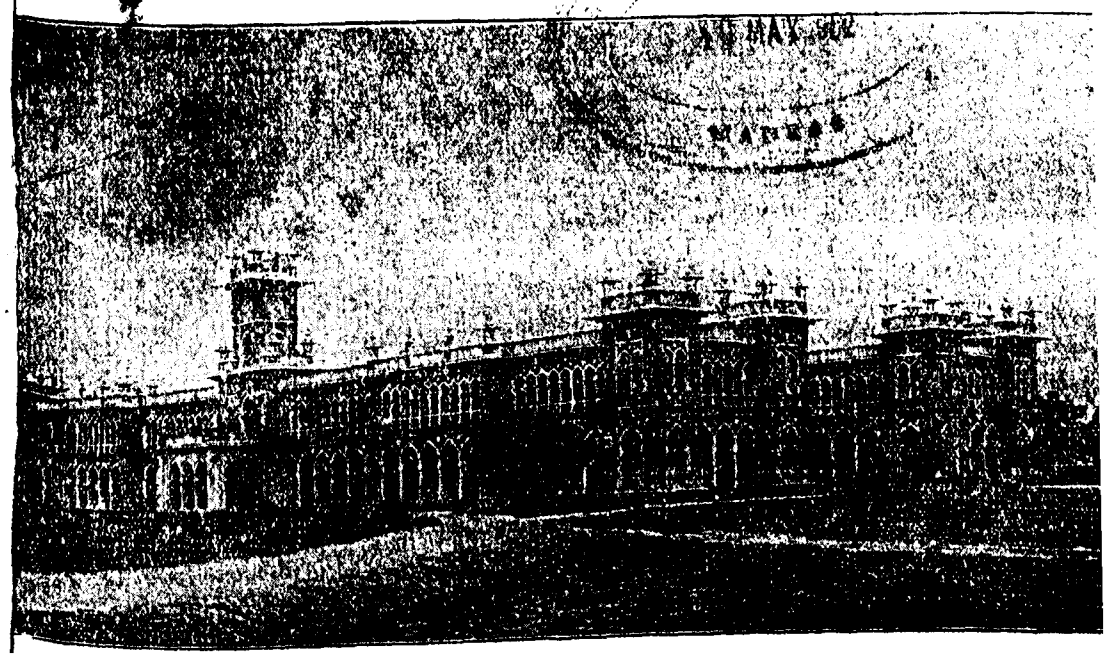
Regd. No. M. 5155

THE MADRAS AGRICULTURAL JOURNAL

Vol. XXXIX April 1952 No. 4



AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE, COIMBATORE.

Published by

THE MADRAS AGRICULTURAL STUDENTS' UNION,
AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE,
COIMBATORE, S. INDIA.

Annual Subscription:
Inland Rs. 6—0—0
Foreign Rs. 7—0—0

Single Copy
As. 8

Announcement

THE RAMASASTRULU-MUNAGALA PRIZE, 1952.

1. The prize will be awarded in July 1952.

2. The prize will be in the form of a Medal and will be awarded to the member of the Union who submits the best account of research or enquiry, carried out by him on any agricultural subject.

3. The subject matter shall not exceed in length, twelve foolscap pages, typewritten on one side.

4. Intending competitors should notify the Secretary of the Madras Agricultural Students' Union with a covering letter giving the full name and address of the sender. The author's name should not be shown on the paper, but should be entered under a *nom-de-plume*.

5. Four typewritten copies of the essay should be sent.

6. The name of the successful competitor will be announced and the prize awarded at the time of the College Day and Conference.

7. Paper or papers accepted will become the property of the Union, and the Union reserves to itself the right to publish all or any of the papers.

8. All references in the paper to published books, reports or papers by other workers must be acknowledged.

9. The last date for receipt of papers is 1st June 1952.

10. Further particulars may be obtained from the Secretary, the Madras Agricultural Students' Union, Lawley Road P. O., Coimbatore.

K. Kuppamuthu,
Secretary.

THE MADRAS AGRICULTURAL JOURNAL

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The number three has always been regarded with something of a mystic reverence; from the Holy Trinity of the Christians and the Brahma – Vishnu – Siva Trinity of the Hindus, the political Big Three of Stalin, Churchill, Roosevelt during the last World War, down to the eternal triangle theme of the novelists.

What is curious is that even in the world of plant nutrition, there should be a Big Three in the shape of nitrogen, phosphorus and potassium. Among these it must be confessed that potassium is perhaps the least well known. In many regions, the soils may contain a total potassium equivalent to 30,000 lb. of K_2O per acre in the root development zone, but only 100 to 300 lb. may be actually available to the crop. Why this should be so is still obscure, particularly when it is recalled that potassium salts are the most soluble of all inorganic salts and are recognised as among the most mobile ions inside the plant tissues.

When a potassium salt is added to the soil it reacts with the soil colloids by what is known as a base-exchange process, displacing calcium, magnesium or sodium ions. In turn, this potassium can be displaced out of the combination by other ions, including hydrogen ions, produced by soil micro-organisms and root respiration. It is by this process that potassium becomes available to plants. Different soils are however different in their ability or capacity to release potassium from non-exchangeable forms and it is this factor more than anything else which underlies the failure of chemical tests to diagnose the real nutrient status of soils as regards potassium.

Certain soils contain only relatively small amounts of exchangeable potassium, but are still capable of supplying sufficient potassium to produce excellent crops. Under such conditions, it is to be surmised that the crop derives potassium from even non-exchangeable forms.

The function of potassium is generally described in text-books, as that of a catalyst, essential for photosynthesis and carbohydrate metabolism, but this is not fully supported by critical evidence. Potassium is no doubt connected in some way with photosynthesis, but it is not quite clear how exactly it is concerned with the normal functions in the green leaf, as experiments on this aspect have yielded somewhat contradictory results. Consistent evidence is also lacking regarding the function of potassium in protein synthesis.

There is however a certain amount of information regarding the interaction of light and potassium and as a corollary on the influence of climate on potassium requirements of crop plants. Thus when tomatoes were raised under low levels of potassium, the growth could be improved either by improving the light or by increasing the potassium supply (Johnson and Hoagland). Similarly, less potassium was needed by tomatoes under green-house conditions, during sunny weather than during dull weather and for wheat and barley crops at Rothamsted, potassium manuring was found to be more effective in years of unfavourable weather.

A twenty-year rotation experiment near Aberdeen has been cited to show that rainfall was beneficial to plots receiving no potassium, as compared with those receiving potassinm. In other words, potassic fertilisers were more effective in dry seasons than in wet ones. This difference may be partly due to the direct harmful effect of drought on potassium-starved plants, where potassium deficiency symptoms appear earlier and are more severe in dry seasons and partly to the helpful effect of rainfall in promoting the absorption of potassium from the soil (Cowie, 1951).

Plants grown under sufficiency levels of potassium do not wilt or get scorched so easily in dry, hot weather as those growing in soils deficient in potassium, indicating that leaves well supplied with potassium transpire less. In other words, it enables the plant to use water more economically, but the question still remains, as to how exactly potossium affects the plant, to bring about this water economising ability.

It would be clear from the above that a great deal yet remains to be known, even for a proper understanding of the role of potassium in the physiology of the plant. The use of radio-active isotopes suggests itself for tracing the movements of potassium from the soil to the plant and leaves, but the main difficulty is that the available isotope 42 K has a high rate of decay, as its half-life is only 12·4 hours.

Under Indian conditions, it is assumed on the strength of past experiments that potassium is not essential, except for a few special crops like coconut and potato, but as Dr. Stewart concludes, our information is at present inadequate and further work is needed to determine the potassium content of individual soil types and the response to applications of potassium at varying levels of other nutrients, particularly nitrogen and phosphorus.

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Cardamom Thrips

(Taeniothrips cardamomi R.)

By

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and

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Cardamom, *(Elettaria cardomum* Maton,*)* is an indigenous spice crop of South India. It is found growing wild in portions of Western ghats from Coorg to Tirunelveli on elevations ranging from 2,500 to 5,000 feet above sea level. It is also cultivated in the above regions on a plantation scale. Only a few places possess the conditions conducive to the growth of cardamoms and as such the area under this spice crop is very much restricted. But the produce has a keen demand in continental markets and enjoys the position of a rare commodity.

Of late, the cultivation of this spice is very much handicapped by the incidence of cardamom thrips *(Taeniothrips cardamomi 'R').* It was first observed in the Anamalais in the year 1932 and has now spread over all the cardamom-growing areas causing heavy damage to the crop, resulting in lower yields and poorer quality of the produce.

The insect belongs to the order *Thysanoptera,* family *Thripidae,* the members which are characterised by fringed wings. The insect is provided with lacerating and sucking mouth parts. The male insects are shorter and about 0·9 to 1·0 mm. in length and of a slightly lighter colour than the female.

Life history of the insect: The whole life of the insect is spent on the cardamom plant itself. Eggs are laid in all the feeding areas at random. The mother digs into the tissue of the plant with its well-developed ovipositor and thrusts the eggs singly with one end of the egg exposed. It was observed that a female laid on an average 19 to 27 eggs in the course of 16–24 days commencing from 2 or 3 days after emergence from the pupa. The egg-laying record of some of the insects kept under observation is presented below:

Date of emergence	Insect I July 1, 1949		Insect II July 1, '49		Insect III July 25, '49		Insect IV Aug. 27, '49		Insect V Aug. 29, '49	
	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.
	July 3	1	July 3	2	July 28	1	Sept. 2	1	Sept. 1	2
	4	1	5	1	29	2	3	2	2	2
	5	2	6	1	30	1	4	2	4	1
	7	2	7	2	2	1	6	2	5	2
	8	3	10	2	3	3	8	1	6	1
	10	1	12	2	4	1	9	1	7	2
	12	2	14	2	6	2	10	2	8	2
	13	2	15	2	7	1	12	1	10	1
	14	2	16	3	10	3	14	1	12	3
	15	2	18	2	12	2	15	3	13	1
	16	3	19	3	13	2	18	2	15	2
	18	2	20	1	14	3	19	2	16	1
	19	3	21	2					17	2
	20	1							19	2
									20	1
									11	2
Total No. of eggs laid		27		25		22		20		27
Died.....	July 22, '49		July 21, '49		Aug. 17, '49		Sept. 21, '49		Sept. 21'94	

Date of emergence	Insect VI Aug. 31, '49		Insect VII Nov. 4, '49		Insect VIII Nov. 4, '49		Insect IX Mar. 10, '50		Insect X Mar. 11, '50	
	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.
	Sept. 2	2	Nov. 5	1	Nov. 5	1	Mar. 12	1	Mar. 12	2
	3	1	6	2	6	1	13	1	13	3
	4	2	7	1	7	2	14	1	14	1
	6	3	8	1	10	3	15	1	15	2
	8	1	9	4	11	2	17	1	16	2
	9	2	10	2	13	2	19	1	17	1
	11	2	11	3	14	3	20	2	18	1
	13	3	12	2	18	1	21	1	20	2
	16	2	13	2	19	2	22	1	21	2
	17	1	14	3	20	1	23	2	23	1
	18	2	15	1	21	1	24	1	24	1
	19	1	16	1			25	2	26	1
	20	2					27	1	28	2
							29	2	29	2
							30	1	30	1
							31	1	April 1	1
							April 1	2	2	2
							2	1		
							3	1		
Total No. of eggs laid		24		23		19		24		27
Died.....	Sept. 22, '49		Nov. 17, '49		Nov. 23, '49		April 4, '50		Ap. 4, '50	

The eggs are minute, about 0·3 m. m. long, pale white in colour, smooth and kidney-shaped. They hatch out 9–12 days after they are laid. A few days before hatching a pair of dark red eye spots develop at the broader exposed end of the egg and it turns brownish in colour just before hatching. There are four nymphal stages viz. the first instar, second instar, pre-pupa and pupa. The first two stages only are active and feeding stages. The prepupal and the pupal stages are non-feeding and quiescent ones. During the prepupal stage the insect develops two pairs of wing pads. These wing pads get well developed in the pupal stage. The pupa differs from pre-pupa in that the wing pads are longer, the antennae are held folded back on the dorsal side of the head and three ocelli are present in between the eyes.

The duration of the above four stages of development was worked out and the data gathered are given in the following table:

S. No.	Date of egg laying	Date of hatching i.e., (I Instar)	Date of I moult (II Instar)	Date of II moult (i.e., Pre-pupa)	Date of III moult (i.e., Pre-pupa)	Date of final moult (adult)	Duration of developmental period
1.	1—3—49	10—7—49	14—7—49	23—7—49	25—7—49	29—7—49	29 days.
2.	10—7—49	19—7—49	24—7—49	1—8—49	3—8—49	7—8—49	29 days.
3.	6—9—49	16—9—49	20—9—49	28—9—49	30—9—49	5-10—49	30 days.
4.	7—9—49	17—9—49	21—9—49	29—9—49	1—10—49	4-10—49	28 days.
5.	17-11—49	29-11—49	3-12—49	11-12—49	13-12—49	16-12—49	30 days.
6.	21—2—49	11-12—49	15-12—49	24-12—49	26-12—49	31-12—49	30 days.
7.	4—3—50	15—3—50	20—3—50	26—3—50	28—3—50	31—3—50	28 days.
8.	5—3—50	14—3—50	17—3—50	25—3—50	27—3—50	31—3—50	27 days.

From the above table it is seen that the duration of various stages are as follows: the egg stage - 9 – 12 days; first instar 3 – 5 days; second instar 7 – 9 days; pre-pupa 2 days only; pupa 3 – 5 days, The complete developmental period from egg to adult ranges from 27 to 30 days. The nymph moults four times before developing into an adult. The adult insects continue to live upto 25 to 30 days after full development.

The phenomenon of parthenogenesis occurs in this insect. In other words the female insect is able to reproduce itself without mating with male insects. To study this phenomenon, the insects were isolated in their pupal stage itself. A few days after emergence from pupa the female adults were found to lay eggs on pieces of leaves placed inside the tubes as feeding materials. The egg-laying record of some of these isolated females are given below:

Date of emergence	Female I 24—12—50		Female II 25—12—50		Female III 26—2—51		Female IV 25—2—51	
	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.
	Dec. 28	2	Dec. 29	1	Mar. 1	1	Mar. 1	2
	30	1	31	2	2	2	2	2
	31	2	Jan. 2	3	3	1	3	2
	Jan. 3	1	4	1	4	1	4	3
	4	1	5	1	5	2	5	3
	5	1	7	2	6	1	6	2
	8	2	8	2	7	1	7	1
	10–18	12	9	1	8	2	8	8
			10	6	9	2	9	1
					10	1	11	2
					11–15	6		
					16	1		
					17	1		
Total No. of eggs laid		22		19		22		26
Died		19—1—51		16—1—51		18—3—51		13—3—51

Date of emergence	Female V 26—2—51		Female VI 21—3—51		Female VII 27—3—51		Female VIII 10—5—51	
	date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.	Date	No. of eggs.
	Mar. 3	2	Mar. 24	2	Mar. 3	2	May 13	2
	4	3	26	2	4	1	14	1
	5	3	27	1	5	1	15	1
	6	2	28-2-4-51	6	6	2	16	2
	7	2	April 4	1	7	2	17	1
	8	1	6	1	9	2	18–27	12
	9	2	7	3	10	1		
	10	2	8	1	12	3		
	11–16	5	10	2	13	2		
	17	1			14	2		
	19	2			16	1		
	20	1			17	1		
	21	1			18	1		
	22	1			19	1		
	23	1						
	25	2						
Total No. of eggs laid		31		20		22		19

Though parthenogenesis is the common method of reproduction, copulation was often found in *Taeniothrips cardamomi*, both in the field and in the laboratory.

Nature and extent of damage: The insects feed on the plant sap. Due to heavy drain on the plant sap the plant loses its vigour. Badly infested panicles dry up. The flowers that survive the attack are malformed with characteristic scabs on the surface. The seeds are also rendered chaffy and odourless. By the incidence of this pest the normal yield has been brought down from 100 lb. to about 25 lb. per acre in recent years.

Control measures: Since the inception of the scheme various insecticides, both foreign and indigenous, were tried against this pest. Of those, nicotine sulphate 0·05% spray at 20 gallons per acre and Gammexane D ·025 dust at 3 - 4 lb. per acre proved to be both efficient and economical. (Subbiah, 1949).

Further trials were made in 1948 to test the efficacy of the following foreign and indigenous insecticides as sprays or dusts.

Spray

1. Nicotox 0·05%.
2. Nicophytan 0·5%.
3. Derryphytan 1%.
4. Lobelia decoction 1 lb. in 5 gallons.
5. Acorus decoction 1 lb. 10 gallons of water.
6. Torch Brand DDT 1%.

Dust

7. Acorus.
8. Turmeric.
9. Sandotox.
10. Gammexane D·025.
11. DDT 5%.

Treatments with the above insecticides were given once a month during a period of 3 months. One hundred flowers from each treated plot were examined for thrips a week after each treatment. The data are presented below :

Treatments.	No. of thrips in 100 flowers examined at random				No. of flowers infested out of 100 flowers examined at random.			
	July '41	Aug. '48	Sept. '48	Average.	July '48	Aug. '48	Sept. '48	Average.
Spray :								
1. Nicotox	24	6	16	15	19	4	13	12
2. Nicophytan	44	19	35	33	19	12	28	23
3. Derryphytan	34	44	42	40	30	21	34	31
4. Lobelia decoction	75	89	74	81	51	54	46	50
5. Acorus decoction	60	79	45	61	32	39	29	33
6. Torch Brand DDT	11	1	33	15	9	1	17	9
Dust :								
7. Acorus	74	55	84	71	45	38	45	42
8. Turmeric	39	74	52	55	27	44	37	36
9. Sandotox	28	50	51	43	22	32	27	27
10. DDT 5%	55	71	47	58	38	38	30	35
11. Gammexane D.025	14	13	14	14	11	10	8	10
12. Control (Untreated)	54	94	75	74	31	54	43	45

Nicotox (a concentrated nicotine preparation), Tata's Torch Brand DDT sprays, and Gammexane dust were found to give good results in the preliminary trials. Spraying with decoctions from indigenous insecticides, Lobelia and Acorus, and with dusts of indigenous materials, Acorus and Turmeric were not at all effective as plots treated with them were as bad as the untreated plots in thrips infestation.

Sprays Derriphytan and Nicophytan and dusts Sandotox and DDT 5% were effective in controlling thrips to some extent but did not compare favourably with nicotine sulphate and Gammexane.

To confirm the efficacy of the Torch Brand DDT spray which was promising in the preliminary trials, a randomised replicated trial on a field scale was started in September 1950 and this experiment is now in progress. In this trial, DDT is used in two concentrations of 0·05% and 0·25% and compared with nicotine sulphate 0·05% spray. Nine monthly treatments have been given so far. Flowers in the treated plots were examined for thrips both before and after every treatment. The data gathered are presented below:

No. of thrips in 100 flowers taken at random

Month	N. Sulphate		D.D.T. 0·25%		D.D.T. 005%		Control	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
September '50	22	2	16	4	26	18	22	24
October	18	6	8	2	30	26	32	34
November	14	6	26	2	52	58	60	88
December	8	2	2	0	14	4	30	32
January '51	4	2	6	0	28	14	30	24
February	18	0	18	0	26	10	30	28
March	10	4	16	4	14	13	20	16
April	6	4	6	2	16	14	24	32
May	14	2	20	6	26	18	22	18
Total ...	114	28	118	20	232	175	270	296
Percentage of reduction	75		83		25		10	

No. of infested flowers out of 100 taken at random

Month	N. Sulphate		D.D.T. 0.25%		D.D.T 0.05%		Control	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
September '50	20	2	14	4	18	16	20	20
October	12	6	8	2	26	20	22	24
November	14	6	12	2	28	38	42	60
December	8	2	2	0	14	4	24	24
January '51	4	2	6	0	24	14	26	14
February	16	0	16	0	22	10	24	22
March	10	4	16	2	12	12	14	10
April	4	4	6	2	14	12	22	28
May	14	2	20	6	18	16	18	12
Total ...	102	28	100	18	176	142	212	214
Percentage of reduction	73		82		19		—1	

It is seen that the dilute form of DDT 0·05% is not very effective in controlling thrips. But DDT 0·25%, a more concentrated form appears to be as effective as nicotine sulphate in reducing the population of thrips. Final conclusions can be drawn only after continuing the trials for one more season. During the next season, in addition to gathering data on the reduction of thrips due to the above insecticides, the effect of the treatments on yield will also be studied. This aspect could not be studied in the last season because the treatments were started only in September 1950. The flowers that were treated in September would have developed into ripe fruits only in January, at the fag-end of the picking season. As the treatments are now being given throughout the year, once a month, yields of 1951—'52 season are expected to give indications as to how the various treatments affect the yield.

"Kitkari AP 315" and "Kitkari BP 505" dusts prepared by Messrs Tatas & Co., and Sandotox dust prepared by Messrs Sandoz Products Ltd., were tried against thrips in another experiment started in April 1950. Gammexane was also included in the experiment for comparison. Twelve treatments were given at intervals of one month. Flowers were examined for thrips both before and after every treatment. The results of the examinations conducted during the season are tabulated below:

Number of thrips on 100 flowers, collected at random.

Month	Gamexane		Sandotox		Kitkari AP 315		Kitkari BP 505		Control	
	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment	before treatment	after treatment
April 1950	16	16	20	6	22	16	12	14	8	18
May	54	48	52	36	74	36	66	60	36	34
July	62	2	40	8	52	10	36	...	66	28
August	10	2	24	14	20	26	3	12	34	26
September	8	4	28	18	42	36	8	4	28	36
October	12	4	22	14	44	34	16	8	42	46
December	12	4	22	14	16	20	8	6	16	28
January 1951	4	2	4	4	18	10	14	8	14	6
February	6	0	30	24	14	10	12	4	22	20
March	10	4	18	14	18	14	16	6	22	20
April	4	0	30	4	14	6	20	6	14	26
Total ...	198	86	290	156	334	218	211	128	302	288
Percentage of reduction	57		46		32		39		5	

Month	Number of infested flowers out of 100 collected at random. Gamexane before treatment	Gamexane after treatment	Sandotox before treatment	Sandotox after treatment	Kitkari AP 315 before treatment	Kitkari AP 315 after treatment	Kitkari BP 505 before treatment	Kitkari BP 505 after treatment	Control before treatment	Control after treatment
April '50	14	2	16	6	10	8	8	16	8	12
May	30	24	24	24	36	20	28	32	20	18
July	46	2	30	8	28	6	28	0	40	18
August	8	2	18	12	18	22	2	12	32	22
September	8	4	32	14	28	24	8	4	20	22
October	6	4	16	10	28	22	14	8	26	28
December	10	4	20	10	16	16	8	6	14	22
January '51	2	2	4	4	12	6	6	6	8	8
February	6	0	22	18	4	6	10	4	20	12
March	8	4	12	8	12	8	16	4	14	12
April	4	0	14	4	14	6	18	6	14	24
Total ...	142	48	208	118	206	144	146	92	216	198
Percentage of *reduction*		66		43		30		37		8

It was seen that while Gammexane reduced the thrips population by 57%, the other insecticides were poorer than Gammexane though they had some little effect as compared with the untreated control.

Seven pickings were done in the trial plots during the season. The extent of damage caused by thrips to cardamom capsules in plots treated with various insecticides was determined by analysing the produce of every picking. The percentage of scab-free pods in the experimental plots is given below:

Treatments	Percentage of scab-free pods I	II	III	IV	V	Total for each treatment	Average
1. Gammexane	50	78	50	46	41	265	53·0
2. Sandox	23	25	35	51	56	190	38·0
3. Kitkari AP 315	11	29	20	23	31	114	22·8
4. Kitkari BP 505	36	60	48	27	33	104	46·8
5. Control	30	27	35	37	18	147	29·4

A statistical analysis of the above data showed that Gammexane gave significantly higher percentage of scab-free pods than the control. The other insecticides, namely Sandotox, Kitkari AP 315 and BP 505 did not give significantly higher percentage of scab-free pods than the control. Thus, none of the above insecticides was superior to Gammexane which is now popular.

Attempts were made to find out if it was necessary to repeat the operations once a month to control thrips effectively. Treatments once in two months with nicotine sulphate and Gammexane were tried and compared with treatments once a month. The object of the trial was to reduce the cost of operations without loss of efficacy. Such attempts proved unwise. The yield was reduced when the intervals between operations were prolonged beyond a month. The loss thus caused was more than the saving in the cost of treatments.

The experiments detailed so far go to show that Gammexane D·025 as a dust and nicotine sulphate 0·05% as a spray are quite effective in controlling thrips. Tata's Torch Brand DDT 0·25% is in the trial stage against cardamom thrips. This insecticide is promising, but final conclusions can be drawn only after completing the experiments now in progress.

The authors feel it a pleasure to acknowledge the valuable work done by their predecessors in the Cardamom Scheme in the campaign against this serious pest on cardamoms.

Testing Seed Viability by Chemical Means

(A biochemical method of testing seeds for germinability)

By

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Introduction: The standard method of testing the germination capacity of seeds is by germinating 100 seeds in either moist sand or blotting paper and counting the number that actually germinates. There are however two drawbacks in this method. One is that a period of 4 to 10 days is often needed to get the full count of seeds that germinate out of every 100 that are kept; the actual number of days required being different for different crops. The other is that in the case of certain crops and varieties, the seeds seem to have a period of "after-ripening" or dormant stage, during which the germination is poor and often nil. In such cases, the ordinary germination tests become inconclusive and valueless.

In recent times various attempts have been made to assess seed viability more rapidly without having to use the ordinary germination tests. Organic dyes like methylene blue and indigo carmine have been tried, where dead seeds get stained and live ones remain uncoloured, and also various salts of selenium and tellurium and chemicals like dinitrobenzene and 2, 3, 5 triphenyl - tetrazolium chloride and bromide, where viable seeds get stained and non - viable ones remain uncoloured.

The use of such chemicals for rapid assessment of seed viabillity has progressed considerably in recent years and the present paper is an account of tests made to see how far the chemical 2, 3, 5 triphenyl-tetrazolium chloride would prove useful in assessing the viability of some important grains and seeds.

Previous work and literature: The earliest record that is available of the use of a chemical for detecting seed viability is in 1876, when Dimitriewicz observed, on applying sulphuric acid to cut sections of grain seeds, that a deep rose colour developed in viable seeds within 2 - 5 minutes, while in poor seeds the colour appeared only after 15 minutes. Loew and Bokorny (1882) used a very dilute solution of alkaline silver nitrate for the same purpose and Molisch (1918) used silver sulphate solution. Lesage (1922) reported that viability could be tested within four hours by soaking seeds of *Lepidium sativum* in certain concentrations of potassium hydroxide. Attempts have also been made to utilise the relationship between germinative capacity and the respiratory activity of grains (Qvam, 1906) and by measuring the amount of heat given off by the seeds under conditions favourable for germination (Darsie et al, 1914) but these methods have the drawback that some special equipment is needed, for measuring respiration and temperature variations. Electrical methods were tried out by Waller (1901) and Fraser (1916) who found that "blaze current" response of seeds could be used as an indication of viability.

Fick and Hubbard (1926) reported that a correlation existed between seed viability and electrical conductivity. Besides these, a number of workers have attempted to make use of the activity of various enzymes and especially of catalase in seeds, as there was always a good deal of catalase activity when there was vitality in seeds. But these attempts were not in general very successful as tests of seed viability, due to the fact that dead seeds also contain catalase.

Another line of study was the effect of organic dyes on seeds, as for example, indigo carmine (Neljubow, 1925) which are capable of staining dead tissue, but do not penetrate living tissue. The chief difficulty in this method is that for each species the relation between the intensity of staining and germinative capacity has to be worked out separately (Mirov. 1936). Thus Sakata (1933) found that when the soaking period was too long in indigo carmine, even viable seeds got stained.

Other chemicals like para and ortho - dinitrobenzene have the property of getting reduced through the respiratory activity of living cells, into compounds that develop a characteristic colour reaction in the presence of ammonia (Gurewitsch 1935, Weise, 1937, and Dobrokhotov, 1937).

Even bacteria have been pressed into service for testing seed viability. Thus Scheurlen (Ref. Eidman 1936) is reported to have found that anthrax bacteria were able to reduce selenium and tellurium salts to form the free elements which could be readily distinguished by their colour reactions.

Sakata (1933) and Hasegawa (1935) reported satisfactory results with selenium and tellurium compounds on seeds of Japanese Cedar, cypress and pine, but Eidmann (1938) found that the selenium salts were more satisfactory. The selenium method was later modified and improved by Johnson (1947), as Hao (1939) pointed out that the selenium reaction was dependent on a number of factors such as respiration rate, temperature and sulphur content of seeds. Flemion (1936, 1938, 1941) found that a qricker assessment of viability was possible, by excising the embryos (peach, apple, pear, hawthorn etc.) and germinating them in moist peat moss or on moist filter paper in petri - dishes at room temperatures.

The chemical 2, 3, 5 triphenyl - tetrazolium chloride was synthesised (Pechmann and Runge) as long as 1894, but it was not until 1940, when Kuhn and Jorchel prepared a number of tetrazolium salts that its usefulness as an indicator of germinability was realised. Since then, a number of workers (Cottrell, 1947, Porter et al 1947, Dufrenoy and Pratt 1948, Goodsell, 1948 and Hyde 1949) have tested this compound and reported on its utility as an indicator for seed viability. The salt is colourless in aqueous solution, but in contact with soaked seeds, it gets reduced phytochemically to the insoluble, red (or carmine - coloured) triphenyl - formazan (Dufrenoy and Pratt). Microscopical examination of longitudinal freehand sections showed that the precipitate form (which indicates reducing activity) was localised at the sites of plasmodesmata and in lipidic parts of the cytoplasm. It was also observed that many other viable materials, in addition to seeds and yeast will reduce this chemical to give the staining reaction, at pH 6·9; such as the fleshy parts of apples, oranges, white and sweet potatoes; young leaves; the stigmas and ovaries of certain pollinated flowers; bull sperm and the blastoderm of hens' eggs (Mattson et al, 1947).

Material and Methods: A representative collection of seeds of important crops was first obtained, to serve as material for testing out the method, and 2, 3, 5 - triphenyl - tetrazolium chloride was tried in various concentrations and soaking periods, following preliminary presoaking in

distilled water. The effect of light and darkness on the staining response of different seeds was also studied and the effect of dehusking the seed, particularly in paddy was also sought to be determined.

The general method was as follows: A constant number of seeds was taken and soaked in distilled water for a specific period and then kept immersed in different strengths of the reagent 2, 3, 5 triphenyl tetrazolium chloride for a definite number of hours, six or eight hours as the case may be, according to the schedule of treatments drawn up beforehand. At the end of the period, the seeds were taken out and examined, where necessary under a hand lens or dissecting microscope, after longitudinal bisection, to note the depth of red colouration developed. The percentage of viability thus obtained was compared in each case, with actual germination tests that were started at the same time as the tetrazolium treatments.

The details of crop seeds and the treatments tried are given below:

(a) *Seeds*

(i) Paddy - Varieties G. E. B. 24, Co. 3, 4, 10, 13, 25, 26, AKP, 3, 4, 8; ADT 2, MTU. 7, 18, PTB. 10

(ii) Millets - Sorghum Co. 1, 2, 3, 5
Cumbu Co. 1, 3
Ragi Co. 1, 2
Tenai Co. 1.

(iii) Pulses - Redgram No. 37, Greengram No. 62, Blackgram No. 212, Cowpea No. C. 57

(iv) Oilseeds - Groundnut TMV. 1, 2, 3
Gingelly TMV. 1, 2, 3

(v) Cotton - MU 1. No. 4433

(b) *Treatments:*

(i) Concentrations - 10, 20, 50, 100, 200, 500, 1000 parts per million and 0·1%, 0·2%, 0·5%, 1·0%

(ii) Husking - Paddy - intact; Cotton - intact;
,, dehusked; ,, testa removed;

(iv) Soaked - (1) dry seed treated with chemical
(2) Soaked in distilled water for 1 hour before treatment in chemical
(3) Soaked in distilled water for 2 hours, 4 hours,
(4) Soaked in distilled water for 16 hours

(v) Light x Darkness.

Results: The results are presented in detail in tables in the Appendix and summarised below;

1. The chemical is capable of giving an index of viability which is closely similar to what can be determined by ordinary germination tests.

2. This result can be achieved more speedily than by ordinary germination, i. e., 24 hours' time as against four to ten days' time by ordinary methods.

3. The percentage of viability as indicated by the reagent is nearly always lower by about 3 to 4%, than the percentage obtained by straight germination tests. This can be considered as an advantage, as it gives a safer estimate in assessing the viability of seeds of improved strains that are intended for distribution to farmers.

4. Dehusking the seeds, especially in paddy, gives a higher percentage of stained seeds and lower concentrations of the reagent are sufficient, but dehusking does not seem to be essential to secure a reliable index of viability, except in the case of dormant varieties as in Co. 3 in paddy and in the case of cotton. This again may be considered as an advantage, since, if dehusking had really been necessary for a correct assessment of viability in all seeds by this chemical, the method would be too tedious for general adoption.

Further work is however, needed to settle the point whether dehusking is essential for certain crop seeds and especially dormant seeds i. e., seeds that need a certain period of "after-ripening" before they *germinate.*

5. The optimum soaking period in the chemical would be 8 hours, after a preliminary soaking in distilled water. Six hours in the reagent is also sufficient in some cases, but taken as a whole, an eight-hour period is preferable as a general rule.

6. Soaking in the reagent for 24 hours, as was suggested by some previous workers does not appear to be necessary, but a preliminary soaking in water is necessary.

7. Tests were also carried out to see if there is any difference in response between seeds kept in the dark and those kept in light, after treatment with the reagent. No difference was perceptible in the staining response and it may therefore be concluded that seed treatment with triphenyl tetrazolium chloride may be done in ordinary light without any extra precautions to ensure darkness.

8. A certain amount of varietal difference appears to exist, at least in paddy, in the staining response to tetrazolium chloride. This aspect needs further study on a more exhaustive basis, to assess the extent of these varietal differences in various crops and decide how far it is related to dormancy and how far such differences could be avoided or overcome.

9. In view of the high cost of the chemical, namely Rs. 21—8—0 for 5 grams, further work is also desirable to find out means of ensuring a reliable viability index with lower concentrations of the chemical than the 0·5% and 1% that are now found necessary. The use of some other chemicals, acids or oxidation-reduction reagents as adjuvants and the use of different temperatures are also possibilities that deserve exploration.

Discussion: The potentialities of tetrazolium salt as a reagent for testing viability in living tissues in general, are sufficiently promising to deserve a fuller investigation. The work of Mattson et al (1947) das shown that the enzyme systems responsible for the reduction of tetrazolium salts are present in a wide variety of living tissues. Thus Dufrenoy and Pratt (1948) utilised the reagent for testing the viability of sugarcane culms. Lakon soaked the seed for several hours in water to initiate the germination process and bisected the seed longitudinally and then treated with 1% tetrazolium for 2 to 10 hours in the dark at room temperature. Porter and his co-workers soaked rice grains in water for 16 hours, then bisected them longitudinally and treated them with 1% tetrazolium in the dark for 4 hours. A large variety of grains was tested viz., corn, wheat, barly, oats, rice, sorghum, cotton, legumes, soybean, pea, buckwheat and bahie grass; using different concentrations ½, 1 and 2% and different periods of soaking in the reagent. They concluded that the method was likely to prove useful in physiological experiments, although it was not found to be entirely dependable in the case of legumes and in sorghum. The sectioning method adopted both by Lakon and Cottrell involves considerable time and labour and in the light of subsequent work does not seem to be quite essential. Similarly it is not also necessary to keep the treated seeds in the dark, to get staining reactions comparable to actual germination tests.

Dehusking was recommended by L. Venkataratnam (1951) as necessary in rice and particularly in the case of rice varieties that have an appreciable dormant period; this aspect requires a fuller investigation before definite conclusions can be made regarding its necessity. In view of the time and labour involved in dehusking the seed without injuring the embryos it seems advisable to explore methods where dehusking can be omitted even in the case of dormant varieties where it is now considered to be necessary. Further work is also needed to settle the limits of reliability of the tetrazolium method. Thus Goodsell (1948) found the method unreliable when applied to immature maize seed which had been exposed to frost and Porter et al (1947) found that this method needed considerable modification when used for *Paspalum notatum*.

Summary and Conclusions: The results of tests made on representative collection of crop seeds, namely rice, millets, pulses, oilseeds and cotton with the chemical 2, 3, 5-triphenyl-tetrazolium chloride are presented and discussed.

The use of this chemical is helpful is assessing seed viability more expeditiously than by the ordinary germination tests.

The lines along which further study is needed to make the fullest use of the potentialities of the chemical as a test reagent for viability in living tissues are briefly indicated.

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APPENDIX.

TABLE I.

Experiment to determine if presoaking in water is needed, before tetrazolium *treatment.*

	Dry seeds soaked in 1% Tetrazolium chloride for 16 hours	Treatments 16 hours in water + 8 hours in 1% Tetrazolium chloride	Control
Paddy:			
AKP 3	4%	92 (in 0·5%)	98%
AKP 4	Nil.	90 (in 0·5%)	100
AKP 5	12	86	100
AKP 8	4	96 (in 0·5%)	100
ADT 2	4	96	100
Co 3	4	44	100
Co 4	4	90 (in 0·5%)	100
Co 10	8	96	100
Co 13	4	96	100
Co 25	4	90	96
Co 26	8	96	98
GEB 24	8	90	96
Ragi:			
Co 1	46	96	100
Co 2	78	98	98
Gingelly:			
TMV 1	30	78	96
TMV 2	38	86	89
TMV 3	24	92	100
Cumbu:			
Co 1	82	94	98
Co 1	90	82	94
		92 (0.5%)	

Conclusion: Presoaking of the seeds in distilled water is necessary, to give reliable staining by subsequent soaking in tetrazolium chloride solution.

Note: In this table as well as in those that follow, the figures given represent percentages of seed-viability as indicated either by actual germination in the case of "Control" or by the number of seeds that develop the carmine red strain after treatment in tetrazolium chloride.

TABLE II.

Experiment to determine the presoaking period in water that is necessary before tetrazolium treatment.

	Concentrations of triphenyl tetrazolium chloride										
	10 ppm	20 ppm	50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm = (1·0%)	0·2%	0·5%	1·0%	Control
Paddy; GEB 24:											
(1) Dry seed in tetrazolium for 8 hours.	Nil	Nil	Nil	Nil	Nil	Nil	2	4	6	6	96%
(2) D. Water 16 hours + tetrazolium 8 hours.	24	28	40	76	92	92	92	96	98	90	96%
Co 4:											
(1) D. Water 1 hour + tetrazolium 8 hours.	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	6	24	28	18	12	100%
(2) D. Water 2 hours + tetrazolium 8 hours.	Nil	Nil	Nil	Nil	Nil	4	10	10	20	2	100%
(3) D. Water 16 hours + tetrazolium 1 hour.	8	20	26	68	76	82	88	50	90	36	100%

Conclusion: A preliminary soaking in water for 16 hours followed by 8 hours in 0·5 or 1·0% solution of the reagent is best.

TABLE III (a) and (b).

Optimum concentration of Tetrazolium Chloride, for Paddy.

(The grains are soaked first in distilled water for 16 hours and then in the reagent for 8 hours and examined for red staining.)

(a) With Husk.

Concentration of reagent	10 ppm	20 ppm	60 ppm	100 ppm	200 ppm	600 ppm	1000 ppm	0·2 %	0·5 %	1·0 %	Control Germination percentage)
Strains											
1. GEB 24	24	28	40	76	92	92	96	98	96	90	96%
2. ADT 2	46	50	56	82	86	94	94	94	96	96	100%

TABLE III (a) and (b)

Optimum concentration of Tetrazolium Chloride, for Paddy.

(a) With Husk.

Concentration of reagent	10 ppm	20 ppm	50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm (≈1·0%)	0·2 %	0·5 %	1·0 %	Control (Germination percentage)
3. Co 3	44	40	44	44	46	44	58	48	58	44	100
4. Co 4	8	20	26	68	76	82	88	50	90	36	100
5. Co 10	84	100	100	98	94	98	100	100	96	96	100
6. Co 13	20	20	98	96	98	94	96	98	100	96	100
7. Co 25	18	20	40	50	74	84	82	92	84	90	96
8. Co 26	94	94	94	96	94	100	100	100	96	96	98
9. AKP 3	14	40	90	98	100	86	78	88	92	82	98
10. AKP 4	4	2	14	4	16	34	74	72	90	72	100
11. AKP 5	20	8	24	20	44	58	74	70	84	86	100
12. AKP 8	40	42	54	46	66	80	84	90	96	88	100
13. MTU 7	4	4	34	50	100	90	98	100	86	90	100
14. MTU 8	40	40	40	50	66	80	72	92	92	84	100
15. PTB 10	18	26	36	40	66	98	100	84	98	94	100

(b) Without Husk.

	10 ppm	20 ppm	50 ppm	100 ppm	200 ppm	500 ppm	1000 ppm	0·2 %	0·5 %	1·0 %	Control
1. GEB 24	68	70	70	80	90	94	92	96	96	96	100
2. ADT 2	54	54	60	82	92	96	96	94	100	96	100
3. Co 3	100	100	100	100	100	100	100	100	100	100	100
4. Co 4	80	62	92	72	96	96	96	94	88	90	100
5. Co 10	28	24	66	76	80	80	94	88	92	96	98
6. Co 13	14	14	72	90	94	94	88	94	96	96	100
7. Co 25	42	20	50	62	74	90	96	100	82	88	100
8. Co 26	86	30	50	64	70	86	90	90	98	90	100
9. AKP 3	94	28	60	80	82	94	88	94	94	100	100
10. AKP 4	8	...	20	6	20	40	92	78	88	72	100
11. AKP 5	24	6	28	20	56	70	80	84	84	90	100
12. AKP 8	52	48	72	68	78	78	98	92	96	88	100
13. MTU 7	10	16	58	86	88	88	88	90	94	98	100
14. MTU 8	6	8	40	60	72	74	76	76	88	84	100
15. PTB 10	20	30	34	40	70	100	100	100	100	98	100

Conclusions: (1) The optimum concentration i.e. the minimum strength of the reagent that gives the nearest approach to the ordinary germination test, lies between 0·2 and 0·5 per cent.

(2) Dehusking the grains *before* treating with tetrazolium chloride does *not seem to be necessary*; except probably in varieties that have a dormant period after harvest e.g. *Co.* 3. In Co 10, dehusking has not improved the percentage of staining.

(3) The germinative capacity indicated by the reagent is nearly always lower than in direct germination tests, by about 3–4 per cent.

TABLE IV (a) and (b).

Optimum Soaking Period — For Paddy.

(The seeds were soaked first in distilled water for 16 hours and then in 2, 3, 5 triphenyl-tetrazolium chloride, for various periods and examined for carmine-red staining. Three concentrations of the reagent were used in this trial.

(a) With Husk.

Concentration of reagent	Time 1 hour 0.2 %	0·5 %	1·0 %	2 hours 0·2 %	0·5 %	1·0 %	4 hours 0 2 %	0·5 %	1 0 %	6 hours 0·2 %	0 5 %	1·0 %	8 hours 0·2 %	0·5 %	1·0 %	Control (with husk) germination percentage
Strains	(Percentage of seeds — stained red)															
1. GEB 24	22	16	16	42	48	58	42	40	54	92	80	94	98	96	90	96
2. ADT 2	70	66	74	74	78	92	86	86	92	94	94	98	94	94	96	100
3. Co 3	8	12	18	8	12	18	28	22	22	34	44	44	48	58	44	100
4. Co 4	16	14	12	22	16	12	20	20	30	36	26	48	50	90	36	100
5. Co 10	40	40	38	44	40	36	42	42	40	58	62	64	100	96	96	100
6. Co 13	8	8	6	40	46	52	54	52	58	98	100	96	98	100	96	100
7. Co 25	...	...	...	...	8	10	4	12	12	4	12	22	92	84	90	96
8. Co 26	14	16	14	20	14	14	24	24	16	20	22	28	100	96	96	98
9. AKP 3	...	...	...	...	4	...	18	10	22	80	88	94	88	92	82	98
10. AKP 4	...	...	...	16	18	14	60	56	54	64	74	94	72	90	72	100
11. AKP 5	...	...	...	16	10	16	22	10	18	60	74	88	70	84	86	100
12. AKP 8	...	...	...	4	8	16	16	20	16	62	96	88	90	96	88	100
13. MTU 7	...	...	...	20	12	6	10	8	8	12	22	8	100	86	90	100
14. MTU 8	...	...	2	10	14	14	20	18	14	20	20	24	92	93	84	100
15. PTB 10	...	4	6	8	8	14	22	28	18	20	32	34	84	98	94	100

(b) Without Husk.

Concentration of reagent	Time 1 hour 0·2 %	0·5 %	1·0 %	2 hours 0·2 %	0·5 %	1·0 %	4 hours 0·2 %	0 5 %	1·0 %	6 hours 0·2 %	0·5 %	1·0 %	8 hours 0·2 %	0·5 %	1·0 %	Control (without husk)
Strains																
1. GEB 24	16	34	30	44	52	60	72	76	72	78	72	72	96	96	96	100
2. ADT 2	20	8	...	58	54	32	80	80	76	92	86	82	94	100	96	100
3. Co 3	58	82	58	88	96	88	92	98	90	94	98	96	100	100	100	100
4. Co 4	28	12	32	48	42	60	78	80	82	84	86	88	94	88	90	100
5. Co 10	2	8	4	12	34	34	62	50	62	80	88	94	88	92	96	100
6. Co 13	14	6	6	46	52	62	92	92	86	94	94	88	94	96	96	100
7. Co 25	...	2	...	40	40	56	54	56	60	90	80	86	100	82	88	100
8. Co 26	30	38	8	54	70	52	74	82	80	86	98	88	90	98	90	100
9. AKP 3	14	40	34	44	66	82	94	88	96	94	94	100	94	94	100	100
10. AKP 4	...	...	...	26	34	22	58	72	62	62	80	66	78	88	72	100
11. AKP 5	...	...	...	26	28	10	60	72	66	74	82	88	84	84	90	100
12. AKP 8	...	2	2	2	2	2	80	82	70	88	96	82	92	96	88	100
13. MTU 7	8	...	...	42	56	48	72	86	80	86	88	82	96	94	98	100
14. MTU 8	2	...	...	22	40	32	40	78	74	76	86	78	76	88	84	100
15. PTB 10	...	4	6	14	20	36	24	32	60	35	46	70	100	100	98	100

Conclusions : (1) A soaking period of 8 hours in the reagent at concentrations of 0·2 or 0·5% may be taken as optimum for paddy varieties.

(2) Dehusking the grains is not essential, except in certain varieties, as in Co 3.

TABLE V.

Optimum soaking period for different crops.

	Concentrations %	Hours: 1 hour 0·2	0·5	1·0	2 hours 0·2	0·5	1·0	4 hours 0·2	0·5	1·0	6 hours 0·2	0·5	1·0	8 hours 0·2	0·5	1·0	Control	Remarks
1.	Black gram 212	80	66	76	50	66	46	58	54	50	80	80	84	68	64	72	98	(Soaked in D.W. for 1 hour and then in reagent for varying periods)
2.	Cow pea Co 57	16	18	18	38	44	74	40	36	38	54	56	52	54	58	56	98	
3.	Red gram 37	10	22	26	10	20	26	28	52	80	36	46	68	70	60	62	94	
4.	Green gram 62	62	60	68	66	66	70	44	68	70	50	68	74	96	96	98	100	6 hours in reagent seem to be sufficient.
5.	Cholam Co 1	20	24	28	26	36	40	28	48	52	42	60	60	92	98	90	98	Soaked first in D. Water for 16 hours and then in reagent for varying periods.
6.	Cholam Co 2	60	64	74	64	78	86	86	96	86	94	92	94	98	100	100	100	
7.	Cholam Co 3	8	14	18	12	20	24	72	74	60	82	70	64	100	100	96	100	
8.	*Cholam Co 6*	14	18	24	16	24	24	62	74	80	66	70	80	82	90	96	98	
9.	Ragi Co 1	42	44	44	52	54	56	60	60	64	62	72	62	100	96	96	100	
10.	Ragi Co 2	38	42	42	70	78	62	88	92	84	88	96	94	88	98	98	98	
11.	Cumbu Co 1	34	38	36	60	82	72	88	86	72	88	94	90	88	92	94	98	
12.	Cumbu Co 3	8	18	22	28	30	34	46	38	38	46	40	38	88	86	90	92	
13.	Tenai Co 1	18	18	16	44	38	24	60	42	40	64	48	40	86	92	82	94	
14.	*Gingelly* TMV 1	2	6	10	8	14	16	42	54	64	60	82	84	52	78	78	96	
15.	Gingelly ,, 2	4	10	14	8	14	20	24	24	22	86	80	82	86	82	86	89	
16.	Gingelly ,, 3	0	4	8	4	8	8	16	18	14	90	84	92	86	86	92	100	
17.	Groundnut TMV 1	12	28	28	36	80	64	64	88	96	76	92	96	72	96	100	100	
18.	Groundnut ,, 2	60	60	68	100	96	96	100	100	100	100	100	100	100	100	100	100	4 hours soaking in reagent seems to be enough.
19.	Groundnut ,, 3	56	88	92	72	100	100	88	100	100	96	100	100	98	100	100	100	
20.	Cotton K 5	12	20	28	48	84	84	84	92	88	92	92	88	92	92	88	96	1950–51 seed } Presoaked first
21.	Cotton MU 1	8	8	24	8	8	28	8	24	32	44	44	60	48	48	64	64	1949–50 seed } in D. W. for 16
22.	Cotton ,,	4	4	12	12	12	28	36	32	36	44	44	66	92	92	92	96	1950–51 seed } hours and then
23.	Cotton 4463	12	16	16	20	24	28	44	44	56	76	84	72	76	88	92	100	1949–50 seed } in reagent for
24.	Cotton ,,	0	4	8	4	16	20	32	56	48	32	64	76	48	68	80	100	1950–51 seed } varying periods.

Conclusions: (1) In general, 8 hours of treatment with reagent solution is needed to get maximum staining.

(2) The exceptions are groundnut varieties TMV 2 and TMV 3 where 4 hours appear to be sufficient and Black-gram where 6 hours were found sufficient. More work is however needed to settle the optimum soaking periods for these crop plants.

TABLE VI

Optimum soaking period—For cotton

Varieties		Concentration 500 ppm	With testa 0·1%		0·2%		0·5%		1·0%		Control.	Testa removed (Dehusked) 500 ppm		1000 ppm = 0·1%		0·2%		0·5%		1·0%		Control
Hours		6	8	6	8	6	8	6	8	6	8		6	8									
Cotton K.5	(1950 seed)	80	84	92	92	92	92	92	92	88	88	96	72	80	76	88	68	84	80	100	88	100	100
Cotton MU 1	(1949 seed)	16	24	20	28	44	48	44	48	60	64	88	68	96	76	100	80	100	80	100	84	100	100
Cotton MU 1	(1950 seed)	24	84	24	84	44	92	44	92	66	92	96	68	88	76	92	84	96	88	100	92	100	100
4562	(1949 seed)	56	68	68	72	76	76	84	88	72	82	100	60	80	72	84	72	92	100	100	92	100	100
4463	(1950 seed)	36	36	36	60	32	48	64	68	76	80	100	96	100	100	100	76	100	76	100	100	100	100

Conclusions:— (1) Removal of testa gives a higher percentage of staining with lower concentrations of reagent.

(2) Old seed has a lower percentage of germination than more recently harvested e.g. 1949 seed as compared to 1950 seed.

(3) 8 hours' soaking is preferable for cotton also.

TABLE VII

Effect of light and darkness on staining effect

Period	1 hour			2 hours			4 hours			6 hours			8 hours			Control
Concentration%	0·2	0·5	1·0	0·2	0 5	1·0	0·2	0·5	1·0	0·2	0·5	1·0	0·2	0·5	1·0	
Paddy (with husk)																
MTU 7, Light	0	0	0	20	12	6	10	8	8	12	22	8	100	86	90	100
,, Dark	14	16	16	18	18	18	18	20	18	18	20	18	24	24	24	100
AKP 3, Light	...	...	...	...	4	...	18	10	22	80	88	94	88	92	82	98
,, Dark	6	10	10	12	16	12	18	24	12	36	22	22	34	34	32	
Co. 3. Light	8	12	18	8	12	18	28	22	22	34	44	44	48	58	44	100
,, Dark	6	2	2	34	34	50	34	38	50	60	58	58	85	88	98	
GEB. 24, Light	...	...	...	...	...	...	42	40	54	92	80	94	98	96	90	96
,, Dark	...	...	...	...	...	...	40	42	28	46	46	48	74	72	72	
Paddy (without husk)																
MTU. 7, Light	8	...	...	42	56	48	72	86	80	86	88	82	96	94	98	100
,, Dark	8	10	20	26	30	40	44	44	80	62	62	88	76	68	96	
AKP. 3, Light	18	40	34	44	66	82	94	88	96	94	94	100	94	94	100	100
,, Dark	60	52	50	84	80	68	90	84	70	100	96	84	100	100	96	
CO. 3, Light	58	82	58	88	96	88	92	98	90	94	98	96	100	100	100	100
,, Dark	4	2	...	52	64	78	78	74	90	92	88	96	98	94	98	
GEB. 24, Light							72	76	72	78	72	72	96	96	96	105
,, Dark							58	64	66	76	72	68	82	72	76	

Mean values of 54 observations.

	Light	Dark
With husk ...	38·3%	32·4%
Without husk ...	76·7%	66·7%

Conclusions :— The seeds can well be treated in ordinary light with the reagent, and no advantage is gained by keeping them in the dark. On the other hand, staining is slightly better in light.

TABLE VIII

Optimum concentration of tetrazolium for different crops

Concentrations	10 ppm		20 ppm		50 ppm		100 ppm		200 ppm		500 ppm		0·1%		0·2%		0·5%		1 0%		Control
Time	6 hrs.	8 hrs.	6	8	6	8	6	8	6	8	0	8	6	8	6	8	6	8	6	8	
1 Blackgram	212	72	72	72	68	70	68	74	68	66	70	80	68	78	76	80	68	80	64	84	72	98
2 Cowpea	C57	32	16	22	32	18	26	58	52	26	44	40	50	36	46	54	54	56	58	52	56	98
3 Redgram	37	...	10	6	12	8	12	8	60	10	42	10	52	8	58	36	70	46	60	68	62	94
4 Greengran	62	26	92	48	92	56	94	54	92	46	96	54	96	68	88	50	96	68	96	74	98	100
5 Cholam	Co. 1	4	20	4	58	10	62	14	66	30	72	44	78	40	92	42	92	60	98	60	90	98
6 ,,	Co. 2	50	96	58	96	62	98	64	96	60	96	88	98	92	98	94	98	92	100	94	100	100
7 ,,	Co. 3	32	74	36	80	38	86	64	96	54	96	72	100	76	92	82	100	70	100	64	96	100
8 ,,	Co. 6	26	42	32	48	36	54	40	60	24	62	54	74	54	80	66	82	70	90	80	96	98
9 Ragi	Co. 1	18	36	20	40	54	60	60	74	76	78	76	92	64	94	62	100	-72	96	62	96	100
10 ,,	Co. 2	26	38	34	48	46	52	60	64	74	76	84	88	76	92	88	88	96	98	94	98	98
11 Cumbu	Co. 3	22	24	34	38	58	60	66	68	86	88	88	88	88	92	88	88	94	92	90	94	98
12 ,,	Co. 3	4	8	4	8	14	18	26	42	28	62	36	62	40	74	46	88	40	86	38	90	92
13 Tenai	Co. 1	12	32	14	38	20	54	40	60	54	92	60	84	60	86	64	86	48	92	40	82	94
14 Gingelly	TMV 1	18	22	20	28	26	30	32	38	34	42	40	84	44	52	60	52	82	78	84	78	96
15 ,,	,, 2	14	20	18	26	26	34	30	46	54	64	84	86	78	80	86	86	80	82	82	86	89
16 ,,	,, 3	34	36	44	46	46	52	60	66	70	72	74	78	82	84	90	86	84	86	92	92	100
17 Groundnut	,, 1	12	36	28	32	28	36	44	68	20	72	40	84	76	88	76	72	92	96	96	100	100
18 ,,	,, 2	40	48	20	24	28	40	52	56	92	96	92	92	96	96	100	100	100	100	100	100	100
19 ,,	,, 3	40	48	16	20	32	36	40	76	80	96	96	98	96	100	96	98	100	100	100	100	190
20 Cotton	K. 5											80	84	92	92	92	92	92	92	88	88	96
21 ,,	MU. 1											24	84	24	84	44	92	44	92	56	92	96
22 ,,	4463			Lower concentrations not tried								36	36	36	60	32	48	64	68	76	80	100
23 ,,	4463											56	68	68	72	76	76	84	88	72	92	103

Conclusions :— (1) A concentration of 1·0% solution of 2, 3. 5 triphenyl-tetrazolium chloride would be the best for general adoption, although 0·5% seems to be sufficient in some cases.

(2) Soaking for 8 hours in reagent is preferable to 6 hours.

Gleanings

What about Krilium? A new Soil Conditioner Hits the News: With the suddenness of an unpredicted summer electrical storm, Krilium has been hurled at the American people via television, radio, trade publications, daily newspapers and monthly newspapers and monthly news magazines. The first wave of publicity has passed and it seems likely that Monsanto Chemical Co., has developed a soil conditioner that may help change the course of history, if the claims presently made for Krilium are borne out in actual practice.

A Fertilizer? Krilium is not a fertilizer. It has no demonstrable plant food value. Krilium is a soil conditioner and a soil stabilizer; and in non-technical terms, it works this way: The polymer is a water-soluble, synthetic chemical of the plastic family. When Krilium is dissolved in water, the small particle of Krilium (negatively charged Krilium ions) have 100 or more negative charges. It is well known that unlike charged particles attract each other, so when positively charged clay particles in the soil meet and touch negatively charged Krilium particles in the wet soil, each clings to the other with the fervency of young lovers in springtime. Not only are Krilium ions attracted to the positively charged clay particles, but also Krilium ions are bound to each other in the Krilium molecule. When the multitude of hungry negative Krilium ions have satiated their appetite for clay particles and can hold no more, an infinitesimally small "lump" of soil is formed. Since these "lumps" are attracted to each other because of positive and negative charge arrangements, a tiny porous soil aggregate is formed in short order.

Principal Uses: Krilium's conditioning effect is particularly noticeble on soils of high clay content. Such soils become more porous and friable within 24 hours of treatment. Further, numerous round, spongy balls appear, ranging in size from a pinhead to a pea. The treated soil becomes remarkably easy to work, offering minimum resistance to plow, harrow or spade. A major use of Krilium is expected to develop in treating banks and slopes to protect them temporarily against rain erosion until vegetation develops. In combating erosion, Krilium mechanically "hold" the soil, improves drainage, lessens packing and slaking, and aids seedling, germination and emergence. Erosion control experimental work has indicated that Krilium treatment is far cheaper than special erosion netting, sod or sprigging. At a rate of 1 pound per hundred square feet, Krilium treatment appears equivalent to straw mulching at the rate of 2 to 4 tons per acre.

Relation to Fertilizer: A significant aspect of the use of Krilium is its ability to assist soil to "catch" and "hold" water for relatively long periods of time. It is this camel-like quality of material that will benefit the users of fertilizer. In rather dry regions of the United States or in other areas where the rainfall is spasmodic, the rate of fertilizer application is comparatively low because there may not be enough water available at certain times for the growing plant to take full advantage of the plant food the former would make available if there were more rain. Because the addition of Krilium causes the more rapid infiltration of water with less runoff during rainfalls and because it assists the soil in holding up to 40 per cent., more water is available to the plant in the treated layer of earth, and farmers can be expected to use more fertilizer per acre as they become better acquainted with the use of Krilium and the benefits of increased fertilizer use. In addition to these advantages, evaporation of moisture from the surface of a treated soil has been determined to be from 30 to 40 per cent slower than from untreated roil of the same lot. Soil aeration also is improved.

Duration of Treatment: Two important facts are known which show that Krilium is highly persistent in its effects on soil. Krilium does not appear to be subject to oxidation or to attack by soil organisms; it is not leached out by weather. In accelerated laboratary tests, Krilium soil treatment has resisted bacterial decomposition and its effect on structure has persisted as much as 30 times as long as commercial composts. No deterioration of greenhouse or field plots have been noted in 3 years. As is true with natural soils of good tilth, the structure can be degraded by mechanical compaction or overworking.

Its Make-Up: Krilium is a polymer of polyacrylonitrile, fine crystal, light yellow in colour, slowly hygroscopic, its bulk density is 57·8 pounds per cubic foot and it dissolves rapidly in water. It can be stored in dry places in tightly closed containers. Krilium can easily be mixed with other products except where the other product offers a hazard. Combinations of Krilium and ammonium nitrate probably should be avoided (Fertilizer Review, Jan.-Feb.-March 1952, p. 10.)

(T. R. N.)

Weather Review — For March 1952

RAINFALL DATA

Division	Station	Total rainfall for the month	Departure from normal in inches	Total since January 1st in inches	Division	Station	Total rainfall for the month	Departure from normal in inches	Total since January 1st in inches
Orissa & Circars.	Gopalpur	0·4	—0·2	0·8	Central Contd.	Coimbatore A. M. O.*	0·3	+0·1	1·1
	Calingapatnam	0·6	+0·2	0·6		Coimbatore	0·5	—0·0	1·2
	Visakhapatnam	0·0	—0·5	0·2		Tiruchirapalli	0·0	—0·4	1·8
	Arakuvalley*	1·3	+0·3 @	1·3	South	Nagapattinam	0·0	—0·8	4·7
	Anakapalle*	0·1	—0·2	1·7		Aduthuari*	0·0	—0·5	6·0
	Samalkot*	Tr.	—0·2	Tr.		Pattukottai*	0·0	—1·4	3·3
	Kakinada	2.7	+2·2	3·6		Madhurai	0·1	—0·6	5·0
	Maruteru*	0·0	—0·5	0·4		Pamban	0·0	—0·7	7·2
	Masulipatnam	0·0	—0·4	0·5		Koilpatti*	0·7	—0·8	3·0
	Guntur*	0·0	—0·5	0·7		Palayamcottai	0·1	—0·9	4·3
	Agrl. College, Bapatla*	0·0	—0·9	0·1		Ambasamudram*	0·3	—0·9	4·8
	Agrl. Farm Bapatla*	0·0	X	0·2					
	Rentachintala	0·0	—0·1	0·3	West Coast	Trivandrum	0·6	—0·9	1·9
Ceded Dists.	Kurnool	0·0	—0·2	0·0		Fort Cochin	2·6	+0·6	6·4
	Nandyal*	0·0	—0·5	0·0		Kozhikode	0·3	—0·1	0·4
	Hagari*	0·0	—0·2	0·0		Pattambi*	0·0	—0·8	2·3
	Siruguppa*	0·0	—0·1	0·1		Taliparamba*	0·0	—0·3	2·0
	Bellary	0·0	—0·2	0·1		Nileshwar*	0·0	—0·3	0·2
	Cuddapah	0·0	—0·2	0·0		Pilicode*	0·0	—0·4	0·2
	Kodur*	0·0	—0·5	0·2		Mangalore	0·0	—0·5	0·0
	Anantapur	0·0	—0·2	0·0		Kankanady*	0·0	—0·6	0·0
Carnatic	Nellore	0·0	—0·2	0·0	Mysore & Coorg.	Chitaldrug	0·0	—0·2	0·7
	Buchireddipalem*	0·0	—0·3	0·1		Bangalore	0·0	—0·4	0·4
						Mysore	0·0	—0·5	0·8
	Madras (Meenambakkam)	0·0	—0·3	0·8		Mercara	0·0	—0·8	0 6
	Tirurkuppam*	0·3	—0·8@	0·9	Hills	Kodaikanal	1·3	—0·5	5·1
	Palur*	0·0	—0·6	1·7		Coonoor*	0 4	—2·1	11·3
	Tindivanam*	0·1	—0·5	2·6		Ootacamund*	1·8	—1·1	3·0
	Cuddalore	0·0	—0·7	2·5		Nanjanad*	0·1	—1·1	2·1
Central	Arogyavaram								
	Chittoor Dt.	0·6	+0·1	0·6					
	Vellore	0·0	—0·3	0·5					
	Gudiyatham*	0·1	—0·2	0·1					
	Salem	0·1	—0·4	0·7					

Note:—

1. * Meteorological stations of the Madras Agricultural Department.
2. @ Average of nine years' data for Tirurkuppam and eight years' data for Araku Valley is given as normal.
3. Average of ten years' data is taken as normal.
4. X The farm was started only this year.
5. Tr. = 1 to 4 cents of rain.

Weather Review for February 1952

An anticyclonic circulation existed over Madhya Pradesh, Utter Pradesh and Madhya Bharat on the first day of the month and persisted for two days. Under the the influence of an anticyclonic circulation over the North and the Central Bay of Bengal on the 4th February, incursion of moist air took place into the Central parts of India. Another feeble anticylonic circulation that was present over the North and the Central Bay of Bengal on the 6th persisted for two more days and extended into Orissa and coastal Andhradesa on the 8th February. Under its influence there was incursion of moist air into Madhya Pradesh and the adjoining parts. A shallow low appeared in the East Arabian Sea, off the Konkan-Kathiawar Coast on 7—2—1952, persisted for three days and became unimportant on 10—2—1952. Due to the presence of an upper air anticyclonic circulation over Central Burma on 10—2—1952, maritime air was sweeping over the Central and the North-East India. A feeble anticyclonic circulation existed over the central parts of the country between 5.000′ to 1,0000′ a. s. l. from 11—2—1952, shifted towards the east to the Gangetic West Bengal on 20—2—1952 and finally moved towards the West and lay over Rajasthan and the adjoining parts on the 24th February. This caused incursion of maritime air into the central parts of the country.

A shallow low existed over South Madhya Bharat and the adjoining areas on 20—2—1952 and on the same day a low pressure wave appeared to pass across the extreme south of the country. There were local to widespread showers in Tamil Nad and along the West Coast from 20—2—1952 to 24—2—1952. Dry weather prevailed generally during the rest of the month over the State.

An anticyclonic circulation persisted over Orissa and East Madhya Pradesh on the 25th and the 26th February and gave place to another anticyclonic circulation existing over the North and the Central Bay of Bengal from 27th to the end of the month.

Five western disturbances with their associated secondaries passed over North-West India during the month.

Night temperatures were above normal over the whole State from the 1st to the 14th and 19th to 25th February. On the other days they were just normal or sub-normal with slight fluctuations here and there.

The particulars of the noteworthy rainfalls during the month and the zonal rainfall are furnished hereunder :

Noteworthy rainfall during the month.

S. No.	Date	Name of place	Rainfall in inches
1.	8—2—1952	Fort Cochin	3·5
2.	21—2—1952	Nagapattinam	1·7
3.	22—2—1952	Mathurai	3·1
4.	23—2—1952	Viralimalai (Pudukottai State)	6·25
5.	24—2—1952	Pamban	1·7

Zonal Rainfall.

S. No.	Name of Zone	Average Rainfall	Departure from normal	Remarks
1.	Orissa and Circars	0·42″	— 0·02″	Just normal
2.	Ceded Districts	0·05″	— 0·19″	Below normal
3.	Carnatic	0·91″	+ 0·54″	Above normal
4.	Central	0·57″	+ 0·25″	Just above normal
5.	South	2·10″	+ 1·06″	Far above normal
6.	West Coast	1·09″	+ 0·71″	Above normal
7.	Mysore and Coorg	0·62″	+ 0·42″	Above normal
8.	Hills	3·85″	+ 2·68″	Far above normal

Weather Review — For February, 1952

RAINFALL DATA

Division	Station	Total rainfall for the month	Departure from normal in inches	Total since 1st January in inches	Division	Station	Total rainfall for the month	Departure from normal in inches	Total since 1st January in inches
Orissa & Circars	Gopalpur	0·4	—0·5	0·4	Central Contd.	Coimbatore	0·6	+0·2	0·7
	Calingapatnam	0·0	—0·6	0·0		Tiruchirapalli	1·0	+0·7	1·8
	Visakhapatnam	0·5	—0·4	0·5	South	Nagapattinam	2·2	+1·4	4·7
	Araku Valley*	0·0	—0·2@	0·0		Adduturai*	2·7	+2·2	6·0
	Anakapalle*	1·5	+1·2	1·5		Pattukottai*	1·3	+0·5	3·3
	Samalkot*	0·0	—0·7	0·0		Mathurai	4·0	+3·5	4·9
	Kakinada	0·9	+0·6	0·9		Pamban	1·8	+0·7	7·2
	Maruteru*	0·4	+0·3	0·4		Koilpatti*	2·0	+0·9	2·3
	Masulipatnam	0·5	0·0	0·5		Palayamcottai	1·9	+0·7	4·1
	Guntur*	0·7	+0·7	0·7		Ambasamudram*	0·9	—1·4	4·5
	Agri. College, Bapatla*	0·1	—0·4	0·1					
	Agri. College Farm Bapatla*	0·2	X	0·2	West Coast	Trivandrum	1·2	+0·4	1·4
	Rentachintala	0·3	—0·2	0·3		Fort Cochin	3·8	+3·0	3·8
Ceded Districts	Kurnool	0·0	—0·3	0·0		Kozhikode	0·1	—0·6	0·1
	Nandyal*	0·0	—0·1	0·0		Pattambi*	2·3	+1·8	2·3
	Hagari*	0·0	—0·7	0·0		Taliparamba*	2·0	+1·9	2·0
	Siruguppa*	0·1	—Tr.	0·1		Nileshwar*	0·2	+0·2	0·2
	Bellary	0·1	—0·1	0·1		Pilicode*	0·2	+0·1	0·2
	Cuddapah	0·0	—0·1	0·0		Mangalore	0·0	—0·2	0·0
	Kodur*	0·2	+0·1	0·2		Kankanadi*	0·0	—0·2	0·0
	Anantapur	Tr.	—0·3	Tr.	Mysore & Coorg.	Chitaldrug	0·7	+0·6	0·7
Carnatic	Nellore	0·0	—0·2	0·0		Bangalore	0·4	+0·1	0·4
	Buchireddipalem*	0·1	—0·1	0·1		Mysore	0·8	+0·6	0·8
	Madras (Meenambakkam)	0·6	+0·2	0·8	Hills	*Mercara*	0·6	+0·4	0·6
	Tirurkuppam*	0·6	+0·1@	0·6		Kodaikanal	2·9	+1·4	3·8
	Palur*	1·1	+0·8	1·7		Coonoor*	8·7	+6·6	11·0
	Tindivanam*	2·3	+2·2	2·5		Ootacamund*	1·8	+1·3	2·7
	Cuddalore	1·7	+0·8	2·5		Nanjanad*	2·0	+1·4	2·0
Central	Chittoor	Tr.	—0·2	Tr.					
	Vellore	0·5	+0·2	0·5					
	Gudiyatham*	0·0	—0·2	0·0					
	Salem	0·6	+0·3	0·6					
	Coimbatore* (A. M. O.)	0·7	+0·3	0·8					

Note :—

1. * Meteorological Stations of the Madras Agricultural Department.
2. @ Average of nine year's data for Tirurkuppam, and eight years' data for Araku Valley is given as normal.
3. Average of ten years' data is taken as normal.
4. X The farm was started only this year.
5. Tr. = 1 to 4 cents of rain.

Weather Review for March, 1952

The shallow low that persisted over Madhya Bharat, during the end of February, 1952, moved eastwards to Madhya Pradesh on 2—3—52 and passed Northeastwards over Upper Assam on 4—3—52. Similarly, the anticyclonic circulation over the north and central Bay of Bengal became less marked on 2—3—52 A shallow low lay over North-West Rajasthan and the adjoining parts of the Punjab (P) on 4—3—52, persisted for a day and moved away North-eastwards across the Punjab-Kumaon hills. A feeble anticyclonic circulation existed over the West central Bay of Bengal and the neighbourhood on 5—3—52 It extended over the coastal Andhradesa and Hyderabad, causing incursion of moist air into the Central and North-East India and coastal Andhradesa. Later, it shifted towards the east on 16—3—52, and became less marked. Meanwhile on 6—3—52, a low pressure area lay over Sind and the adjoining parts of the Pubjab, extended to a trough on the next day and got filled up on 8—3—52. This was replaced by a shallow low over the Central parts of India, which moved away eastwards across Upper Assam on 10—3—52. Another shallow low lay over east Madhya Pradesh and the adjoining parts of Orissa on 10—3—52 and became unimportant on the following day. A shallow trough of low existed over the belt extending from North-west Madhya Pradesh to Mysore on 14—3—52. A trough of low existed over North Rajasthan and the adjoining parts of the Punjab on 16—3—52 and passed away over the Simla-Kumaon hills on the following day. Another anti-cyclonic circulation established itself over Rajasthan, Gujarat, Saurashtra and Kutch and the adjoining parts upto 70000' a s.l. on 17—3—52, moved towards the east and gave rise to an elongated ridge of high pressure extending from North-west Bay and the adjoining parts of Orissa to South Tamil Nad on 23—3—52. A shallow low lay over South-East Uttar Pradesh and the adjoining areas on 22—3—52, causing incursion of moist air into North-east India, and got filled up on 25—3—52. A shallow trough of low pressure appeared off the Malabar South-Kanara coast on 25—3—52 and became less marked after two days. Another anticyclonic circulation existed over the the north and the central Bay of Bengal on 29—3—52 and persisted till the end of the month. A shallow low pressure wave was noticed over the South Madhya Pradesh and Hyderabad on the last day of the month.

Seven western disturbances with their associated secondaries passed over North-West India during the month.

Light thunder-showers occurred at a few places over the Madras region from 16—3—52 to 19—3—52. Mainly dry weather prevailed over the region on the remaining day of the month.

Night temperatures were generally above normal over the region, except during the period 6—3—52 to 9—3—52, with slight fluctuations.

The noteworthy falls and the zonal rainfall for the month furnished below :—

Noteworthy Falls

S. No.	Date	Name of Station.	Rainfall for past 24 hrs.
1	15—3—52	Fort Cochin	2·4″
2	18—3—52	Kakinada	2·7″
3	19—3—52	Nagercoil	1·3″

ZONAL RAINFALL

S. No.	Name of Zone	Average rainfall	Departure from normal	Remarks
1	Orissa and Circars	0·40″	– 0·06″	Nearly normal
2	Ceded districts	0·00″	– 0·30″	Below normal
3	Carnatic	0·06″	– 0 50″	do.
4	Central	0·23″	– 0·16″	do.
5	South	0·15″	– 0·83″	Far below normal
6	West Coast	0·40″	– 0·37″	Below normal
7	Mysore and Coorg	0·00″	– 0·48″	do.
8	Hills	0·50″	– 1·20″	Far below normal

Agricultural Meteorology Section,
Lawley Road Post. Coimbatore.
Dated, 9th April, 1952.

M. B. V. N., C. B. M. & M. V. J.

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Edited and Published by T. R. Narayanan, B. sc. (Ag.), M. A., (Cantab.) for The Madras Agricultural Students' Union and Printed by A. Subramaniam, at The Coimbatore Co-operative Printing Works, Limited, Coimbatore.