Rice Cultivation in Sabah, Malaysia

I. Yield and yield components in major paddy areas

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The yield of rice is made up of four components, i.e. number of panicles, number of spikelets per panicle, percentage of ripened grains and weight of one thousand grains (kernels).[1]

However, as far as varieties which have a similar weight of one thousand grains are concerned, the weight of one thousand grains slightly influences the grain yield and thus can be disregarded. Therefore, the yield can be well expressed by the product of the number of grains per unit field area and the percentage of ripened grains. The former parameter is an index of the sink capacity and the latter is the ratio of the amount of starch available during the ripening period to the capacity of the sink.[6]

In order to obtain higher yield, one has firstly to increase the number of spikelets per unit field area.[2] When the number of spikelets per unit field area is extremely small, no definite correlation between the yield and the percentage of ripened grains can be demonstrated (case 1). As the number of spikelets per unit field area increases, the percentage of ripened grains tends to decrease. With the further increase in the number of spikelets per unit field area, the percentage of ripened grains decreases, showing a negative correlation between them[6] (case 2). In the case 1, the most important aspect is how to increase the number of spikelets per unit field area, and in the case 2, it is how to increase the percentage of ripened grains.[1,2,6] It is necessary for rice growers to identify the yield components of their rice in order to increase the yield. To estimate yield and yield components by means of sampling, methods of sampling must be studied to determine the number of hills to be sampled, and the variability of individual yield components (units).

To estimate the mean values of these units at a level of similar preciseness a large number of sample must be used for a unit with larger variability and a less number of samples for a unit with lower variability.

Research on the estimation of the yield and yield components of rice plants and the coefficient of variance of the yield and yield components in individual fields was carried out during the period from 1977 to 1979.

Materials and methods

Rice plants were collected from farmers fields in seven major rice areas, Tuaran, Kota Belud, Papar, Kota Marudu, Tambunan, Keningau and Ranau.

Fifty hills were randomly collected from each field. Then, variety name, amount of fertilizer applied, transplanting/sowing date were recorded. Planting density at the location of the sampling was also recorded.

In the laboratory, yield, number of hills per unit field area, number of panicles per hill, number of spikelets per hill, number of degenerated spikelets per hill, percentage of ripened grains and weight of one thousand grains were determined. Coefficients of variance of each component within each field were computed.

Results and discussion

Results are shown in Table 1, Figs. 1 and 2. The yield ranged from 1.3 t/ha (Ranau) to

Table 1. Yield and yield components of rice plant in each district

District	Variety group	Plant density (hills m^{-2})	No. of panicles (m^{-2})	No. of spikelets ($panicle^{-1}$)	No. of spikelets ($10^3 m^{-2}$)	Percentage of degenerated spikelets (%)	Percentage of ripened grains (%)	Wt of 1000 grains (g)	Yield (t/ha)
a) Yield and yield components									
Tuaran	Improved	18.8–19.7	184–350	76–115	18.7–38.8	11.9–27.0	76–86	22.9–25.5	2.1–5.7
	Local	6.6–12.3	115–140	109–170	14.8–19.5	26.4–37.0	74–85	25.3–28.8	3.1–4.3
K. Belud	Improved	7.9–15.4	130–256	85–138	14.0–28.5	5.9–32.6	52–84	24.7–27.4	1.7–5.4
	Local	5.5– 6.4	90–127	121–163	13.9–15.1	31.5–47.2	57–81	25.0–26.7	2.1–2.6
Papar	Improved	11.2–23.4	161–293	84–122	15.4–26.4	18.3–38.3	59–82	21.1–27.5	3.4–6.7
K. Marudu	Improved	9.1–15.8	144–189	105–135	15.1–28.3	14.0–18.3	75–80	24.0–25.0	3.0–4.7
Tambunan	Local	4.7– 9.3	69–161	91–163	6.8–17.3	27.7–46.9	80–90	21.7–31.5	1.8–4.3
Keningau	Local	7.9– 9.5	93–182	110–166	11.0–27.3	19.0–43.6	74–89	22.1–27.6	2.2–6.4
Ranau	Local	5.8– 7.8	58– 72	103–146	5.0–10.0	30.1–37.6	80–86	26.4–32.8	1.3–2.5
b) Coefficient of variance of yield components (%)									
Tuaran	Improved	4–25	13–36	10–22	14–33	—	5–10	2.3–5.3	14–41
	Local	7–13	24–35	10–24	23–29	—	5–9	3.9–6.1	24–31
K. Belud	Improved	6–14	16–27	13–19	15–25	—	4–17	2.3–4.3	23–29
	Local	5–6	14–32	11–15	20–25	—	23–25	2.4–4.2	21–40
Papar	Improved	4–17	15–30	11–30	20–24	—	5–23	2.7–7.0	21–35
K. Marudu	Improved	5–13	17–21	8–19	18–23	—	5–8	2.5–5.1	15–22
Tambunan	Local	5–10	11–35	15–24	20–37	—	4–14	1.9–5.4	19–33
Keningau	Local	3–16	16–31	14–23	16–34	—	4–15	2.7–5.5	18–33
Ranau	Local	5–10	20–28	15–21	19–32	—	6–9	3.6–5.1	20–31
c) Coefficient of variance of average value of yield and yield components within all districts									
		37.5	43.6	23.8	36.2	35.4	10.1	10.4	31.0

6.7 t/ha (Papar). In general, the yield of improved varieties was higher than that of the local long term varieties, except a few samples. There was a highly positive correlation coefficient between the yield and the number of panicles per unit field area ($r=0.909^{***}$) as seen in Fig. 1. A positive correlation was also found between the yield and the number of panicles per unit field area ($r=0.435^{***}$), although it was not as high as that between the yield and the number of spikelets per unit field area. But in the group of improved varieties or that of local long term varieties, there was a higher correlation coefficient between the yield and the number of panicles per unit field area ($r=0.738^{***}$ for the improved variety group, $r=0.721^{***}$ for the local long term variety group). There was also a positive correlation coefficient between the number of panicles per unit field area and the number of spikelets per unit field area ($r=0.741^{***}$) but no correlation was found between the yield and the percentage of ripened grains.

Therefore, it is concluded that the yield of rice in Sabah is controlled by the number of spikelets per unit field area, which depends on the number of panicles per unit field area. There was also a relationship between the number of panicles per unit field area and planting density ($r=0.750^{***}$). Nozaki already reported that the yield of paddy was controlled by the number of spikelets per unit field area in farmers fields of West Malaysia.[5]

Planting density was higher for the improved varieties than for the local long term varieties, and it was higher in Tuaran, Papar, Keningau than in Kota Belud and Ranau.

The number of panicles per hill ranged from 13 to 27 for the improved varieties, and 12–26 for the local long term varieties, showing only a few differences between the improved varieties and the local long term

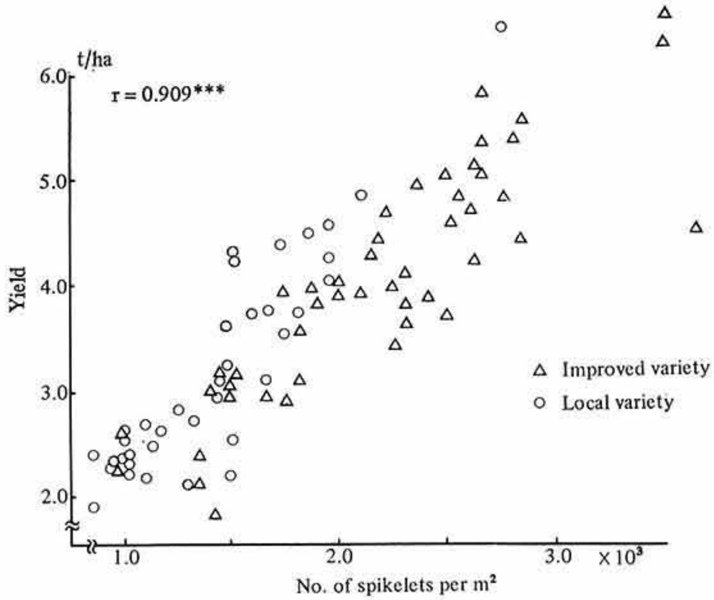

Fig. 1. Relationship between number of spikelets and yield

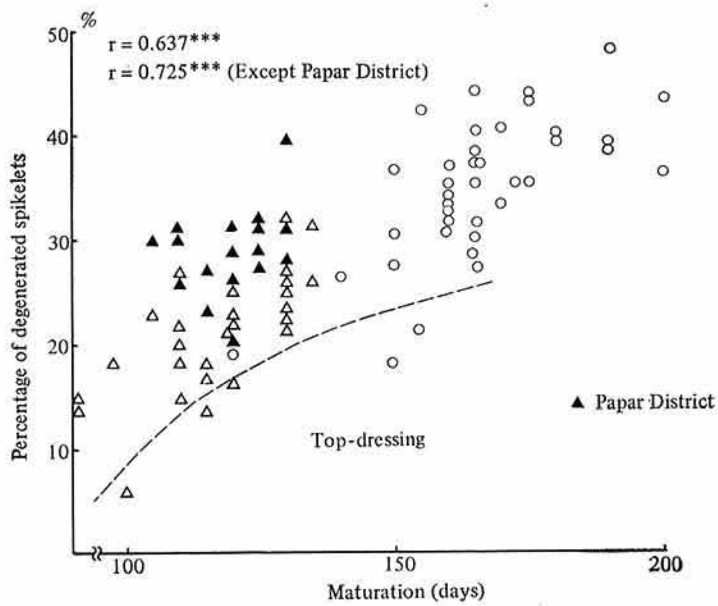

Fig. 2. Relationship between number of maturation days and the percentage of degenerated spikelets

Note: * Plots located below the curve indicate that they were top dressed and hence they showed low percentage of degenerated spikelets.

varieties and also among different districts.

The number of panicles per unit field area was higher for the improved varieties than for the local long term varieties. It was higher in Tuaran and Papar than in Kota Marudu and Kota Belud in the case of the improved varieties. In the case of the local long term varieties, it was lower in Ranau than in other districts.

The number of spikelets per panicle was higher for the local long term varieties than for the improved varieties. It was higher in Kota Marudu than in Tuaran and Papar in the case of the improved varieties. There were a few differences in the number of spikelets per panicle among different districts in the case of the local long term varieties.

The percentage of the number of degenerated spikelets to that of differentiated ones was much higher for the local long term varieties than for the improved varieties, suggesting a highly positive correlation with the life span of varieties (Fig. 2). The longer the life span (exclusive of the nursery stage) of rice plants in the field, the higher percentage of degenerated spikelets was found.[3] The reason for this phenomenon can be ascribed to the nitrogen metabolism of rice plant.[3,6]

Therefore, the number of differentiated spikelets per panicle must be much larger for the local long term varieties than for the improved varieties.

As already shown in Fig. 1, the number of spikelets per unit field area was higher for the improved varieties than for the local long term varieties except a few samples. However, the number of degenerated spikelets per unit field area was much higher for the local long term varieties than for the improved varieties, although the number of differentiated spikelets per unit field area was not so much different between the both groups. Therefore, the difference in the number of spikelets per unit field area between the both groups appears to be primarily controlled by the number of degenerated spikelets per unit field area. The way of increasing the number of spikelets should be different between the both groups. For the improved varieties, it is most important to increase the number of differentiated spikelets per unit field area by increasing the planting density and the rate of basal fertilizer. However, for the local long term varieties it is important not only to increase the number of differentiated spikelets per unit field area but also to decrease the number of degenerated spikelets by application of nitrogen fertilizer during the period from the late spikelet initiation stage to the stage immediately prior to the reduction division stage of pollen mother cells (PMC).[1,5]

As seen in Fig. 2, the position of Papar District is far isolated from other districts, showing that the yield performance of rice in Papar was different from that of other districts. Therefore, it can be assumed that cultural practices (selection of varieties, fertilizer application, planting density, etc.) adopted in Paper must be different from those in other districts.

The percentage of ripened grains ranged from 75% to 85% in almost all the fields except a few cases where damage caused by diseases or insect pests was recorded. There was no difference in the percentage of ripened grains among different districts and between the improved varieties and the local long term varieties. Since these values were satisfactory, it can be concluded that it would be difficult to further improve the percentage of ripened grains to increase the yield.

The coefficients of variance (CV) of yield and each component within a district are shown in Table 1(b). Using the CV of each yield component, one can easily determine how many samples should be collected by using Matsushima's table.[1]

The CV of the average value of each component for all the districts is shown in Table 1(c). Using this value one can easily determine which component is the most variable in the State and hence requires improvement.

The CV of each component in the districts of Sabah showed the same value as that in Kedah, Malaysia and in Japan except for the planting density.[1,4] But, in some fields, the CV of the weight of one thousand grains was high (mainly in the local long term varieties) when compared with standard cases. The CV of the weight of one thousand grains is usually 2.5%. When it exceeds 3%, there must be a segregation of varieties or mixing of different varieties. Sometimes this phenomenon may account for the low yield recorded. In such cases seeds should be renewed in order to increase the yield.

Summary

Yield and yield components of rice in major paddy areas in Sabah were studied.

The yield was mainly dependent on the number of spikelets per unit field area, which depends on the number of panicles per unit field area. On the other hand, the percentage of ripened grains was satisfactorily high in all districts, showing that it would be difficult to further increase it to increase yield.

The way how to increase the number of spikelets per unit field area differs between improved varieties and local long-term varieties. For the former, it is most important to increase the number of differentiated spikelets per unit field area by increasing the planting density and the rate of application of basal fertilizer. For the latter, it is important not only to increase the number of differentiated spikelets, but also to reduce the number of degenerated spikelets by means of nitrogenous fertilizer application during the period from late spikelet initiation stage to the stage just prior to the reduction division stage of pollen mother cell.

The percentage of the number of degenerated spikelets to the number of differentiated spikelets shows a high positive correlation to the length of life span of varieties. It implies that the longer the growth duration, the more the spikelet degeneration occurs, due to shortage of nitrogen nutrition. Top dressing of nitrogen is effective in suppressing spikelet degeneration.

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