ANALYSIS OF THE YIELD POTENTIAL OF THE INDICA HYBRID, H-4

By

DR. NOBORU YAMADA*

(Chief Research Co-ordinator, Department of Agriculture, Ceylon)

IN the paper on "The Nature of Fertilizer Response on Japonica and Indica Rice Varieties", the type of fertilizer response manifested by H-4, the hybrid selection produced by Mr. H. Weeraratne, Manager, Central Rice Breeding Station, Batalagoda, from a cross between *Murungakayan* 302 and *Mas,* was subjected to detailed analysis. This communication attempts to examine the yield potential of this hybrid under normal field conditions.

On a paddy field in the Central Research Station at Peradeniya, H-4 was cultivated in the *Yala* season of 1959, under the management of Mr. L. T. P. de Soysa, the Farm Manager of the Station. The growth and yield of the paddy plants were examined in detail. As explained below, plants grown in a part of the field showed very clear evidence that a yield higher than 160 bushels per acre is possible with this variety under the present cultural techniques of this country, although the average yield of the whole field was 120 bushels per acre. This growth and yield were not obtained in experimental or small-scale pot culture, but in actual paddy fields with normal cultivation methods.

1. Condition of the field and cultural practices

The paddy field is 11,000 square feet (approximately quarter acre) in extent as shown in fig 1. Portion A of the field showed poor plant growth due to severe rush of water which frequently occurred after heavy rain, while in portion C plant growth was somewhat better than that in portion B. The observation was made on the portion B where plant growth was intermediate between A and C.

* Expert from Japan, under the Colombo Plan.

The whole extent of the field has a very deep soil layer of about two feet for the development of the root system of plants, with the exception of the area C, where the soil is more or less sandy. Irrigation water is available from a spring but the water supply is sometimes inadequate.

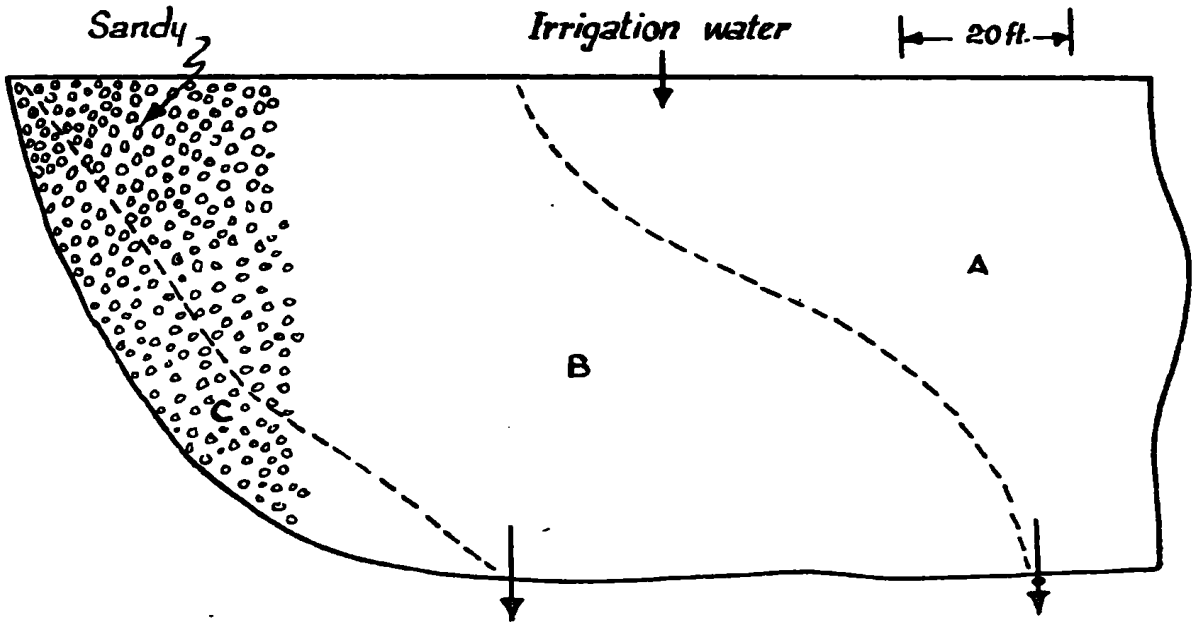

fig: 1. MAP OF PADDY FIELD

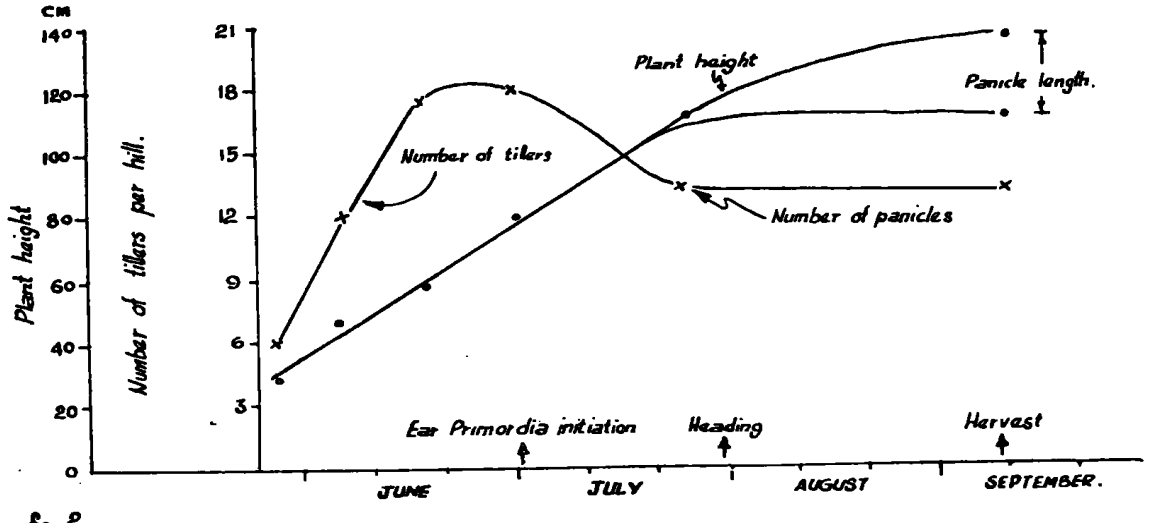

fig: 2 PLANT HEIGHT AND NUMBER OF TILLERS PER HILL

The variety H-4 was sown in a nursery bed on 10 April. On May 2, seedlings (22 days old) were transplanted in the field at a spacing of 10 in. × 6 in. with three seedlings per hill. Fertilizers applied were as follows :—

Basal dressing :	
Sulphate of ammonia	50 lb. per acre
Conc. superphosphate	67 lb. per acre
Muriate of potassium	50 lb. per acre
Top dressing :	
Sulphate of ammonia	100 lb. per acre.

Basal dressing was made just before the second ploughing, and top dressing of nitrogen was made on July 1 (about 30 days before heading time). Two weedings were done with the rotary weeder. No severe incidence of diseases and insect pests was observed.

2. Growth of the plants

Growth of the plants as expressed by plant height and number of tillers per hill is shown in Fig. 2. Number of tillers per hill increased up to approximately 18 by the end of June. Final number of panicles per hill was 12.8, as shown in Table 1. Therefore the percentage of fruitful tillers to the total (maximum) number of tillers was about 70 per cent. This percentage value is as high as that usually observed with Japonica varieties of same growing duration in Japan (1) indicating that tillering was not excessive in proportion to the nutritional supply during the later growing period, even though the tillers were as many as 18, and that there was no shortage of nutrients causing lowering of percentage of fruitful tillers in proportion to the magnitude of early growth. In other words, the growth during the early period and the later period of vegetative growth stage was fairly well balanced.

At the time of heading, several plants were sampled and starch content of the plants was determined. The basal portions of leaf sheath and stems were found to contain a great deal of stored starch, estimated to be as much as ten per cent. of the total dry weight of these organs. This indicated that the plants were able to accumulate a great deal of starch to be utilized in the development of grains after heading. It is well known that shortage of nitrogen results in small plants with high content of starch, while a high nitrogen level induces big plants but with a low content of starch. (2) In the former case, although starch content is high, total quantity of starch available for grain development is less, and the daily production of starch after

heading too cannot be high because of the small plant size and restricted leaf area. In the latter case, daily production of starch after heading is high because of the large leaf area and high photosynthetic rate due to high nitrogen content of leaf, but the quantity of starch stored for grains before heading is less, and the result is shortage of starch in proportion to the increased number of spikelets (due to high nitrogen content), to which starch is to be delivered. Therefore, in the former case yield cannot be high, and in the latter case numerous empty grains and small grains are produced, which tend to reduce yield. But the H-4 plants which were sampled were large and at the same time they had accumulated a great deal of starch. This is the typical characteristic of high-yielding paddy plants.

3. Harvest crop examination

With ten hills sampled at random from the area B of the field just before harvesting, observations shown in Tables 1 and 2 were made. In Table 1, plant height, number of tillers and panicles per hill, and length of panicle borne on the longest stem are shown. Twenty panicles were then sampled at random from the above ten hills, and measured as shown in Table 2. Sterility percentage by number of grains and by weight was determined as shown in Tables 3 and 4.

According to these results, average values of the yield components are as follows :—

Number of panicles per hill .. 12·8
Number of grains per panicle .. 111·6
Number of grains per hill .. 12·8 × 111·6 = 1428·5
Number of fruitful grains per hill = 1428.5 × 0.784 = 1119.9
Weight of 1,000 grains = 30.2 gm.
Then, weight of total fruitful grains per hill = 33.8 gm.

Average grain yield per hill, 33.8 gm., thus calculated, is slightly less than the value obtained by simply averaging grain yield of ten hills, 36.1 gm.

4. Yield estimation

Taking average grain yield per hill as 33.8 gm., and taking average spacing as 10 x 6 inches, yield per acre is estimated as follows :——

33.8 gm. × 104544 = 3533.6 kg = 7773.9 lb. = 169 bushels.
where, 104544 = number of hills per acre, and bushel weight is taken as 46 lb.

This estimation is based on the minimum value of average grain yield per hill and the minimum number of hills per acre, but still the estimated yield shows more than 160 bushels of paddy per acre.

Unfortunately the cultivation was not done for the purpose of this experiment, so that the growth and yield of paddy are not uniform throughout the field as shown in Fig. 1 and harvesting was not made separately with A, B and C areas. There was also a certain amount of loss due to grain shattering during harvesting and transporting.

The divergence between the estimated yield of 169 bushels per acre for the plot B of the field and the actual harvest of 120 bushels per acre from the whole field can be attributed to these reasons.

The poor growth and yield in area A of the field indicates that the improvement of irrigation and drainage is an important factor in raising the general level of yield.

The total number of hills per unit area is just the same with the spacing of 10 in. × 6 in. and of 12 in. × 5 in. Therefore, it is suggeted that it would be better to adopt the spacing 12 in × 5 in., instead of 10 in × 6 in., order to secure more light and aeration to the plants and also to facilitate field practices such as weeding and spraying, without reducing the number of plants per unit area.

Strictly speaking, this report deals only with the evidence shown by plants themselves of possibility of obtaining 160 bushels of paddy per acre. But, it gives us confidence and encouragement that the yield as high as 160 bushels per acre could be achieved, because it was actually obtained even though in a small area.

It has been believed for long years that paddy is better suited to the sub-tropical and warm temperate zones than to the tropics, and that paddy grown under tropical conditions may possibly not be capable of giving the high returns possible in more temperate climes. (Grist 1959) (3). However, the progress in improving varieties and cultural techniques in this country has achieved a yield as high as that reported here. Even a yield of 120 bushels per acre is the higher class of yield in Japan. The possibility of obtaining a higher yield than this is indicated by the above observations.

LITERATURE CITED

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Table 1.—Plant and Panicle

Plant No.	*Plant height*	*No. of tillers*	*No. of Panicle*	*Panicle Length*
	cm			*cm*
1	128·5	15	11	29·0
2	145·0	23	15	31·0
3	133·5	13	12	28·5
4	134·5	19	13	31·0
5	140·5	23	13	28·0
6	135·5	25	19	28·0
7	140·5	18	11	30·0
8	138·5	14	9	30·0
9	135·5	15	14	28·5
10	134·0	13	11	29·5
Mean	136·6	17·8	12·8	29·35

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Table 2.—Panicle and Grain

Panicle Sample	*Panicle length*	*No. of grains*	*No. of rachis branch*	
			1st order	*2nd order*
	cm.			
1	26·0	101	12	16
2	25·5	117	12	22
3	26·3	133	12	24
4	28·6	176	13	34
5	26·8	140	12	26
6	24·5	126	12	26
7	22·3	59	9	13
8	22·8	76	9	10
9	27·1	119	12	17
10	28·6	163	12	32
11	23·7	93	9	11
12	24·6	120	13	22
13	27·7	160	14	34
14	25·4	128	12	22
15	26·0	112	12	21
16	16·7	30	6	3
17	20·8	95	10	13
18	25·8	98	11	17
19	25·6	139	13	25
20	27·8	147	13	26
Mean	25·13	111·6	11·4	20·7

Table 3.—Sterility and grain weight

Sample No.	*Fruitful grains*	*Empty grains*	*Total number of grains*	*Weight of 1000 grains*
A	156	36	192	30·15
B	168	52	220	28·04
C	179	43	222	31·21
D	140	47	187	31·36
E	294	70	364	30·44
F	189	63	252	30·12
Total or Mean	1,126	311	1,437	30·22

Sterility percentage by number of grains .. $\frac{311}{1437} = 21{\cdot}6\%$

Table 4.—Weight of Straw and grain per ten plants

Weight of straw	578·5 gm
Weight of total panicles	409·7
Weight of total panicles without grains	28·5
Weight of empty grains	19·9
Weight of fruitful grains	361·4
Sterility percentage by weight $= \frac{19{\cdot}9}{381{\cdot}2}$	$= 5{\cdot}2\%$