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Effect of plant density on canopy structure, growth and yield in Sunnhemp

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Abstract: Effect of five planting densities (15, 25, 30, 35 and 55 plants/m^2) on morphological features, dry mass (DM) production, reproductive efficiency and seed yield was investigated at Mymensingh (240 45'N, 900 11'E) in sunnhemp (*Crotalaria juncea*). Results revealed that plants at the lowest density (15 plants/m^2) flowered and matured late. Tap root length, number of effective branches/ plant, leaf/plant, racemes/plant and TRU/plant (total reproductive unit) were significantly greater at 15 plants/m^2. Total DM yield/plant was greater at 15 and 25 plants/m^2 (average of 300.7 g/plant) than in the others. The seed yield/plot was also greater at 15 and 25 plants/m^2 (average of 0.87kg). In the present study, it was not possible to achieve optimum density for seed and DM yield in Sunnhemp. Future research in this regard is suggested.

Key words: Population, Biomass, Reproductive efficiency, *Crotalaria juncea*

Introduction

Sunnhemp (*Crotalaria juncea* L.) is an important green manure, cover and fodder crop of Papilionaceae. In Bangladesh, sunnhemp occupies third position in fibre crops and second as phloem fibre crop (Alam *et al.,* 1989). In every year above 2000 tons sunnhemp fibres are produced from 4000 ha land which is one fourth of jute in this country. Seed yield of sunnhemp in 'Kharif' was 665 kg/ha and that of 'Rabi' is 700 kg/ha in 1980-81 (Alam *et al.,* 1989). The seeds contain approximately, 8.6% water, 34.6% protein, 4.3% fat, 41.1% carbohydrate, 8.1% fibre and 3.3% ash (Purseglove, 1988) and would be an ingredient of ideal feed composition.

Density alters canopy structure, growth and yield. Low density accelerates growth by allowing more nutrients, sunlight and water to plants. High density, on the other hand, decelerates plant growth and yield by curtailing environmental elements and edaphic factors. Optimum density is, therefore, needed to investigate for any density experiment. In green gram planting density and fertilizer management influence extraction of nutrients from the soil (Sathyamoorthi *et al.,* 2007). Population density is an important factor affecting the yield and yield contributing characters like branches/plant, filled grain/plant and finally reduced the yield of soybean (James and Peter, 1994). On the contrary, excessive density in an intercrop of soybean and sorghum reduces the total yield (Raei *et. al.,* 2008). There is only one report on the effects of density on growth and yield in sunnhemp in Bangladesh (Barua, 2006). The present research work was carried out (i) to study the effect of different plant populations on some of the important morphological features (ii) to investigate the effect of densities on DM production and seed yield at maturity stage and (iii) to determine the optimum density for seed and DM yield in the sunnhemp.

Materials and Methods

The experiment was conducted at the field laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, between 17 November 2005 and 7 April 2006. Five treatments (15, 25, 30, 35, and 55 plants/m^2) were randomly allotted to each plot in a block. The desired densities were achieved by planting seeds at 25 × 30 cm, 25 × 25 cm, 25 × 20 cm, 25 × 15 cm, 25 × 10 cm, respectively. The experimental plots were divided into four blocks each representing a replication. Each block was then divided into five unit plots each of 3 m x 2 m size. Important parameters relevant to morphological structures, dry mass production and partitioning and seed yield were recorded at maturity stage. Total reproductive unit (TRU) was estimated following the method of Fakir *et al* (1998) i.e. TRU /plant = No. of mature pod + No. of immature pod + No. of flower + No. of bud + No. of scars. Per cent podset estimated was as follows: % Podset= (No of matured pods ÷ TRU) × 100. Total dry mass (TDM)/plant were estimated by collecting and oven drying (80^0 ±2^0C, for 48 hour) plant parts excluding roots as follows: TDM yield/plot = TDM/plant × actual no. of plants/plot.

Data were compiled and analysed and mean differences were evaluated by Duncan's New Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Morphological characters: Generally, tap root length was decreased significantly with increasing density (Table 1). Tap root length varied between 18.1 cm and 20.2 cm with the tap root length was greater at 15 plants/m^2 (20.2 cm) than 35 plants/m^2 (18.4 cm) and 55 plants/m^2 (18.1 cm) (Table 1). However, Tap root length was similar between 30, 35 and 55 plants/m^2 (average of 18.5 cm).

Density influenced number of branches/plant production in the following ranking: 15 plants/m^2 (29.1) > 25 plants/m^2 (26.3) > 30 plants/m^2 (24) > 35 plants/m^2 (22.4)> 55 plants/m^2 (19.6) (Table 1). In the current investigation the number of branches/plant was progressively decreased at higher population. Similar results were obtained by James and Peter (1994) who noted that number of branches/plant was decreased with the increased population in an annual Legume (*Senna obtusifolia*). This might be due to intense competition of light, space and aerial environment in the densely populated plant stands. Reduced number of branches/plant due to narrow spacing was also reported by Singh and Dhillon (1991).

The number of leaf/plant was greater at 15 and 25 plants/m^2 (average of 319.1) than 30 and 35 plants/m^2 (average of 276.6) and 55 plants/m^2 (191.3) (Table 1). The current result of reduction of number of leaf/plant with increasing density was also similar with the report of Ibrahim (1996) who observed that number of leaves/plant was also decreased with increasing plant density in soybean.

The number of racemes/plant was greater at 15 plants/m^2 (32.5) than 25 and 30 plants/m^2 (average of 29.2), 35 plants/m^2 (25.6) and 55 plants/m^2 (22) (Table 1). The number of TRU/plant was smaller at 55 plants/m^2 (246.8) than in the others (average of 271.5) (Table 1).

Table 1. Effect of density on morphological characteristics in sunnhemp

Density (plants/m^2)	Tap root length	Branches/plant	Leaf/plant	Racemes plant	TRU/plant
15	20.2 a	29.1 a	332.0 a	32.5 a	282.1 a
25	19.7 ab	26.3 b	306.2 a	29.9 b	271.1 a
30	19.1 abc	24 c	284.9 b	28.4 b	266.4 a
35	18.4 bc	22.4 d	268.2 b	25.6 c	266.2 a
55	18.1 c	19.6 e	191.3 c	22 d	246.8 b

In each column, figures bearing uncommon letter(s) differ significantly at P≤0.05 by DMRT; TRU = Total reproductive unit.

Dry mass production and partitioning

Generally, leaf dry mass/plant was decreased significantly with the increasing density with the magnitude being in the order of 15 plants/m^2 (54.4g) >25 plants/m^2 (50.1g) >30 plants/m^2 (46.6g) >35 plants/m^2 (43.9 g) >55 plants/m^2 (31.3g) (Table 2). Flower plus husk had greater dry mass/plant at 15 and 25 plants/m^2 (average of 28.6 g) than 55 plants/m^2 (25.6g) (Table 2).

Table 2. Effect of density on dry mass (DM) production and partitioning in sunnhemp

Density (plants/m^2)	Dry mass partitioning/plant (g)		Seed yield/plant (g)	Total DM/plant (g)	Estimated TDM yield/plot (kg)
	Leaf wt.	Flower wt. + husk wt.			
15	54.4 a	29.2 a	36.3 a	305.6 a	27.5 e
25	50.1 b	28.1 a	35.0 a	295.8 ab	40.4 d
30	46.6 c	27.5 ab	30.9 b	284.4 bc	47.2 c
35	43.9 d	27.6 ab	29.3 c	276.4 cd	54.0 b
55	31.3 e	25.6 b	28.1 c	256.9 d	74.8 a

In each column, figures bearing uncommon letter(s) differ significantly at P≤0.05 by DMRT

There was a gradual decrease in seed yield/plant with the increasing population density (Table 2). The influence of density on the seed yield/plant had the following ranking: 15 and 25 plants/m^2 (average of 35.7g) >30 plants/m^2 (30.9g) >35 and 55 plants/m^2 (average of 28.7g) (Table 2). TDM/plant varied between 256.9 g and 305.6 g (Table 2). TDM/plant was greater at 15 and 25 plants/m^2 (average of 300.7 g) than 35 plants/m^2 (276.4g) and 55 plants/m^2 (256.9g) (Table 2). Estimated TDM yield/plot was significantly influenced by different densities in sunnhemp (Table 2). Estimated TDM yield/plot increased progressively with increasing density and had following ranking: 15 plants/m^2 (27.5 kg) < 15 plants/m^2 (40.4 kg) < 30 plants/m^2 (47.2 kg) < 35 plants/m^2 (54.0 kg) < 55 plants/m^2 (74.8 kg). (Table 2).

Dhingra *et al.* (1981) conducted an experiment in pigeonpea with dates of sowing (June 1, 10, 20 and 30), two cultivars (T-21 and AL-15), row spacings (25, 37.5, 50 and 75 cm) and plant densities of 16, 10.6, 8 and 5.3 plants/m^2, respectively. The author observed that total dry matter production decreased consistently with increase in the row spacing. The highest dry matter yield (12215 kg/ha) was from the closest row spacing of 25 cm, which was 6930 kg/ha more than that from the 75 cm row spacing. But in the present investigation, higher DM yield/plant was obtained at lower population (Table 2). This may be due to different species. Further, in the current study it was not possible to achieve optimum density for DM production but Roy and Biswas (1991) observed that dry matter production increased with the increasing plant population and the highest quantity of dry matter was achieved from 20 plants/m^2 in cowpea. However, in future, further lower population (<15 plants/m^2) should be tried to get optimum density for DM production.

Yield and yield attributes

The number of pods/plant was higher at 15 and 25 plants/m^2 (average of 175.3) than 30 plants/m^2 (152.1) and 55 plants/m^2 (138.0) (Table 3).

Table 3. Effect of density on yield and yield attributes in sunnhemp

Density (Plants/m^2)	Pods/plant	Podset (%)	Seed yield/ plant (g)	Harvest index (%)	Seed yield/ plot (kg)
15	178.5 a	63.2 a	36.3 a	20.0 a	0.90 a
25	172.0 a	63.4 a	35.0 a	18.1 ab	0.84 a
30	152.1 b	57.0 b	30.9b	17.0 bc	0.72 b
35	144.3 bc	54.2 c	29.3 c	16.2 bc	0.63 b
55	138.0 c	53.5 c	28.1 c	15.1c	0.51 c

In each column, figures bearing uncommon letter(s) differ significantly at P≤0.05 by DMRT

In the current study no significant effect on number of seeds/pod was observed due to density in sunnhemp (Table 3). Similarly, Prasan *et al.* (1983) found that population densities had no effect on the number of seeds/pod in soybean because this is more or less a genetically controlled character.

The number of pods/plant is one of the most important yield contributing characters in sunnhemp. In soybean, Epler *et.al.* (2008) observed the increased density decreased number of pods/plant but total yield was not reduced because the total number pods/acre did not reduce. In the present study, density exhibited marked effect on the number of pods/plant. Number of pods/plant decreased with increase in density. The lower density probably facilitated the individual plants to develop properly by utilizing available resources resulting in higher seed yield/plant at lower density. The reduction in seed yield/plant at higher density might be attributed to fewer pods/plant and seeds/pod.

Generally, there was a decreasing trend in per cent podset with the increasing density (Table 3). Podset was significantly greater at 15 and 25 plants/m^2 (average of 63.3%) than at 30 plants/m^2 (57.0%) and 35 and 55 plants/m^2 (average of 53.9%).

There was a gradual decrease in seed yield/plant with the increasing population density (Table 3). The influence of density on the seed yield/plant had the following ranking: 15 and 25 plants/m^2 (average of 35.7g) > 30 plants/m^2 (30.9g)> 35 and 55 plants/m^2 (average of 28.7g) (Table 3). Seed yield/plot followed a trend similar to that of seed yield/plant. The effect of density on harvest index (HI) was significant (Table 3). The HI was greater at 15 plants/m^2 (20.0%) than 55 plants/m^2 (15.1%) (Table 3).

The current result of increased seed yield/plot at lower densities (15 and 25 plants/m^2) contradicts to the report of Singh and Yadav (1989) that the highest plant density (50 plants/m^2) had 12.6% higher grain yield than 33.3 plants/m^2 in pea. Similarly Kwapata and Hall (1990) also found increased vegetable pod yield at extremely high densities (40 plants/m^2) in cowpea. However, in the present study, it was not possible to achieve optimum density for seed yield and TDM. In future, further lower population (<15 plants/m^2) should be tried to get optimum density.

References

Alam, M. S.; Iqbal, M. T.; Amin, M. S. and Gaffar, M. A. 1989. Krishitattic Fosholer Utpadon O Unnayan (Production and development of Agric. Crop). Papirus Press, 142 Arambug, Dhaka-1000. p. 45-46.

Barua, H. 2006. Effect of density on canopy structure, growth and yield in sunnhemp. MS Thesis, Dept. Crop Botany, Bangladesh Agric. Univ. Mymensingh, Bangladesh.

Dhingra, K. K.; Singh, S. and Tripathi, H. P. 1981. Phenological Behaviour and Yield of Pigeonpea Genotypes Under Different Dates of Planting and Row Spacings. Proc. Int. Workshop Pigeonpeas, Vol. 2, 15-19 Dec. 1980, Int. Crops Res. Inst. Semi-Arid Tropics (ICRISAT), Patancheru, A. P., India.

Epler, Staggenborg, M. and Scott. 2008. Soybean yield and yield component response to plant density in narrow row systems. Crop management. http://hdl.handle.net /2097/1280.

Fakir, M. S. A.; Umaharan, P. and McDavid, C. R. 1998. Estimation of floral abscission in pigeonpea [Cajanus cajan (L.)]. Trop. Agric. (Trinindad), 75 (3): 393-395.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons, New York. P. 97-111.

Ibrahim, M. E. 1996. Response of determinate and indeterminate soybean cultivars to planting pattern and density. Ann. Agric. Sci., 34 (4): 1431-1456.

James E. S. and Peter W. J. 1994. Stand Density Effects on Branching in an Annual Legume (Senna obtusifolia), Annals of Botany 74: 17-25.

Kwapata, M. O. and Hall, A. E. 1990. Response of contrasting vegetable cowpea cultivars to plant density and harvesting of young green pods. I: Pod production. Field Crop Res., 24: 1-40.

Parsan, Y., Umporn, S. and Wanchai, C. 1983. Improved cultural practices in soybean. Res. Rep. Kasetsast Univ. Bangkok, p. 5-6.

Purseglove, J. W., 1968. Tropical Crops. Dicotyledons vol. 1. Longmans, Green and Co. Ltd., London and Harlow. p. 250-252.

Raei, Y., Golezani, K. G., Javanshir, A., Aliari, H. and Mohammadi. A. 2008. Effects of Plant Density on Soybean (Glycine max L.) and Sorghum (Sorghum bicolor L.) Intercropping, J. Sci. & Technol. Agric. & Natur. Resour., 12: 45 (A).

Roy, S. K. and Biswas, P. K. 1991. Effect of cultivar and plant population on growth, nodulation and yield of cowpea (Vigna unguiculata L.) Bangladesh J. Agric., 16: 21-27.

Sathyamoorthi, K., Amanullah, M. M., Vaiyapuri, K. and Somasundaram, E. 2007. Influence of Increased Plant Density and Fertilizer Application on the Nutrient Uptake and Yield of Greengram (Vigna radiata (L.) Wilczek). Res. J. Agric. & Biol. Sci., 3(6): 886-895

Singh, T. and Dhillon, S. S. 1991. Response of toria to sowing date and row spacing in South Western Punjab. Indian J. Agron., 36 (4): 614-617.

Singh, V. K. and Yadav, D. S. 1989. Effect of sowing date and plant density on dwarf filed peas. Indian J. Agron., 34 (1): 92-95.