High-yielding and stable rice varieties in the flood plains of Upper Volta River in Ghana

Rice consumption is drastically increasing in West Africa; however, domestic production has not matched the increase in consumption. Moreover, the increasing cost of imported rice is putting the squeeze on the national budget. The utilization of fertile flood plains is thus being eyed as one solution to increase rice production in the region.

The fertility of flood plains changes drastically according to the distance from rivers. In addition, there is a large annual environmental variation in the areas where crops are grown.

We tried to screen suitable rice varieties for the flood plains. The experiments, which used 28 varieties, were conducted at 4 places (Fig. 1), each experiencing different flood conditions from 2012 to 2014 (Table 1). The result of cluster analysis showed the yield responses of four genotypes across three environments.

G-2 (Genotype-2) had the highest yield in E-3 (Environment-3) but showed lower yields in other environments (Fig. 1). A genotype showing high yield only in a particular environment is not adequate for flood plains because the environment undergoes large changes every year. On the other hand, G-3 showed moderate yields and was stable under different environments. Meanwhile, G-4 showed the highest yield in E-1 and relatively higher yields in other environments. Therefore, G-4 was considered the most favorable genotype in flood plains. We can see which varieties are favorable in flood plains by performing AMMI (additive main effect and multiplicative interaction) analysis. Varieties that are stable in any environment are plotted near the origin. The tested varieties, IRBL9-W[RL] (Japan-IRRI Project; https://www.jircas.affrc.go.jp/kankoubutsu/seika/seika2011/pdf/2011-10.pdf), in addition to some local varieties such as Amankwatia, Bodia, and Sakai, are among the top 20% in terms of yield (Fig. 2). IR42 (No.4) had the highest yield on average; however, it was not stable.

Our results showed that planting early-maturing varieties to avoid drought is not effective. We believe that this information will be useful in designing breeding strategies for rainfed rice in flood plains. We also hope that our results will contribute to achieving the goal of CARD (Coalition for African Rice Development), which targets rainfed lowlands for increased rice production.

(*M. Oda, Y. Tsujimoto, K. Katsura [Kyoto Univ.], K. Matsushima [Tokyo Univ. of Agriculture], B. Inusah [(Savanna Agricultural Research Center], W. Dogbe [SARC], J. Sakagami [Kagoshima Univ.]*)

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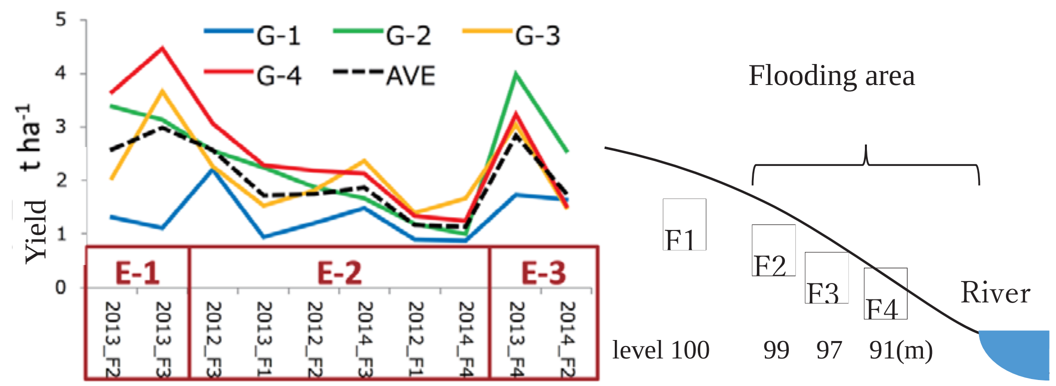

Fig. 1. Average yields of genotype groups across environment groups.
G: Genotype by cluster analysis, E:Environment group

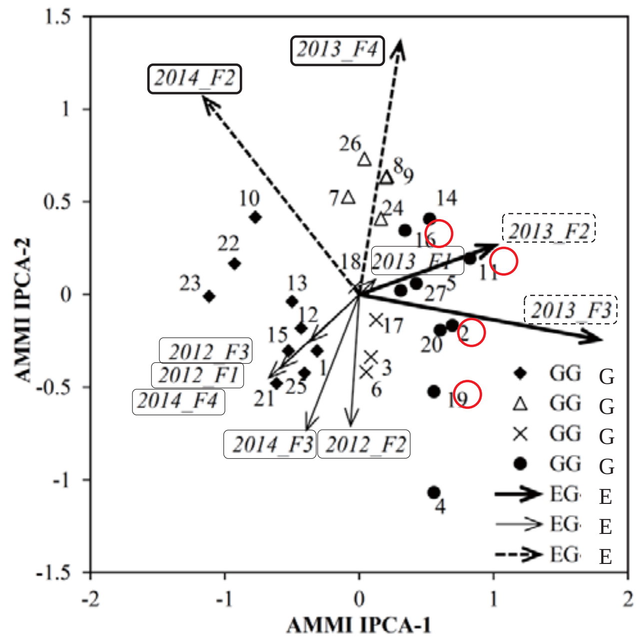

Fig. 2. Feature of each variety by AMMI analysis

Table 1. Average yields of the sampled varieties

No.	Genotype	Species	Yield	Character
G-1 (Very stable but low yield)				
1	CK40	*O. sativa*	1.91	Lowland
10	IR73020-19-2-B-3-2B	*O. sativa*	1.74	Submergence
12	N22	*O. sativa*	0.78	Upland
13	Nylon	*O. sativa*	1.38	Deepwater
15	Vandana	*O. sativa*	0.90	Upland
21	CG14	*O. glaberrima*	1.42	Lowland
22	Mala Noir IV	*O. glaberrima*	1.19	Deepwater
23	Yélé 1A	*O. glaberrima*	1.08	Deepwater
25	Séidou Bayebeli	*O. glaberrima*	1.66	Upland
G-2 (High yield in E-3)				
7	IR71700-247-1-1-2	*O. sativa*	2.12	Lowland
8	IR72431-5B-18-B-10-1	*O. sativa*	2.66	Elongation
9	IR73018-21-2-B-2-B	*O. sativa*	2.35	Submergence
24	Douboutou II	*O. glaberrima*	2.30	Lowland
26	Saligbeli	*O. glaberrima*	2.37	Deepwater
G-3 (Standard)				
3	IR07F323	*O. sativa*	2.01	AG + *Sub1*
6	IR67520-B-14-1-3-2-2	*O. sativa*	2.09	Submergence
17	Jasmin85	*O. sativa*	2.15	Lowland
18	Sikamo	*O. sativa*	2.25	Lowland
G-4 (High yield especially in E-1)				
2	IR07F297	*O. sativa*	2.39	AG + *Sub1*
4	IR42	*O. sativa*	2.76	Irrigated
5	IR11141-1-6-1-4	*O. sativa*	2.30	Elongation
11	IRBL9-W[RL]	*O. sativa*	2.61	*Sub1*
14	PSBRC80	*O. sativa*	2.18	Lowland
16	Amankwatia	*O. sativa*	2.75	Lowland
19	Bodia	*O. sativa*	2.60	Lowland
20	Sakai	*O. sativa*	2.59	Lowland
27	WAB1159-2-12-11-6-10	NERICA	2.44	Lowland

Varieties in red letters are in the top 20%（>2.5t）in terms of yield.