Contribution of potential yield, drought tolerance and escape to adaptation of 15 rice varieties in rainfed lowlands in Cambodia**.**

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Abstract

In Cambodia, grain yield in rainfed lowland rice is often affected by drought during late vegetative or reproductive stage. Several experiments were conducted to quantify the contribution of potential yield, drought tolerance and drought escape mechanisms to yield under water stress conditions. In total nine pairs of well irrigated and simulated drought (by draining water) experiments were conducted. Potential yield was obtained under irrigation. Grain yields and flowering dates were recorded in 15 varieties. Drought tolerance was quantified by using drought response index (DRI), which is grain yield under drought adjusted for potential yield and flowering date of the variety. Drought escape is expressed as days to flower under drought conditions. Mean yield reduction due to drought of nine experiments was 27 % (range 12-44). The relative contribution of yield potential, flowering date and DRI to observe yield under drought were evaluated by multiple regression for each experiment. Potential yield accounted for 54% (with a range of 10-80) of the variation in actual yield under drought. This was followed by DRI and flowering date with 34 (with a range of 0-60) and 12 (with a range of 0-30) of the contribution, respectively. It is concluded that selecting for drought tolerance as well as for high yield potential would be important in developing cultivars for rainfed lowlands in Cambodia. Although flowering dates are important for drought escape, it had a small contribution probably because drought developed slowly in these experiments in Cambodia.

Key Words

potential yield, drought response index, days to flower, yield reduction.

Introduction

In Cambodia, grain yield (GY) in rainfed lowland rice is often affected by drought during late vegetative or reproductive. Plant breeders rely on direct selection for GY in the target environments as the main criterion for selection. Evidence on other crops (e.g. pearl millet, Bidinger *et al.,* 1987) showed that varieties could be developed for improved yield under drought stress yet respond well to well-watered conditions. Potential yield would have an important role to achieve such yield advantage in rice under drought. Drought response Index (DRI) (Bidinger et al, 1987; Makara et al, 2006) is often used to indicate drought tolerance of genotypes while phenology is associated with drought escape (Fukai and Cooper, 1995), and they are also important in developing cultivars for drought-prone area. Experiments were conducted at two locations in five years to quantify the contribution of potential yield, drought tolerance and drought escape mechanisms to yield under water stress conditions in Cambodia. This paper quantified the contribution of these three characters to yield under different drought conditions.

Methods

Experimental condition.

In total nine pairs of well irrigated and simulated drought (by draining water) experiments were conducted at CARDI (4) and Prey Veng (5) in Cambodia. Each experiment had 15 varieties in a randomized block design with 3 replications. Adequate N, P and K were applied to minimize the effects of nutrient deficiency for growth and yield. Potential yield was obtained under irrigated conditions. Grain yields and flowering dates were recorded in all experiments. Ten main culms were marked in each plot before flowering, and daily counts were taken on the number of culms which start flowering. The number of days to 75%

flowering was determined for both irrigated and drained experiments. DRI was calculated using the method described by Bidinger et al (1987) and later modified by Makara et al (2006). The relationship between flowering (well watered) and grain yield (drought) was used for calculation of DRI.

Data analysis

The relative contribution of potential yield, drought escape (days to flower) and drought tolerance (DRI) were quantified by using multiple regression technique described by Silim and Saxena, (1993). The sums of square of regressions were partitioned to three components in the analysis of variances. The contribution of each component was expressed as percentage of the sum of squares it accounted for.

Results and discussion

Out of nine experiments only two experiments (PV99 and CA01) had severe drought while five had mild drought conditions. Severe drought occurred at flowering in PV99 while it was slow and continuous in CA01. There were significant variations among genotypes for potential grain yield under irrigated conditions, grain yield under drought, days to flower, yield reduction and DRI. The correlations between yield under well water and the water stressed conditions were significant in most of the experiments. Mean yield reduction due to drought of nine experiments was 27% (with a range of 12-44%). Potential yield was the major contributor for yield reduction and it accounted 54% (with a range of 17-79%) of the variation in actual yield under drought. This was followed by DRI and with 31% (with a range of 1-60%) and flowering date with 16% (with a range of 1-58%) of the contribution, respectively (Table. 1). This method of partitioning would provide an useful estimation of major factor contribution for yield losses under drought conditions.

Despite the low relative contribution of DRI for drought adaptation few varieties with high DRI showed some drought tolerance in these experiments. However, under stress conditions, the highest the contribution of potential yield (less stress), the least the contribution of DRI.

Table 1. Mean grain yield (GY) at Prey Veng (PV) and CARDI (CA) under the well-watered (WW) and water-stress (WS) treatments, relative grain yield reduction (YR), severity of drought for 15 rice genotypes, percentage contribution of potential yield, DRI and days to flower (as partition of sums of squares of the regression) for yield reduction in nine experiments.

?	PV98		PV99		PV00		PV01		PV02		CA99		CA00		CA01		CA02	
?	WW	WS	WW	WS	WW	WS	WW	WS	WW	WS	WW	WS	WW	WS	WW	WS	WW	WS
GY (t ha^{-1})	1.93	1.52	1.98	1.08	1.49	1.17	2.46	1.71	2.21	1.77	2.72	2.07	2.42	2.13	2.63	1.47	2.15	1.47
YR (%)	21		46		21		30		20		24		12		44		32	
Drought severity	Mild		Severe		Mild		Moderate		Mild		Mild		Mild		Severe		Moderate	

Potential yield (%)	72	60	79	43	41	75	39	17	55
DRI (%)	26	18	14	39	1	23	60	56	44
Days to flower (%)	2	22	7	18	58	2	1	27	11

Conclusion

Quantifying the contribution of drought related characters for yield reduction is a useful tool for breeders to develop selection strategies for drought adaptation in rice. It is concluded that selecting for drought tolerance as well as for high yield potential would be important in developing cultivars for rainfed lowlands in Cambodia. Although, flowering dates are important for drought escape, it had a small contribution particularly where drought developed slowly in Cambodia.

References

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