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Growth and yield in two Cassava Morphotypes

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Abstract: Growth of leaf, stem and storage root was investigated in two Cassava Morphotypes *viz*., Philippine and Nagra in Mymensingh (24^0 75' N and $90^0$50' E) at 120, 140, 160, 180, 200, 220, 240 and 260 days after planting (DAP). Results revealed that estimated leaf area increased up to 220 and 180 DAP in Philippine and Nagra, respectively, followed by a decline in both the Morphotypes. Stem dry weight was highest between 140 and 160 DAP followed by a decline in both the Morphotypes. Maximum storage root growth occurred between 200 and 240 DAP in both the Morphotypes. A positive correlation between storage root yield and total dry matter was observed. The Morphotypes Philippine produced higher fresh storage root yield (7.3 ton/ha) than Nagra (2.4 ton/ha) at 260 DAP. Therefore, the Philippine Morphotype is suitable for Mymensingh region.
Key words: *Manihot esculenta,* Growth, Dry mass, Storage root yield.

Introduction

Casava (*Manihot esculenta* Crantz.) is a perennial shrub of Euphorbiaceae. It is least known crop as 'Simul alu' to tribal people in Bangladesh. Morphological features and characterization of different morphotypes of this crop were investigated (Islam, 2004). Cassava is an important tropical root crop and food for about 500 million people (Cock, 1985). The crop is an important staple food used mainly as a source of carbohydrates for human consumption in Africa. Cassava root is eaten after boiling like sweet potato. It has many industrial uses, for starch in garment industry, raw materials in bakery, food and pharmaceutical company, also as animal feed and alcohol industry (El-Sharkawy and Cadavid, 2002). Cassava is drought tolerant crop and is propagated usually from stem cutting (El-Sharkawy and Cadavid, 2002). Cassava yield or storage tuberous root yield depends on canopy growth. The growth of the canopy was observed maximum at 90-180 days after planting (DAP) (Ramanujam, 1985). The storage roots continue to bulk between 120 and 150 DAP when the leaves are able to intercept the most of the incident light on canopy (Veltkamp, 1985).

Cassava assimilates from source (leaf) is translocated mainly to stem and storage roots. (Cock *et al*., 1979). The storage root accumulate assimilates and increase in size rapidly, reaching 50-60% of the total dry mass (DM) around 120 DAP (Howeler and Cadavid, 1983). However, Cassava can be harvested from 7 months after planting. Improved varieties selected for early bulking may be harvested after 6 months, but maximum yields are obtained at 9-12 months since the highest DM accumulation in storage root occurred within 180-300 DAP (Boerboom, 1978). Although the crop has a great potential, research works on the development of high yielding and disease resistant variety with suitable agronomic practices, have not yet been carried out in Bangladesh. There is only one report on morphological features, growth and yield in some Cassava morphotypes (Islam, 2004). This research was carried out to investigate the growth behaviour of shoot and root, and to envisage the relationship between growth and yield in two Cassava morphotypes.

Materials and Methods

Crop establishment: The experiment was conducted at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh between March and December, 2003. The soil was silty loam and poorly drained. The plots were spaded one day before planting. Well-decomposed cow dung was also applied (1656 kg/ha) during initial land preparation. The entire amount of urea, triple super phosphate and muriate of potash at the rate of 83, 62 and 62 kg/ha, respectively, was applied at the time of final land preparation. The stem cutting of the two Cassava morphotypes (Philippine and Nagra) were planted in a Randomized Complete Block Design (RCBD) with three replications. The size of the unit plot was 3.6 m × 3.6 m and the distance between blocks and plots was 0.9 m and 0.6 m respectively. The plots were raised up to 15 cm from the soil surface. Healthy and uniform sized (about 12 cm long with 6 nodes) cutting stalks (stems) of 12 months old cuttings were collected from Modhupur and planted on March 28, 2003. The stalks were planted at an angle about 30^o, placing basal two-thirds of the cutting in the soil. The distance between two stalks was 90 cm and 2 stalks were planted in each hole. There were 16 plants /plot (12.96 m^2). The cuttings were watered after planting and continued for several days until their establishment. Other cultural practices were carried out when needed.

Crop sampling and data collection: The first destructive harvest of the complete plants was started 120 days after planting (DAP) and continued at an interval of 20 days till 260 DAP. At each harvest, five plants were randomly selected from each replication. Leaf length and breadth, fresh weight of leaf-lobe, fresh mass of storage root and oven dried (80^0C ± 2) stem, leaf lobe and storage root was weighed by an electronic balance. Percentage DM partitioning and absolute growth rate (AGR) of plant parts were calculated (Islam, 2004; Hunt, 1982).

Statistical analysis: The collected data were processed and subjected to analysis of variances. The mean differences were evaluated by Duncan's New Multiple Range Test (DMRT) (Gomez and Gomez, 1984). A correlation and regression between storage root yield and other important yield parameters were also carried out.

Results

Leaf area development, stem and root growth: The estimated leaf area (LA) of two Cassava Morphotypes (Philippine and nagra) is illustrated in the Fig. 1A. Leaf area/plant (y) was estimated by a regression equation (y=123.46x + 1.2653, where x is the leaf lobe dry weight, r= 0.8828*). LA varied between 2000 and 4300 cm^2 (Fig 1A). There was little difference in LA between two morphotypes at 120 days after planting (DAP), but it became maximum at 180 DAP followed by a decline in Nagra (Fig. 1A). However, LA in Philippine still continued to increase up to 220 DAP followed by a decline later on. Absolute growth rate (AGR) of stem followed a pattern of a normal curve skewed during early growth in both the morphotypes (Fig. 1B). Of the two morphotypes, the Philippine maintained greater stem AGR throughout the overall growth period. AGR of storage root followed a quadratic pattern with the magnitude of being again greater in the Philippine than the Nagra (Fig. 1C). Increase in LA and greater stem and storage root AGR in Philippine consequently reflected higher mean AGR (AGR of TDM) in this morphotype than in the Nagra (Fig. 1D).

Storage root yield and dry mass (DM) partitioning: Actual or absolute fresh and dry weight of storage root (SR) showed a lag phase up to 200 DAP followed by a linear increase in both the morphotypes (Fig. 2 A, B). There were little differences in fresh weight of storage root/plant between 120 and 180 DAP in the morphotypes. However, during later stages of growth, especially between 180 and 260 DAP, storage root fresh weight /plant became greater in the Philippine than in the Nagra (Fig. 2A). Dry weight of SR/plant followed a trend similar to that of fresh weight of SR (Fig. 2B). Dry mass (DM) partitioning into different plant parts in Philippine is presented in Fig. 2C. DM partitioning into leaf was about 38% at 140 DAP and decreased to 5% at 260 DAP (Fig. 2C). DM distribution into stem plus petiole (S+P) growth was 30% at 140 DAP increased to 42% at 180 DAP followed by a decline to 19% at 260 DAP. DM partitioned to fibrous root (FR) was within 10% between 120 and 260 DAP (Fig. 2C). In contrast, DM distribution in storage root (SR) followed a sigmoidal curve with 28% DM invested at 140 DAP became the highest, 72% at 260 DAP (Fig. 2C). The pattern of DM investment into different plant parts in Nagra was similar to that of Philippine (Fig. 2D). However, the magnitude of DM allocation in SR was much greater in Philippine than in Nagra (Fig. 2C, D).

Relation of storage root yield with growth parameter: Results of the correlation study revealed that storage root dry mass/plant had and significant positive correlation with total dry mass production ($r = 0.972$, $P \leq 0.01$; N=48, 2 morphotypes × 8 ages × 3 replications; Data not shown). Further, total dry mass production was again positively and significantly correlated with leaf-lobe dry mass/ plant ($r = 0.568$, $P \leq 0.05$), stem dry mass/ plant ($r = 0.986$, $P \leq 0.01$) and root dry mass/plant ($r = 0.996$, $P \leq 0.01$).

Discussion

DM production and growth of plant parts: Leaf is the major source for photosynthates in Cassava . Greater reduction in leaf area (LA) in Nagra during later part of growth indicated higher senescence and sheding of leaf in Nagra than in Philippine. Such reduced leaf growth may have contributed to lower yield of storage root in Nagra. This was supported by Segnou (2002) who observed that smaller leaf area in local clone was responsible for lower yield of storage root (both fresh and dry) than the improved clones of Cassava. Further, increased number of branches may have provided greater loci for leaf development in Philippine (Islam, 2004) which may have increased storage root yield in this variety and this was supported by Nair *et al.* (2002) who stated that profuse branch and more leaves were responsible for high yield in Cassava in India. In the morphotypes Philippine, therefore, good development of vegetative characters perhaps produced greater yield. Storage root (SR) initiated 120 days after planting (DAP) in both the morphotypes. However, Segnou (2002) observed that the initiation of storage root began only 30 days from planting. This difference may be due to wet condition of the land in the present investigation which perhaps delayed initiation of SR apart from other varietal and environmental factors. Bulking of SR began between 180 and 220 DAP and this was supported by Boerboom *et al.* (1978) who also observed bulking of SR between 180 and 300 DAP. However, Veltkamp (1985) noted early bulking in Cassava (120-150 DAP) and this differences could be attributed to different location and environment. It is interesting to note that decreasing stem growth during later part coincided with increased bulking of SR in both the morphotypes. This indicated that the translocation of assimilates from stem to storage root may have occurred in response to demand of stronger sink demand of SR (Veltkamp, 1985).

Relationship of storage root yield with DM production and growth: Not only DM production but also allocation of the same into the harvestable organ determines yield (Evans, 1978). In the current research, the morphotypes Philippine produced high yield where increased DM production and greater partitioning of DM occurred compared to the low yielding Nagra. This was evidenced by a positive correlation between storage root (SR) yield and total DM. Further increased amount of DM partitioning (30-70%) to SR growth in Philippine compared to only 20-50% in Nagra may have induced greater yield in the former. So there is a possibility of increasing storage root yield by increasing TDM (El-Sharkawy and Cock, 1990). Again, TDM is a function of leaf, stem and root growth (Veltkamp, 1985). Therefore, TDM can be increased by increasing leaf, stem and root growth. In the present investigation this was also indicated by a positive correlation of TDM with leaf, stem and fibrous root. Such means of increasing yield through greater biomass (TDM) production by favourable leaf, stem and fibrous root growth was also observed by

Granda *et al.* (2000) in Cassava. Other yield contributing characters such as increased number, length and diameter of SR also influence storage root yield (Granda *et al*., 2000). In the earlier research it was observed that greater storage yield was observed in Philippine than in the Nagra and such higher yield was due to thicker and larger storage root in the former than in the latter (Islam, 2004). In the present study leaf area (LA) was observed greater during the major part of growth in the morphotypes Philippine than in the Nagra. Such higher LA may have provided greater assimilate to SR.

From the above study, it was found that there was a considerable variation among the Cassava morphotypes in the leaf, stem and storage root growth and yield characteristics, and Philippine was better than Nagra in respect of yield. Further increase in yield may be obtained by increasing biomass production.

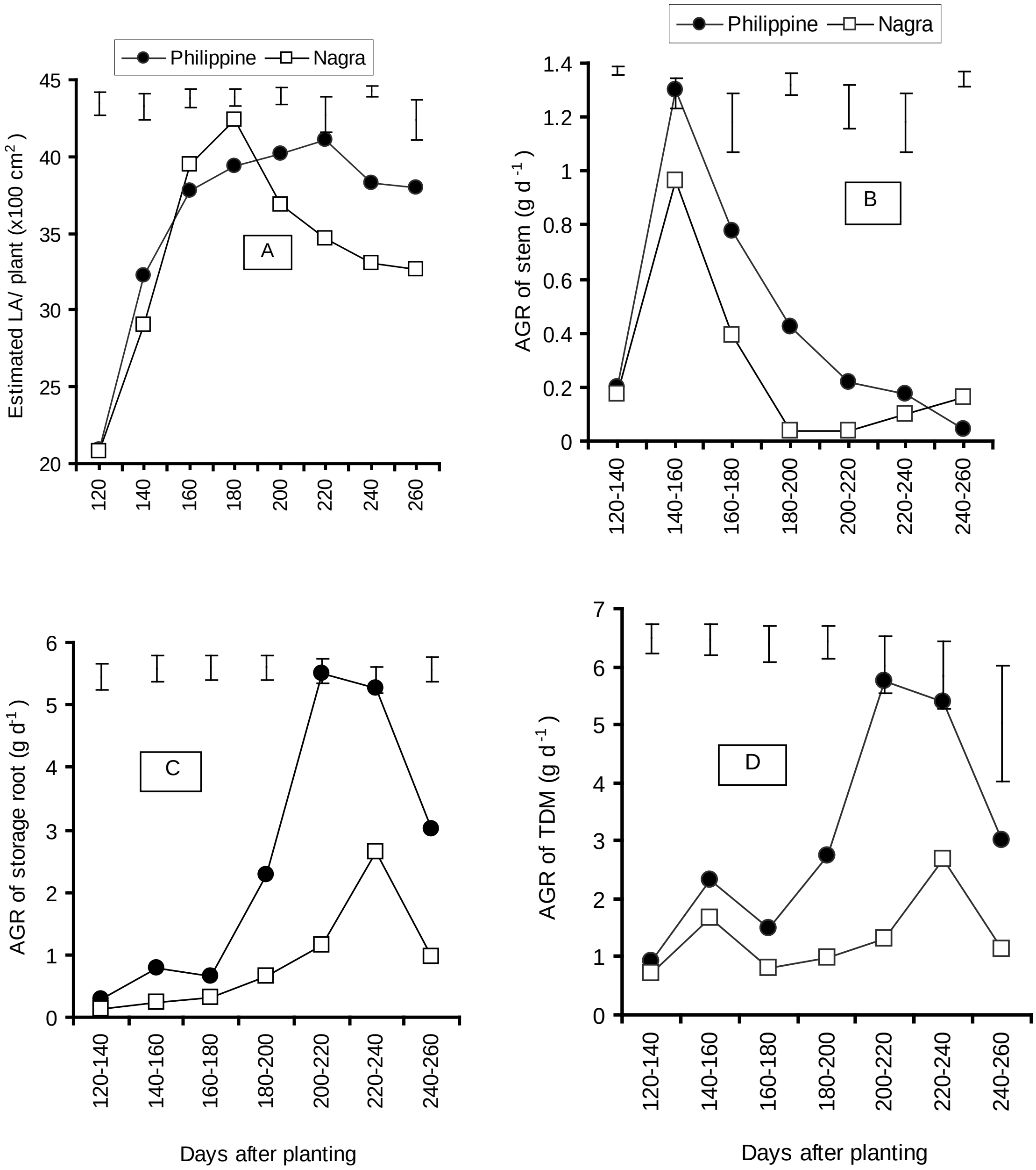

Figure 1. Changes in leaf area (cm^2) (A) and absolute growth rate (AGR) in two Cassava Morphotypes (B: stem, C: storage root, D: Total dry mass). Vertical bars indicate Lsd $_{0.05}$.

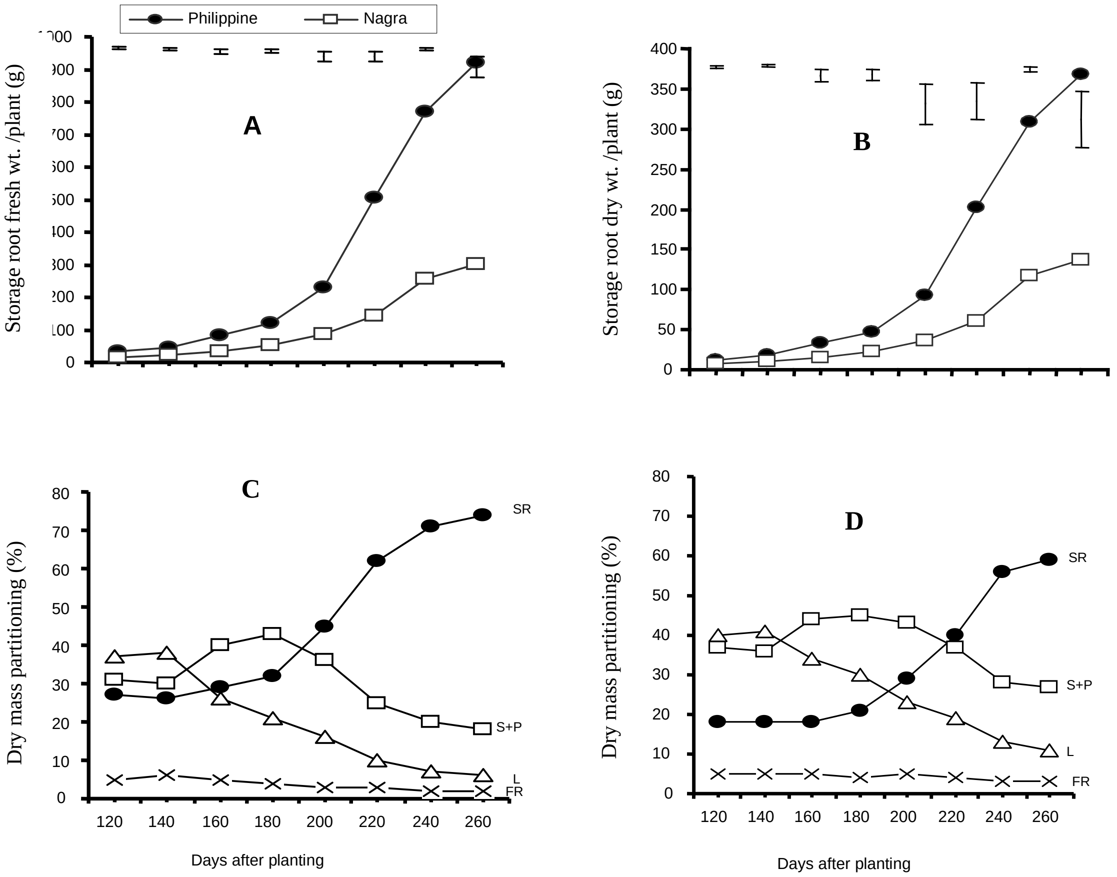

Figure 2. Changes in actual fresh (A) and dry (B) weight of storage root and dry mass (DM) partitioning into storage root (SR), stem plus petiole (S+P), leaf (L) and fibrous root (FR) in two Cassava Morphotypes (C: Philippine, D: Nagra). Vertical bars indicate Lsd $_{0.05}$.

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