STUDIES ON CROP GROWTH AND HARVEST INDEX IN SEMIDWARF MUTANTS OF BASMATI RICE (*ORYZA SATIVA* L.)

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Harvest index and crop growth rate was studied in eight semidwarf mutants and two standard varieties at 4 different growth stages viz. seedling, tillering, flowering and maturity. Semidwarf mutants DM38, DM-16-5-1, DM-15-1 exhibited highest CGR at maturity stage. The results of the study with respect to harvest index showed a significant variation among all the semidwarf mutants. Mutant DM-24, DM-107-4 and DM-38. It was also noticed that harvest index is not related with biological and grain yield.

INTRODUCTION

Variation in biomass accumulation by different varieties or species may be related to leaf area, net assimilation rate, leaf area ratio, and relative growth rate (RGR). Khan (1973) found that relative growth rate which affected the total plant dry weight was found to be positively correlated with leaf area ratio of rice. Baruah and Singh (1982) found varietal differences with respect to growth rate in six cultivars of rice. Hussain (1986) also found varietal differences with respect to relative growth rate.

Harvest index, the ratio of economic yield to biological yield (Donald and Hamblin, 1976) is considered to be a useful selection criterion in modern cereal breeding programmes. Since economic yield is only a fraction of the dry matter, the harvest index forms a useful measure of yield potential and is relatively easy to measure on a large number of plants. It has been suggested that selection for high harvest index may have value for improving grain yield of cereals Singh and Stoskopf, 1971). Chandler (1969), reported that dwarf rice varieties possessed higher harvest index than those of tall varieties. Haloi and Tiwari (1988) also found variation in harvest index of rice varieties. The present study was undertaken to identify the physiologically efficient genotypes of basmati rice on the basis of crop growth rate and harvest index for utilizing them in breeding programme.

MATERIALS AND METHODS

Seed of eight semidwarf mutants of Basmati 370, viz. DM-16-5-1, DM-2, DM-107-4, DM-15-4, DM-15-11, DM-24, DM-38 and DM-179-1 alongwith two commercial varieties, viz. Basmati 370 and IR 6 were sown in the nursery bed replicated three times. Thirty-day old seedlings were uprooted. Five seedlings from each replication were used for determination of biomass whereas the remaining seedlings were transplanted in a randomized block design with 3 replications (plot size 2.00 x 4.00 m). Normal cultural practices were adopted for raising the crop.

Biomass accumulation converted to g/m^2 was determined using 5 hill samples at seedling, tillering, flowering and maturity stages by oven drying at 70°C for 24 hours.

Crop growth rate (CGR) for a unit area of canopy cover at any given time (t) may be defined as the increase in plant material per unit of time. CGR was computed for different growth intervals, viz. seeding to seedling, seedling to tillering, tillering to flowering, and flowering to maturity using the formula (Radford, 1967) as under:

$$CGR = \frac{W_1 - W_2}{t_2 - t_1}$$

Where W_1 and W_2 are plant dry weight at times t_1 and t_2, respectively.

For harvest index, ten competitive plants from each genotype in each replication were selected at random. At maturity, culms of the plants were cut at ground level and observation were recorded for grain yield (g) and biological yield (g). Harvest index was determined as the ratio of grain yield per plant to biological yield and multiplied by 100 to express as percent.

RESULTS AND DISCUSSION

Crop growth rate: Up to the stage of flowering, there was a general increase in the crop growth rate in all the varieties (Fig. 1). The highest value of CGR at this stage was obtained in mutant DM-15-11 and lowest in DM-2. After stage 3, a decline in growth was observed in all the genotypes except in DM-16-5-1 which showed a marked increase. This tendency was in accordance with the findings of Chaturvedi *et al.* (1980) who reported that relative growth rate was the highest in earlier stages and it gradually declined as the proportion of mature tissues increased. Variation in crop growth rate has also been studied in rice mutants by Siddiq and Reddy (1984). Differential rates of growth of varieties are required to suit different agroclimatic situations. For example in upland and directly seeded varieties, a rapid growth rate during pre-tillering phase could enable plants to compete successfully with fast growth of weeds. Similarly, rapid growth rate would be advantageous in varieties for which vegetative phase (particularly the maximum tillering phase) falls within the period of heavy rains and cloudy weather. Secondly, the harvest index would itself depend on growth rate at a particular stage. For instance, it is known that a high CGR prior to flowering would ensure a high sink index size via grain number, while a high CGR during post

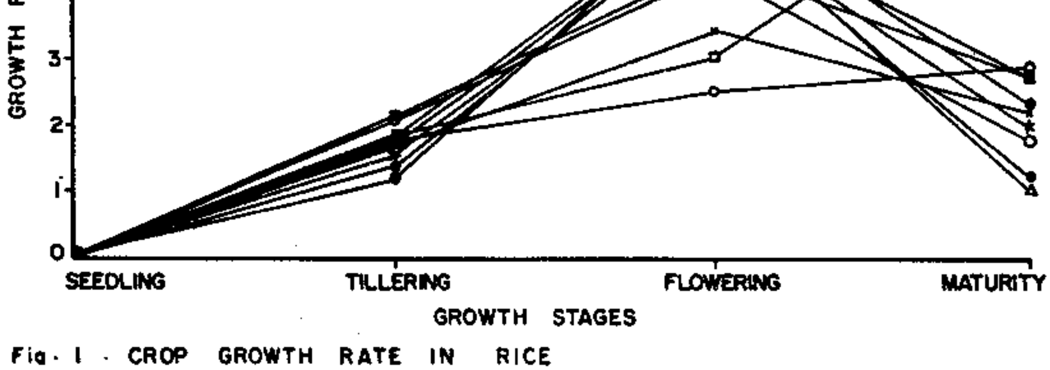

Fig. 1. CROP GROWTH RATE IN RICE

Table 1. Mean values of Biological yield(g), grain yield(g) and harvest index(%) of rice varieties/Mutants

	Biol. Yield per plant	Grain yield per plant	Harvest index
Basmati 370	75.71	15.90	21.00 E*
IR 6	51.51	17.14	33.27 A
DM-16-5-1	85.07	21.44	25.20 D
DM-2	6.39	19.30	29.07 BC
DM-107-4	59.78	16.50	27.60 BCD
DM-15-4	83.16	14.08	16.93 F
DM-15-11	89.37	19.6	21.93 E
DM-24	67.2	20.16	30 B
DM-38	60.08	16.3	27.13 CD
DM-179-1	91.85	13.2	14.37 G

*** Figures followed by the same letter(s) are not significantly different at 5% level of probability**

flowering stage affect the sink weight and level of spikelet fertility. In the present study semidwarf mutants DM-15-4 and DM-24 showed a high CGR at tillering whereas DM-15-11 and DM-16-5-1 exhibited a high CGR at flowering stage. DM-107-4 exhibited the highest CGR at maturity stage. In majority of the genotypes, the high growth is restricted to the tillering-flowering phase only. The most interesting observation is that the genotypes differ in their tendency for growth from flowering, showing a decline except DM-107-4 which exhibited an upward trend. Exploitation of the identified sources of high CGR (DM-15-4, DM-24, DM-15-11 and DM-16-5-1) for one or more phases of growth could be very useful for breeding varieties adaptable to specific agroclimatic situation.

Harvest index: Maximum harvest index was observed in variety IR-6 which is significantly higher than all the mutants and the variety Basmati 370. Of the semidwarf mutants DM-24 exhibited the highest value of harvest index whereas DM-179-1 exhibited the lowest harvest index. A significant variation of harvest index in the mutants show the possibility of selection of better genotypes for use in the breeding programme aiming at the yield improvement of basmati rice. It is interesting to note that although biological yield of semidwarf mutants DM-24, DM-2, DM-38, DM-107-4 and variety IR-6 was lower than that of Basmati 370, their grain yield was higher than the tall variety Basmati 370 due to more efficient division of resources into grain and straw. Hence, the harvest index in these genotypes was higher compared to Basmati 370. The results of the present study substantiate the findings of Sapra and Hughes (1977) that advancement could be made in selection for higher grain yield combined with higher harvest index values.

The results also provide evidence that a reduction in plant height may not adversely effect the grain yield in basmati rice. Donald and Hamblin (1976) grouped factors contributing to high harvest index in to a two categories; those which make up the grain yield and should have a relatively high expression such as grain weight, number of spikelets per panicle, number of panicle per plant and plant per unit area and those which make up the non grain parts and should have a relatively low expression, i.e. weight of stem, weight of leave, leave per stem etc. The factors in the first group are "the components of yield" whereas those in the second grpup are usually considered only indirectly in relation to grain production, as and when dwarfness is sought to avoid lodging. It has also been pointed out by Donald and Hamblin (1976) that a high harvest index for a plant community does not perse indicate a high grain yield per unit area.

In the present study maximum grain yield per plant was obtained in DM-16-5-1 but its harvest index was lower than those in IR-6, DM-24, DM-2 and DM-38. Similarly maximum biological yield was obtained in DM-179-1 yet it exhibited the lowest harvest index. These results indicate that high harvest index is not related with high biological yield and grain yield. However semidwarf mutants, DM-24, DM-2, DM-107-4 and DM-38 could be used as parents in cross breeding programme aiming at breeding for high harvest index and grain yield in basmati rice. In subsequent generations, a rigorous selection should be done for harvest index and yield to combine them in a single genotype.

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