measures has taken place. The control work has however been done in scattered blocks surrounded by ryots' plots in which no control has been attempted, and in spite of the large number of hoppers and eggs destroyed the total population of the pest cannot have been reduced to any extent. It is realised that co-operative effort on a large scale is required to prevent plots on which control measures have been tried from being re-infested, especially as the adults are very active and at night are found flying considerable distances. It is probable therefore that the intrinsic value of the control work done this season is practically nil. The local ryots are inclined to put down an insect attack of this sort to their bad luck and to accept the position with resignation and the main idea in attempting control work was to give them a lead and show them that something can be done to fight the pest. If the work done this season results in a less apathetic attitude being taken in the case of future attacks it will have been worth while.

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THE PERIOD OF RECEPTIVITY OF RICE STIGMA *

By K. RAMASWAMY, B. Sc. (Ag.),

Assistant to Paddy Specialist.

Introduction. A knowledge of the natural pollination and fertilisation in cultivated crops is of extreme importance to the plant breeder in the matter of evolving successful techniques of artificial hybridisation for crop improvement. In most of the crop plants, which are self fertilised, natural pollination occurs at the time of flower opening, when the anthers dehisce and shed their pollen on the stigma, which is receptive then, enabling the pollen to germinate and fertilise the ovule. In plants where cross fertilisation is the rule, self fertilisation is prevented in nature by the different times of maturity of the anther and the stigma i. e., the pollen is shed either long before (protandry) or long after the stigma is receptive (protogyny). In grasses protandry is more common than protogyny. A study of the period of pollen viability and the receptivity of the stigma forms an important preliminary work in crop improvement. The present paper deals with the studies on the period of receptivity of the rice stigma.

Review of Literature. Biffen (1905) mentions about emasculating wheat flowers and successfully pollinating the stigma a week after,

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proving that the stigma is receptive for a week after anthesis. Solomon (1914), experimenting on wheat to determine the relation between non-fertilisation and occurrence of open glumes, found out that in unpollinated spikelets, " the glumes remained open until the stigmas began to die, which took place in 8 to 10 days ". Anthony and Harlan (1920) have reported of a systematic investigation on the period of receptivity of barley stigma. They found that " the percentage of successful pollination increased for two days. Of these pollinated 2 days after emasculation 100% of the ovaries set seed. From this time there was a gradual decrease until on the sixth day no pollinations were successful ". Dietz (1928), in connection with his studies of the inheritance of rust resistance in *oats* conducted some preliminary trial to determine the best technique to be adopted in hybridisation of *oats*. His results brought out that the optimum time for pollination is after an interval of 24 to 72 hours after emasculation, both with regard to the percentage of fertility and the production of true hybrids. It is presumably based on a knowledge of this phenomenon of the prolonged receptivity of stigma that the practice is in vogue in certain countries of cross pollinating the flowers some time after emasculation. Love and Craig (1918), in Cornell Station generally cross pollinate oat stigmas a day or two after the emasculation of the flowers. Kraus (1907) in his rice investigations at Hawai recorded his observations that " if the stigma fails to receive pollen from the anthers of the same floret, foreign pollen may fertilise it even after a considerable interval. About hybridising rice, Jenkin Jones (1929), from California, Rodrigo (1925), and Torres (1923), from the Phillipines, report that after emasculating the spikelets, the stigmas may be pollinated the same or the next day.

So far as the writer is aware no systematic study has however, been reported about the period of stigma receptivity in rice.

Method of work. The series of artificial hybridisations in connection with this study were conducted during flowering seasons, 1929-30, and 1930-31. The procedure of study adopted was to emasculate a number of spikelets a few hours before their normal opening time, to pollinate them on the same day or at one day intervals on successive days and finally to compare the receptivity of stigma by the percentage of set seeds obtained in each pollination. The technique of hybridisation followed was the one practised all along in the Paddy Breeding Station at Coimbatore with good success (Ramiah 1927). The method adopted in Japan, Java, Phillipines and California viz., of clipping off the upper half of the fertile glumes before emasculation, was not followed as the set seeds obtained in this way are easily liable to be damaged by external agencies and at least some of them rendered nonviable since they are but partially protected by the glumes. Rodrigo in Phillipines appears to employ some nutrient medium to germinate

the hybrid seeds after they are sterilised whereas no such procedure is adopted in Coimbatore. Only five to twenty five per cent success is claimed by the method of clipping the glumes. As the results in the accompanying table will show, the method adopted at Coimbatore has given better results, when the pollinations are done at the optimum condition of the stigma, as for instance till the fourth day after anthesis. The emasculation method advocated by Sharangapani (1924) i. e., to tie up the emasculated flowers with silk thread was also not adopted for this experiment, as the process would naturally restrict the number of spikelets that could be operated on in a short period of interval, whereas, for the present study, the larger the number of cross seeds obtained the greater should be the accuracy of the results.

There was no difficulty in choosing the materials for the crosses from among a collection of over 600 pure lines of rice grown year after year in the station. In selecting the two parents for each set of cross a non-pigmented type was chosen as the female and one with anthocyan pigment on the leaf sheath as the male so that the success of pollination of each grain could be confirmed even in the early stages of the seedlings raised from the crossed seeds, from the presence of pigment on the leaf sheath. Care was also taken to see that the blooming periods of the two parental types synchronised as closely as possible, so that fresh pollen could be procured in abundance from the male parent.

For each set of cross, half a dozen plants true to the type were chosen as mother parents and in each of them only the spikelets of the first three tillers were operated upon for the study. Each panicle was considered to be a separate unit for pollination instead of the entire plant and a sort of randomisation was adopted for emasculating and cross pollinating the spikelets of the different panicles on different dates i. e., within the same plant the three different panicles would have been emasculated on different dates and pollinated at different intervals after emasculation. A scheme was drawn up beforehand and the emasculation and cross pollination of spikelets of each tiller were carried out according to the scheme. The panicles were properly labelled after emasculation and cross pollination. For emasculation on a particular day, only the spikelets that would open that day were chosen and those are easily discernible to a trained eye. A panicle takes 5 to 6 days for completing the blooming of all the spikelets in it and for this experiment the panicles were treated on the 2nd or 3rd day after the starting of anthesis, as the maximum number of flowers open on these days. Besides, the later blooming flowers in a spikelet were purposely omitted, as unsetting in rice, even under natural condition is mainly confined to these spikelets (Ramiah 1931). Artificial cross-pollination was always effected at the time of the natural anthesis of the male parent so as to ensure the maximum viability of

the pollen. When the grains were ripe, the panicles were separately harvested with the respective labels and the set and unset grains carefully counted under each set of pollination. The set grains of all the groups were then separately preserved after giving them two or three dryings in the sun and they were sown in seed-pans on a subsequent date to ascertain the success of the cross pollination.

Results and Discussion. The results of the different sets of artificial cross pollinations are set forth in a table below.

Table I

Showing the percentages of setting of grains when cross pollinated at different intervals after emasculation.

Time of Cross pollination.	T. 40xT. 130			T.430xT.137			T. 63xT. 344			T. 30xT. 341			Total		
	Set.	Unset.	%set.	Set.	Unset.	%set.	Set.	Unset.	%set	Set.	Unset.	%set.	Set.	Unset.	%set.
Same day of emasculation	10	33	23·3	11	15	42·3	...	...	...	26	4	86·7	47	52	47·5
One day after emasculation	23	70	24·7	0	11	0·0	...	...	...	38	5	88·4	61	86	41·5
Two days after emasculation	19	40	32·2	8	16	33·3	4	13	23·5	16	5	76·2	47	74	38·8
Three days after emasculation	26	38	40·6	19	35	35·2	4	19	17·4	26	8	76·5	75	100	42·9
Four days after emasculation	4	20	16·7	1	35	2·8	4	13	23·5	9	9	50·0	14	77	15·4
Five days after emasculation	...	...	...	0	24	0·0	2	12	14·3	1	5	16·7	3	41	6·8
Six days after emasculation	...	...	...	...	...	...	...	...	...	4	4	50·0	4	4	50·0
Seven days after emasculation.	...	...	...	...	...	...	...	...	...	0	8	0·0	0	8	0·0

Except for the occurrence of a few non-crosses among the first day pollinated spikelets, the set grains obtained from all subsequent pollinations proved to be true hybrids. In cross No. 3 the programme of pollinations on the first two days could not be carried out on account of some unavoidable circumstances. For that particular cross, therefore, only the results of pollinations at subsequent intervals are given here. In cross No. 2, the complete failure to set, when pollinated one day after emasculation is inexplicable. Grouping the results of all the crosses together, the percentages of setting under the different sets of pollinations are represented by a graph below.

Graph. There is no uniformity in the percentage of setting at corresponding intervals of pollination in the different sets of crosses. This is partly due to the varietal differences with regard to their ease of manipulation. In some rices, specially, where the glumes are broad, emasculation is comparatively easier and hence they give a greater percentage of set grains in hybridisation. However, it can be seen from the graph that the rice stimga retains a fairly high degree of receptivity for three days after the natural opening of the flowers

and that later on, the receptivity gradually diminishes until it is completely lost by the seventh day. The high percentage of setting on the sixth day after emasculation in cross number 4 is not quite reliable as the number of spikelets cross pollinated in that particular case was rather small viz., 8.

It is needless to stress on the limitations of this experiment, the results of which are judged purely by artificial hybridisation by mechanical means, as it is well known that atmospheric factors like temperature and humidity play a very important role in the natural opening and pollination of flowers. These are of course, beyond control under ordinary field conditions. Fortunately however, the atmospheric conditions remained favourable during the course of the experiment, as bright weather prevailed throughout this period. The uniformity of skill and care exerted during the crossing operations is another important factor affecting the reliability of the results. This error due to personal factor may however be taken as uniformly distributed over all the sets of emasculations and cross pollinations, as these operations were all done entirely by the writer himself exercising equal amount of care throughout. The limited number of spikelets that could possibly be handled formed another handicap in this investigation. This is due to the short period of 4 or 5 days within which the spikelets of the primary tillers of a pure line of rice complete their flowering phase. A tiny caterpillar which used to damage the emasculated flowers by eating away the stigmatic tissues was another source of trouble which contributed to the reduction in the number of emasculated flowers available for cross pollination.

Summary and Conclusions. The degree of receptivity of rice stigma is reckoned in this study from the percentages of setting exhibited by spikelets which were emasculated one to two hours before the time of their natural opening and cross pollinated on the same day or at one day intervals upto 7 days. Four different sets of crosses were done in connection with this investigation. Although the percentages of setting in the different sets of crosses are not uniform at the corresponding intervals of pollination, it is fairly evident from the data, that for the first three days after the natural opening of the rice flowers, their stigmas maintain nearly as high a degree of receptivity as on the first day, but gradually lose it afterwards until on the seventh day the receptivity is completely lost.

The results obtained from the present study are of importance for the rice breeder in his artificial hybridisation work in the following ways :—

1. In case two parental types differ in their flowering durations by not more than a week, cross pollination may be effected between them by bagging the emasculated spikelets of the earlier variety and cross pollinating them with the later one within six days after

emasculation, although the percentage of set grains thus produced may be somewhat reduced.

2. If, after emasculation of spikelets, unfavourable weather conditions or some other external disturbances do not permit of immediate cross pollination, the latter operation can be safely postponed for two or three days with full confidence of obtaining the same amount of success as can be had by pollination on the same day of emasculation.

3. Cross pollination done one or two days after emasculation is of decided advantage in hybridisation work, as the set grains obtained in this way are sure to be hybrids, as any self fertilized flowers among the emasculated spikelets can easily be detected even the next day after emasculation, from the withering condition of their stigmas and slight enlargement of their ovaries and can thus be rejected then and there.

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MULBERRY CULTIVATION IN KOLLEGAL AND THE SERICULTURAL INDUSTRY

BY P. V. HANUMANTHA RAO,

Assistant Agricultural Demonstrator, Kollegal.

The cultivation of mulberry is simple and may be done in a wide range of climate and soil provided the latter is fairly fertile; the rearing of silkworms is however possible only in temperature ranging between 70° to 90° F. with a humidity of 50 to 70%. During the hot weather the rearing is as a rule stopped and the bushes pruned for a fresh flush of leaves. The above named conditions exist in the Kollegal taluq almost throughout the year and hence the rearing of silkworms is carried on all the year round giving occupation for well over 5000