

## THE INFLUENCE OF THE TOPMOST THREE LEAVES OF THE PADI PLANT ON PANICLE EXSERTION.

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### RINGKASAN

Pengeluaran tangkai padi adalah dipengaruhi kuat oleh tiga daun teratas sebelum peringkat susu. Peringkat tumbuhan "Reduction Division" adalah waktu yang paling keritikal dalam aspek ini. Tiga daun tersebut mempengaruhi pengeluaran tangkai secara sandar-menyandar. Perbezaan diantara jenis-jenis padi adalah disebabkan oleh perbezaan baka. Bagi jenis-jenis padi Bahagia dan Murni, gerakbalas ini adalah serupa. Dengan pertambahan kadar nitrogen, keadaan sifat begini tidak begitu jelas.

### INTRODUCTION

The physiological roles of leaves in the rice plant in general and the topmost three leaves in particular, had been extensively studied to date. Their roles in starch metabolism, grain formation and ripening, grain yield, root formation and its growth, and the regrowth processes of organs had been clarified (SATO, 1964, 1965 & 1969; PARK *et al.*, 1968; NAGATO and CHAUDHRY, 1970; TRIPATHI and PUROHIT, 1971; ISHIZUKA, 1973). However, the influence of the topmost three leaves on panicle exsertion remains to be identified.

Panicle exsertion can be defined as the extent to which the panicle and a portion of the uppermost internode protrude beyond the flag-leaf sheath. Often this exsertion is measured as the distance from the neck node to the collar of the flag-leaf (CHANG and BARDENAS, 1965).

Good panicle exsertion is one of the various morphological characters that breeders take into consideration when they evaluate the "ideal plant type" in rice. Good panicle exsertion is necessary to facilitate threshing after harvest, to prevent the formation of sterile spikelets due to poor exsertion and to reduce fungal infection at the collar of the flag-leaf. CHIN (1974) observed that Sheath Rot was always associated with poor panicle exsertion.

### MATERIALS AND METHODS

A split-split-split plot design with three replications was used. The four factors were: six varieties, three levels of nitrogen application, three growth stages of leaf detachment and eight leaf detachment combinations of the topmost three leaves. For each leaf-cutting exercise, nine hills were used and every tiller in the hill was subjected to leaf detachment. The eight cutting combinations are as follows:-

Control	3rd leaf cut
All cut	Flag + 2nd leaf cut
Flag-leaf cut	2nd + 3rd leaf cut
2nd leaf cut	Flag + 3rd leaf cut

For all cutting treatments, the leaves were detached at their collars.

The varieties studied were: Mahsuri, Malinja, Bahagia, Sri Malaysia II, Ria and Murni. The nitrogen levels used were zero, 68 and 135 kg (N)/ha.  $P_2O_5$  and  $K_2O$  were maintained at 45 and 34 kg/ha respectively. These were all applied at basal while nitrogen application was split into basal, first, second and third topdressings. The topdressings were broadcasted at three weeks after transplant, reduction division stage and initial heading respectively. Urea (46% N), Christmas Island Rock Phosphate (36%  $P_2O_5$ ) and Muriate of Potash (60%  $K_2O$ ) were the fertilisers used.

The three growth stages for leaf detachment were peak reduction division stage, 50% heading in the plot and milk ripe stage of the grains. Generally, detachments were started five days before the expected arrival of the growth stage and were terminated five days after its arrival.

In measuring for panicle exertion, five valid tillers per hill from five hills were used. Both were randomly selected. When the neck node of the panicle was below the collar of the flag leaf, the negative symbol was placed before the measured distance in centimeters. The figure zero indicates that the neck node and the flag-leaf collar were at the same level. Positive distances indicate that exertion was above the flag-leaf collar.

The results presented were obtained from an experiment conducted for two seasons: off season 1974 and main season 1974/75.

## RESULTS AND DISCUSSION

Panicle exertion can be viewed as a two step process involving the initiation and subsequent development of the panicle together with the rapid growth and elongation of the culm. These growth processes eventually cause the panicle to protrude above the flag-leaf sheath.

One source of physical resistance that can restrict or even inhibit this protrusion of the panicle is the resistance offered by the leaf-collars and leaf sheaths of the valid tillers. If these leaf sheaths were to envelop tightly around each other, panicle protrusion could be prevented or checked. Field observations showed that the flag-leaf collar or the leaf sheaths of these three leaves could not have provided any physical restriction to the emerging panicle. If they did, there would be no impediment to panicle protrusion once the flag-leaf was detached at the collar and the resistance there was nullified. Further, detachments of the second and/or third leaves would also reduce the surrounding pressure of their leaf sheaths on the emerging panicle. The panicle should be able to emerge from the leaf sheaths. On the other hand, the control with all these physical restrictions would be the one in which panicle exertion would be prevented or checked. From the tables, panicle exertion was obtained in all controls of all varieties. Further, where detachments were carried out, panicle exertion was inhibited or reduced.

VERGARA and LILIS (1968) showed that application of varying photoperiods after panicle initiation could influence panicle exertion. The effects of varying photoperiods could not be responsible for influencing panicle exertion in this experiment. This was because all treatments were subjected to the same natural environmental conditions during the same seasons of growth of the crop.

It is highly probable that disturbed photosynthesis and translocation of assimilates were the causes for the influence on panicle exertion.

Studies as reviewed by ISHIZUKA (1973), had indicated that photosynthesis and translocation of assimilates are vigorous during the vegetative phase and they reach their peak at the panicle initiation stage. At the reproductive stage the assimilates are stored in situ and are not translocated throughout the plant. During ripening the translocation process becomes important again, the assimilates going towards the panicle. With respect to the topmost three leaves, it had been clarified that during the flowering stage either the second leaf or the third leaf translocates its assimilates mainly to the flag-leaf, panicle and the elongating culm. During the milk ripe stage, the flag-leaf translocated the assimilates mainly to the panicle. The third leaf at this stage translocates the assimilates to the panicle, stem base and the roots. At the maturing phase, the assimilates in the flag-leaf or the second leaf enter into the panicle. Leaves other than the topmost three, are mainly responsible for the growth of the roots and the stem.

*Table 1* indicates that defoliation of the topmost three leaves during the reduction division stage and 50% heading stage significantly inhibited or reduced panicle exertion. Defoliation at these stages could have affected panicle exertion through the reduction in the rates of photosynthesis and translocation of assimilates. The 'in situ' food reserve which was needed for the subsequent growth, was diminished. The growth of the elongating culm was checked and panicle exertion was reduced or inhibited depending upon the degree of growth inhibition in the culm.

Defoliation at the milk ripe stage did not significantly reduce or inhibit panicle exertion. This was because panicle exertion had already occurred by the time leaf detachments were carried out. Moreover, translocation of assimilates was now directed towards the panicle where grain-filling was taking place. It is more probable that at this stage of growth, the effects of defoliation would be on the grains themselves.

The panicle exertion values for the defoliation of each of the topmost three leaves were similar (*Table 1*). No evidence could be found to identify which of the three topmost leaves had the greatest influence on panicle exertion. The highly significant inhibition or reduction in panicle exertion for the "all cut" treatment indicated that the presence of all these three leaves was essential for proper panicle exertion in the later stages of growth of the rice plant. Further, defoliation of all three leaves or any other two of the three leaves could significantly affect panicle exertion during the reduction division stage and the 50% heading stage. This implied that their roles in influencing panicle exertion at these stages of growth were complementary in nature. The flag-leaf and the second leaf were slightly more influential in view of their roles in photosynthesis and translocation of assimilates to the panicle and the stem during the flowering, milk ripe and maturing stages of growth of the rice plant. Simultaneous defoliation of these two leaves at the reduction division stage inhibited or reduced panicle exertion to a greater extent than defoliation of either one of these three leaves or combinations of either one of these two leaves with the third leaf.

The reduction division stage was particularly sensitive to defoliation treatments of the topmost three leaves. The tallied well with its other known sensitivity to changes in the environmental conditions of the crop. Drought and deep-water submergence at this growth stage had been found to inhibit growth and reproduction of the crop (MATSUSHIMA, 1962; SUGIMOTO, 1969).

Significant varietal differences in response to defoliation of the topmost three leaves were present (*Table 2*). The differences in panicle exertion between the varieties can be ranked: Mahsuri>Malinja>Sri Malaysia II and Ria>Bahagia and Murni.

TABLE 1. EFFECTS OF INTERACTIONS BETWEEN LEAF DETACHMENTS AND TIME OF LEAF  
DETACHMENTS OF THE TOPMOST THREE LEAVES ON PANICLE EXERTION IN RICE.  
OFF SEASON 1974 AND MAIN SEASON 1974/75.

Treatments	Time of leaf detachment						Leaf detachment means	
	R.D.S.*		50% Hd.*		M. Stg.*			
	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S
Control	3.0	2.6	3.0	2.5	2.9	2.8	3.0	2.6
All cut	-1.7	-1.5	0.9	0.5	2.6	2.5	0.6	0.5
Flag-leaf cut	1.9	1.4	2.3	2.0	2.8	2.6	2.3	2.0
2nd leaf cut	1.9	1.3	2.3	1.8	2.8	2.6	2.3	1.9
3rd leaf cut	2.2	1.9	2.4	2.2	2.7	2.6	2.4	2.3
Flag + 2nd leaf cut	-0.2	-0.1	1.4	1.3	2.7	2.3	1.3	1.2
2nd + 3rd leaf cut	1.1	0.3	2.0	1.5	2.7	2.6	1.9	1.5
Flag + 3rd leaf cut	0.9	0.9	1.9	1.5	2.7	2.5	1.8	1.6
Time of leaf detachment mean	1.1	0.9	2.0	1.7	2.7	2.6		

(O/S 1974) L.S.D. 1% between leaf detachments for a given time = 0.43

L.S.D. 1% between detachment time for a given leaf detachment = 0.49

(M/S 1974/75) L.S.D. 1% between leaf detachments for a given time = 0.36

L.S.D. 1% between detachment time for a given leaf detachment = 0.40

\*R.D.S. = Reduction Division Stage; 50% Hd. = 50% Heading; M. Stg. = Milky Stage

'-' = means failure of neck node to emerge above flag-leaf collar.

TABLE 2. EFFECTS OF INTERACTIONS BETWEEN LEAF DETACHMENTS OF THE TOPMOST APPLICATION AND PADDY VARIETY ON PANICLE EXERTION, OFF SEASON 1974 AND MAIN SEASON 1974/75.

Treatments	PADDY VARIETIES											
	Mahsuri		Malinja		Bahagia		S.M. II*		Ria		Murni	
	O/S	N/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S
Control	5.2	4.9	3.9	4.4	1.2	0.8	3.6	3.1	2.9	2.1	1.0	0.4
All cut	2.1	2.2	1.6	2.2	-1.5	-1.9	1.1	1.5	1.2	0.4	-0.9	-1.4
Flag leaf cut	4.1	4.4	3.5	4.1	0.3	0.1	2.4	2.3	2.7	1.5	0.5	-0.4
2nd leaf cut	4.5	4.3	3.2	3.7	0.6	-0.1	2.7	2.2	2.6	1.6	0.4	-0.3
3rd leaf cut	4.5	4.9	3.3	4.0	0.8	0.3	3.0	2.7	2.5	2.5	1.6	0.0
Flag + 2nd leaf cut	2.6	3.4	2.6	3.2	-0.5	-1.2	1.3	1.5	1.9	1.0	-0.3	-0.9
2nd + 3rd leaf cut	4.0	4.0	2.9	3.3	0.2	-0.5	2.3	1.9	2.2	0.8	0.0	-0.7
Flag + 3rd leaf cut	3.5	4.0	3.1	3.7	0.2	-0.4	2.1	1.9	2.3	1.3	-0.2	-0.7
Varietal mean	3.8	4.0	3.0	3.6	0.2	-0.4	2.3	2.1	2.3	1.3	0.1	-0.5

(O/S 1974) L.S.D. 1% between leaf detachments for a given variety = 0.61

L.S.D. 1% between varieties for a given leaf detachment = 0.70

(M/S 1974/75) L.S.D. 1% between leaf detachments for a given variety = 0.51

L.S.D. 1% between varieties for a given leaf detachment = 0.56

'-' = means failure of neck node to emerge above flag-leaf collar

\* Sri Malaysia II

If the varieties were grouped according to their culm height, the following groups can be recognised: Group I (Mahsuri and Malinja), Group II (Bahagia and Sri Malaysia II) and Group III (Ria and Murni). Within the groupings of II and III, significant differences were present between the two member varieties for any given defoliation treatment. Within Group I and between its members, significant differences (1% level) were found for the second leaf, third leaf and second plus third leaf defoliation treatments. Differences between the controls of these two varieties in the group were significant at the 1% level for the off-season crop and at the 5% level for the main season crop. Comparisons between members of the three groups showed that in both seasons, differences in panicle exertion between Bahagia and Murni for any defoliation treatment were non-significant. This close similarity in responses of panicle exertion to different defoliation treatments between Bahagia and Murni could be attributed to the dominant influence of Bahagia in Murni's parentage.\*

*Table 3* indicates the particular susceptibility of Bahagia and Murni to defoliation treatments of the topmost three leaves.

Significant (variety x nitrogen) interactions were present (*Table 4*). Comparisons between varieties at each nitrogen level indicated that differences in panicle exertion between Bahagia and Murni were non-significant for all nitrogen levels in the off-season, but only in the zero and 68 kg(N)/ha levels in the main season. With increasing nitrogen levels of application, no clear trend in panicle exertion could be identified.

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## SUMMARY

Panicle exertion in the rice plant was strongly influenced by the topmost three leaves before the milky stage of growth. The Reduction Division Stage was the most critical growth stage in this aspect.

These leaves exert their influences in a complementary manner.

Varietal differences in this character were due to differences in parental heritage. For Bahagia and Murni, the responses in panicle exertion to defoliation treatments of the topmost three leaves were similar.

With increasing levels of nitrogen application no clear trend in panicle exertion was found.

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\*Murni = Bahagia x Ria.

TABLE 3. EFFECTS OF INTERACTIONS BETWEEN LEAF DETACHMENTS, TIME OF LEAF DETACHMENTS AND PADDY VARIETY ON PANICLE EXERTION IN RICE, OFF SEASON 1974 AND MAIN SEASON 1974/75.

Leaf detachment treatments	MAHSURI						MALINJA						BAJIAGIA					
	R.D.S.*		50% Hd.*		M. stg.*		R.D.S.*		50% Hd.*		M. stg.*		R.D.S.*		50% Hd.*		M. stg.*	
	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S
Control	5.0	4.8	5.3	4.7	5.2	5.1	4.2	4.5	3.8	4.2	3.5	4.5	1.3	0.5	1.2	0.7	1.0	1.0
All cut	-1.3	-1.0	3.1	2.4	4.6	5.2	-0.3	-0.1	1.6	2.3	3.6	4.3	-4.6	-4.0	-0.8	-1.7	0.9	0.0
Flag-leaf cut	3.1	3.5	4.1	4.4	5.0	5.3	3.6	3.5	3.8	4.2	3.2	4.7	-0.1	-0.5	0.1	0.1	0.8	0.5
2nd leaf cut	4.1	4.0	4.4	3.8	4.8	5.0	3.0	3.3	3.0	3.6	3.7	4.3	-0.1	-0.5	0.5	-0.4	1.2	0.5
3rd leaf cut	4.2	4.8	4.3	4.6	4.9	5.2	2.9	3.8	3.6	4.0	3.5	4.4	0.6	0.1	0.9	0.2	1.0	0.6
Flag + 2nd leaf cut	-0.1	1.7	3.0	3.3	4.9	5.2	1.8	2.2	2.3	3.4	3.8	4.0	-2.3	-2.3	-0.3	-1.2	1.1	0.0
2nd + 3rd leaf cut	3.1	2.9	4.2	3.7	4.6	5.3	2.2	2.2	2.8	3.6	3.5	4.1	-0.9	-1.4	0.3	0.6	1.1	0.6
Flag + 3rd leaf cut	2.2	3.4	3.4	3.8	4.9	4.9	2.6	3.2	3.0	2.8	3.7	4.2	-0.6	-1.0	0.4	-0.8	0.9	0.4

  

Leaf detachment treatments	SRI MALAYSIA II						RIA						MURNI					
	R.D.S.*		50% Hd.*		M. stg.*		R.D.S.*		50% Hd.*		M. stg.*		R.D.S.*		50% Hd.*		M. stg.*	
	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S
Control	3.5	3.1	3.8	3.2	3.6	3.1	2.9	2.1	3.1	2.0	2.8	2.2	1.1	0.3	0.9	0.2	1.1	0.6
All cut	-1.0	0.9	1.6	1.1	2.7	2.5	0.5	-1.3	1.3	0.4	2.9	2.1	-2.4	-3.3	-1.1	-1.7	0.6	0.7
Flag-leaf cut	2.3	1.9	2.1	2.3	2.8	2.7	2.1	0.9	2.8	1.7	3.1	2.0	0.2	-0.8	0.6	-0.8	0.6	0.5
2nd leaf cut	2.3	1.5	2.8	2.5	3.1	2.6	2.1	0.5	2.6	1.9	3.1	2.4	-0.2	-0.9	0.4	-0.4	1.0	0.5
3rd leaf cut	2.9	2.5	2.9	2.6	3.0	3.1	2.3	1.0	2.5	1.9	2.6	2.0	0.2	-0.6	0.4	0.0	1.2	0.6
Flag + 2nd leaf cut	-0.4	0.1	1.6	1.9	2.9	2.5	0.9	0.1	1.9	1.2	2.9	2.0	-1.2	-2.3	-0.3	-0.8	0.7	0.4
2nd + 3rd leaf cut	1.4	0.7	2.4	2.2	3.0	2.7	1.5	0.6	2.2	1.9	2.9	2.0	-1.0	-2.0	-0.1	-0.7	1.0	0.7
Flag + 3rd leaf cut	0.9	1.1	2.3	1.9	3.0	2.7	1.4	0.2	2.7	1.6	2.9	2.2	1.0	-1.6	-0.3	-1.0	0.7	0.5

L.S.D. 1% between time of detachments for given variety and type of leaf cut = (M/S) 0.98

L.S.D. 1% between leaf detachments for a given variety and detachment time = 1.06 0.89

L.S.D. 1% between varieties for a given detachment time and type of leaf cut = 1.20 0.98

' ' = means failure of neck node to emerge above flag-leaf collar

\*R.D.S. = Reduction Division Stage; 50% Hd = 50% Heading; M.stg. = Milky stage.

TABLE 4. EFFECTS OF INTERACTIONS BETWEEN NITROGEN LEVELS OF APPLICATION AND PADDY VARIETY ON PANICLE EXERTION, OFF SEASON 1974 AND MAIN SEASON 1974/75.

Nitrogen Level (kg/ha)	PADDY VARIETIES											
	Mahsuri		Malinja		Bahagia		S.M. II*		Ria		Murni	
	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S	O/S	M/S
0	4.6	3.9	2.7	2.9	0.3	-0.5	2.3	1.9	2.4	1.6	0.3	0.3
68	3.7	3.8	2.8	3.5	0.2	-0.5	2.5	2.4	2.3	1.2	0.2	0.4
135	3.1	4.4	3.7	4.4	0.0	0.0	2.2	2.2	2.2	1.1	0.1	0.8

(O/S 1974) L.S.D. 1% between N-levels for a given variety = 0.83

L.S.D. 1% between varieties for a given N-level = 0.71

(M/S 1974/75) L.S.D. 1% between N-levels for a given variety = 0.64

L.S.D. 1% between varieties for a given N-level = 0.50

'-' means failure of the neck node to emerge above flag-leaf collar

\* = Sri Malaysia II



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