SEASONAL CHANGES IN PHOTOSYNTHETIC RATE OF 6 PANICUM GENOTYPES

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ABSTRACT

Three varieties each in *Panicum maximum* (PM) and *P. coloratum* (PC) were measured for the seasonal changes in the gas exchange rate in the field at Miyazaki, Japan. The gross photosynthetic rate (Pg) under the same photosynthetic active radiation (PAR) of 1000 *μmol* $m^{-2}s^{-1}$ and the dark respiratory rate (Rd) of leaf blade under the mean environmental air temperature on the measuring day differed among six varieties from autumn to the next spring. With the decrease in air temperature, the Pg and the Rd in the varieties of PM (typically, cold-sensitive Natsukaze (NAT)) declined more rapidly than those of PC (typically, cold-tolerant Makarikari (MAK)). The regression coefficients of the Pg to chlorophyll concentration differed among varieties and it was suggested that the decrease in the chloroplast efficiency with the decreasing of air temperature was significantly greater in NAT and Coloured guineagrass (COL) than in MAK.

KEYWORDS

Chlorophyll concentration, overwintering, *Panicum maximum* , *Panicum coloratum* , photosynthetic rate, season

INTRODUCTION

Information on plant responses to the climatic conditions in tropical grasses, especially the photosynthetic ability after autumn, is required for popularizing tropical grasses in southwestern Japan (Ito, 1973). The species of *Panicum maximum* and *P. coloratum* within the genus Panicum are important grazing and fodder grasses in tropical and subtropical areas, which were introduced into the southern Kyushu island in Japan as parts of main tropical grasses (Numaguchi, 1983). However, there has been little information about the genotypic variations in the environmental response among *Panicum maximum* (PM) and *Panicum coloratum* (PC) (Bogdan, 1977). This study was carried out to understand the different seasonal changes in gas exchange rate from autumn to the next spring and their relation to the overwintering ability among six *Panicum* genotypes.

MATERIALS AND METHODS

Three varieties in PM, i.e. Natsukaze (Designated as NAT), Gatton (GAT) and Green panic (GRP, var. *trichoglume*), and three in PC, i.e. Makarikari grass (MAK, var. markarikariense), Tayutaka (KAB, var. *kabulabula*) and Coloured guineagrass (COL) were grown in the field with a density of 16 plants/m^2 in spring of 1995.

Seasonal and diurnal changes in photosynthetic rate, dark respiratory rate (Rd) and transpiratory rate (Tr) were measured from early autumn to the next spring by the portable infrared gas analyzer (Model LCA4, Analytical Development Co. Ltd., England). Chlorophyll concentration (Chl) was calculated for each varieties by the standard regression equation of chlorophyll concentration (Arnon method) to the value of SPAD, measured by a chlorophyll meter (Model SPAD-501, Minolta Co. Ltd., Japan). At each measurement for gas exchange and Chl, the uppermost expanded green leaf, judged to be the youngest in a moderate grown plant was chosen at the rate of one leaf per plant by 3 replications for each variety.

The gross photosynthetic rate (Pg) was estimated by the sum of net photosynthetic rate and the Rd, which was recalculated to the rate under the temperature of photosynthesis measurement by assuming Q_{10} to be 1.8 (Ito, unpublished).

RESULTS

Changes in the Pg and the Rd. Air temperature regime (Fig. 1-A) was similar to that in a normal year. On the basis of the regression equations of Pg to photosynthetic active radiation (PAR), the Pg under the PAR of 1000 *μmol* $m^{-2}s^{-1}$ was estimated in six varieties on each measuring day from autumn to the next spring (Fig. 1-B). The Pg of 6 varieties in Panicum decreased from autumn to winter with decreasing air temperature and PAR (data not shown). The relationship between the Pg and air temperature differed among varieties, particularly between PM and PC. The Pg of PM varieties was higher than that of PC when the minimum temperature was over 15½C, and the reverse was true when it was below 10½C, except for GAT which behaved similarly to PC. Thus, the Pg of NAT and GRP in PM decreased more rapidly than that of 3 PC varieties and GAT from late October to late November. However, the Pg of all six varieties declined toward nearly zero after the heavy frost on December 10. The photosynthetic ability of the regrown plants in spring resumed to be similar to that in early October and showed similar rate among four varieties, except for NAT and COL without any spring regrowth.

The seasonal change in the Rd (Fig. 1-C) was similar to that in the Pg during the period from October to November. However, seasonal change in the Rd was much larger in PM than in PC, showing that the Rd of PM was more responsive to the change in air temperature than that of PC. The decrease in the Rd in December was smaller than that in the Pg both in PM and in PC, which suggested that the Rd was less sensitive to low temperature than the Pg.

Changes in Chl. The Chl in the gas exchange measuring leaf decreased with decreasing air temperature from October to December (Fig. 2). The Chl was lower in GRP than in others. The correlation between the Pg and the Chl was significant in all varieties and the regression coefficients differed among varieties. The correlation between the Pg and the Tr was significant in all the varieties from September to December (data not shown). The regression coefficients of the Pg to the Chl and the Pg to the Tr were significantly higher in NAT and COL than in MAK, in which both the coefficients were the lowest among six varieties.

DISCUSSION

In this experiment, the seasonal changes in the Pg and the Rd of Panicum varieties before winter did not appear to be related distinctly to the regrowth in the next spring, which appeared nil in NAT and COL. Ito and Numaguchi (1989) reported similar results for the six tropical grasses including GRP and MAK. Inferior overwintering ability of PM compared to PC (data not shown) may be due to reduced carbohydrate accumulation before winter, as resulted from the lower ratio of the Pg to the Rd in PM. Long (1982) pointed that plant responses to temperature stress vary greatly with species. We found the typical two *Panicum* varieties in the response of the Pg and the Rd to air temperature such as cold-sensitive NAT and cold-tolerant MAK. From the correlation of the Pg to Chl, it was inferred that the decrease in the efficiency of chloroplast activity with lowering air temperature was different among varieties and was greater in NAT and COL than in MAK. The chloroplast might be a primary inhibition site in photosynthesis by the low temperature (Ort and Martin, 1982). Therefore, the difference in the Pg response to climatic condition may be caused by the genotypic difference in the sensitivity of chloroplast activities in *Panicum* grasses.

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Figure 2

Changes in chlorophyll concentration in the gas exchange measuring leaf.

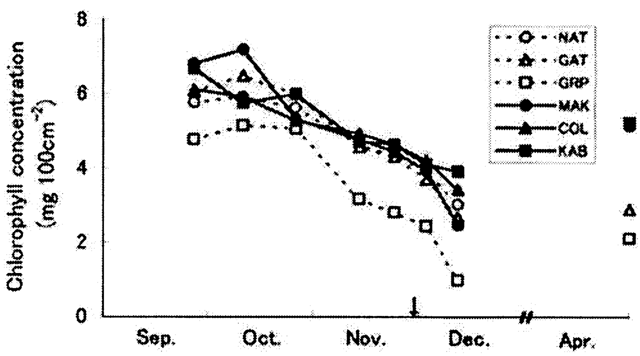

Figure 1

Changes in air temperature (Temp., A) on the measuring day, gross photosynthetic rate (Pg, B) under the photosynthetic active radiation of 100 µ mol m^{-2}s^{-1} and dark respiratory rate (rd, C) under the mean temperature on the measuring day.the first frosting day.