EFFECT OF NITROGEN ON PRE-ANTHESIS RESEREVE TRANSLOCATION IN AROMATIC RICE

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ABSTRACT

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A field experiment was conducted to study the effect of nitrogen fertilizer on pre-anthesis reserve translocation in indigenous aromatic rice cultivars under stacking and non-stacking conditions during Aman season, 2002. There were four cultivars, namely, Shakkorkhora, Chinigura, Kalijira and Kataribhog, each with three levels of nitrogen fertilizer (0, 60 and 120 kg N ha^{-1}). At the time of heading the experimental plots were equally divided into two parts. The crop in the half of the plot was left on the fate of the nature and that in the other half of the plot was mechanically supported by stacking to prevent lodging. The dry matter production of the plants varied significantly among the treatments. In all the cultivars, highest dry matter production was obtained from Kataribhog under stacking condition and in Shakkorkhora under non-stacking condition at 120 kg N ha^{-1}. Reduction in pre-anthesis dry matter of leaf blade, leaf sheath and culm was higher with the higher levels of N application. Reduction in dry matter after heading was higher under non-stacking condition than under stacking. Accumulation of dry matter at heading in leaf blade, leaf sheath and culm increased due to application of higher levels of nitrogen fertilizer. The reduction in pre-anthesis dry matter from plant components was higher under non-stacking condition.

Key words: Nitrogen fertilizer, dry matter translocation and aromatic rice

INTRODUCTION

Among various nutritional requirements for production, nitrogen is the key element for its significant role in rice physiology. Maximum production of dry matter requires a sufficient supply of nitrogen and sufficient carbohydrate for its conversion to protein (Darwinkel, 1975). The driving force in crop yield formation is well known: both a source for dry matter production and a sink for dry matter storage are needed. The source is formed by chlorophyll containing tissues, mainly the leaves. Culms, leaf sheaths and panicles contribute marginally to canopy photosynthesis. The amount of dry matter stored in grains comes from the remobilization of culm and leaf reserves, which are produced in pre-heading stage and assimilates in the grain filling period. Thus the source for grain production is determined by three components 1) amount of culm and leaf reserves reallocated to the grains 2) rate of the dry matter production in the grain filling period 3) length of the grain filling period.

Dry weight of rice plant is an important character for the vegetative dragness and growth forecast of this plant (Kusuda, 1993). There are many reports on the increase in total dry matter due to increased fertilizer application, particularly N (Park, 1987). Dry matter production depends upon the balance between photosynthesis and respiration (Tanaka *et al*., 1964). Fertilization of crop with the higher rate of nitrogen (120 Kg N ha-1) was found superior to the lower rate (80 Kg N ha^{-1}) in dry matter production (Mehrotra and Singh, 1982). Takana (1968) found close correlation between yield and the amount of dry matter produced between heading to maturity. Excess nitrogen gives higher dry weight around heading simultaneously becomes low, causing a yield decline due to reduced ripening percentage. This situation is often referred to as overgrowth. The varieties which had high DM weight also had high leaf area. Leaf area is positively correlated with total DM (Anonymous, 1988).

Biomass is the function of photosynthetic carbon metabolism, which in turn is dependent on leaf area development and light interception. Nitrogen application influences light transmission ratio (LTR) significantly (Khanam, 1994).

Achieving high yields in rice requires increased biomass production and favorable partitioning to grains. Crop environmental conditions with high solar radiation during the growing season and abundant supply of N (Akita, 1989) favored accumulation of high amount of biomass and high yields provided varieties respond favorably to N.

Considering the above facts, the present study was undertaken to know the dry matter portioning of four indigenous aromatic rice cultivars at three levels of nitrogen under stacking and non-stacking conditions.

MATERIALS AND METHOD

A field experiment was carried out at the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during the rainy season of 2002. The experimental site is located at the center of Madhupur tract ($24^{o}09^{/}$ N latitude and $90^{o}26^{/}$ E longitude) having an elevation of 8.2 meter from the sea level.

The climate of the experimental site is sub-tropical in nature characterized by heavy rainfall during the months from June to September and scanty rainfall during winter with gradual fall of temperature. Average air temperature ranged from 30.18^oC (Maximum) to 19.86^oC (minimum) and total rainfall recorded 744.6 mm during the study period (August to December 2002). The soil type of the experimental field belongs to the shallow red-brown terrace type of Salna series. The soil is characterized by poor fertility and impeded internal drainage. Rice cultivars, Chinigura, Kalijira, Shakkorkhora, Kataribhog were grown with three levels of nitrogen fertilizer (0, 60 and 120 Kg N ha^{-1}).The experiment was laid out in a randomized complete block design.

Triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied as the sources of P_2O_5, K_2O, S and Zn, respectively. P_2O_5, K_2O, S and Zn were applied at the rate of 90, 50, 40, and 5.0 kg ha^{-1}, respectively. All fertilizers except urea were applied and thoroughly mixed with the soil at the time of final land preparation. Urea was applied as top dressing in three equal installments, first at active tillering stage (18 Days after transplanting), 2nd at maximum tillering stage (35 days after transplanting) and 3rd before panicle initiation stage (50 Days after transplanting). The seedlings were transplanted at 30 days after seeding. One seedling per hill was used maintaining 25 cm row to row and 10 cm plant to plant distance in well prepared land. Weeding, irrigation and application of pesticide were done as and when necessary. Standing water of 2 to 4 cm. was maintained in the field until the crop attained hard dough stage.

At the time of heading the experimental plots were equally divided into two parts. Thus every part of the plot occupied 3.75 m^2 land area. The crop in the half of the plot was left on the fate of the nature (treated as 'non-stacking') and that in the other half of the plot was mechanically supported by stacking (treated as 'stacking') to prevent lodging. Bamboo sticks and plastic ropes were used for stacking. Mechanical supports were provided in such a fashion that the canopy architecture and light interception remained almost unaffected.

Destructive plant sampling was made at active tillering, maximum tillering, heading and maturity stages to determine accumulation and partitioning of the dry matter. At each sampling five representative hills from inner rows of each plot were uprooted and thoroughly washed under tap water. The roots were then separated from the base of the hill. Thereafter the hills were partitioned into leaf blade, leaf sheath, culm and panicle (in case of emerged panicle). The segmented plant samples were kept in separate brown paper envelopes and oven dried at 70 ^oC for 72 hours, and dry weight was recorded.

The data were analyzed by partitioning the total variance by using MSTATC program. The treatment means were computed using Least Significant Difference test and interrelationship was worked out employing regression analysis.

RESULTS AND DISCUSSION

Dry matter accumulation and its partitioning

Partitioning of accumulated dry matter into plant components is an important consideration in achieving desirable yield. Yield is determined substantially by the partitioning of dry matter into reproductive organ (Sing *et al.,* 1995). The partitioning of dry matter varied remarkably among various nitrogen levels and within different cultivars. The partitioning of dry matter of the cultivars Shakkorkhora, Chinigura, Kalijira and Kataribhog under non-stacking and stacking conditions was illustrated in Figs. 1, 2, 3 and 4, respectively.

Total dry matter

Dry matter is the material which has been dried to a constant weight. Total dry matter (TDM) production indicates the production potential of a crop. Irrespective of cultivars and N levels, the dry matter accumulation at initial growth stages was lower and it gradually increased with the increase in plant age (Figs. 1, 2, 3 and 4).

At heading the TDM ranged from 21.27 g $hill^{-1}$ (Chinigura without N) to 50.03 g $hill^{-1}$ (Kataribhog with 120 kg N ha^{-1}). Application of 60 kg N ha^{-1} increased the TDM by 10, 8, 8, 8 g $hill^{-1}$ and 120 kg N ha^{-1} by 20, 14, 17, 25 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively.

Under stacking condition, the application of 60 kg N ha^{-1}, increased the TDM by 10, 8, 10 and 14 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively at maturity. Whereas, the application of 120 kg N ha^{-1} , increased the TDM by 18, 17, 17 and 25 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively.

Under non-stacking condition the TDM increased from 8 to 11 g $hill^{-1}$ depending on cultivars at 60 kg N ha^{-1}, whereas it increased by 10 to 14 g $hill^{-1}$ at 120 kg N ha^{-1}. The TDM at maturity was higher under stacking condition than non-stacking in all cultivars at both 60 kg N ha^{-1} and 120 kg N ha^{-1}. However, the increase in TDM was more prominent under stacking condition.

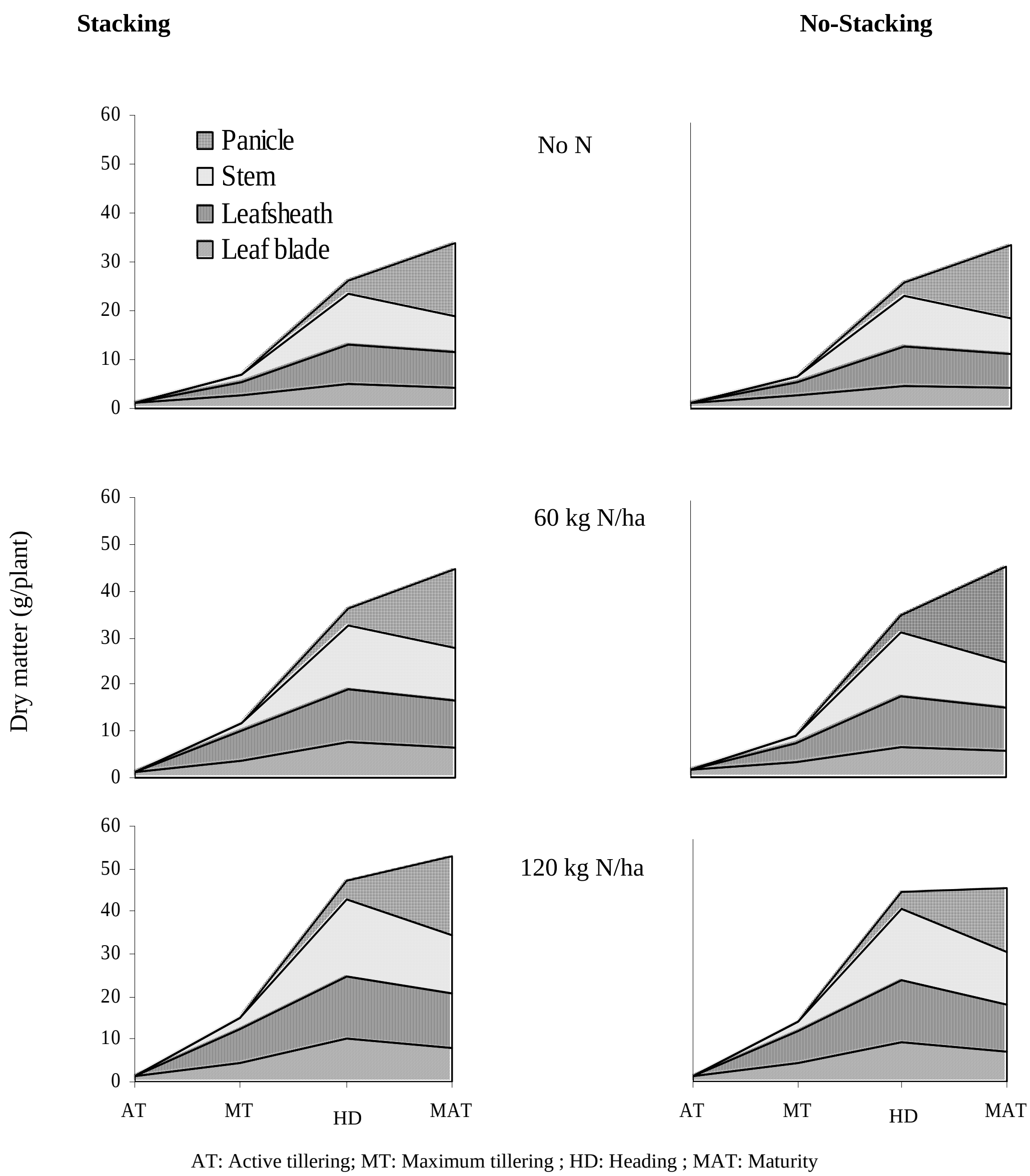


Fig. 1. Dry matter accumulation pattern of cultivar Shakkorkhora at different nitrogen levels under stacking and non-stacking conditions.

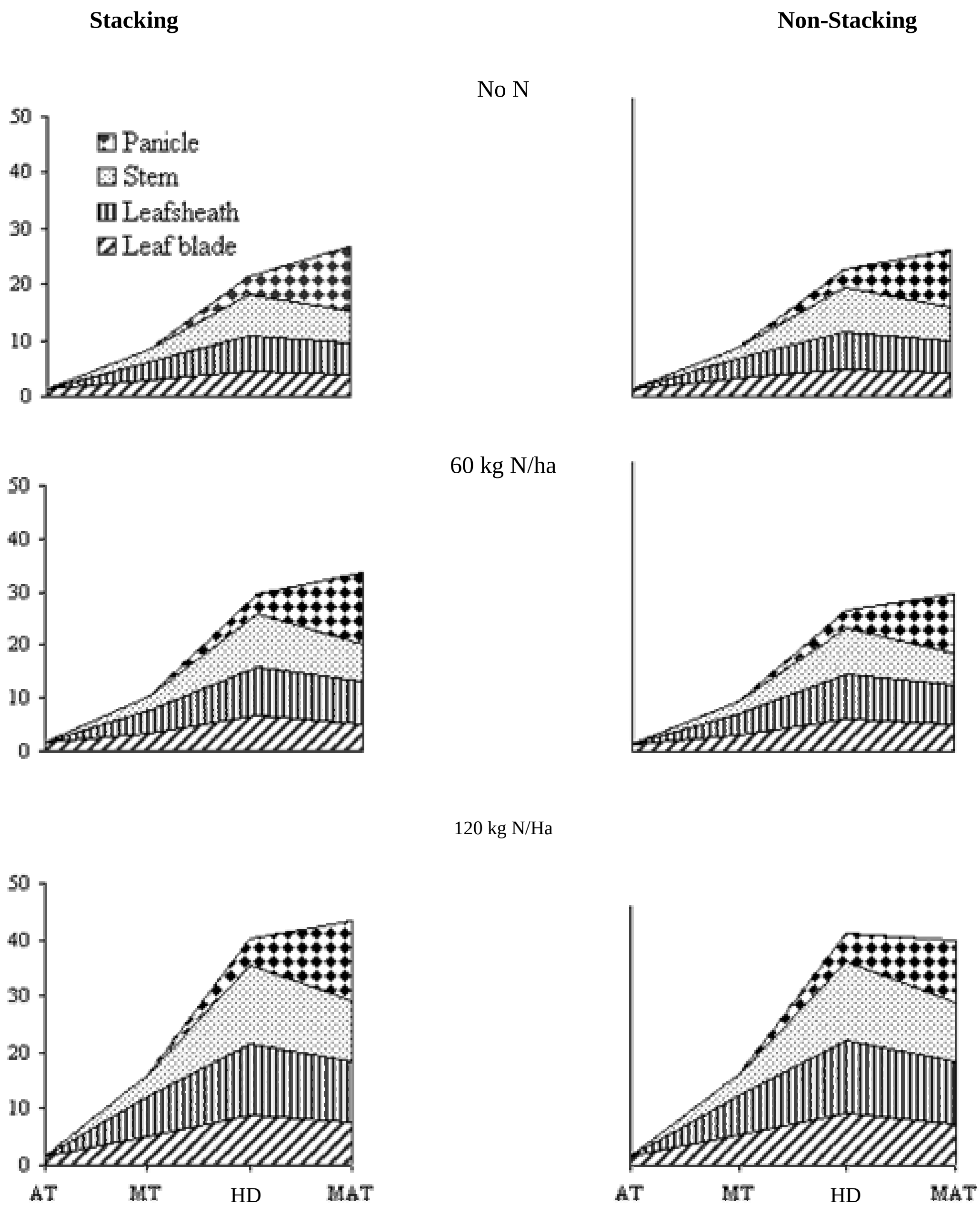
Leaf blade dry matter

Leaf blade dry matter accumulation reached its peak at around heading stage and decreased gradually thereafter regardless of cultivar and N dose. At Active tillering stage there was no significant variation in leaf blade dry matter accumulation among the treatments. The application of 60 kg N ha^{-1} increased the dry weight of leaf blade by 2.6, 2.2, 1.2 and 3.9 g $hill^{-1}$ at heading stage in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively, whereas the application of 120 kg N ha^{-1} increased the dry weight of leaf blade by 5, 4.4, 2.6 and 5.9 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively.

At maturity stage, 60 kg N ha^{-1} increased the dry weight of leaf blade from 1.2 g $hill^{-1}$ (Kalijira) to 3.4 g $hill^{-1}$ (Kataribhog) and from 1.0 g $hill^{-1}$ (Kalijira) to 3.2 g $hill^{-1}$ (Kataribhog) under stacking and non-stacking conditions, respectively. Application of 120 kg N ha^{-1}, the dry weight of leaf blade increased from 2.1 g $hill^{-1}$ (Kalijira) to 5.1 g $hill^{-1}$ (Kataribhog) and from 1.9 g $hill^{-1}$ (Kalijira) to 5 g $hill^{-1}$ (Kataribhog) under stacking and non-stacking conditions, respectively.

Leaf sheath dry matter

At heading stage, the application of 60 kg N ha^{-1} increased the dry weight of leaf sheath by 3, 2.8, 2.6 and 5.4 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively, whereas the application of 120 kg N ha^{-1} increased the dry weight of leaf sheath by 6.7, 6.4, 5.4 and 10 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively.



AT: Active tillering; MT: Maximum tillering ; HD:Heading ; MAT: Maturity

Fig. 2. Dry matter accumulation pattern of cultivar Chinigura at different nitrogen levels under stacking and non-stacking conditions.

At maturity stage the leaf sheath dry matter increased at 60 kg N ha^{-1} by 2.8 and 2.4 g $hill^{-1}$ in Shakkorkhora , 2.6 and 2.8 g $hill^{-1}$ in Chinigura , 2.7 and 2.3 g $hill^{-1}$ in Kalijira , and 4.5 and 4.3 g $hill^{-1}$ in Kataribhog under stacking and non-stacking condition, respectively. Whereas, at120 kg N ha^{-1} the leaf sheath dry matter increased by 5.5, 5.3, 4.7 and 8.4 g $hill^{-1}$ under stacking and 4.4, 5.5, 4.3 and 8.4 g $hill^{-1}$ under non-stacking condition in Shakkorkhora, Chinigura, Kalijira and Kataribhog , respectively.

Culm dry matter

Culm dry matter accumulation continued upto heading stage and then declined. At heading stage, application of 60 kg N ha^{-1} increased the culm dry matter by 3.6, 2, 4 , 3 g $hill^{-1}$ and 120 kg N ha^{-1} by 7.2, 6.3, 8 , 7 g $hill^{-1}$ in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively.

At maturity stage, the culm dry matter increased at 60 kg N ha^{-1} by 3.7 and 3.8 g $hill^{-1}$ in Shakkorkhora , 1 and 1 g $hill^{-1}$ in Chinigura , 2.8 and 3 g $hill^{-1}$ in Kalijira , and 2.2 and 1.9 g $hill^{-1}$ in Kataribhog under stacking and non-stacking conditions, respectively. Whereas, at120 kg N ha^{-1} the culm dry matter increased by 6, 4.8, 5.9 and 4 g $hill^{-1}$ under stacking and 5, 4.6, 5.7 and 4 g $hill^{-1}$ under non-stacking condition in Shakkorkhora, Chinigura, Kalijira and Kataribhog , respectively.

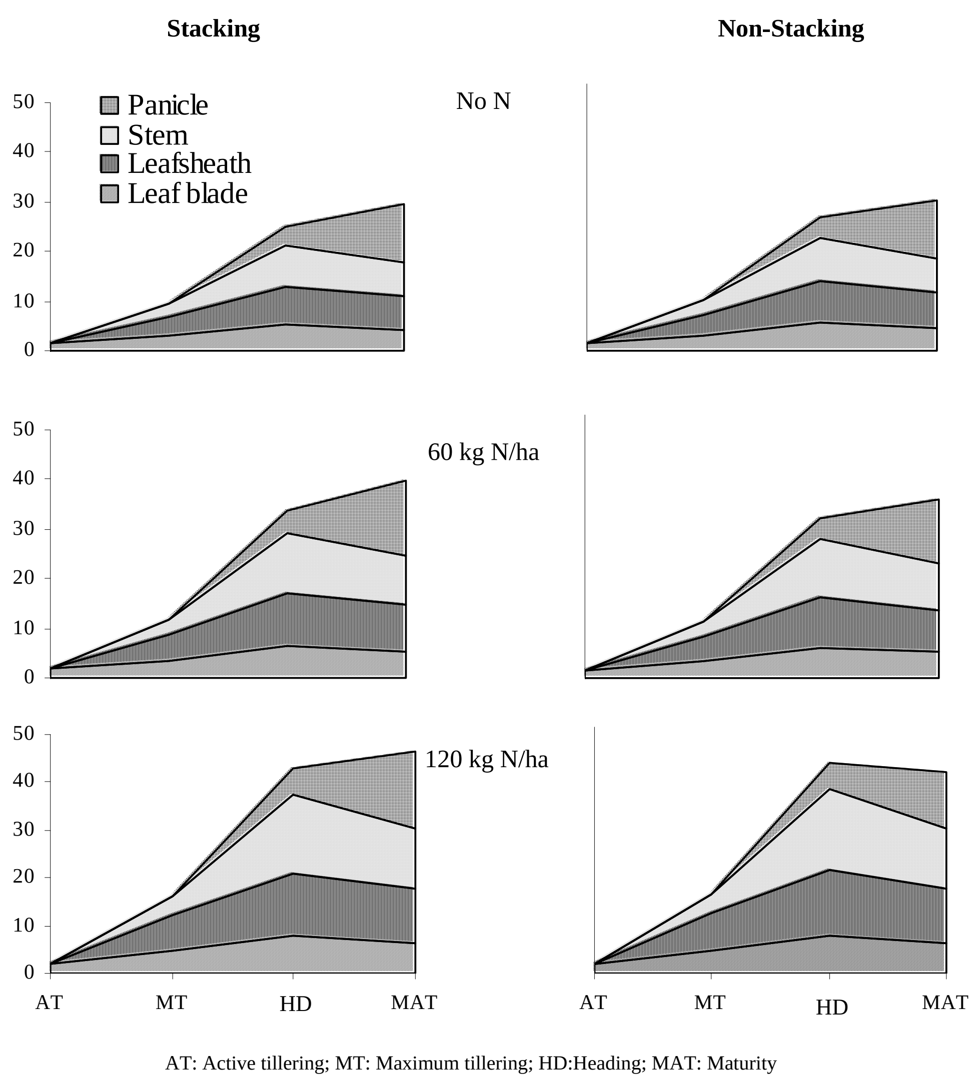
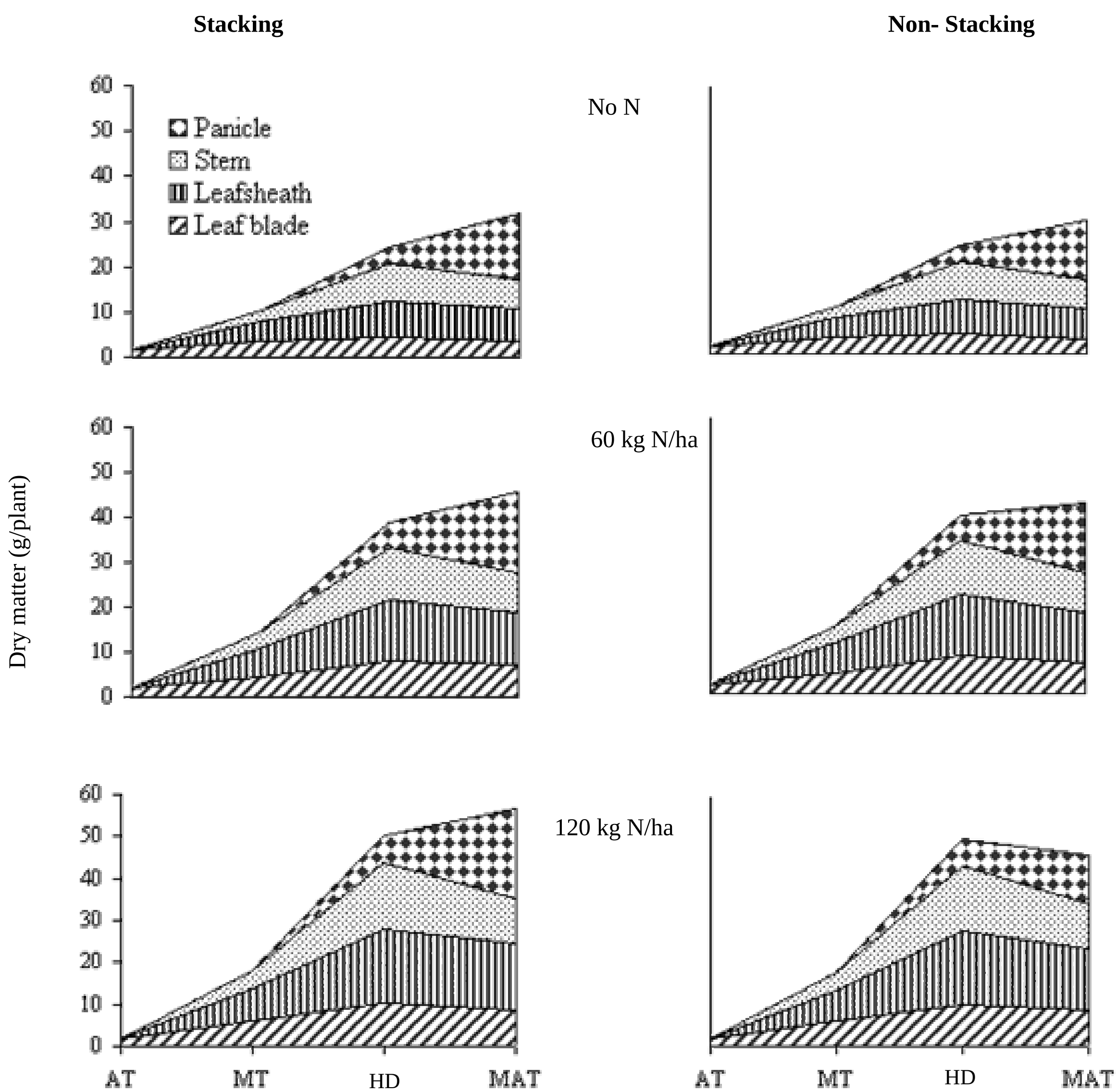


Fig. 3. Dry matter accumulation pattern of cultivar Kalijira at different nitrogen levels under stacking and non-stacking conditions.

Panicle dry weight

Application of 60 kg N ha^{-1} increased the panicle dry weight by 1.78, 1.9, 3.8, 3.8g hill^{-1} and 120 kg N ha^{-1} by 3.6, 3, 4.4, 7 g hill^{-1} in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively under stacking condition. Whereas, under non-stacking condition, application of 60 kg N ha^{-1} increased the panicle dry weight by 1.5, 2.5, 2.3, 2.2 g hill^{-1} and 120 kg N ha^{-1} by 0.4, 1.1, 0.73, 1.2 g hill^{-1} in Shakkorkhora, Chinigura, Kalijira and Kataribhog, respectively.



AT: Active tillering; MT: Maximum tillering; HD:Heading; MAT: Maturity

Fig. 4. Dry matter accumulation pattern of cultivar kataribhog at different nitrogen levels under stacking and non-stacking conditions

Considering the above discussion, it is concluded that the dry matter production of the plants varied significantly among the treatments. In all the cultivars, highest dry matter production was obtained from Kataribhog under stacking condition and in Shakkorkhora under non-stacking condition at 120 kg N ha^{-1}. Reduction in pre-anthesis dry matter of leaf blade, leaf sheath and culm was higher with the higher levels of N application. Reduction in dry matter after heading was higher under non-stacking condition than under stacking.

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