13. PRESENT SITUATION OF FERTILIZER USE ON RICE IN THE PHILIPPINES

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Rice is the major agricultural crop grown in the Philippines and is the staple food of about 80 per cent of the country's 36 million people. The country's average production of rice in the past has been among the world's lowest in comparison to those of other countries. The average production in 1967 was 30 cavans per hectare or 1.32 metric tons per hectare (one cavan weighs 44kg of palay) The higher average production in other countries can be attributed to such factors as good irrigation facilities, use of improved rice varieties, and better management practices along with the use of fertilizers and agricultural chemicals.

In 1968, the Philippines became self-sufficient in rice and began to export rice for the first time in its history of perennial importation. The increase in rice production was made possible through the introduction of improved rice varieties with high yield potentials. Also, progressive rice farmers started adopting improved cultural practices in response to the national intensified program in rice production initiated in 1966.

This paper presents some recent studies on the use of fertilizers in the Philippines, particularly as it relates to the production of rice. The extent of land area devoted to rice and the results of some fertilizer experimens conducted in the past are briefly reviewed.

Extent of land area grown to rice

Rice is grown under several field moisture situations throughout the country on 3.09 million hectares of land or on 39 per cent of the Philippines' 7.96 million hectares of cultivated land (Yearbook, 1966). Of the total land area used for rice, 0.6 million hectares are upland, 0.8 million hectares are irrigated and the remainder are rainfed lowland fields (BAE, 1966).

The relative area on rice and the average yield of rice grown under different production conditions are shown in Table 1. The non-irrigated (i. e., rainfed) first crop (wet season) areas are the most prevalent throughout the country and accounts for about 65 per

Table 1. Hectarage and yield of rough rice in the Philippines 1965-1966[1]

Soil Condition	Area Harvested % of Total	Rice Yield m.t./ha		
		Irrigated	Non-irrigated	Average
Lowland 1st Crop	64.6	1.88	1.32	1.51
Lowland 2nd Crop	15.9	1.63	0.67	1.22
Upland	19.5	—	—	0.72

[1] Adapted from Rice Production Manual, 1967. R.I.C.E., U.P. College of Agriculture.

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Table 2. **Yield response of palay due to nitrogen fertilization**[1]

Croup	No. of expts.	Yield of control	Yield Response		
			1st 30N	2nd 30N	3rd 30N
		Tons/ha	30kg N applied		
Lowland					
Increased yield	19	2.78	396	343	158
No response	7	3.26	—	—	—
Decreased yield	2	2.94	-414	-264	-502
Upland					
Increased yield	13	1.66	343	-304	154
No response	2	1.77	—	—	—
Decreased yield	3	2.12	-233	-92	—

[1] Adapted from Uichanco, 1959.

cent of the total rice hectarage. The area accounted for by the lowland second crop (dry season), either irrigated or non-irrigated, is about 16 per cent, with 19 per cent accounted for by the upland crop. In 1966, the average yields of rice for irrigated areas over the non-irrigated areas in the first and second crops were about 42 and 143 per cent higher, respectively.

Results of some fertilizer experiment in the past

Table 2 shows the results of past field fertilizer experiments conducted by the Department of Soils, UPCA, with the commonly grown varieties under lowland and upland conditions. There was no consistent trend in the response of rice to the application of nitrogen. Only about 65 per cent of the lowland and 72 per cent of the upland experiments showed yield increases due to nitrogen application. In both upland and lowland varieties, the increases started to level off even at the 60kg N/ha level.

Table 3 shows the yield response of three tall-stemmed varieties to N application. Milfor 6(2), a lodging-resistant variety, was benefitted by N even at higher rates of application. Thailand lodged at higher N levels while Mangasa lodged at all N levels. Lodging is recognized as one of the biggest problem in rice production in the Philippines (Uichanco, 1959). The application of nitrogen to the traditional local varieties on relatively fertile soils induces excessive vegetative growth, mutual shading, lodging, and disease susceptibility, hence, decreased grain yields.

Thus, recommendations for nitrogen application in the past were modest and the rate moderated with prior knowledge of the lodging tendency of the variety used in the field.

Table 3. **Yield response of 3 lowland rice varieties with nitrogen application**[1]

N applied	Milfor 6(2) (Non-lodger)	Thailand (Medium-lodger)	Mangasa (Lodger)
(kg/ha)	(M. T. per hectare)		
0	3.62	3.56	3.16
45	4.19	3.45	3.17
90	5.04	3.46	2.90
135	5.44	3.63	3.17

[1] Adapted from Uichanco, 1959.

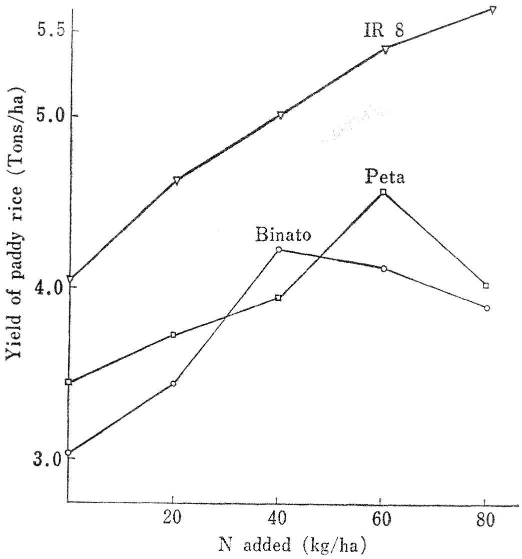

Fig. 1. Nitrogen effect on different varieties of lowland rice. Iloilo, 1966 wet seoson (Chu, 1967).

When no lodging was observed in the previous cropping, 20 to 30kg N/ha was recommended during the wet season with no N recommended if lodging occurred. In the dry season, recommended fertilizer rates were somewhat higher, as much as 45 to 60kg N/ha. The application of N may be a single dose of nitrogen applied late in the season or may be split, one-third to one-half at transplanting time and the rest towards the panicle initiation stage. Early experiments did not show much need for the application of P or K for rice. When needed, 30kg/ha of P_2O_5 or K_2O were applied at transplanting time.

Recent experiments on the fertilization of rice

There are presently two types of rice varieties in the Philippines in so far as response to N is concerned : (a) the traditional local varieties which respond only to low or moderate levels of N, are tall and easily lodge on fertile soils but relatively resistant to diseases ; and (b) the recently-developed varieties, which respond to high levels of N, are relatively short, non-lodging and with high yield potentials. Experimental results show that the variety plays a very important role in the response of rice to fertilizers.

(1) Comparative response of traditional and improved varieties to N application.

Figure 1 shows that in the 1966 wet season crop in Iloilo, IR 8, a recently developed variety, can tolerate more nitrogen than Binato and Peta. The yield of IR 8 was still increasing even at the highest rate of 80kg N/ha but for Binato and Peta, they already lodged and their yields correspondingly reduced at the 80kg N/ha treatment. The results also show that IR 8 outyielded the local varieties even in the No N-treatment.

The composite graphs in Figure 2 showing the relative performance of the high nitrogen-response type and the low nitrogen-response type were based on actual field trials comparing the yields of the nitrogen-responsive IR 8 and of the low responsive Peta under varying nitrogen levels. Figure 2 shows that maximum yield of about 3. 5 tons/ha may be

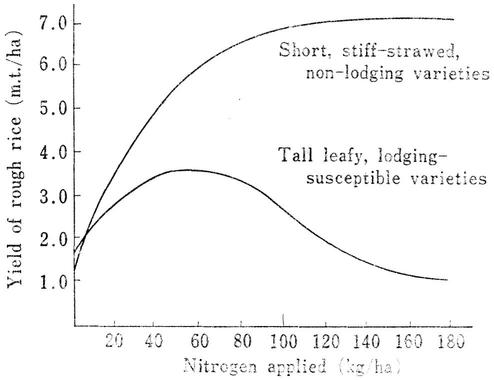

Fig. 2. **Composite graphs on comparative performance of low-and high-nitrogen response varieties** (Rice Production Manual, 1967).

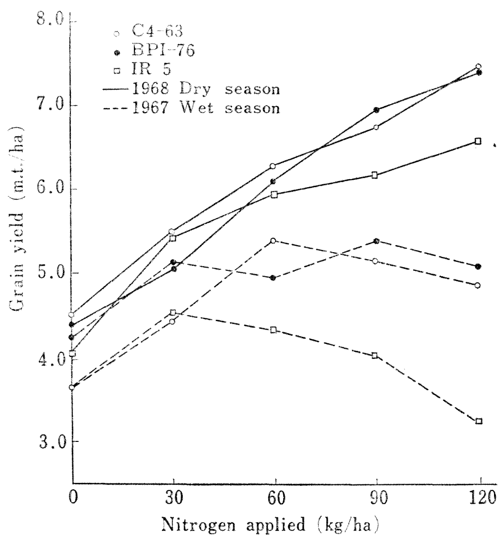

Fig. 3. **Grain yield of three newly-developed lowland rice varieties with different levels of applied N for two seasons.**

obtained from the low-response type at 40 to 60kg N/ha level. Yields start to decrease at higher rates. In the case of the high nitrogen-response type, yields continue to increase as more nitrogen is applied. A maximum yield of about 9. 5 tons/ha was obtained with the 120kg N/ha rate for IR 8 while the yield of Peta was highest at 50kg N/ha.

One is therefore led to conclude that following good cultural practices, such as the application of fertilizers, with the traditional varieties has had its problems in the past. The farmer's reluctance to use fertilizers too intensively has had some justification with the risk in using excess fertilizer being great.

Table 4. Effect of depth of N placement on grain yield and on recovery of applied N[1]. Variety : BPI-76. (1966, Wet sesson).

N Treatment[2]	Yield Grain	Yield Straw	N uptake	N recovery[3]
	mt/ha		kg/ha	%
A. Broadcast on surface	4.45	6.14	97.0	12.0
B. Applied in rows on surface	4.57	6.62	103.7	14.5
C. Applied in rows, 5 cm. depth	4.77	7.00	107.7	34.1
D. 〃 〃 〃, 10 cm. depth	4.68	6.96	108.6	36.8
E. 〃 〃 〃, 15 cm. depth	4.84	7.26	109.2	39.2
LSD .05	n. s.	n. s.		
CV %	5.0	15.2		

1 Date of Dept. of Soils, UPCA, conducted under Joint FAO/IAEA Coordinated Program on Rice Fertilization Using Isotope Techniques, 1966.
2 60kg. N/ha. as ammonium sulfate applied at transplanting time.
3 Based on N^{15} absorbed by plant.

Table 5. Yield of grain and straw and nitrogen in plant with different treatments (1966, Dry season).* **Variety : BPI-76.**

Treatment[1]	Time of Application[2]	Yield of grain	Yield of straw	Total N uptake	N recovery[3]
		tons/ha.		kg./ha.	%
Ammonium Sulfate	T P	4.43	7.48	136.9	34.5
Urea	T P	4.50	7.61	128.7	40.8
Ammonium Nitrate	T P	4.57	7.45	121.2	27.2
Sodium nitrate	T P	4.38	6.12	105.7	4.7
Ammonium sulfats	E I	4.45	6.35	127.4	40.3
Urea	E I	4.14	5.89	119.8	37.0
Ammonium Nitrate	E I	4.23	5.73	113.1	29.3
Sodium Nitrate	E I	4.43	6.58	123.1	17.5
Ammonium Sulfate (120 kg)	T P	2.89	6.82	103.4	—
Control (No N)		3.78	5.74	80.7	
LSD .05		0.55	1.05		
.01		0.73	1.41		
C.V. (%)		9.4	11.2		

* Conducted by the Department of Soils, UPCA, under the Joint FAO/IAEA Coordinated Research Program on Rice Fertilization Using Isotope Techniques.
1 Unless otherwise specified, N rate=60kg./ha.
2 TP=Applied at transplanting time.
EI=Applied at ear initiation.
3 Based on N^{15} absorbed by plant.

(2) **Performance of lowland rice in the wet and dry season.**

Field results with the improved rice varieties show that much greater yield responses at even higher rates of N application are obtained in the dry than in the wet season. Figure 3 shows the comparative grain yields of three recommended rice varieties on Maahas clay, the soil in the Central Experiment Station farms, UPCA. Yields were markedly higher in the dry than in the wet season. There was an indication of lowered grain yields above the 60kg N/ha level in the wet season crops. Similar trend of results have been observed on experiments conducted on farmers' fields. The low response or lack of response to nitrogen fertilization of lodging susceptible varieties in the past can be attributed to the direct effect of lodging or to low light intensity or to both (Galvez, 1963).

(3) **Experiments on depth of placement and efficiency of source of N.**

The data presented in Tables 4 and 5 were obtained from experiments conducted on the relatively fertile Maahas clay using N-15 labelled fertilizers.

Table 4 shows the yield of rice with ammonium sulfate fertilizers applied at different depths. While there was no significant difference in grain yield with the different depths of placement, yields tended to increase with deeper placement of N fertilizers. Nitrogen recovery followed a similar trend. The recovery was higher when N was sub-surface applied than when broadcast on the surface or applied in rows at the surface. Results would rather indicate that there could be some benefits derived, though slight, with the deep placement of ammonium sulfate fertilizers.

Results in Table 5 show that there was no marked difference in yield at the 60kg N/ha level with the different nitrogen sources. Yields were lower when the fertilizers were applied at ear initiation. The low yield of BPI-76 in the 120kg N/ha treatment was due to the lodging of the plants. Results also show that ammonium sulfate and urea are about equal in effectiveness. Nitrogen recovery by plants was low with the nitrate forms of fertilizers. Higher N recovery was obtained with the application of N at ear initiation.

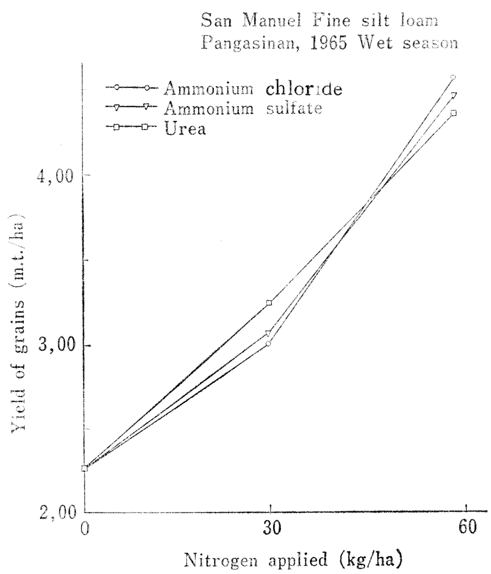

Fig. 4. Relation between N-source and yield of rice (Chu, 1967).

Table 6. **Grain yield of four rice varieties as affected by time of N application in the wet and dry season, 1967-1968** (Data from Department of Soils, UPCA).

N treatment* TP	TP-EI (kg/ha)	EI	C4-28	C4-63 (metric tons per hectare)	BPI-76-1	IR5
1967 Wet season						
0	0	0	1.63	1.72	2.95	2.33
60	0	0	1.80	1.89	2.68	2·11
0	60	0	2.11	1.98	2.64	1.98
0	0	60	1.89	2.11	2.51	1.98
20	0	40	2.33	2.02	2.90	2.46
10	20	30	1.85	2.02	2.46	2.29
MEAN			1.94	1.98	2.68	2.20
1968 Dry season						
0	0	0	3.43	3.34	2.77	4.22
90	0	0	5.85	6.12	4.93	5.98
0	90	0	5.06	5.24	5.06	6.25
0	0	90	4.18	4.44	4.14	5.15
30	0	60	5.24	5.37	4.71	5.81
15	35	40	5.32	5.94	5.32	5.85
MEAN			4.84	5.06	4.49	5.54

* TP-N application at transplanting.
TP-EI-N application midway between transplanting and ear initiation.
EI-N application at ear initiation.

Another comparison on the efficiency to rice production of three forms of nitrogen fertilizers is presented in Figure 4. No significant difference in fertilizer efficiency was observed between ammonium sulfate, urea and ammonium chloride. The rate of N application played the more imporving grain yield.

(4) **Time of nitrogen application.**

The results of an experiment to determine the best time of applying nitrogen to lowland rice are shown in Table 6. In these experiments, N was incorporated into the mud, with each treatment plot receiving a blanket application of P and K at transplanting time.

Marked differences in grain yield due to N application at different stages of growth were exhibited only during the dry season. For all four varieties, yields in the 1968 dry season were lower with all the nitrogen applied at ear initiation. Nitrogen applications other than at ear initiation appeared to be comparatively effective in increasing grain yields. IR 5 yielded most when all nitrogen was applied between transplanting and ear initiation, while the C4 varieties responded well to the addition of all nitrogen at transplanting. On the other hand, the maximum yield of BPI-76 was obtained by applying nitrogen three times during the growth period. It should be mentioned that the 1967 wet season crop was adversely affected by bad weather condition which may partly explain the apparent lack of yield response to N addition at different stages of growth.

The best time of N application on improved varieties appears to be a moot issue. Some experiments at UPCA and IRRI reportedly show no yield advantage of split application of nitrogen if the variety is lodging-resistant and early maturing, as IR 8 or C4-63. Marked losses of nitrogen through leaching, may occur in some soils, especially coarse textured soils, when all of the the nitrogen is applied at transplanting time. The split application of nitrogen fertilizers (a third to one-half of the dose applied at transplanting time with the rest applied at the panicle initiation stage) still remains safe to recommend.

Recent information on rice production in the philippines

(1) Findings of the UNDP/Bureau of Soils Soil Fertility Survey and Research Project.

Under this research project which became operative in 1964, about 3,180 field fertilizer experiments on rice were conducted in the different parts of the country. A summary of the findings based on these experiments is given below.

There is a conspicuous response of rice to nitrogen in all Philippine soils where the experiments were conducted. As compared to the world's mean response to nitrogen of 12-13kg/ha of rough rice per kg of added N, the Philippines' is 15-16 kg/ha per kg N for the first 30kg increment. Yields can almost be doubled with the use of high response varieties. The economics of fertilizer use largely reduces to the analysis of nitrogen responses. The economically optimum nitrogen level is more a function of the variety than the soil.

The responses to phosphorus are much more common in Philippine soils than was previously believed. Marked yield responses of rice to phosphorus is observed more markedly in terraced soils than alluvial soils in the bottom lands. The mean phosphorus response appears to be higher in the Philippines than in most other countries : 5-7 kg/ha of rough rice per kg of applied P_2O_5 as against the world's average estimated at 3 kg/ha. It is recommended that all fertilizer formulations for rice should include phosphorus since (a) economic responses to this nutrient are widespread, and (b) N applications may produce no benefit unless accompanied by phosphorus, as N and P often interact.

The responses to potash in the Philippines are generally uncertain and rarely are economic. The mean response is much less than even the responese to P and rarely exceeds 3 kg/ha of rough rice per kg of added K_2O. Limestone-derived soils are a conspicuous exception and exhibit potash responses of considerable magnitude. Two other soil types often benefit by potash applications, viz. (1) very light sandy soils and (2) ill-drained soils. When heavy nitrogen dressings accompany the growing of responsive varieties, some potash (about 30 kg/ha of K_2O) should be included as a measure of insurance against the dangers of soil depletion.

(2) Rice production statistics.

From the data obtained by the personnel of the Rice and Corn Production and Coordination Council, Cada (1969) repored that of the total land area devoted to rice from July, 1968 to June, 1969, only about 11.9 per cent or 356,179 hectares were growu to the improved rice varieties during the wet season (July-December, 1968) and only about 6. 0 per cent or 179, 573 hectares were used for the dry season (January-June, 1969). An average production of 73. 8 cavans par hectare is reported for the improved varieties (IR 5, IR 8, IR 8-78, BPI-73-1, C18 and C4-63) ; 43. 1 cavans for the other Seed Board varieties and 32. 5 cavans for the "other" rice varieties. The over-all average production of the country for this period was 42. 6 cavans per hectare.

(3) Philippine Fertilizer Institute Report.

An article (PFP, 1969) on a recent report from the Philippine Fertilizer Institute gave the following statistics : (1) Approximately 30 per cent of the Filipino rice farmers use fertilizers and only at an average of 40 per cent of the recommended levels ; (2) Less than 1 per cent of coconut planters use fertilizers and only at 40 per cent of the recommended levels ; (3) Only 10 per cent of corn farmers use fertilizers at only 15 per cent of recommended levels ; and (4). The sugar planters, which represent the most sophisticated and highly developed agricultural sector, use fertilizers at only 85 per cent of the recommended levels.

The reasons advanced for the reluctance of farmers to use fertilizers are ; (1) Lack of sufficient knowledge on the part of the farmers on the use of fertilizers ; (2) unpleasant experience in the use of fertilizers ; (3) the lack of credit assistance to buy fertilizers ; and (4) the lack of sufficient market outlets where the fertilizers would be available when the farmer needs them most.

Resume

Until recently, the average productlon of rice in the philippines was among the world's lowest. In 1968, the philippines became self-sufficient in rice. The increase in rice production was made possible through the development of improved rice varieties and the adoption by progressive farmers of improved cultural practices.

Some of the recent studies on the use of fertilizers in the production of rice were reported in this paper. There are presently two types of rice varieties in the philippines as regards response to nitrogen : (a) the traditional local varieties, which respond to low or moderate levels of nitrogen are tall, leafy and lodging-susceptible ; and (b) the improved varieties, which respond to high levels of nitrogen, are short, non-lodging and with high yield potentials. The traditional varieties commonly grown are prone to lodge that nitrogen applications on highly fertile soils tend to increase lodging and decrease yield. Thus, the reluctance of farmere to use fertilizers has had some justification in the past. Recent statistics indicate that only about 30 per cent of the Filipino rice farmers use fertilizers and only at about 40 per cent of the recommended rate.

Findings of the UNDP (Special Fund) Soil Fertility Survey and Research Project show that nitrogen still is the crucial need of rice as manifested by the conspicuous response to nitrogen in all soils studied. Response to phosphorus was more common than was formerly believed. Fertilizer formulation for rice should therefore include phosphorus since economic responses to this nutrient are widespread and nitrgen application may produce no benefit unless accompanied by phosphrous. In the case of potash, responses were uncertain.

From July, 1968 to June, 1969, the improved rice varieties were grown in only about 18 per cent of the total area grown to rice with an average production of 3. 25 metric tons per hectare. Within this period, the average rice production of the country was increased by 42 per cent over the 1967 average production of 1. 32 metric tons per hectare.

Much work still needs to be done to further improve on the present production of rice in the Philippines. These would include among others : (a) the possible development of varieties which will perform more efficiently in the wet season ; (b) the dissemination of seeds of the improved varieties to all farmers so that they can derive the benefits therefrom ; (c) the improvement of irrigation and drainage facilities without which fertilizers will be ineffective ; and (b) the training of people in the intelligent use of fertilizers.

Discussion

H. Nakayama, Japan : Have you some data about yield component in these examinations? If the changing of yield component (panicle number, spikelet number, etc.) is shown as the data, we can understand about the condition of growth and develpment.

Answer : I believe we have. Normally data on yield components are collected. I can check what information we have on this and share them with you upon my return to the Philippines.

S. Matsushima, Japan : Table 6 shows that besal dressing gives the best yield in many cases. Is it true throughout your country? Does split application give the best yield in some places?

Answer : This will be dependent on the variety, whether lodging-resistant or lodging-susceptible. In many instances. split application has given the best results. In this connection, it may be mentioned that the improved, lodging-resistant varieties were grown in about 18% of the total rice area during the period July, 1968 to June, 1969.

M. Shafi, Pakistan : The yield figures of C4-63 and BPI-76 given in Fig. 3 are identical during wet and dry seasons. I would like to know in what other characters these two varieties differ.

Answer : The C4 varieties, like the C4-63, are relatively shorter, erect, resistant to lodging, long grain and with good milling recovery while the BPI-76 is relatively taller, with leaves slightly drooping at harvest, only moderately resistant to lodging, with medium size of grain (about 5. 0-5. 9mm) and with milling recovery somewhat lower than the C 4-63. Both have good eating quality, acceptable to filipino consumers.

S. K. De Datta, IRRI : When was the nitrogen applied in treatment A in Table 4? Did you have control plots without added nitrogen? If in treatment A, fertilizer was applied at transplanting, why there was no difference in the treatments A vs. C, D or E?

Answer : For treatment A, the N-fertilizer was just spread on the surface at transplant time. I believe that even if we had control plots in the experiment, yield differences due to placement of ammonium sulfate fertilizers at different depth would still not be significant. I am aware that in a study on N-placement, comparing, I think, ammonium sulfate and urea in IRRI, grain yields were significantly higher with deeper placement of the fertilizers.

S. P. Chee, Malaysia : Your Table 6 gives IR 5-42-2. Does this refer to IR 5 released by IRRI? If so, it should be IR 5-47-2, as I know of.

Answer : Yes, it should be IR 5-47-2 and better referred to as just "IR 5".

Y. Ota, Japan : In Table 6, two of the varieties C 4-28, C 4-63 are good in response when applied as basal, and two of the varieties BPI-76-1, and IR 5 are good in response when applied as top-dressing. Is there any relation to varietal character?

Answer : Yes, I believe this will be very much dependent on the variety whether the variety is resistant or susceptible to lodging. For one, BPI-76-1 is proved to lodge at higher levels of N.

H. R. von Uexkull, Germany : Referring Table 5, in this table, four different forms of N are tested. At the LSD 1% level only ammonium nitrate is significantly better than the control. Could you explain why ammonium nitrate gave the best yield in this experiment?

Answer : The rate of N application was the same, 60 kg N/ha, for the different N sources. Since there was no significant difference in grain yield with the different N sources, it can be said that as far as grain yield is concerned the different N-sources were equally effective. There is however, a conspicuous differences in fertilizer recovery based on the N^{15} absorbed by plants. Nitrogen recovery by plants was low with the nitrate forms of fertilizer.

Soebijanto, Indonesia : See Table 4. Please explain the relatively high C.V. for straw yield.

Answer : I observe that our C. V. for straw yield is usually higher than for grain yield. This could be due to a difference in stage of drying the straw.

Soebijanto, Indonesia : See Fig. 3. C 4-63's yield is reduced obviously during the wet season compared with the crop in the dry season. What would be the limiting factor?

Answer: It has been established, especially with the improved varieties, that grain yields are higher during the dry than during the wet season. The limiting factor would be the difference in light intensity during the wet and dry season.

K. Kawaguchi, Japan: How many percent of rice plant residue is returned to a field now in your country? Has it been increasing or decreasing in recent years? How about in near future?

Answer: Some of our farmers burn their rice straw after harvest espcially if they are soon preparing for a second crop, others leave them in the field until the wet season. It will therefore depend upon the practice and also on whether at harvest they only harvest the panicles or cutting the stems closer to the ground. I believe the amount of residues returned to the field will be increasing in the near future as we are encouraging farmers to make compost of farm residues.

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