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Influence of Plant Population Density on Growth and Yield of Two Blackgram Varieties

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Abstract: A field experiment was carried out to evaluate the growth and yield performance of two blackgram varieties i.e., BARImash 3 and BINAmash 1 under three different population densities. The planting configurations were 40 × 10 cm^2, 30 × 10 cm^2 and 40 × 5 cm^2 representing 25, 33 and 50 plants m^{-2}. Both the blackgram varieties showed identical results in LAI, CGR, NAR, RGR as well as grain yield. But planting density had significant effects on LAI and CGR of the blackgram varieties. The highest planting density showed the highest LAI and CGR but the highest grain yield was recorded from intermediate population density due to the highest number of pods per unit area. The NAR and RGR did not differ due to different population densities.

Key words: Population density, blackgram, plant population BARImash 3, BINAmash 1

Introduction

Blackgram is one of the important multipurpose grain legumes in Bangladesh. The low yield of grain legumes compared to the other crops is due to low yield potential of existing varieties, short growth duration, slow rate of dry matter accumulation and non responding to high inputs (Hamid *et al.*, 1991). Early leaf area development of blackgram may be slow, so that ultimate seed yield potential is limited by inadequate vegetative dry matter accumulation prior to flowering (Matsunaga *et al.*, 1989; Lawn and Ahn, 1985). As a result, LAI is an important determinant of dry matter production and grain yield of blackgram and it can be altered by manipulating planting density (Rahman *et al.*, 1994). The population density influences dry matter production and partitioning, growth rate and seed yield of legume pulses (Herbert and Beggerman, 1983; Rowden *et al.*, 1981). For high productivity of blackgram it is essential to explore the pattern of dry matter accumulation and partitioning which helps to adjust proper crop management practices (Nakaseko *et al.*, 1979). However, studies of dry matter accumulation and partitioning associated different growth parameters in relation to seed yield of blackgram are very limited. Therefore, the present study was undertaken to evaluate the physiological basis of yield improvement with a view to find out the optimum population density to achieve higher grain yield of blackgram.

Materials and Methods

A field experiment was carried out at research farm of Bangabandhu Sheikh Mujib-ur-Rahman Agricultural University during the kharif-II season of 1999. The soil of the blackgram varieties BARImash 3 and BINAmash 1 were used in this experiment. A randomized complete block design with four replications was used. Plot size was 10 × 5 m^2. Planting configuration of the three densities were 40 × 10 cm^2, 30 × 10 cm^2 and 40 × 5 cm^2 respectively for each of the variety. The seeds were sown in rows by hand, providing two seeds per hole and finally single plant per hole was retained at trifoliate stage. The crop received 40, 60 and 40 kg N, P and K per hectare. Intercultural operations such as weeding, mulching, plant protection measures were done as needed. A light irrigation was applied to establish the seedling properly.

Plant samples were taken at seven days interval beginning from 15 days after emergence (DAE) and continued up to harvest from half linear meter for each replication. Leaf area per square meter of ground area was measured by an automatic leaf area meter (Model AA M-7 Hayashi, Dehnco Co. Ltd, Tokyo, Japan). The above ground portion of the crop was segmented into leaf, petiole, stem and reproductive organs and oven dried at 70°C for 72 hours and dry weight of each component was recorded. On the basis of leaf area index (LAI=Surface area of sampled leaf/Ground area occupied by the sampled plants) and dry matter accumulation, the growth parameters such as crop growth rate (CGR = 1/Ground area x W_2-W_1/T_2-T_1 g m^{-2} day^{-1} where, W_1 = Dry weight at time T_1 and W_2 = Dry weight at time T_2), net assimilation rate (NAR = W_2-W_1/T_2-T_1 x Ln L_2-Ln L_1/L_2-L_1 g m^{-2} day^{-1} where Ln = Natural logarithm, L_1 = Leaf area at time T_1 and L_2 = Leaf area at time T_2) and relative growth rate (RGR = 1/W_1 x W_2-W_1/T_2-T_1 x Ln W_2-Ln W_1/T_2-T_1 g $g^{-1}day^{-1}$) were calculated according to Gardner (1985). Data on yield and yield attributes were recorded from 30 randomly selected plants from each plot. Yield was determined by harvesting an area of 8 m^2 for each replication and converted into tons per hectare at 11% moisture content. The results were analyzed statistically and treatment means were compared by least significant difference test.

Results and Discussion

Leaf area index: Leaf area index of blackgram was influenced due to variety and population densities at different growth periods. Regardless of variety and density, leaf area index of blackgram increased slowly up to 22 DAE and thereafter it increased till 57 DAE and then declined sharply (Fig. 1). The highest values of LAI were recorded at the highest density and the lowest at the lowest population densities in all the growth periods. Varietal differences indicated that BARImash 3 showed higher LAI than BINAmash 1 during the most of the growth periods. Both the varieties showed the highest leaf area index at pod filling stage. Similar findings also reported by Rahman *et al.* (1994). The decline of LAI at later part of growth might be due to senescence of leaves associated with the remobilization of the stored metabolites from the leaf to the developing pods of blackgram. Similar results in chick pea were also reported by Prasad *et al.* (978).

Dry matter accumulation: Accumulation of total dry matter of two blackgram varieties was differed with the population densities (Fig. 2). Dry matter production resembled to that of the leaf area development up to 57 DAE which may be explained by better relationship (r = 0.99*) between leaf area and dry matter production. Variation in dry matter accumulation between the varieties was not profound. But the effect of population density on dry matter accumulation was remarkable mean higher the density, higher the dry matter accumulation in blackgram. Dry matter production resembled to that of leaf area development which may be explained by better relationship (r = 0.99*) between leaf area and dry matter production in blackgram. The subsequent decrease rate of dry matter production at later stage of crop growth may be due to the dropping LAI. Similar trend of dry matter production in mungbean was reported by Tsiung (1978).

Crop growth rate: Crop growth rate did not differ due to variety but population density had significant effect on crop growth rate. Crop growth rate increased gradually and attained a peak at 57 DAE and there after it showed a rapid decline (Fig. 3). The highest CGRs were obtained from the highest population densities and the lowest from the lowest population densities of blackgram. This parameter showed significant relationship with LAI at flowering (r = 1.00**) and at pod filling stage (r = 0.99*) and negative relationship at maturity stage (r = -0.34). Similar result was also reported by Khader and Bhargava (1985). Decrease of

Table 1: Yield and yield attributes of blackgram under different population densities

Treatments	Pods plant^{-1} (no.)	Seeds pod^{-1} (no.)	Pod length (cm)	1000 seeds weight (g)	Yield (kg ha^{-1})
Variety					
BARImash 3	20.00	6.778	5.092	46.68	1926.24
BINAmash 1	22.67	6.444	4.794	38.12	1836.03
SE	NS	NS	0.049	0.112	NS
Density (plants m^{-2})					
25	28.00	6.50	4.880	42.59	1718.23
33	22.83	6.667	4.935	41.59	2061.87
50	13.18	6.667	5.014	43.02	1863.29
LSD (0.05)	3.523	NS	NS	NS	268.6
CV (%)	12.84	8.13	3.01	4.29	11.10

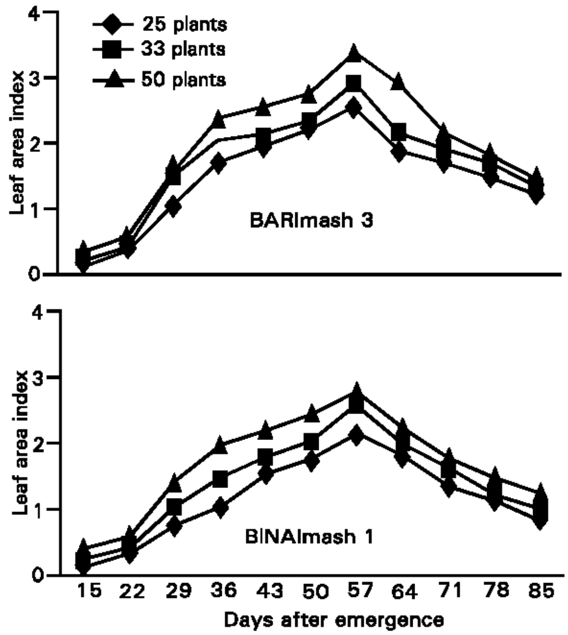

Fig. 1: Leaf area index of two blackgram varieties at different growth periods as affected by population densities.

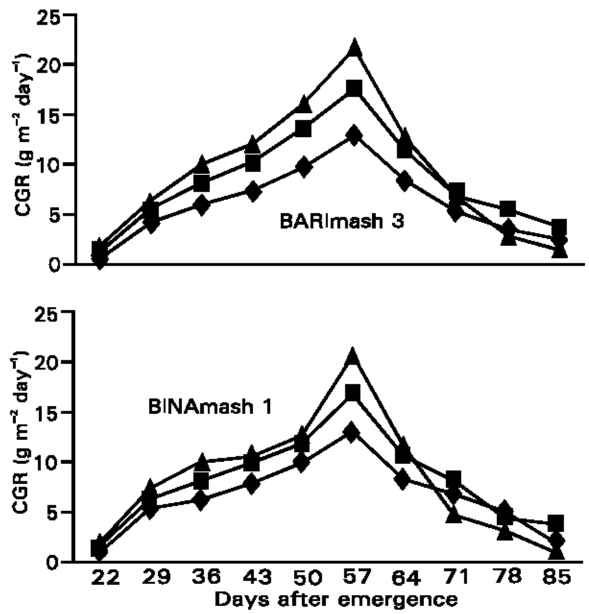

Fig. 3: Crop growth rate of two blackgram varieties at different growth periods as affected by population densities.

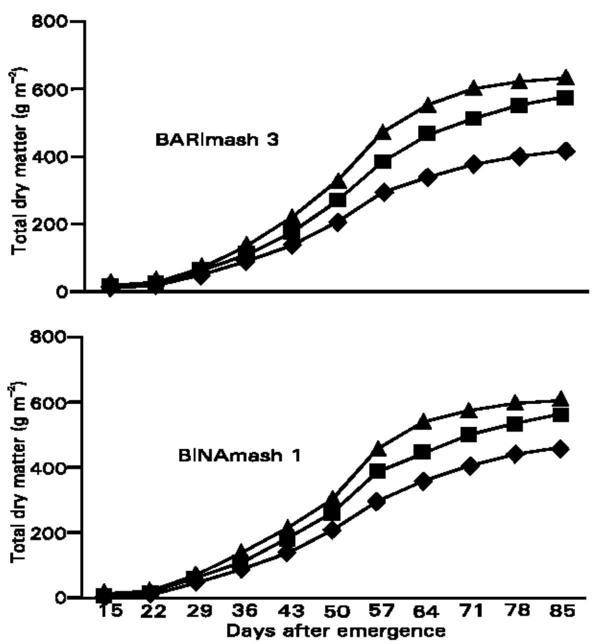

Fig. 2: Total dry matter production of two blackgram varieties at different growth periods as influenced by population densities.

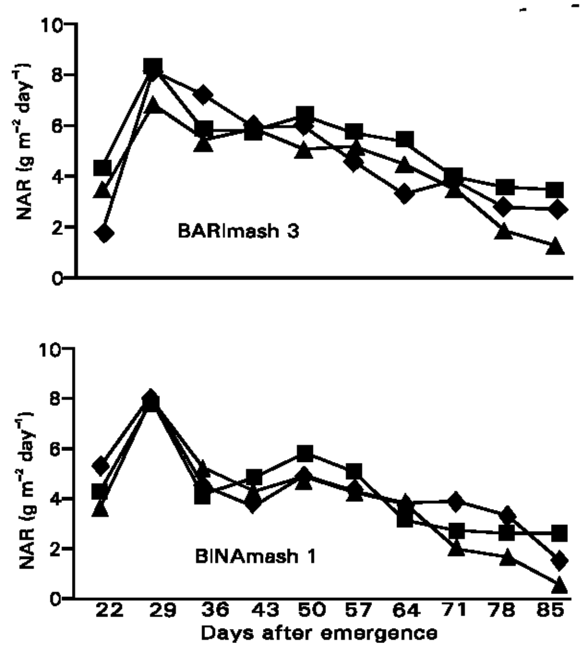

Fig. 4: Net assimilation rate of two blackgram varieties at different growth periods as affected by population densities.

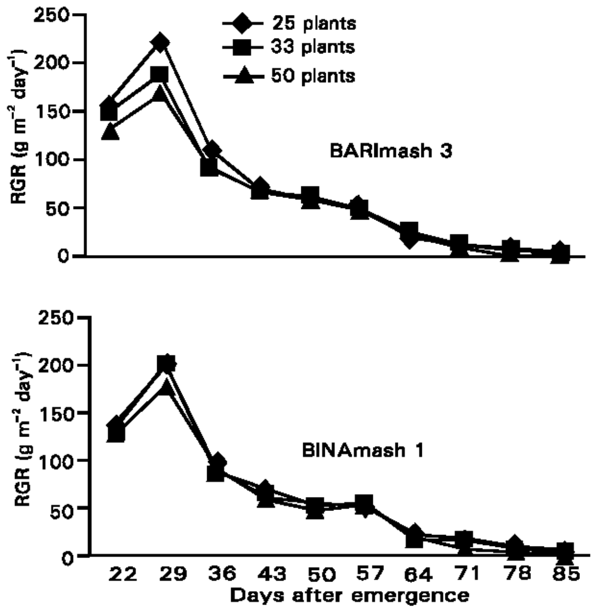

Fig. 5: Relative growth rate of two blackgram varieties at different growth periods as affected by population densities

CGR in blackgram at later growth stage was due to the decrease of LAI. The highest population density of blackgram showed the faster decrease of CGR than the lowest density. This might be due to severe mutual shading in the highest density. The general trend of declination in CGRs after 57 DAE possibly due to slower accumulation rate of dry matter production in blackgram (Prasad *et al.*, 1978).

Net assimilation rate: Net assimilation rate represents the photosynthetic efficiency of plant was differed due to population density and variety up to 29 DAE. After 29 DAE net assimilation rate did not differed due to either variety or population density. In general, NAR of blackgram was minimum at 22 DAE which increased gradually and peaked at 29 DAE and declined thereafter (Fig. 4). Both the blackgram varieties with intermediate population density showed highest NAR at 29 DAE. However, there was slight increase in NAR at pod development stage and again declined with the increase of age of the plant. Similar trend of NAR was also reported by Rahman *et al.* (1994) in blackgram. The decrease of NAR in later part of growth of blackgram may be attributed to mutual shading and increase of number of old leaves with low photosynthetic efficiency (Wallance and Munger, 1965).

Relative growth rate: Relative growth rate of blackgram did not differ due to the variety and population density. Relative growth rate of blackgram was lower at 22 DAE and peaked at 29 DAE and there after it decreased steadily with the advent of time (Fig. 5). However, a slight increase in RGR was found at pod filling stage of blackgram. Similar trend in RGR was also reported by Rahman *et al.* (1994) in blackgram and Pandey *et al.* (1978).

Yield and yield attributes: Most of the yield attributes of two blackgram varieties were not differed statistically. As a result, yield of BARImash 3 and BINAmash 1 were identical. But population density had significant effect only on pods per plant and seed yield of blackgram (Table 1). The highest pod per plant (28) was recorded from the lowest population density. Higher number of pods in lower population density also reported by Rahman *et al.* (1994) in blackgram and Mackenzie *et al.* (1975) in mungbean. The increase in pod number in lower population density may be the result of availability of better growth resources to the individual plant. However, the highest number of pods per plant under lowest population density could not able to increase the seed yield of blackgram. Contrary, the highest population density contributed to the lowest number (13.18) of pods per plant. Densely planted blackgram might have caused mutual shade which may be responsible for reduction in photosynthetic efficiency and dropping of flowers and pods in lower canopy layers. The lowest number of pods per plant ultimately produced the lowest seed yield of blackgram (1863 kg ha^{-1}). The highest yield (2262 kg ha^{-1}) of blackgram was found from intermediate population density with 33 plants per unit area due to highest number of pods per unit area. Similar result was also reported by Rahman *et al.* (1994) in blackgram.

The two blackgram varieties showed almost similar pattern in growth habit and yield but population density had profound effect on growth and as well as seed yield of blackgram. The results of this experiment revealed that the population density of 33 plants (30 x 10 cm^2) m^{-2} showed the optimum planting density for maximum seed yield of two blackgram varieties and variation in planting density either resulted in reduction of grain yield.

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