ADAPTABILITY OF RICE TO UPLAND AND IRRIGATED CONDITIONS

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Abstract:

In April 1973 twelve rice cultivars were concurrently planted under upland and irrigated conditions.

The ratio of grain yields under irrigation to those under upland conditions ranged from 1.16 to 6.31. Those with a high adaptability ratio were considered to have narrow adaptability. Those with relatively low ratio and with acceptable yields under both conditions were considered to have wide adaptability and suitable for both conditions. The best adapted was TOs 78 with a ratio of 1.16, yields being 4360 kg/ha and 5061 kg/ha under upland and irrigation respectively. Eight of the entries matured later under upland condition than under irrigation. There were higher percentages of productive tillers under irrigation. With one exception, the entries were taller under irrigation. There was less disease and insect attack under irrigation than in upland.

The findings indicated that there were very few cultivars that performed satisfactorily under the two conditions.

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INTRODUCTION

Rice is rightly referred to as water loving plant. Hence most of the early rice research and introductions were based on culture under deep-flooded, controlled irrigation or swamp conditions. A common factor for all these is sufficient water.

Availability of water distinguishes between upland rice and irrigated rice. Recently many researchers are studying the problems of rice cultivation under upland conditions, most of which are associated with the availability of water.

Plant breeders, agronomists, pathologists, physiologists and entomologists working on upland rice in West Africa are faced with producing varieties that will survive under a wide range of available soil moisture. In some areas where rice is cultivated in West Africa the condition ranges from true irrigated paddy to true upland condition. For these areas it is important to have rice varieties that will adapt to these conditions. This paper shows the performance of some rice varieties and lines under two extreme conditions and defines what might be regarded as adaptable varieties under the two conditions.

MATERIALS AND METHODS

Twelve entries were involved in trials at IITA to compare performance under both upland and irrigated conditions. Table 1

contains information on them. They will be referred to in this report by their TOs numbers.

Table 1. Varieties or advanced lines concurrently planted under upland and irrigated conditions at IITA, 1973.

TOs	Varieties	Source or origin
858	Pankaj	India
78	IR 269-26-3-3-3	IRRI
887	AXEC-15-3	Sierra Leone
46	IR 305-3-17-1-3	IRRI
856	Jaya	India
121	IR 773A-1-36-2-1	IRRI
1108	IR 442-2-2-58-2-1-2	IRRI
921	IR 937-76-2-2	IRRI
912	IR 1163-134-1-2	IRRI
542	IR 790-28-2-1	IRRI
920	IR 112-28-1-1	IRRI
486	OS6	Nigeria

The irrigated entries were sown in a seedbed April 12, 1973 for transplanting the same day upland entries were planted. Similar cultural treatments were given for the two trials except that one trial depended on rainfall only while the other trial had water supplied at a minimum depth of 7 cm. The definition of our upland condition is a piece of unbunded, well drained soil depending only on rainfall for its soil moisture.

Plot size for the trials was 12.6 m^2 with six and four replications in upland and lowland respectively. The experiment design was a randomized complete block and statistical analyses were done in IITA by Dr. Little on an IBM 1130 computer. Observations taken included tiller count, maturity, height, lodging, grain yield, disease and pests resistance.

RESULTS AND DISCUSSION.

As indicated in Table 2 there are yield differences between the entries when grown under irrigation and upland conditions. The ratio between the two yields is an important measure of adaptability under two conditions. Levit (1957) used this type of ratio in studying drought resistance. The criterion was however found misleading in wheat by Harrington in 1935. Nevertheless, from previous trials at IITA it is found to be a useful criterion to judge adaptability.

The lower this ratio is, the more adaptable the variety or lines. An important condition, however, is that the yields being considered must be an acceptable yield for the location where the trial is done. Thus a variety producing 1500 kg/ha under both conditions will give a low ratio but may not be regarded as well adapted to either environment whereas if the yield were 5000 kg/ha in both conditions it would be regarded as well adapted to both.

Table 2. Grain yield in kg.ha at 14% M.C. and yield differences of entries planted concurrently under upland and irrigated conditions at IITA, 1973.

TOs	YIELD Upland	Irrigation	Difference (Irrigation-Upland)	Adaptability Ratio (Irrigation-Upland)
858	868* e	5474* a	4606	6.31
78	4360 a	5061 ab	701	1.16
887	1470 de	4936 ab	3466	3.36
46	3076 b	4724 ab	1648	1.54
856	2191 c	4557 abc	2366	2.08
121	1800 c	4426 bc	2626	2.46
1108	2274 c	4344 bcd	2070	1.91
921	3258 b	4298 bcd	1040	1.32
912	2084 de	4149 bcd	2065	1.99
542	2235 c	3663 cd	1428	1.64
920	2032 cd	3395 de	1363	1.67
486	2040 cd	2737 e	697	1.34
C.V.	24.9	14.4		

*Figures within same column having the same letter are not significantly different at 5% level.

TOs 858 produced the highest grain yield under irrigation but the lowest under upland condition. The adaptability ratio is 6.31. In other words under irrigation it yielded more than six times as much as under upland condition. Thus a variety with such a high adaptability ratio is regarded as having narrow adaptability. It will do well under irrigated condition but poorly under upland

Another extreme example is that of TOs 486 with a ratio of 1.34 and low grain yield under both conditions. Its yield of less than 3000 kg/ha is uneconomical under irrigation considering investments in paddy land development. This illustrates the performance of a strict upland variety, which the entry is. It is the currently recommended upland variety in Nigeria.

TOs 78 with a low adaptability ratio produced the highest grain yield under upland condition and second only to TOs 858 though not significantly different from it under irrigation. This line is therefore considered to have a potential wide adaptability as far as water requirement is concerned. It will produce an economical yield both under irrigated, or swamp, and under upland conditions. This type of rice line will be acceptable to farmers with land having differing soil moisture conditions. The urland-swamp conditions are found in many parts of West Africa where rice farmers grow rice in bottom valleys, hydromorphic soil or river banks with the planting extending uphill into true upland conditions.

Table 3 contains information on days to maturity and percentage productive tillers. Eight entries matured later under upland condition than under irrigated condition. On the average moisture stress, the days to maturity were increased by 5.5 days.

Productive tillers are the panicle bearing tillers. Number of panicles per plant is one of three main yield components and therefore percentage productive tillers is an important character to investigate. It helps to explain the yield differences obtained under the two conditions. The differences range from 3.8 - 42% for all the entries. Under irrigation more lines produced panicles than under the upland condition. The adaptability of TOs 78 is also seen here with its least difference in percent productive tillers (Table 3). Thus this character explains why it did well under both conditions.

Data on height are given in Table 4. Plant height is an important character as far as lodging and competition with weeds at the early growth stage are concerned. In this investigation, with the exception of TOs 486, all entries were taller under irrigation than under upland condition. The height differences of other entries ranges from 2 - 47%. TOs 486 is a typical upland variety behaved differently. It was 15% shorter under irrigation. Being an upland variety TOs 486's root and stem elongation might have been affected under the flooded condition. Future investigations will study this phenomenon.

Most of the materials in the trials are short types hence the height differences were not reflected in Lodging. Only TOs 858 and TOs 486 lodged.

The most important disease of rice in West Africa is blast (Pyricularia oryzae) especially under upland conditions.

Table 3. Maturity and productive tillers of entries under upland and irrigation at IITA, 1973

	Days to Maturity			Percentage productive tillers		
TOs	Upland	Irrigation	Difference Upland-Irrigation	Irrigation	Upland	Difference Irrigation-Upland
858	160	163	-3	96	67	29
78	151	144	7	87	83	4
337	146	135	11	98	56	42
46	132	136	-4	100	80	20
856	133	131	2	99	79	20
121	110	112	-2	97	78	19
1108	139	133	6	100	78	22
921	149	136	13	100	84	16
912	155	143	12	87	68	19
542	145	146	-1	93	73	20
920	150	134	16	96	88	8
486	130	120	10	100	80	20
C.V.	6.7	3.3				

Table 4. Height in cms of entries concurently planted under upland and irrigated conditions at IITA 1973.

TOs	Irrigation	Upland	Difference (Irrigation-Upland)
858	143	110	33
78	117	103	14
887	165	162	3
46	101	83	18
856	104	88	16
121	98	80	18
1108	127	100	27
921	111	81	30
912	113	96	17
542	112	87	25
920	104	86	18
486	151	177	-26

The pathogen may attack the leaves, the node and the neck. The three different expressions are called leaf blast, node blast and neck blast or neck rot. In these trials observations are taken on percentage neck blast as shown in Table 5 .

With the exception of two entries the percentage of neck blast was higher under upland than under irrigation.

Table 5. Diseases and pests of entries under upland and irrigation at IITA, 1973.

TOs	% Neck Blast		% White Head	
	Upland	Irrigation	Upland	Irrigation
858	26.7	0.0	0.2	0.0
78	14.7	3.8	0.0	0.0
887	15.3	0.0	0.0	0.0
46	43.7	45.0	7.3	0.0
856	68.5	3.0	0.0	0.0
121	11.8	5.0	1.2	0.0
1108	17.0	6.0	0.2	0.0
921	58.3	3.2	3.3	0.0
912	14.5	35.0	1.0	0.0
542	22.0	4.8	0.5	0.0
920	28.5	2.8	0.5	15.0
486	6.7	0.0	3.3	0.0

This confirms previous results at IITA. Therefore, unless a variety is strongly resistant it will not yield well under the upland condition. The relatively low incidence of neck blast of TOs 78 might also account for its good grain production under both upland and irrigated condition.

The most important insect pest of rice in West Africa is stem borer, with Sesamia calamistis being the predominant borer at IITA. The percentage of white head is a good field measurement of damage done by stem borer.

There was relatively little damage measured as percent white head in this trial. White head was found, however, on nine entries under upland and on only one entry under irrigation. TOs 78 had no incidence of stem borer attack under either conditions. This further proves its apparent adaptability for both conditions as far as pests are concerned. TOs 887 and TOs 851 also had no borer attack under both conditions (Table 5).

CONCLUSIONS

Exposure of 12 rice cultivars to upland and irrigated conditions revealed that only three of the entries performed satisfactorily under both conditions with TOs 78 outstanding. Adaptability ratio, discussed mainly for yield, is a good factor for considering wide adaptation with some assumptions having been satisfied.

The 1973 wet season was comparatively a good season for upland rice, therefore, the results of this preliminary study may be different in other seasons and locations. Further investigations will be carried out to find out other mechanisms of the satisfactory wide adaptability found for TOs 78. The questions raised by this investigations if answered will be useful for determining what characters to look for in selecting for wide adaptability in rice. TOs 78 will be compared with new upland varieties being developed at IITA.

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