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Investigation of Physiological Indices of Different Rice (*Oryza sativa* L.) Varieties in Relation to Source and Sink Limitation

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Abstract: An experiment was conducted at Iran Rice Research Institute-Deputy of Mazandaran (Amol) in 2007, to study the physiological and morphological indices of different rice varieties. The experiment was carried out with, Factorial experiment in randomized completely block design comprising four replications. Studied factors were limitation of source and sink in 4 treatments viz., (1) cut all of leaves except flag leaf, (2) cut flag leaves, (3) cut 1/3 end of panicle and (4) control. Variety in four treatment was as Tarom, Neda, Shafagh and Fajr. Completion of source and sink limitation treatments were carried out at 50% flowering stage. Results showed that the most CGR was related to Shafagh variety (25.18 g/m^2/day) in 1650 GDD and the least CGR was produced in the Tarom variety (21.1 g/m^2/day) in 1452 GDD. The most RGR was obtained in the Shafagh and the least RGR was obtained in the Neda variety at the 850 GDD. Completion source and sink limitation treatments on leaf area index showed that cut all leaves except flag leaves had least leaf area index also with cut all of leaves and flag leaves in all of varieties the RGR was decreased. Results of morphological characteristics measurement showed that highest plant height and least plant height were produced in the Tarom and Shafag varieties, respectively. Maximum leaves number in the Tarom variety was produced in the 1180 GDD. Also, the Neda variety with produced 24 tillers per plant had most tiller number. The Tarom variety with coefficient 81.25% had most conversion all tillers to fertile tiller percentage.

Key words: Rice, physiology, CGR, leaf area, source, flag leaf

INTRODUCTION

Determination of morphological and physiological indices of rice is necessary. Indices that measured in rice studies are its Leaf Area Index (LAI), Leaf Area Duration (LAD), Crop Growth Rate (CGR) and Net Assimilation Rate (NAR) (Poshtmasari *et al*., 2007). The CGR and LAI are the best criterion of the rice's physiological analysis. Farrel *et al.* (2003) indicated that grain yield in rice had positive correlation with LAI, CGR and NAR. There is also a correlation between tiller initiation and leaf initiation. Increase of LAI in case of increase tiller number and length of leaves were the reasons of LAI increase in high and low tillers varieties. Leaf area index influenced by environmental factors. Reports showed that the appropriate LAI for the rice was between 4 and 7 and it is amount is almost twice as much for upland varieties (Dutta *et al*., 2002). The most CGR in rice was reported between 30 to 36 g m^{-2} in Philippine and Japan conditions. Jennings *et al.* (2003) reported that leaf area index had significant effect on the CGR before canopy closing. Horie (2003) reported that in early maturity lines, the CGR increases before flowering had significant correlation with grain yield, while in the late maturity lines of CGR increases after flowering had significant correlation with yield. Peng *et al.* (1999) indicated that in all of phenology stages in direct seeding and transplanting method of the rice, the NAR and the LAI had positive correlation with the grain yield. At 70 and 85 days after planting the NAR and LAI had not significant effect on the grain yield. Mahmood and Chowdhry (2000) showed that planting date can determined phenological staged initiation that among these stages, first stage had most important role. Also, there is a negative correlation between air temperature decreases and a positive and significant correlation with first stages length. Kobata *et al.* (2000) indicated that with delay in transplanting the days from transplanting to

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maximum tillering were decreased mean high temperature in vegetative stage was related to early tillering and leaf growth. Jennings *et al.* (2003) reported that grain yield had significant correlation with the tiller number of LAI, TDM in the 85 days after seedling transportation and had negative correlation with canopy height. Study of morphological and physiological characteristic of rice and their relation to yield and yield components of rice and also effect of source and sink limitation in physiological indices changes are the purposes of this study.

MATERIALS AND METHODS

An experiment was conducted at Iran Rice Research Institute in 2007. The experiment was laid out as a factorial in basis of randomized completely block design with four replications in 2007. Transplanting date was done at 25×25 cm planting spaces . Studied factors were limitation of source and sink in 4 treatments viz., (1) cut all of leaves except flag leaves, (2) cut flag leaves, (3) cut 1/3 end of panicle and (4) control. variety in 4 treatments viz., (1) Tarom, (2) Neda, (3) Shafagh and (4) Fajr. The plot size was 12 m^2. All plots received 110 kg urea ha^{-1} and 100 kg P_2O_5 ha^{-1} and also 80 kg K_2O ha^{-1}. Nitrogen fertilizer in the form of urea was applied in two split doeses. Half of nitrogen fertilizer was applied before transplanting, while the remaining quantity applied as a top dressing in the maximum tillering stage. Standards cultural practices were carried out until the crop was mature. The flag leaves cutting was done in 50% flowering stage. Five hills (excluding border hills) were randomly selected from each plot in flowering stage for measuring flag leaves action in plant. Six hills (excluding border hills) were randomly selected from each plot prior to harvest for measure yield components. Grain yield was determined from harvest area of 5 m^2 adjusting to 14% moisture content Morphological characteristics like plant height, hill length, leaf number were measured each 10 days after transplanting. All statistical tests were done using the statistically analysis software (SAS, Institute, 1996) and mean values were compared by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Leaf Area Index (LAI): In this study most LAI was observed in Neda variety, while the least was obtained in the Tarom variety (Fig. 2-5). TDM charngs in different variates are shown in Fig. 1. LAI was increased at first stage and this process in all of varieties until before flowering was highest amount after that because of being withered in low leaves and they shedding. The LAI

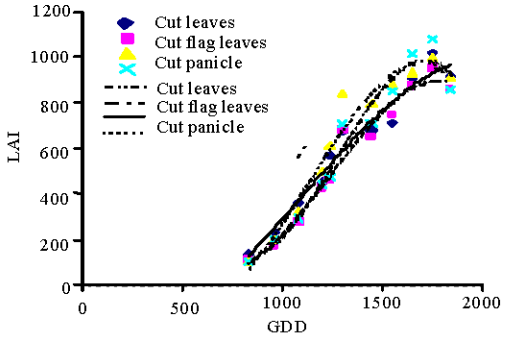

Fig. 1: TDM changes in different varieties

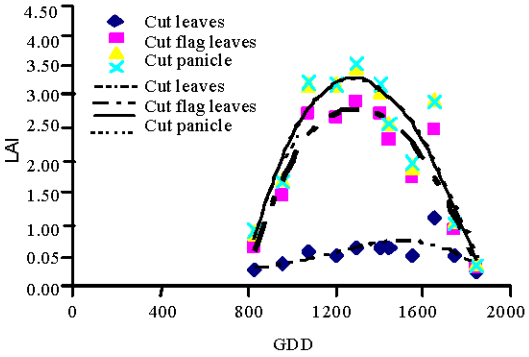

Fig. 2: LAI changes in Tarom variety

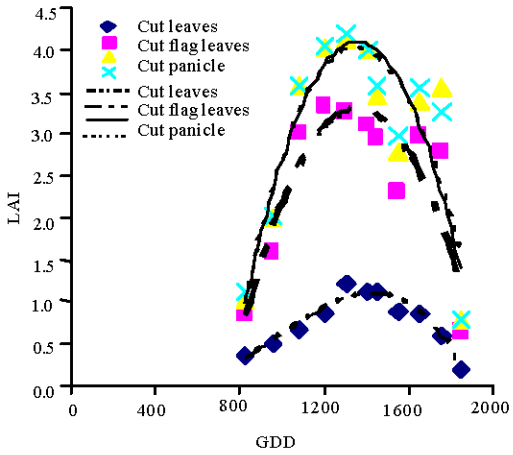

Fig. 3: LAI changes in Fajr variety

was decreased and this decreased in Tarom variety that was an early ripening variety was more. The most LAI in the Tarom, Neda, Shafagh and Fajr varieties were 3.97, 5.09, 4.24, 4.9 and with received of 1300, 1410, 1200, 1300 GDD in flowering stage respectively (Fig. 2-5). For obtained of appropriate yield the best way is that maximum solar radiation reach to ground in flowering

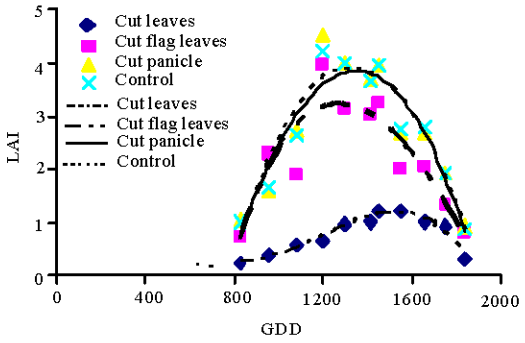

Fig. 4: LAI changes in Shafagh variety

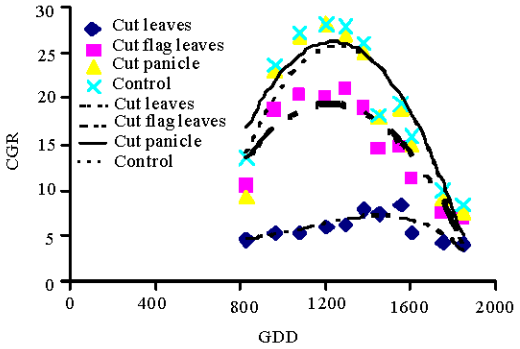

Fig. 6: CGR changes in Tarom variety

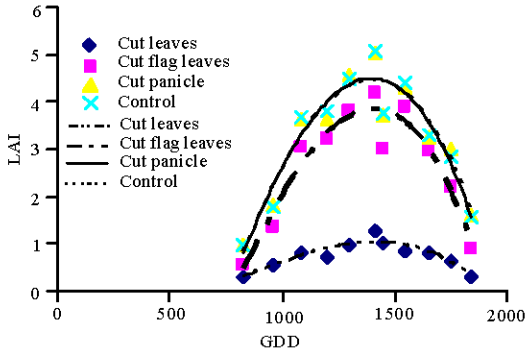

Fig. 5: LAI changes in Neda variety

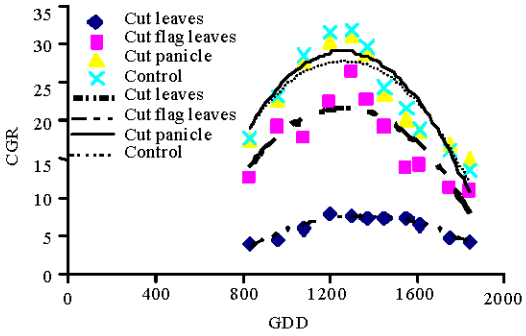

Fig. 7: CGR changes in Neda variety

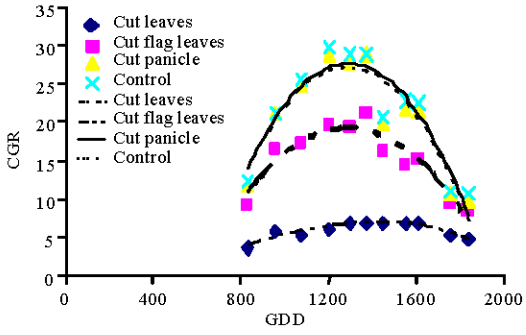

Fig. 8: CRG changes in Shafagh variety

stage to produce maximum photosynthetic activity. Among treatments leaf cutting treatment had less height toward other treatments. Poshtmasari *et al.* (2007) showed that hybrid and high yielding lines had most the LAI and also most photosynthesis rate in grain filling period. The results of this research are the same that Horie (2003) obtained.

Crop Growth Rate (CGR): The CGR values in all varieties until flowering stage was increased and were varied between 1200 to 1300 degrees day^{-1} after planting was reach to maximum amount. The most CGR was produced by Neda variety with 1300 degrees day^{-1} and the least CGR value was produced by Tarom variety with 1200 degrees day^{-1} (Fig. 6, 7, 9, 10). Result of this increases could be absorb sun radiation with increase of leaf area in first growth season and also increase dry matter accumulation in plant. The CGR after reach to maximum rate, decreases and in 1750 degree day reached to minimum rate. That was in case of leaves to grow old and shedding as a result of dry matter decreases because of leaves shedding. Amount of decreases in the Tarom variety was more than the other varieties. Among the treatments leaf cutting treatment had the least CGR amount for delete of plant green organs that decrease of photosynthesis material producing from flowering stage to maturity. Peng *et al.* (1999) got almost the similar results.

Net Assimilation Rate (NAR): The NAR in all varieties in growth period length was descent in primary growth stages when a plant was little and when exposed to sun light had high Net Assimilation Rate. The NAR changes

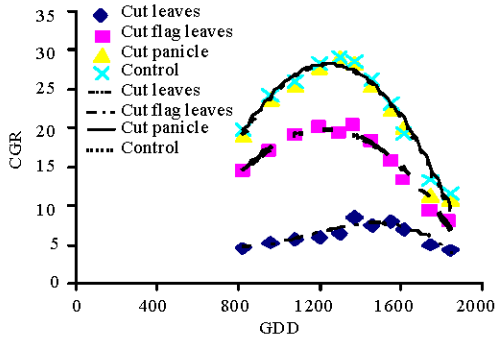

Fig. 9: CGR changes in Fajr variety

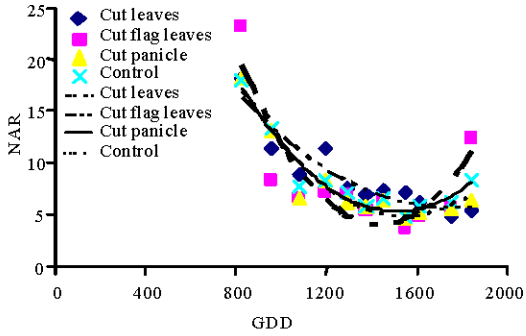

Fig. 12: NAR changes in Neda variety

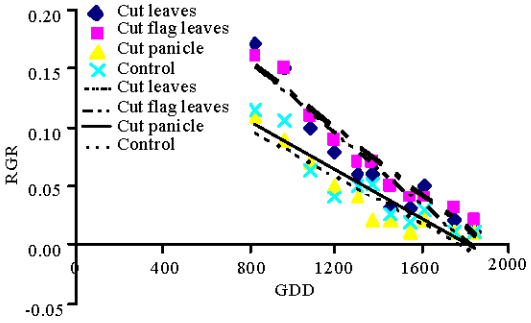

Fig. 10: NAR changes in Tarom variety

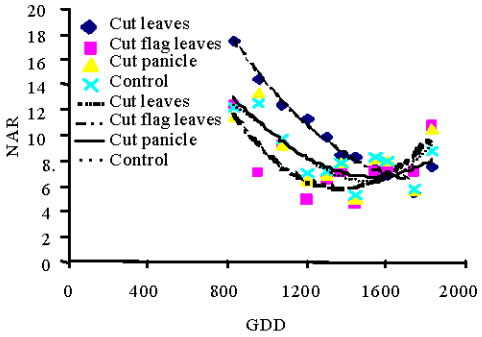

Fig. 13: NAR changes in fajar variaty

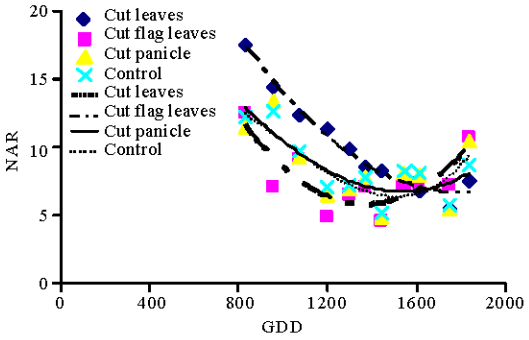

Fig. 11: NAR changes in Shafagh variety

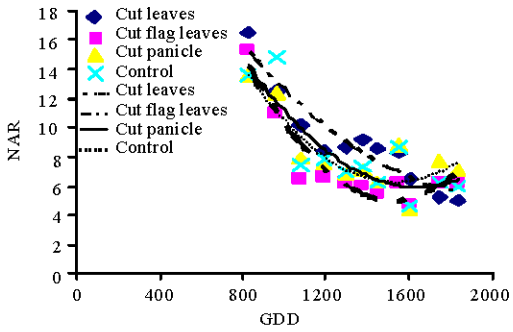

Fig. 14: RGR changes in Tarom variety

showed that in 830 to 960 degree day the NAR amount from maximum started to decreases (Fig. 8-13). With plant growth and increase of the LAI most leaves were established in shadow and the NAR at the last growth stage was increased. This case was for double tillering and more ability of leaves in sun absorption and high material transportation in these varieties. For this reason in these cultivars NAR values were formed as a curved. But, this case was not seemed (or observed?) in the Tarom cultivar because they lost their upward leaves. Horie (2003) showed that increase of grain yield causes increase in the NAR and also LAI increases.

Relative Growth Rate (RGR): Results showed that the RGR was decreased with increase in degree days and in 1800 degree day was reached to minimum amount because of agedness and leaves shedding (Fig. 14-17). Due to this reason, between the RGR and growth degree day was negative correlation (mean is not clear). Reason of the RGR decreases in growth season length is with increase of plant age in rate of structure texture to metabolic tissue was decreased and shadow of upwards leaves to lower leaves restricted appropriate usage from sources. Dutta *et al.* (2002) reported that the LAI and total dry matter were related to each other and the high LAI in the

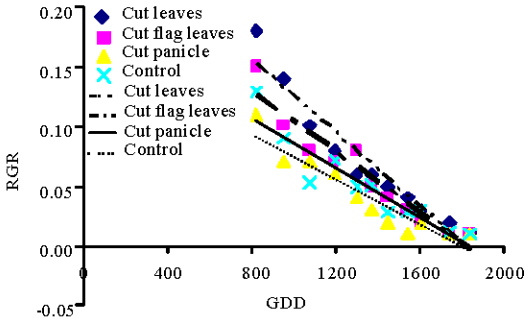

Fig. 15: RGR changes in Fajr variety

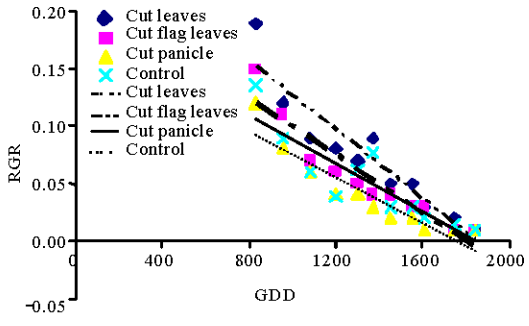

Fig. 16: RGR changes in Shafagh variety

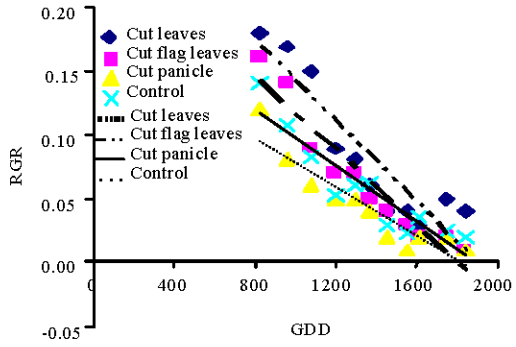

Fig. 17: RGR change in Neda variety

flowering stage is necessary for the obtained of high yielding. Kobata *et al.* (2000) showed that in different planting spaces, tillers numbers, leaves and growth period were changed and significant differences were appearance in panicles numbers, grains numbers and leaf area index.

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