green	140	35	12

* These green plants show poor vigour and produce green plants only.

% The segregation of these plants is determined by the extent of striping.

@ These albino plants die after a few days of germination.

Experiment No. V. : In order to study the breeding behaviour of the white plastids the following crosses were made and the progenies studied.

(i) white spikelets in a striped panicle were pollinated with pollen from a pure green plant.

(ii) Similarly a reciprocal cross viz., the green spikelets of the green plant was pollinated with the pollen from the white spikelets.

The data is presented in Table-VI.

TABLE VI

Cross Nos.	Crosses ♀ Parent	♂ Parent	F_1	F_2 Green	Striped	Albino
12	P. T. 827/2 white spikelets only.	x P. T. 820/6 Pure green spikelets.	albinos only	...	...	...
13	Reciprocal of cross No. 12		green	113	47	9

Discussion: The general pattern of the stripe in pearl millet is quite similar for the most part, to that described in Sorghum and Zea. Since the emerging leaves from the germinated seeds themselves show the expression of green and white patches, it indicates that the plasmotype of these plastids are determined in the embryonic stage itself. As the striped plants with the normal panicle continuously threw out green, striped and albino progenies similar to the (heterozygous) green plants, it indicates that striping does not breed true to its type. When the striping extends to the panicles its progenies are green, striped and white in accordance with the location of the parent seed in relation to the presence of the white stripes in the panicle. This indicates that the parental tissue from which the spikelets orginate determines the nature of the progeny.

The behaviour of the selfed progeny of green plants, presented in Table III indicate that the gene for the production of chlorophyll is dominant. When the striped and albino plants are considered as one unit, the ratio between the green progenies and the rest (striped plus albino) approximate to a monogenic segregation. Subsequently these indications were confirmed from the behaviour noted in the F_1 and F_2 progeny of the reciprocal corssess (Table-IV) between homozygous and heterozoygous green planns. Thus it can be reasonably presumed that the albino plants are extreme case of striping.

The difference in the F_1 behaviour of the crosses between the heavily striped and pure green plants (Table V) indicates that the transmission of the striping when the panicles are striped, is purely maternal. This has been again confirmed in the behaviour of the F_1 progeny of the reciprocal crossess between the white and the green spikelets (Table- VI).

Summary: The nature of striping in the pearl millet *Pennisetum typhoides* Stapf and Hubbard) has been described. Striped plants continuously give rise to green, striped and albino plants. when crossed with green plants, the striped plants were found to be a monogenic recessive. The character is carried only through the mother indicating its close affinity with the cytoplasm. In heavily stripped plants the stripe extends to the panicle and the spikelts from the albinotic zone gives rise to albino seedlings. Transverse section of the leaf reveals the white stripe to be completely devoid of chloroplasts.

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Radiation-induced plant mutations* — A Review

by

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Introduction: Radiation may be considered as the movement of energy through space, in either corpuscular or electromagnetic form. Corpuscular radiation consists of streams of atomic or sub-atomic particles which can transfer their kinetic energy to any matter with which they collide. The particles may be negatively charged such as the electrons in beta rays, positively charged as the helium nuclei of alpha rays, or electrically neutral as the neutrons. Electro-magnetic radiation, on the other hand, may behave as a self-propagating stream of particles, called photons, which cause electric and magnetic disturbances affecting the internal structure of matter and thus dissipate their energy. Radio waves, visible light, x-and gammarays are fundamentally similar classes of electromagnetic radiation.

An electron which had been excited to a sufficiently high level of energy leaves the atom or molecule to which it belongs. This process is called "ionization" because it results in an outright separation of electric charges. Lower radiation frequencies like radio waves and visible light are not able to knock out electrons. High energy radiations like X-rays have a greater potency which is not only capable of ejecting electrons from all kinds of atoms - i. e., of forming ions - but also of initiating chemical changes. Such radiations are called ionizing radiations. During the process of ionization by radiation the ejected electrons get attached to the atoms of the substance, forming pairs of positive and negative ions, The means by which different radiations cause changes in biological materials is still not clearly understood. Energy from radiation may be dissipated by a process of ionization in which electrons are ejected from atoms or molecules, and through excitations which raise the electrons of a molecule to higher energy levels (10, 13).

Radiations that have been used most extensively to induce mutations are ultraviolet rays, X-rays, alpha, beta, and gamma rays from radioactive nuclides, and fast and slow neutrons.

* The manuscript of this article was written during 1958—'59 when the writer was ICA - TCM - U. S. A. partcipant.

Ultraviolet rays: Are produced in mercury vapour lamps which are relatively inexpensive. They are non-ionizing and limited in their tissue penetrating ability. Ultra violet ray is capable of producing biological effects only through excitation and photochemical reactions. On an energy basis it is far less efficient in producing structural aberrations in chromosomes than are the ionizing radiations. It is selectively absorbed by the nucleo-proteins of the chromosomes, more by nucleic acid than by protein. In genetic experiments on plants its use is restricted to spores or pollen grains. So far as is known, no mutants of economic interest have been obtained in higher plants with ultra-violet radiation.

X-rays and gamma rays: Have identical properties and differ only in their mode of origin. They are electromagnetic short-wave radiations. They interact with matter by photoelectric effect, Compton Scattering and pair production. Gamma rays from natural or artificial radioisotopes such as Co. 60 have a shorter wave-length and possess more energy than X-rays. X-rays are generally produced in a broad range of energies. Soft X-rays of longer wave-length (10 to 1A°) are less penetrating but more densely ionizing than the shorter wave-length (0·1 to 0·05 A°) hard X-rays. In the energy range used for most biological experiments X-rays and gamma rays transfer their energy to tissue through ionization and through excitations of atoms or molecules. They have relatively sparse ion density. Genetic alterations may be effected through direct change in the molecules of the ganes or indirectly through other chemical changes in the cell.

Beta rays: Such as those from P^{32} and S^{35}, produce nearly the same effects in the tissue as x- or gamma rays (21). They are high speed electrons emitted from the nucleus of an unstable atom. They have a lower specific ionization and greater penetrating power than alpha rays. Their special characteristic is that the source may be incorporated directly in the cell molecules giving a somewhat greater localization of the site of action. Though beta rays seldom penetrate more than a few hundred microns of tissue, for genetic purposes a beta-emitting isotope may be absorbed into or near the chromosome.

Neutrons: They are electrically neutral particles which are obtained mostly from nuclear fission reactions in an atomic pile. The more energetic fast neutrons cause ionization, indirectly releasing their energy in elastic collisions with nuclei of atoms present in the tissue, particularly with hydrogen, producing densely ionizing protons from it. Slow or thermal neutrons cause transmutation of certain specific atomic nuclei with a consequent release of alpha, beta or gamma rays or protons. The principal nuclear transmutations by thermal neutrons in tissue are those with nitrogen which ejects a proton, with an isotope of boron which ejects an alpha particle, and with hydrogen which emits a gamma ray. The linear energy transferred per unit length of track in tissue is greater for alpha particles than protons, and greater for protons than electrons. This is one of the most important physical factors influencing the biological effect of an ionizing radiation (15, 23).

Doses of x-. alpha, beta and gamma rays are commonly measured in roentgen (r) units. Beta rays, which are streams of electrons, are measured in terms of "rep" (roentgen equivalent physical), with one rep being the unit of energy absorption equal to 93 ergs/gram of tissue. Several energy units have been employed to measure neutron doses. In America the n-unit has been commonly used and it is equivalent to 2·5 r units of X-rays or gamma rays (1 r = $1{\cdot}61 \times 10^{12}$ ion pairs/gm (air)). Since 1953 'rad' is used as the unit of absorbed dose of radiation at the site of interest and 1 rad is equal to 100 ergs/gram.

Wilhelm Conrad Roentgen discoverrd x-radiation in 1895. Investigations were immediately begun about its injurious effects on plants. In 1896, Henri Becquerel discovered natural radioactivity. The discovery gave further impetus to investigations concerning the biological effects of ionizing radiations. A few years later, in 1898, Marie Curie discovered radioactivity in radium and polonium, which were isolated in 1904 from a uranium mineral, pitchblende. Such naturally radioactive elements, particularly radium, were also employed by many early investigators. Gager published a book of 278 pages on the effects of ionizing radiation on plants as early as 1908 (7). There was a rapid rise in the number of investigations on the subject in nineteen-twenties and another period of rapid work began about 1945 (31).

Radioactive isotopes of some heavy as well as lighter elements are known to ocaur naturally, but the major contribution to biological research has resulted from the advent and general availability of artificial radio isotopes. By products of the nuclear age, such as kilocurie sources of radiation or high intensity nuclear radiations in or near reactors, have also helped to stimulate experiemental work on various plants. In fact, artificial radioactivity was discovered in 1934. Before the advent of the nuclear reactor various radioisotopes were made through the use of cyclotrons and other sources of high speed sub-atomic particles. The nuclear reactor, in which uranium–235 is fissioned through a chain reaction process, is a source of radioisotopes in quantities millions of times greater than available previously, with much greater variety of radiations and at greatly reduced cost. Radioisotopes are used (1) as sources of ionizing radiations in much the same way as radium and X-rays and (2) as tracer atoms. The useful radiations from radioisotopes are alpha particles, beta particles, gamma rays and positrons (similar to beta particles but positively charged). As tracer atoms these isotopes serve to follow the complicated course of individual batches of atoms in physical transfer or chemical or biological reactions (34).

There are several kinds of radioisotopes now available. Hundreds of isotope-labeled compounds have been prepared by synthesis. Some of the commonly employed radioisotopes are P^{32}, Ca^{45}, C^{14}. H^3 Tritium, Co^{60}, Cu^{64}, Fe^{59}, S^{35}, Cr^{51}, Cs^{137}, I^{131}, Rb^{86}, K^{42}, Sr^{90}, and Na^{24}. Of these, the first nine are used as important tracers in agricultural research. In radiation genetics P^{32}. S^{35}, H^3, Co^{60} and Co^{137} are commonly used. Important radiation properties of a few radioisotopes are given below (4):

Carbon^{14} emits beta rays of 0·155 Mev strength. Its half-life is 5568 years (half-life is the period during which the element loses half of its radiation energy periodically).

Phosphorus^{32} emits beta particles of strength 1·712 Mev with a half-life of 14 days.

Sulphur^{35} emits beta rays of strength 0·166 Mev and its half-life is 87 days.

Cobalt^{60} emits beta particles of strength 0·31 Mev and gamma rays of 1·17 Mev and 1·33 Mev strengths. Its half-life is 5·3 years.

Calcium^{45} emits beta rays of strength 0·254 Mev and its half-life is 152 days.

Hydrogen^{3} (Tritium) emits beta rays of strength 0·01795 Mev and its half-life is 12·46 years.

Ionizations caused by radiations from the nuclides are revealed either by electrical effects or by recombination effects of the ions. The radiations are detected and counted most commonly with sensitive electronic Gieger scalers and Scintillation Counters. Photographic visualization of tracer distribution is obtained from autoradiograms, and in the estimation of minute quantities of the substance, paper chromatography with autoradiography or electronic counting is employed.

Genetic effects of ionizing radiations on plants: The first discovery that hereditary changes similar to those occuring naturally could be induced in animals and plants by man-made radiations was made by two American Scientists, Dr. H. J. Muller (19, 1927) and Dr. L. J. Stadler (32, 1928), but two Swedish Scientists, Dr. Herman Nilsson-Ehle and Dr. Ake Gustafsson were the first to put the idea to practical use in crop breeding (1929). Muller x-rayed male fruit-flies and obtained a wide variety of sports. Stadler got the same results with barley and corn. Since most of his new plants were distorted and inferior, Stadler then concluded that no radiation-spurred mutant could be of practical value. The two Swedish Scientists began shooting x-rays at barley seeds in almost lethal doses and in a few years found that they could step up nature's mutation rate as much as a thousand fold (17, 29). A few geneticists and plant breeders in Germany and Russia also recognized early that this method might be used to increase variability in crop plants.

In U. S. A. until the 1950's there was little research or confidence in the potentialities of radiation-induced mutations for agriculture, as many geneticists believed that radiation caused only destructive changes. The persistent, successful efforts of European workers in producing useful plant mutations (36), the greater availability of radiation sources and an interest in finding peaceful uses for atomic energy, the generally increased knowledge of hereditary materials and the production at a number of laboratories of mutants having special significance to practical plant breeders, have been the causes for the recent more optimistic attitude toward the use of radiations for plant improvement (14).

With better radiation sources, radiation genetics is under study from two different points of view. The first approach is designed to give a better understanding of the science of radiation genetics and consequently of genetics itself. The second is a much more practical approach to the use of radiation for the solution of specific agricultural problems. By means of fundamental studies, plant scientists have been able to difine to a certain extent the way in which radiation should be given to plant, the biological conditions

which must be fulfilled, the type of radiation to use and the results that may be expected as well as a great many other factors necessary for an intelligent approach to the problem. The genetic effects of ionizing radiations on plants may be briefly reviewed under general effects of radiation on cells, effect of ionizing radiations on chromosomes, radiation-induced gene and somatic mutations, and modifying factors.

Side by side with the frequence of aberrations, radiation causes certain amount of damage also to cells. Some of such damages are - depression of mitotic activity, depression in the synthesis of desoxyribonucleic acid, and the stickiness of metaphase and anaphase chromosomes. The depression of mitotic activity by radiations has been studied in a variety of organisms. The dosage of radiation employed and the sensitivity of cells of different species are the important factors here. Inhibition of mitosis has been observed with even low doses of x-rays and ultraviolet rays of certain wavelengths. With x-rays there seems to be a compensatory effect in cell-division following the depression, but with ultraviolet radiation, no compensatory rise is observed. UV of certain wave-lengths is absorbed strongly in the nucleic acids of the cell, and this is of significance in determining its genetic effects. Pollen grains of many species of plants are found to be effectively treated with ultraviolet radiation. Even low doses of x-rays inhibit the synthesis of DNA, as observed in Vicia root tips, and thus cause mitotic delay. Another general effect of radiation on dividing cells is the appearance of clumped chromosomes at metaphase and an irregular separation at anaphase. The chromosomes appear to be pyenotic or sticky as a primary effect of radiation (13, 33).

It has long been known that ionizing radiation causes chromosome aberrations. Depending on the stage of nuclear development at the time of irradiation three general classes of aberrations are produced (16, 24).

(a) Irradiation at the resting stage results in chromosomes aberrations. At this stage of the nuclear cycle, the chromosomes respond to irradiation as if they were single strands and at metaphase anaphase the induced aberrations are seen to involve both of the two sister chromatids. The chromosomes aberrations include dot deletions, rod deletions dicentric chromosomes, and ring chromosomes. Though it is difficult to detect them, inversions and free translocations are also produced.

(b) Irradiation at prophase results in chromatid aberrations. At this stage, the chromosomes have divided into sister chromatids, and the irradiation may break both or only one of the two sister chromatids at any given locus. The chromatid aberrations include deletions of one of the two chromatids, deletion of both chromatids to form iso-chromated aberrations, breakes and reunions in the chromatids of different chromosomes followed by illegitimate reunions to form chromatid dicentrics or chromatid exchanges, and breaks and reunions of chromatids of the same chromosome to form chromatid rings or exchanges. The chromatid exchanges or translocations can usually be detected only at metaphase, but the chromatid deletions, isochromatids dicentrics and rings can be recognized at either metaphase or anaphase.

(c) Irradiation in very late prophase or prometaphase produces half chromatid or sub-chromatid aberrations. These include half chromated exchanges between sister chromatids, and more rarely, half chromatid exchages between chromatids of different chromosomes. They can be detected only at anaphase as a rule, and even at that stage the existence of half chromatids is inferred from the nature of the aberration.

The inhibition of cell-division by ionizing radiation is important in studies of radiation sensitivity at various stages of cell cycle. Chromosomes show great variation in their sensitivity to ionizing radiation at different periods in their nuclear cycle of mitosis and meiosis. It has been noticed that meiotic chromosomes are more sensitive than mitotic chromosomes and that chromosomes at the time of nuclear division are much more sensitive than they are during the resting stage (work on Tradescantia microspores and the meiotic chromosomes of Trillium). Cytological studies of chromosome breakage induced by ionizing radiation at various stages of nuclear development have provided evidence regarding the time of chromosome duplication and the nature of chromosome breakage and reunion (work on Tradescantia microspores). The above mentioned aberrations constitute chromosomal alterations including changes in structure, delections, duplications, inversion and translocations of genetic loci.

Effects of radiation may frequently cause changes in the chromosome number also. This class includes types with increases or decreases in the number of whole chromosomes or sets of chromosomes aneuploids and polyploids and other genetic changes. Polyploidy is often induced as a result of inhibition of mitosis by radiation. It is

commonly observed that ionizing radiation causes abnormal distribution of chromatids to the daughter nuclei, both at mitotic and meiotic divisions, bringing about aneuploid condition, which sometimes has a lethal effect on the individual. Ionizing radiation also affects the frequency of crossing-over altering transmission of genes (13).

Each type of aberration bears a particular relation to the doses of radiation and exhibits a quantitative relation to the intensity of the radiation, the relation depending largely on whether one break or two breaks are necessary to produce that type of aberration. Earlier studies on the comparative efficiencies of various ionizing radiations indicated that there was but little difference between the gamma rays and the hard and medium x-rays. Increased efficiency was observed in soft x-rays. Neutrons and alpha particles are considerably more effective per unit of energy dissipated in tissue than electromagnetic radiations. Utilizing the neutron-x-ray comparisons, Lea and Catcheside (1942) attempted to determine the approximate under of ionizations required to produce a chromosome break, Their conclusion was that seventeen ionizations, on the average, are required for a breakage to occur (16). Ultraviolet is the only non-ionizing radiation capable of fragmenting chromosomes. On the energy basis, UV is by far less efficient compared to x-rays. 400 Kev beta rays are essentially similar in effectiveness to gamma rays emanating from Co^{60}. P^{32} and C^{14} both producing beta rays, when absorbed by the cut stems of inflorescences of Tradescantia, were found to produce chromosome aberrations similar to those produced by x-rays (8, 9 Giles 1947; Giles and Bolomey 1948).

There are some gene mutations induced by radiations, which are genetic changes characterized by the absence of cytologically visible alterations in the chromosomes (sometimes, these have been called "point mutations"). Radiation is the first highly effective means discovered for producing gene mutations in quantity. Stadler produced such mutations in maize and barley employing x-rays. Different kinds of radiations were used by different workers to produce the same effect in different kinds of material. Experimental facts indicate one-hit event for the production of gene mutation and gene mutation shows a linear dose dependence (37). An important application of radiation has been its use for the production of mutations at many loci, making possibile the construction of chromosome maps, better understanding of the action and interaction of many genes, and confirmation of the general similarity of the biochemical processes under genetic control found in lower and higher organisms.

Effects of ionizing radiations in the production of cytoplasmic mutations (maternally inherited changes also deserve attention. The most striking effect of this kind is the segregating of chlorophyll mutants in the progenies of irradiated plants like barley found by Stadler, Gustafsson and many others. A wide range of types of chlorophyll mutations has been defined and described. X-irradiation, and chronic gamma- irradiation from Co^{60} have been employed in this line. Mutation rates increased with the radiation dose. In some cases, maternally inherited gigas mutants with greater yield are obtained (5, 35).

Plants are irradiated in the early flowering stages in order to affect the developing gametes. Somatic mutations are first induced in seeds by irradiation. Such affected cells may subsequently give rise to germinal tissue which transmits the mutations to later generations. Vegetative cuttings and fruit trees have also been exposed to gamma radiation from Co^{60}. Many economically important somatic mutations have been induced by radiation in plants like carnations, antirrhinums and dahlias etc. (28).

Many external and internal factors have been found to modify the genetic effects of radiation (37). According to early hypotheses, the machanism by which radiations induced structural aberrations was based largely on physical consideration. The principal factors were considered to be the type, does and intensity of radiation (16). Later work has indicated that some environmental factors like moisture, oxygen, storage and temperature have also much influence on the genetic effects of radiation (x-rays and gamma rays). On the other hand, the genotype age of the tissue, stage of the chromosome number of an organism have been found as important internal factors influencing its radiosensitivity. It has also been noted that an increase or decrease in the yield of aberrations can be brought about by supplementary environmental treatments like fractionated dosage, centrifugation of the cells during irradiation, irradiation with infra-red before or after x-irradiation, anoxia, irradiation in an atmosphere of Co or Co_2 and treating the cells with various chemical agents (13, 14).

The interplay between the effects of moisture, oxygen, storage and temperature are found to be complex, particularly with radiations of sparse ion density (20). Major experimental conclusions show that there is a pronounced effect of oxygen is increasing the frequency of of x-ray induced aberrations of all types. Moisture content in the

embryo of irradiated seeds influences the radiation response in resulting seedings. The highest total number of mutations is observed from high radiation does to seeds in their dormant condition. The oxygen effect and the temperature effect seem to be closely inter-related. So is the effect of storage of seeds after irradiation and before hydration. In the case of neutron irradiation these factors do not seem to influence the effects (20).

Differences in response to irradiation have been noticed among species, varieties and genetic strains within a variety.

Regarding the stage of life cycle for getting more mutations by irradiation, the following general inferences has been made from the experimental results. Aged seeds show greater frequency of induced mutations than fresh seeds. Young plants are more radio-sensitive than mature plants. Meiotic cells have been found to be more radiosensitive to radiation than mitotic cells (23, 29). Chromosome aberrations are relatively more frequent when pollen is irradiated than when seeds are irradiated. Pollen irradiation has an advantage over seed irradiation because a change induced in a single cell will be represented in every cell of the progeny, if it fertilizes an egg. In bud and seed irradiation a desired change may be seen in one or a few cells which produce only a small sector of the mature plant. There is also a possibility of the neighbouring cells outgrowing the altered cells and change may be imperceivable. Polyploids are in general more resistant to radiation than related diploids.

Radiations in plant breeding: The use of radiations in plant breeding is very promislng. What is more important is not the induction of mutations, but the survival of the induced mutations through cell division. An ionizing radiation causes a change in the fundamental hereditary material at a molecular level. It is then taken up by the self-reproducing chromosome units in the cell. Recombination takes place with the residual genotype. There is the reaction of the genotype with the environment. Then the plant breeder selects those genotypes which are suitable to his particular needs. Thus, it is a series of events from the induction of mutation to the growing of a new variety of plant in an area. In other words, one has to get a useful and viable mutation induced in a cell and that single cell, uncontaminated by other cells, has to pass down a cell lineage to make a new plant. After the mutation has been artificially induced, the techniques of selection and testing are the same as those employed in conventional breeding methods.

Dr. Ditervon Wettstein, one of the Swedish workers in the field of radition genetics says, " We have found that by radition we can get almost anything out of plants we really want. Most food plants of today are rather old-fashioned, and their variations have exhausted by many years of inbreeding. They need to be reconstructed to suits the needs of modern agriculture, with its emphasis on high yield and mechanization. We now have an instrument with which we can rebuild all the food plants in the world ". This is a very optimistic view! " We have only made a start in creating useful new plant varieties. Now we are trying to learn how to control the mutation process - to discover the conditions under which we can produce at will the plants the world needs. We get the widest variety of mutations from some plants by irradiating them for short periods at certain times; others seem to do better if exposed for a whole season. Many new practical developments are on the way. For instance, we expect to develop grains that will mature earlier, which will be very important not only in Sweden, but in all northern countries. Even a few days' earliness will make a great difference in world production by anticipating frost and storm. We already have the early strains, but their yield is not high enough. We are confident that we can get both qualities " (17).

Ake Gustafsson and Olof Tedin conclude (12), " However well-founded the scepticism against the value of irradiation experiments in plant breeding may once have appeared, it is by now evident that induced mutations can increase the yielding capacity of a variety, or on the other hand leave its production capacity in tact and improve special qualities of importance in modern agriculture, such as stiffness of straw, earliness, protein content, baking quality, fibre strength, grain size - in cereals as well as in peas, lupines, flax, tomatoes, etc. This series of papers goes to indicate that mutation research is indispensable for the progress of plant breeding. Artificial mutation implies a means of augmenting variability. Some mutants directly increase agricultural fitness. Others are useful in recombination work. We are now able, to some scant degree, to influence and to control the sum total of the mutation process, as well as to direct the mutation of individual loci ".

Disease resistance is the most outstanding contribution of radiation to plant breeding. There are some special uses of radiation as a tool in plant breeding such as those pioneered by Sears (27) and and Elliott (6) in transferring a small useful piece of chromosome from Aegilops and Agropyron respectively to wheat to get the disease resistance to wheat.

With reference to crop improvement the following achievements are so far made in various parts of the world by causing desirable mutations by radiation (14, 22).

Plant	Improvement
1. Barley	Stiff straw, earliness, dense spike, increased yield of seed and straw, higher protein content, improved malting quality, disease. resistance.
2. Oats	Stem rest resistance, earliness, short straw, stiff straw, increased test-weight, improved quality.
3. Wheat	Short and stiff straw, earliness, increased yield, improved baking quality, stem and stripe rust resistances.
4. Peanuts (Ground nuts)	Increased yield and oil production, disease resistance, size and shape, better adopted to mechanical harvesting.
5. Soybeans	Earliness, increased yield.
6. Vetch	Greater vitality.
7. Beans	Increased yield, disease resistance, earliness and bush habit.
8. Mustard	Increased yield and oil production.
9. Peas	Gigas mutant form with higher yield.
10. Sesame	Higher yield (3).
11. Jute	Taller plants (2).
12. Tomato	Increased yield.
13. Apple	Red fruit.
14. Pear	Striped fruit.
15. African violet	Self-fertile varieties.
16. Carnations	Flower color sports (25).
17. African violet	Leaf shape and flower color variants.
18. Rice	New dwarf type which may substantially reduce loss due to lodging.
19. Peaches	Early varieties.

Of these varieties, the Primex White mustard Svalof the "Stralart" of Weibullsholm, and the "Schafers Universal" in Phaseolous were released into the market in Sweden. Numerous mutants in barley, wheat, peas, lupine, being rather promising, await their final large-scale testing (12). In the U. S. A. the Michigan Experimental Station has released a new bean variety, Sanilac (Phaseolus vulgaris, L.,), with its earliness and bush habit. As a result of the efforts of Gregory (11) an improved peanut variety was released in North Carolina State in January 1959. A large number of irradiated crops comprising cereals, forage grasses, legumes, vegetables, fruit trees, oil and fibre crops of economic importance are at present under observation regarding the beneficial mutations they may be showing (22). Regarding the potential uses of radiation in plant breeding, the following points may be mentioned :

1. It is useful in inducing variability.
2. It may be used in breaking extremely close linkages by which may things can be achieved.
3. In the realm of interspecific and intergeneric hybrids, parts of non-pairing chromosomes may be transferred with the help of radiation to stable synapsing chromosomes.
4. It may be practical to have a crop with "induced heterosis" by irradiation of pollen.

Conclusion: It is beyond dispute that beneficial mutations can be produced by irradiation. Radiation does not produce ready-made varieties but it increases variability with a greater frequency than that occuring in nature through spontaneous mutations. The plant breeder has a very large scope to make selections. He has to grow large progenies and make effective screening to get what is needed. The good features of a mutation can be recombined with other outstanding characteristics through conventional methods of hybridization and selection. When the induced mutation process is controlled and directed to give the desired mutations, by decreasing the chromosome aberrations, physiological injury and sterility, ionizing radiation will be a very usful tool in plant breeding. Mutation induction, as a technique of plant breeding will then be a profitable supplement to the conveniional methods of selection and hybridization.

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Research Notes

Indirect application of phosphate to paddy through legumes.

It was reported that phosphates applied (broadcast) direct to paddy are not completely utilised, as nearly two thirds of phosphorus gets reverted quickly to an unavailable form. It was also reported that if phosphates are applied to green manure crops preceding paddy, they are built up in the green manure crop, which on decomposition makes available the phosphorus needed by the succeeding cereal or other crops.

Earlier experiments on indirect application of phosphates to paddy through legumes conducted in the different parts of the State did not give any appreciable response - in the grain yield of paddy (only 10% increase in yield was obtained at Maruteru).

Under the co-ordinated Model Agronomic experiments of the Indian Council of Agricultural Research, an experiment is being conducted at T. C. M. centre, Aduthurai (Cauvery alluvium) since 1957—'58, with different levels of phosphates (0, 40 lb., 80 lb. P_2O_5 per acre) applied to leguminous green manure crops (Kolinji and Pillipesara) nitrogen was given to paddy crop as ammonium sulphate at 0, 15 lb. and 30 lb. N per acre.

In this experiment, good response in grain yield as high as 41% over control was obtained for 80 lbs. P_2O_5 and 30 lbs. Nitrogen. Thus, it is seen that high levels of phosphates applied indirectly to paddy through leguminous green manures would increase the yield of paddy to an appreciable extent.

Average acre yields of grain obtained in the above experiment conducted on 1957—'58 are presented in a two way table below:—

Grain yield in pounds per acre.

	Legumes P_0	P_1	P_2	No legume
N_0	1744	1956	2046	1703
N_1	1911	2162	2210	2017
N_2	2009	2186	2424	2027

A detailed scheme under the auspices of the Indian Council of Agricultural Research is being worked currently in the state for obtaining basic information on the uptake of phosphorus by the common green manure crops from different forms of phosphates and their availability to paddy. The findings will give an idea of the best form of phosphatic fertilizer to be applied to a green manure crop preceeding paddy in the different places of the state.

Model Agronomic Experimental Centre, Aduthurai.

S. ARUNACHALAM.

REFERENCE

Narasinga Rao, M. B. V. 1952 Madras Agricultural Journal, Vol. xxxix, P. 65.

Seed production in Guar (Cluster beans) *Cyamopsis psoraloides.*

Guar (Cluster beans) — ***Cyamopsis psoraloides*** is a quick growing leguminous plant native to India. It is one of the important fodder crops in the Punjab especially in the dryfarming areas where rainfall is scanty(1). In South India its cultivation is confined to kitchen gardens where it is grown ŭnder irrigationf or its tender pods which are used as vegetables. Previous experiments conducted at the Millet Breeding Station, Coimbatore have shown that Guar can also be grown as a green manure crop yielding 20,000 lb. of succulent green material with 60 days growth(2).

Guar was introduced into United States of America about fifty years ago as a green manure and a cover crop. In recent years, it has attained the status of a commercial crop in that country as its seeds have proved to be a potential source of an economic vegetable gum which has found a variety of uses in textile products. The outer seed coat of the seed which is seperated through milling is used for preparing various grades of gums. An addition of 0·5% of Guar gum is found to enhance the strength of tissue sheets. The triacetate of galactomannan from Guar gum can be cast into transparent flexible films(3). Besides the gum products, its flour has proved useful for thickening ice cream mixes, salad dressings and bakery preparations. The flour is dispersable in hot or cold water yielding highly viscous solutions at low concentrations and having five to eight times the thickening power of ordinary starch(4). Owing to these variety of uses in food, paper and textile products, the demand for its seed is on the increase. As Guar comes up well under Indian conditions both in the karif and rabi seasons, there is a vast scope for promoting the export of Guar seeds or gum which will earn valuable foreign exchange. To achieve this object, the seed production of Guar has to be stepped up. Since there is no data on the acre yield of Guar seeds and also the economic type for seed production, the present study was taken up. Ten high yielding economic types of Guar were studied in a preliminary yield trial in 1959 summer season. The seeds

were sown in randomised plots which were replicated five times. The crop which was sown on 2—2—1959 was given three irrigations and harvested four months after the date of sowing. The pods picked were dried to constant weight and threshed. The calculated acre yields of pods, seeds and the percentage of seed to pod are given below :—

Selection Number.	Origin	Acre yield of dry pods	Acre yield of seed	Percentage of seed to pod
Ordinary Types				
C. P. 78	Mylapore	1141	600	52.5
C. P. 39	Salem	1133	593	52.3
C. P. 66	Rasapalayam	1033	567	54.9
C. P. 40	Mettupalayam	1025	567	53.8
Guar American	U. S. A.	1050	527	50.2
C. P. 67	Sudan	1000	520	52.0
C. P. 59	Tiruchirapalli	1008	500	49·6
Fleshy Types				
C. P. 177	Palni	791	333	42.1
C. P. 380	Extracted type	750	287	38.3
Pusa Mousmi	I. A. R. I., Pusa New Delhi	441	167	37·9
Whether significant or not		Data not analysed	yes	...
Critical Difference		...	234	...

It may be seen from the data presented above that C. P. 78 has given the highest yield of 600 lb. of seed per acre. It is interesting to note that the ordinary types have shown a higher proportion of seed to pod ranging from 49.6 to 54.9 percent whereas the all the three fleshy types including Pusa Mousmi have shown a low seed to pod ratio ranging from 37.9 to 42.1 percent. From the above studies, it may be concluded that among the available types which are maintained for economic work at the Millet Breeding Station, Coimbatore C. P. 78 is the best for purposes of large scale seed multiplication. For quality of pods, Pusa Mousmi is the best as it has low seed to pod ratio.

Millet Breeding Station, Coimbatore.

A. SUBRAMANIAM.
S. PREMSEKHAR.

REFERENCES

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2. R. Veeraswami and Miss. V. K. Kunjamma. Guar and its scope as a short duration green manure crop. M. A. J., 45(1), 7—9 (1958).
3. Chemical Abstracts. 1948. 42. 7073.
4. Food Manufacture. 1948. 23. 302.
5. Wealth of India — Raw materials — Vol. II. P. 407 — 408.

Studies on the life cycle of *Asphondylia tephrosiae* Mani (Cecidomyidae), a cecidogenous pest of Kolingi.

The author recorded pod galls caused by the then unidentified *Asphondylia tephrosiae* Mani (Cecidomyidae) for the first time on Kolingi (*Tephrosia purpurea* Pers) a valuable green manure especially for paddy(2). Incidentally it has been found that this is the first record of a new host for *Asphondylia tephrosiae* which was originally found to occur on the ovary of *Tephrosiae candida* De. 3, 4.

Observations on the biology of *A. tephrosiae* were made from samples collected on the banks of Vellar estuary, Portonovo, in the suburbs of Chidambaram and along the railway track at Coleroon and Thirumailadi. Kolingi develops tender shoots and flowers early in September and March. It is reported that this plant though hardy and resistant to drought normally shows low seed-setting (1). From the shoots kept under observation young and minute (1.5 mm) midge larve (Fig. 1), yellow in colour, emerge during night time and move about actively. Many succeed in boring their way into tender pods. The larva feeds on the inner walls of the pod and when it grows up it becomes less active. The affected pods are seedless, turn grey and swell into galls (Fig. 3).

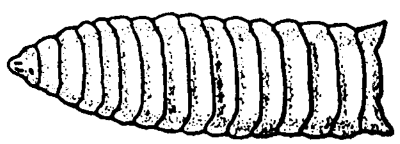

Fig. 1

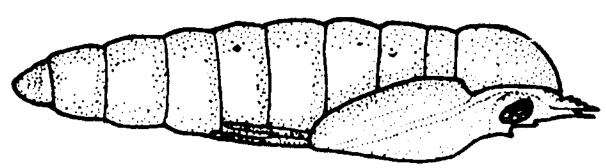

Fig. 2

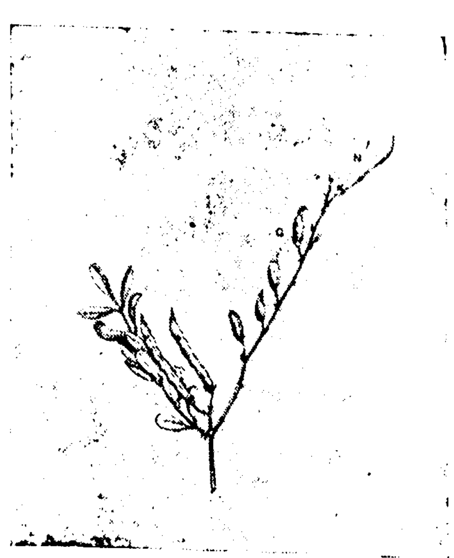

Fig. 3
N. normal pod
G. gall

Each gall is occupied by a single midge larva. The larval period lasts about 15 days and pupation takes place inside the gall. There are three serially arranged spines at the anterior end of the pupa (Fig. 2). With the help of the head spines the pupa makes the exit hole. This pest is however kept under check by its natural enemy *Neanastatus proximus* Fer. (Eupelmidae) which parasitises nearly 50% of the Cecidozoan.

Acknowledgments: The author is thankful to Dr. P. Govindan, Professor of Zoology, Annamalai University, for guidance in this investigation. The author's thanks are also due to Dr. S. N. Rao, College of Science, Nagpur, for his kindness in identifying the specimens.

Department of Zoology,
Annamalai University,
Annamalainagar.

N. P. KALYANAM.

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College and Estate News

Lectures: Dr. Sadasivam, Dirtetor of Botany department of the Madras University delivered the foundation lectures on "Rhizosphere" on 19—3—1960 to the Post Graduate trainees in Agriculture at Coimbatore.

Dr. Gopalan, Forest Voterinary Officer of Madras delivered a lecture on "capture of elephants and their management" to the members of the study group on 12—3—1960.

Students' Hostel: Agricultural College, Coimbatore: The hostel day of the Madras Agricultural College hostel was celebrated in the hostel premises under the presidentship of Sri G. D. Naidu of Coimbatore on 5—3—1960.

N. C. C. Day: The company day of the "D" coy 4th Madras Battalion NCC Agricultural College, was celebrated on 6th March 1960. The function started with a gala carnival in the morning. Sri S. R. Shenai, Dy. Inspector General of Police, Western Range, presided over the evening function, which included sports, ceremonial parade and other activities.

THE INDIAN COUNCIL OF AGRICULTURAL RESEARCH

The Rafi Ahmed Kidwai Memorial Prizes for Agricultural Research.

The Indian Council of Agricultural Research has with a view to creating an incentive for research workers and to recognising outstanding research work done by them in the fields of Agriculture, animal husbandary and allied subjects instituted 11 prizes of the value of Rs. 5,000/- each. These prizes are known as 'The Rafi Ahmed Kidwai Memorial prizes for Agricultural Research' and one prize will be awarded biennially i. e., one in two years for outstanding research work done in India in each of the following subjects.

1. Agronomy
2. Agricultural Engineering
3. Agricultural Chemistry
4. Agricultural Botany
5. Agricultural Zoology (including fisheries)
6. Horticulture
7. Animal Breeding
8. Animal Nutrition (including Physiology and Bio-chimistry)
9. Animal Diseases
10. Dairying and
11. Agricultural and Animal Husbandry Economics and Statistics.

2. These prizes will be in the form of gold medals or cash or both and one prize in each subject will be awarded on the basis of outstanding results of researches achieved by research workers in the country either individually or jointly during the calendar year 1958 and 1959 i. e., 1st January 1958 to 31st December 1959. Results achieved prior to the calendar year 1958 or after the calendar years 1959 will not be recognised for the purpose of the present award.

3. The award of each of the prizes will be based on significant advances in human knowledge in a particular subject as revealed by books, monographs or papers published in the name of the candidate or any other unpublished account of the outstanding research work done or discoveries and inventions made by him. The selection of a candidate for the award of a prize will be made on the recommendations of a Judging Committee consisting of eminent scienticsts appointed for the purpose by the Indian Council of Agricultural Research. The award of a prize may be made to more than one research worker and the prize money divided amongst them in such proportion and manner as may be decided by the Council,

4. All research workers, engaged in research work in India, in the field of Agriculture, animal husbandry and allied sciences are eligible for competing for these prizes. Application should be made in quadruplicate in the prescribed form, which can be had free of cost from the Secretary, Indian Council of Agricultural Research, Dr. Rajendra Prasad Road, New Delhi. Candidates working in research Institutes etc., should submit their application through the Head of the Institute/Department etc., Others may submit their applications direct.

5. All applications should be sent addressed to the Secretary, Indian Council of Agricultural Research, Dr. Rajendra Prasad Road, New Delhi, so as to reach him not later than the 30th June 1960. The cover of applications should be superscribed as under:—

Application for the award of the 'The Rafi Ahmed Kidwai Memorial Prize research in ... ...

Applications received after the 30th June 1960 will not be considered.

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Utilisation of the services of retired scientists in the field of Agriculture, Animal Husbandary and allied sciences.

The existing rules regarding superannuation sometimes put an abrupt end of the research work of an active scientist or at any rate make the continuation of such work extremely difficult as a result of which the talent of a good number of scientists who are physically fit and mentally alert is wasted after retirement for lack of opportunities to pursue work in their field of specialization. In order that the experience and talent of such scientists as have finishd with their active professional career is not wasted, the Indian Council of Agricultural Research has decided to initiate, with effect from the 1st April 1960 a scheme for the utilization of the service of retired scientists in the field of Agriculture, animal husbandary and allied sciences.

2. Under the scheme retired/retiring scientists of established reputation, who are still active in research will be enabled to continue their research with suitable financial assistance from the Indian Council of Agricultural Research. The retired or retiring scientist should try to secure sponsoring institution (which may be one from which he has retired or a different one) which would provide him necessary facilitites for continuing his work e. g., access to the laboratory and library, accommodation for work etc., Failing this, the scientist may apply to the Indian Council of Agricultural Research and the council will try to place him in a suitable institution. The choice of the Institution at which the retired scientist would continue his researches will be left to the Scientist himself but such Institution should be one acceptable to the council. The retired or retiring scientist (within a year of his retirement) will submit to the Council, an outline scheme of research which he intends to undertake after retirement. In doing so, he will clearly give an account of the research work done by him during five years preceding the date of his retirement or application whichever is later.

3. An annual allowance not exceeding Rs. 6,000/- will be provided to the retired scientist himself, if asked for by him and a grant ordinarily not exceeding Rs. 4,000/- to cover the cost of one research assistant and other expenses as may be decided by the Council. The amount of the grant may be increased in exceptional cases when the investigations involve field work necessitating undertaking of tours or where costly equipment/apparatus have to be purchased.

4. The allowances and grants to the scientists under the scheme will be provided, in the first instance, for a period of three years only. As usual, annual progress reports shall be submitted to the Council by the Scientist. Where the retired scientist would like the grant to be renewed, he will have to submit a year in advance of termination of the first sanction, an application to that effect indicating the progress made under the scheme and the programme proposed to be followed during subsequent years. The allowances and grants to the retired scientists will be payable on a quarterly basis through the institution to which the retired scientist is attached.

All applications for grant under the scheme should be submitted to the Council in the prescribed proforma which can be obtained, free of cost, from the Secretary, Indian Council of Agricultural Research, Krishi Bhavan, Dr. Rajendra Prasad Road, New Delhi.

Weather Review — for February, 1960.

RAINFALL DATA (IN INCHES)

Region	Station	Total rainfall for the month	Departure from normal	Total since 1st January
North	Madras (Meenambakkam) ...	0·0	— 0·4	1·0
	Tirurkuppam*	0·0	— 0·2	0·6
	Vellore	0·0	— 0·3	0·0
	Gudiyatham*	0·0	— 1·3	0·0
East Coast	Palur*	0·0	— 0·3	0·5
	Tindivanam*	0·0	— 0·6	0·1
	Cuddalore	0·0	— 0·9	0·9
	Nagapattinam	0·6	— 0·2	3·5
	Aduthurai*	0·1	— 0·6	0·6
	Pattukkottai*	2·6	+ 1·5	2·8
Central	Salem	0·0	— 0·3	0·0
	Coimbatore (A. M. O.)* ...	0·3	+ 0·1	0·3
	Coimbatore	0·1	— 0·3	0·1
	Tiruchirapalli	0·4	+ 0·1	0·4
South	Madurai	0·2	— 0·4	0·2
	Pamban	3·0	+ 2·1	3·3
	Koilpatti*	1·0	— 0·2	1·0
	Palayamcottai	1·7	+ 0·6	2·0
	Ambasamudram*	2·8	+ 1·9	3·2
	Nagercoil*	0·0	— 0·9	0·5
Hills	Kodaikanal	0·5	— 1·1	0·5
	Coonoor*	0·0	— 3·3	1·3
	Ootacamund*	0·0	— 0·6	0·1
	Nanjanad*	0·0	— 0·4	0·0

1. * Meteorological Stations of the Madras Agricultural Department.

Mainly dry weather prevailed over the entire region for the first nine days of the month. Except for scattered showers on 10th and 11th in south Madras State, weather remained dry elsewhere. For a period of another ten days i. e., up to 21—2—1960 the weather was dry in the region. Localised rain or showers prevailed in south Madras State on 22—2—1960 and 26—2—1960. Scattered showers were recorded on 23rd, 25th and 27th February 1960. Dry weather prevailed on 24—2—1960, 28—2—1960 and 27—2—1690.

Night temperatures were fluctuating except for a spell of below normal temperatures from 12—2—1960 to 20—2—1960 (both days inclusive).

During the month ground frost was observed on about 15 days in Ootacamund area and Nanjanad has reported heavy frost on 11 days and low frost on 3 days.

The noteworthy rainfall and zonal rainfall for the month are furnished below.

Noteworthy rainfalls.

S. No.	Date	Name of Place	Rainfall in inches
1.	22—2—1960	Pamban	1·14
2.	26—2—1960	Pattukkottai	1·26
3.	26—2—1960	Ambasamudram	1·45

Zonal rainfall (in inches)

Name of the Zone	Rainfall for February, 1960	Departure from normal	Remarks
North	0·0"	— 0·6	Below normal
East Coast	0·6"	— 0·2	,,
Central	0·2"	— 0·1	,,
South	1·5"	+ 0·5	Above normal
Hills	0·1"	— 1·4	Far below normal

Agricultural Meteorology Section,
Lawley Road Post, Coimbatore-3.
10th March, 1960.

C. B. M., C. M. B., & B. S.

ADDENDA

to the Weather Review for January, 1960.

Region	Station	Total rainfall for the month	Departure from normal	Total since 1st January
South	Ambasamudram*	0·4	— 2·3	0·4

Zonal Rainfall (in inches)

Name of Zone	Rainfall for January, 1960	Departure from normal	Remarks
South	0·3	— 1·3	For below normal

Departmental Notifications

Gazetted Officers — Madras Agricultural Department

Postings and Transfers during the month of March, 1960

Name and Designation	Posted or Transferred to
Sri A. Abdul Samad, Paddy Specialist, Coimbatore	Earned leave for 31 days from 1—3—'60
Dr. S. Kanakaraj David, Lecturer in Entomology, Coimbatore	Reader in Entomology, Regional Post-Graduate Research Institute, Coimbatore from the date of taking charge
Sri N. M. Thyagarajan, Assistant in Chemistry, Coimbatore	Asst. Agrl. Chemist for Soil Survey of the Parambikulam Upper Aliyar Project, from date of taking charge
,, C. R. Thiruvengadam, Asst. Agronomist, Cuddalore	Services placed at the disposal of the Madurantakam Co-operative Sugar Mills, Ltd., Madurantakam

Name and Designation	Posted or Transferred to
Sri E. V. Abraham, Asst. in Entomology, (on leave)	(Asst. Entomologist) i. e., Crop and Plant Protection Officer, Tanjore
,, T. S. Muthukrishnan, Crop and Plant Protection Officer (Entomology) Tanjore	Asst. Entomologist (Toxicology), Coimbatore
,, K. R. Nagaraja Rao, Asst. Entomologist (Toxicology), Coimbatore	Lecturer in Entomology, Coimbatore
,, A. N. Ramalingam, Extension Officer for Agriculture, Poondi	Asst. Agrl. Engineer, (Soil Conservation Scheme) from the date of taking charge with Head-quarters at Palladam

Upper Subordinates — Agricultural Department

Postings and Transfers during the month of March, 1960

Name and Designation	Posted or Transferred to
Sri G. Mutharasan, Extension Officer for Agriculture, Nallur Block	Farm Manager, State Seed Farm, Vanur
,, S. Sreyankumaran, Farm Manager, State Seed Farm, Vanur	Alloted to Madurai Division
Emergency Appointments of new Candidates.	
,, T. Augusthy Joseph,	Soil Conservation Asst. Tiruvellore
,, Jayaram Babu,	Spl. Agrl. Demonstrator, (Sugarcane), Kallakurichi
,, M. K. Vijian,	Asst. Lecturer in Agriculture, A.C.R.I., Coimbatore
,, K. Gopakumar,	Soil Conservation Asst. Bodinayakanur.
,, D. Joseph,	Marketing Asst., Madurai
,, George Koshi,	Agrl. Demonstrator, Vellore, Vice Sri S. V. Subramaniam
,, S. V. Subramaniam, Agrl. Demonstrator, Vellore.	Spl. Agrl. Demonstrator (Sugarcane), Vellore
,, Jacob Kurian,	Agrl. Demonstrator, Tirukoilur
,, V. C. Karunakara Paniker,	Spl. Agrl. Demonstrator (Audit), Madurai
,, V. T. George,	Spl. Agrl. Demonstrator (Sugarcane), Karur
,, M. Joseph Thangchan,	Plant Protection Asst., Pollachi
,, P. N. Chellappan Pillai,	Farm Manager, State Seed Farm, Vandarayampet, S. A. Dist.
,, R. Kumaraswamy,	Fruit Asst., Periyakulam

Review of market conditions of commercial crops in the notified areas of Madras State for the month of February, 1960.

Cotton: In this Section Cotton Kapas: Pothis of 280 lbs.
Cotton lint: Candy of 784 lbs.

Coimbatore District: Season: There were no rains during the month under report. This complete absence of rains had affected the standing crop of cotton especially Karunganni cotton.

Arrivals and Transactions: (a) *Lint:* The lint market at Tiruppur opened with a stock of 4678 candys of Cambodia and 211 candys of Karunganni. The total arrivals into the market during the month (upto 27—2—'60) were 5225 of Cambodia and 83 candys of Karunganni. Transactions during the months amounted to 5995 candys of Cambodia and 201 candys of Karunganni. The closing stock were 3808 candys of Cambodia and 93 candys of Karunganni.

(b) *Kapas:* The kapas market began with a stock of 2569 pothis of Cambodia and 12 pothies of Karunganni. The total arrivals into the Market were 25891 pothis of Cambodia and 28 pothis of Karunganni. Transactions during the month amounted to 22521 pothis of Cambodia and 20 pothis of Karunganni. The month closed with a balance of 5939 pothies of Cambodia and 20 pothis of Karunganni.

(c) *Prices:* The prices of cotton lint and kapas during the month as compared to that of previous month were as follows:

(Lint)

Variety.		*February 1960*	*January, 1960*
Cambodia Superior quality	Rs.	924 to 981	941 to 981
Cambodia Average quality	,,	899	806 to 854
Karunganni Superior quality		No transactions	
Karunganni Average quality		No transactions	
M. C. U. I. Lint rates range	,,	1059	1030 to 1137

Variety.		(Kapas)	
Cambodia Superior quality	Rs.	125 to 142	125 to 141
Cambodia Average quality	,,	105 to 122·50	111 to 123
Karunganni Superior quality	,,	117·37 to 129·37	126·50 to 134·00
Karunganni Average quality	,,	105	—
M. C. U. I. Lint rates range	,,	N. T.	N. T.

N. T. = No transaction.

Ramanathapuram District: Season: Hot sun and clear sky accompanied by chill windy nights prevailed during the month with occasional rains.

Arrivals and Transactions: The arrivals and sales of cotton in the three markets of Virudhunagar, Sattur and Rajapalayam were as hereunder:

Name of Markets	Opening Stock	Receipts	Disposals	Closing Stock
Kapas				
1. Virudhunagar ...	...	3600	3600	...
2. Sattur ...	...	...	...	...
3. Rajapalayam ...	...	1,100	1,100	...
Lint				
1. Virudhunagar ...	60	260	280	40
2. Sattur ...	...	...	...	...
3. Rajapalayam ...	1,920	140	360	1,700

Due to lack of rains during January, 60 and February, 60 the season for Karunganni cotton started late and arrivals were poor during the month. However demand from mill sector was heavy with brisk transactions. The arrivals of cambodia were also poor due to on set of Karunganni season. Uganda cotton market continued to rule dull during the month due to lack of sufficient demand.

Prices: The prices of cotton lint and kapas during the month as compared to that of previous month were as follows:

Lint.		*February, 1960*	*January, 1960*
Karunganni ...	Rs.	840 to 936	Rs. 876
Tinny Karunganni ...	,,	...	,, ...
Certified Uganda ...	,,	1,186	,, ...
Uncertified Uganda ...	,,	...	,, 1,026 to 1,100
Cambodia best ...	,,	906	,, 876 to 946
Cambodia average ...	,,	...	,, ...
Cambodia inferior ...	,,	780	,, 746 to 786

Kapas.				
Karunganni Ist crop Karunganni IInd crop } ...	Rs.	116 to 136	Rs.	N. T.
Tinny ...	,,	...	,,	N. T.
Uganda average quality ...	,,	...	,,	133 to 146
Uganda inferior quality ...	,,	...	,,	100 to 125
Cambodia ...	,,	108 to 142	,,	100 to 135

Cotton Seeds. (Prices in Rs./nP. per standard maund)				
Karunganni ...	Rs.	15·68 to 16·00	Rs.	14·03 to 16·00
Tinny ...	,,	16·32 to 16·64	,,	15·67 to 16·98
Uganda ...	,,	...	,,	11·09
Cambodia ...	,,	8·84 to 9·14	,,	8·16 to 10·11

South Arcot District: As it is off season the transactions of cotton in both Panruti and Villupuram markets were negligible. The stock with the trade during the month was reported to be 816 pothis. The price that prevailed at Villupuram market was Rs. 82/- per pothi.

Groundnut: (In this section a candy of Groundnut kernel is 531 lbs.)

South Arcot: As the marketing season for winter crop was coming to a close arrivals in the regulated markets declined. Arrivals during the month amounted to 2143 tons from districts produce and 897 tons from other districts via Tiruchirapalli and North Arcot. Export to Pondicherry was 6 tons while despatches to other districts namely, Madras, Salem and Coimbatore was 1986 tons. The quantities consumed by oil mills and country chekkus within the state were 2376 tons and 244 tons respectively. Wastages were calculated at 213 tons. The stock with the trade stood at 928 tons at the close of the month.

The average prices of groundnut kernels in all the markets in the district ranged from Rs. 179·75 to 195·10 per candy of 531 lbs. as against Rs. 164·75 to Rs. 180·50 per candy of 531 lbs during the previous month.

North Arcot District: Season: The weather continued to be dry with practically no rains. The days were hot with chilly nights.

Arrivals and transactions: The arrivals, disposals, stocks etc., of groundnut in the district during the month were as hereunder:

Quantity in tons

Name of crops	Opening Stock	Arrivals	Sales	Closing Stock
Groundnut pods in tons	344·598	1017·855	1121·426	241·27
Groundnut kernels in tons	151·145	1785·086	1763·597	162·634

During the first and second week of the month the arrivals and disposals of groundnuts were practically steady with prices ruling high. In the third week of the month the arrivals declined in all the markets. However the prices of kernels were quoted upto Rs. 206 per candy of 531 lbs.

Following were the price fluctuations of groundnut pods, kernels and oils during the month as compared to that of previous month:

	Prices in Rs./nP.	
	February, 1960	*January, 1960*
Groundnut pods (bag of 80 lbs).	Rs. 18 to 23	14 to 23
Groundnut kernels (candy of 531 lbs.)	,, 196 to 205	179 to 203
Groundnut oil (candy of 500 lbs.)	,, 370 to 397	337 to 375

Ramanathapuram District: During the month the arrivals, sales and stock of groundnut pods, kernels in the district were as hereunder:

Quantity in tons

	Opening Balance	Arrivals	Sales	Closing Balance
Groundnut pods	Rs. 400	700	1,000	100
Groundnut kernels	Rs. 4,500	3,800	5,600	2700

The following were the prices that prevailed for groundnut pods, kernels and oils and cake during the month as compared to that of previous month.

	February, 1960	*January, 1960*
Groundnut pods (bag of 82·2/7 lbs.)	Rs. 21 to 22	Rs. 18 to 22
Groundnut kernels (candy of 531 lbs.)	,, 186 to 205	,, 150 to 180
Groundnut oil (candy of 500 lbs.)	,, 364 to 375	,, 350
Groundnut oil cake (Md. of 82 2/7 lbs.)	,, 12·70 to 13·88	,, 12 to 14

Tiruchirapalli District: Season: During the month dry weather conditions prevailed except for a light to moderate showers in some of the taluks of the district. These showers facilitated sowing of summer groundnut which was taken up during the month. Harvesting of tobacco in Karur taluk of the district.

Arrivals and Transactions: The peak season having come to an end the arrivals in all the markets dwindled considerably. The regulated market at Jayankondan attracted 5523 bags of pods (80 lbs.) as against 8825 bags during previous month and 4684 bags during corresponding period of last year.

The average prices of kernels that prevailed in different markets in the district during the month ranged from Rs. 189 to 204 per candy of 531 lbs. as against Rs. 170 to 210 per candy of 531 lbs during January, 1960.

Gingelly: (A bag: 168 lbs.)

South Arcot: The arrivals at Virudhachalam market declined and amounted to 550 bags (168 lbs.) nearly out of which 50% were from the produce of Tiruchi district as against 620 bags during the previous month. Despatches were mainly to Madras, Salem and Coimbatore dists., which amounted to 236 bags A quantity of 622 bags were crushed by the country chekkus in the district. The stock with the trade at the end of the month a mounted to 549 bags.

The prices were on the increase and the average during the month was Rs. 70/56 per bag of 168 lbs. as against Rs. 64 to 72 per bag of 168 lbs. during the previous month.

Tobacco: (A candy of 500 lbs).

Coimbatore District: At the end of the month under report there was a stock of 8835 candys of chewing and 2560 candys of cheroot tobacco with the trade. About 5765 candys of chewing and 550 candys of cheroot tobacco were exported to Bombay, Andhra, Mysore, Kerala and to other districts in the State.

The prices that ruled during the month for different grades in the districts were as follows:

Prices per candy of 500 lbs.

Variety	I Grade	II Grade	III Grade
1. *Chewing tobacco* (Sun cured):			
(a) Meenampalayam	400 — 500	330 — 400	250 — 300
(b) Other varieties	360 — 465	295 — 375	205 — 270
2. *Cheroot varieties* (Sun cured): (grown in Erode and Bhavani taluks)	280 — 340	210 — 270	140 — 200
3. *Chewing tobacco:* Pit cured (grown in Palladam & Sulur areas)	200 — 250	150 — 195	80 — 130

Cardamom: During the month arrivals of Cardamom in the important assembling centres like Bodinaickanur, Pattiveeranpatti, Thevaram have gone down. Despatches of cardamom from Bodinaickanur to other markets in the state also declained during the month.

The following were the opening stock, arrivals, despatches of cardamom during the month :

Names of Assembling Markets	Opening Stock	Arrivals	Disposals	Closing Stock
		(Quantity in lbs.)		
1. Bodinaickanoor	60,000	122,000	170,000	12,000
2. Thevaram	19,000	9,000	13,000	15,000
3. Pannaipuram	15,000	6,000	13,000	8,000
4. Kombai	5,000	5,000	5,000	5,000
5. Uthamapalayam	5,000	7,000	10,000	2,000
6. Cumbum	35,000	35,000	5,000	65,000
7. Gudalur	5,000	5,000	3,000	7,000
8. Pattiveeranpatti	6,000	23,000	23,000	6,000
9. Virudhunagar	20,000	40,000	15,000	45,000

Prices: The trend in prices of cardamom in different market during the month were as hereunder :

	Price in Rs./nP. per lb.	
1. *Pattiveeranpatti :*		
Name of quality.	Sun-dried.	Store green quality
(1) Superior and Bold	10·50—11·00	10·73—11·04
(2) Medium and Bulk	10·00—10·41	10·27—10·64
(3) Inferior and smalls	9·54— 9·96	9·58—10·10
(4) Seeds	12·02—12·42	...
2. *Bodinaickanoor :*		
(1) Extra Bold	12·42—12·45	
(2) Special	10·70—11·75	
(3) Superior and Bulk	9·86—10·77	
(4) Medium Bulk	9·41—10·71	
(5) Inferior	9·00— 9·92	
(6) Splits	10·86—10·76	
3. *Virudhunagar :*		
(1) Bold quality	11·00—11·50	
(2) Smalls	9·87—10·00	
(3) Seeds	12·75—13·25	

Review of administrative activities of Market Committees during February, 1960

The Market Committees of South Arcot, North Arcot, Coimbatore and Tiruchirapalli continued to function during the month.

Enforcement: The progress of enforcement during the month were as detailed below :

Name of Committees	Section 5 (1) A	Section 5 (1) B	Section 5 (3) A	Section 5 (3) B	Weighmen A	Weighmen B
South Arcot Market Committee	.........Report not Received.........					
North Arcot Market Committee	254	531	240	513	141	313
Coimbatore Market Committee	130	668	102	517	52	354
Trichy Market Committee	164	360	134	292	116	232

A = Licences issued during the month.
B = ,, ,, up to the end of the month.

Meetings: There was one meeting of the Trichy Market Committee on 13—2—1960 and 14 subjects were disposed of.

Quality Analysis: Nil.

Quality Competition: Nil.

SPECIFYING METRIC VALUES IN STANDARDS
AN INDIAN STANDARD DRAFTED

The Indian Standards Institution has drafted an Indian Standard Guide for specifying Metric values in Standard [Doc: EC 5(50)]. The draft provides guidance for resolving technical problems concerned with determining and specifying values in terms of the metric system while preparing new Indian Standards or converting existing Indian Standards to the metric system. It is also expected to furnish guidance to agencies or departments other than ISI in writing or re-writing their standards and specifications in metric terms.

As a result of India's decision to adopt the metric system for all weights and measurements before December 1966, it has become necessary to convert all existing Indian Standards to the metric system and also to write all new standards in this system. In carrying out this task, ISI has had to resolve many problems which are not always technical in nature, because some tend more twards managerial or even administrative types, requiring adjustments and co-ordination with the existing practices, within the changing pattern of industry.

The draft guide is now in wide circulation for comments. It is hoped, because of the general interest in the change over to metric system, many departments and organisations will be interested in the draft standard.

Copies of the draft guide are available, free on request, from the office of the Indian Standards Institution, Manak Bhavan, 9 Mathura Road, New Delhi - 1 and from its branch offices at Bombay, Calcutta and Madras. The last date for receipt of comments is *30th April 1960*.

(Extract from Press Note No. 48/60 dated 26 February 1960 of the Indian Standard Institution).

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