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A Note on Nutritional Disorders of the Rice Plant in Java, Indonesia*

by

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Outline of the Survey

Quite a few number of "physiological diseases" of the rice plant have been reported from various countries in Asia. Many of them have been or are still being studied, and the causes of these diseases are becoming clearer in recent years. Generally speaking the results of these studies indicate that these "physiological diseases" are not due to peculiar nature of the flooded soils, but rather due to deficiency or excess of one or more of the elements. Attempts have been made to correlate these "physiological diseases" or nutritional disorders reported from various countries.[1] However, more information is needed to have a complete understanding of them.

A survey was made by the authors to add some more information of nutritional disorders of the rice plant in Java. In this survey emphasis was given to what is called "Mentek".

"Mentek" has been known for a long time in Indonesia. It is a kind of disorder of the rice plant. A guide book on rice cultivation in Indonesia[2] describes "Mentek" as follows: *Seedlings stage*—Growth is inhibited; leaves become reddish yellow or dry up from the periphery; there are chances of recovery at this growth stage. *Tillering stage*—Symptoms become clearer 3–4 weeks after transplanting; leaves become yellow and the tiller number decreases. *Elongating stage*—Leaves change to yellow in color, and become dry; elongation is inhibited and tillers and leaves become rozet type. Old leaves change to rosy rusty in color and finally die; symptoms continue to develop on young leaves; roots become

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blackish brown in color and are hollow, and the number of root haires decreases. Plants with these symptoms produce almost no grain. The disorder develops in patchy circles in the field and the area of the patches enlarges with the growth of the plant. In some year it is more serious than in other years.

There are many theories of the cause of "Mentek", such as nematode attack, nutritional deficiency especially in potassium, suffocation of the roots due to reductive soil condition, etc[3]. More recently virus is suspected as the cause.[4,5] However, all of them are more or less hypothetical or based on rather limited surveys and further clarification is needed.

The present authors made a survey in Java during January, 1970 for about one month period. They travelled across major rice growing areas in Java, especially those areas where "Mentek" and other nutritional disorders have been reported.* Whenever abnormal rice plants were observed, symptoms were described, samples were taken for further investigations in the laboratory.

When abnormality of the plants was observed and suspected to be a nutritional disorder, the leaf-blades on which characteristic symptoms developed were taken. In most cases lower leaves, but not the lowest leaves, were taken, because generally symptoms were apparent on the leaves which were old but not yet withered. The sample leaves were air dried during the survey trip, brought back to the laboratory in Japan, oven-dried, ground, and analyzed for various elements by routine methods.

Top soils of the fields where the plant samples were taken were also sampled. These soil samples were brought back to the laboratory and air dried. The pH of the air dried soils were measured by mixing one part of the soil with 2.5 parts of water. Elements[6] soluble in NH_4NO_3 and also the available P by the Bray No. 1 method were analyzed.

When virus diseases were suspected from the symptoms such as dwarfing and discoloration, live plants showing the symptoms were collected for virological investigations. The sample plants were uprooted and brought back to Bogor. Preparations for electron microscopy were made at Bogor. Some of the live sample plants were brought back to Japan. These were transplanted in pots in the greenhouse at Hokkaido University and used for electron microscopic examination, insect transmission tests and diagnosis by the symptom development on the potted plants.

The locations and brief descriptions of the samples are given in Table 1. The locations are also plotted in Fig. 1.

The results of chemical analysis of the plant and the soil samples are presented in Table 2 and 3, respectively.

* The authors also visited South Sulawesi. However, as the information which they could collect were rather scattered, these are not included in this report.

Table 1 Description of Samples

No.	Place (soil type)	Symptoms	Soil & plant samples for chemical analysis	Plant samples for virological observation
1	Genteng, East Java	Yellow green leaves with rusty spots, C–4.	—	○
2	Tongas, Probolinggo Alluvial soil, low lying spot, high in organic matter	Zn deficiency suspected.	○	—
3	Batu, terraced field (Andosol)	P deficiency symptoms, one month after transplanting.	○	—
4	Baron, Ngandjuk,	Serious *Helminthosporium* attack.	○	—
5	Bagor (Grumusol)	P deficiency suspected.	○	—
6	Ngale, Ngawi (Grumusol)	Brown discoloration of the leaves with rusty spots. Severely dwarfed. C–4. They say this is a typical case of"Mentek". Zn deficiency suspected.	○	○
7	Kebonsari, Demak (Grumusol)	P deficiency apparent.	○	—
8	Sedu, Gadjah	P deficiency suspected. Dark green leaves having brown spotty streaks at the tip.	○	—
9	Kebonsedja, Temon Alluvial soil, lime stone hills near by, ill drained	Brown lower leaves with rusty spots, also affected by *Helminthosporium*. They call it "Mentek". Zn deficiency suspected	○	○
10	Kebonsedja, Temon Near No. 9.	The same as above. The symptoms occurring in patches at the center of the fields.	○	—
11	Patjet, Tjipanas	Yellow-orange discoloration from the tip of the old leaves. Tungro suspected. PB-5, C–4, Ribon under upland condition.	—	○
12	Patjet, Tjipanas	Greenish yellow leaves with rusty spots. Dwarfing of plants. Grassy stunt suspected. PB-5 under upland condition.	—	○
13	Seladjambe near Tjiandjur	Same as above. Local variety.	—	○
14	Tjiandjur	They call it "Penyaki Merah". The affected area appears to be reddish for distance.	○	—
15	Tjihea	Brown discoloration of leaves. They call it "Mentek", PB-5.	○	○

No.	Place (soil type)	Symptoms	Soil & plant samples for chemical analysis	Plant samples for virological observation
16	Tjihea	Greenish yellow leaves with rusty spots. Dwarfing of plants. Grassy stunt suspected. Syntha.	—	○
17	Tjibiru, Udjungberung	Yellow orange leaves. Local variety.	—	○
18	Nambo, Walantake (Red yellow podzolic soil)	Stunted growth. *Helminthosporium* infested. Young leaves dark green color.	○	—
19	Muara, Bogor	Yellow discoloration of all leaves. Yellow dwarf suspected. PB-5.	—	○

Table 2 Element Content of Leaves

Element	N	P	K	Ca	Mg	SiO_2	Fe	Mn	Zn	Na	Cu	Al
No.	%						ppm					
2	3.63	0.28	2.38	0.33	0.28	15.9	290	300	16	320	10	26
3	2.58	0.18	2.34	0.53	0.11	9.3	440	460	27	160	19	53
4	3.05	0.09	1.51	0.72	0.18	8.4	260	225	31	800	16	25
5	3.43	0.13	1.82	0.54	0.23	7.4	1320	220	34	560	18	158
6	2.32	0.23	2.02	0.73	0.31	17.4	800	165	18	190	21	119
7	2.46	0.08	1.44	1.33	0.18	8.9	200	235	26	350	11	24
8	2.28	0.07	1.32	1.12	0.09	9.6	140	255	26	350	7	9
9	2.49	0.10	1.62	0.82	0.44	11.2	1300	325	19	1500	16	146
10	2.40	0.11	1.26	0.92	0.43	15.6	1600	840	18	700	16	147
14	1.98	0.16	0.79	0.66	0.26	25.0	190	980	19	520	5	7
15	1.90	0.21	0.59	0.43	0.27	28.7	150	1000	24	680	6	5
18	3.50	0.10	0.80	0.35	0.08	12.2	260	475	29	620	6	10

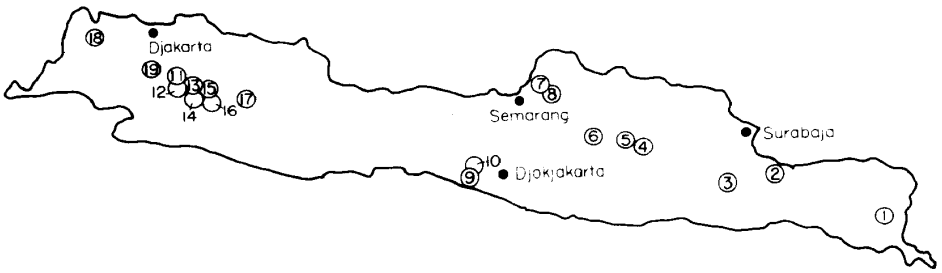

Fig. 1 Site of Sampling

Table 3 pH, 1N NH_4NO_3 (pH 7.0) Soluble Mineral Elements and Available Phosphorus of Soils

No.	pH	1N NH_4NO_3 soluble							Available phosphorus* ppm
		Ca	Mg	K	Na	Fe	Mn	Zn	
		mg/100 g				ppm			
2	8.26	585	272	40	41	tr.	tr.	0.66	1.24
3	7.22	388	85	24	15	0.23	2.6	0.70	0.08
4	7.83	554	108	17	22	tr.	tr.	0.77	0.27
5	7.80	602	133	7	18	tr.	tr.	2.05	tr.
6	7.63	1000	175	15	7	0.59	1.9	0.60	4.94
7	7.90	867	78	42	28	tr.	tr.	1.21	tr.
8	8.00	1012	54	31	22	tr.	24	1.68	tr.
9	8.53	568	72	5	32	tr.	tr.	0.84	tr.
10	8.05	568	77	4	20	tr.	tr.	0.99	tr.
15	5.45	301	60	2	13	tr.	605	1.98	0.27
18	6.05	118	8	3	1	tr.	35	2.05	tr.

* By the Bray No. 1 solution

Diagnosis of Disorders

Based on the field observations, chemical analyses and virological investigations, the following cases of disorders were identified or suspected.

Nutritional Disorders

Zinc Deficiency: A typical case of zinc deficiency was observed at the Field Station at Ngale (No. 6).

The soil is a Grumusol, having pH of 7.6, heavy clay-textured, high in calcium and magnesium, but rather low in sodium, low in 1N NH_4NO_3 soluble zinc, and adequate in available phosphorus.

The plants showed the following symptoms: Abnormality occurred in patches in the field. Affected plants 30 or 40 days after transplanting were stunted with many tillers. Young growing leaves were chlorotic at the mid-rib, and old leaves had brown spots. These symptoms are typical of zinc deficiency.[7] Virological examination disproved possibility of virus diseases. Leaf analysis indicated that the plants were low in zinc. Accordingly, it is concluded that the abnormality was, at least partly, due to zinc deficiency. People at the Station mentioned that this type of abnormality is locally called "Mentek".

A similar case of abnormality was observed in a small low lying patches at Tongas, Probolinggo(No. 2). In this case the soil is high in pH, and also rich in sodium and organic matter. Farmers there said that the area is kept flooded throughout the year. The symptoms were identical with those of No. 6. The plant sample was low in zinc. These indicate that No. 2 is more or less the same as No. 6. The only difference between

these two is that the No. 2 soil is high in pH due to a high sodium content, whereas the No. 6 soil is rather low in sodium.

In a large area at Temon (No. 9, No. 10), rice plants were suffering from abnormality similar to the one at No. 6. They say that "Mentek" is frequent in this area.

In these cases the soils are rather sandy, but appear to be illdrained. Soil pH is 8.0–8.5. The soils are rather high in sodium and low in potassium. There was no evidence of virus disease on this sample. Plant analysis indicated that the plants were low in zinc, rather low in potassium, high in iron, calcium and magnesium. These data indicate that zinc deficiency is, at least partly, the cause of the abnormality. However, this case is somewhat different from the one at No. 6 or No. 2, because the plants were high in iron.

Phosphorus Deficiency: A typical case of phosphorus deficiency was observed at Kebonsari, Demak (No. 7). The soil is a Grumusol, high in pH, high in calcium and extremely low in available phosphorus. The plant was high in calcium and low in phosphorus. This is a typical case of lime induced phosphorus deficiency. In this area an experiment to demonstrate the effect of phosphorus application was being conducted in farmer's field by the extension agency. The effect of phosphorus was very remarkable in the experiment.

The abnormality observed at Sedu, Gadjah (No. 8) was also the same as the one at No. 7.

At Bagor, Ngandjuk (No. 5) rice plants were showing the phosphorus deficiency symptoms. The soil is a Grumusol, high in pH and also in calcium, rather low in potassium, and low in available phosphorus. The phosphorus content of the plants was not extremely low. However, this case seems to be similar to the one at No. 7.

At Batu (No. 3), the plants seemed to be suffering from mild phosphorus deficiency. The plants were not very low in phosphorus. The soil is low in available phosphorus. This may be an example of rice plants on Andosol.

As the survey was made too early in the season, the authors could not come across the cases of phosphorus deficiency on Latosols or Red-Yellow Podozolic soils in West Java, but it is a serious problem as described previously by one of the authors.[1)]

Potassium Deficiency: Typical symptoms of potassium deficiency were observed in a field at Baron, Ngandjuk (No. 4). In this case, however, the plants were not extremely low in potassium, but was low in phosphorus, and fairly high in sodium. This may be a case of potassium deficiency interacted with high calcium and sodium. Judging from the symptoms and leaf analyses of No. 4 and No. 5, it seems that whether potassium deficiency or phosphorus deficiency develops as visible symptoms on this type of soils is controlled by delicate conditions. At any rate these soils are low in both phosphorus and potassium.

In West Java, for example at Tjiandjur (No. 14) or Tjihea (No. 15), a type of abnor-

mality which they call "Mentek" was observed. Virological examinations on the No. 15 sample did not give any positive sign of virus diseases. Plant and soil analyses indicated that potassium content was very low, and manganese content was high. Zinc content of the plants was rather low, though its level in the soil is adequate. In this case the symptoms were not typical of potassium deficiency though the plants were extremely low in potassium. Low level of potassium may be interacting with high level of manganese in developing the symptoms. There was also a case of *Helminthosporium* infestation due to a low level of potassium (No. 18).

Virus (& *Mycoplasma*) *Diseases*

Grassy stunt: Typical symptoms of grassy stunt were observed in West Java, such as Patjet (No. 12), Seladjambe (No. 13), Tjirandjang, Tjihea (No. 16), Tjibiru, San Hjang Sri and Tjangkudu. However, this disease occurred only scatteredly in a plot, but not in patches. The sample taken in East Java (No. 1) was suspected to be grassy stunt though it was not confirmed. So far as we observed, PB-5, Syntha and other local varieties were affected. Although the virus particle of this disease has not been detected by electron microscopy, the characteristic symptoms of yellowish-green leaves with numerous rusty spots, dwarfing and bushy appearance with narrow leaves enable the authors to identify this disease.[8]

Tungro: Typical symptoms of tungro were found in the field of Patjet, Tjipanas on PB-5, C-4, Ribon and Gundil Putih growing under upland conditions (No. 11). PB-5 showed clear orange yellow discoloration from the tip of the old leaves and the plants were stunted. C-4 showed characteristic reddish orange discoloration of the leaves and the plants were dwarfed. Only the tip of the old leaves changed slightly yellow or yellowish orange in color on Ribon and Gundil Putih, and the plants did not show stunting. The disease symptoms, suspected to be tungro, were also observed in the fields of Batukaropa in South Sulawesi, and in a few fields in West Java (No. 11, No. 17). Electron microscopy of ultra-thin sections of the leaves from the diseased plants of No. 11 revealed small particles of about 30 mμ in diameter, the size and the shape of which are characteristic of tungro virus,[9] within the cells.

Yellow dwarf: Recent studies on the rice yellow dwarf showed that the causal agent of this disease is most likely to be mycoplasma-like microorganism, but not of virus origin.[10] There were a few fields in South Sulawesi and West Java (No. 19), in which typical symptoms of yellow dwarf were observed on Syntha, Gentjah Ratji and PB-5. Ultra-thin sections of a material from No. 19 was examined by electron microscopy, in which mycoplasma-like structures were confirmed in the phloem cells of the diseased leaves.

"Mentek" and Nutritional Disorders

During our survey we could not come across a definite case of "Mentek". However, we saw quite a few cases of what they call "Mentek". Through these experiences the authors started to doubt whether there is real "Mentek" or not.

Apparently virus diseases (No. 11), zinc deficiency (No. 6, No. 9, No. 10) and also potassium deficiency (?) (No. 14, No. 15) are called "Mentek" by the farmers in respective areas. This indicates that "Mentek" does not designate a disorder induced by a definite cause, but is a name for a certain type of symptoms whatever their causes may be.

On account of these reasons the term "Mentek" should be erased from scientific vocabularies, though the term has been used for a long time by local farmers and also in scientific literatures.

Generally speaking, the soils in Java are more suited for rice cultivation in comparison with the soils in many other parts of rice growing areas in tropical Asia. However, the following nutritional disorders will impose a big problem in the future when improved varieties will be grown with more intensive management including heavier doses of nitrogen.

1. Phosphorus deficiency on high pH soils in Central Java.
2. Phosphorus deficiency on acidic soils high in iron in West Java.
3. Potassium deficiency on acidic soils in West Java.
4. Zinc deficiency on high pH soils in Central Java.

Several cases of virus diseases, such as grassy stunt, tungro and yellow dwarf, were identified. Local improved varieties are known to be resistant to tungro. Newly introduced varieties seem to be more susceptible to some of these viruses. There is a possibility for virus diseases to become more serious if new varieties become popular among farmers.

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