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INFLUENCE OF NITROGEN FERTILIZATION AND IRRIGATION ON THE GROWTH AND SEED YIELD OF LENTIL

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ABSTRACT

An experiment was conducted at the Sher-e-Bangla Agricultural University farm, Dhaka to study the influence of nitrogen fertilization and irrigation on the growth parameters of lentil (*Lens culinaris*) cv. BARI mashur-4 during the period from November 2006 to March 2007. Ten treatment combinations of 20, 30, and 40 kg N ha^{-1} applied at sowing and 2 equal split at sowing and flowering stage with and without irrigation were tested. Irrespective of treatment differences the lentil plant as a pulse crop showed a lag phase in early growth stage (up to 25 DAS) to produce number of leaves, leaf dry weight and stem dry weight per plant. Application of 20 kg N ha^{-1} as basal with 20 kg N ha^{-1} as split application with one irrigation at flower initiation stage (55 DAS) of lentil improved the growth parameters significantly. Maximum dry matter eventually supported the plant to produce more number of branches and biological seed yield.

Key words: *Growth, lentil, irrigation, nitrogen*

INTRODUCTION

Lentil (*Lens culinaris)* is one of the important pulse crops grown in Bangladesh. Among the pulse crops, lentil ranks second in acreage and production but ranks first in market price. Lentil grain contains 59.8% carbohydrates, 25.8% protein, 10% moisture, 4% mineral and 3% vitamins (Khan, 1981; Kaul, 1982). The green plants can also be used as animal feed and its residues have manural value. Lentil grains contain high protein, good flavor and easily digestible component. It may play an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh but the acreage and production of lentil are steadily declining (BBS, 2006).

The average yield of lentil is 0.80 t ha^{-1} which is very poor in comparison to lentil growing countries of the world (BBS, 2006). There are many reasons of lower yield of lentil. The management of fertilizer is the important one that greatly affects the growth and development of this crop. Pulses although fix atmospheric N, there is evident that application of N fertilizers becomes helpful in increasing growth and yield (Patel *et al.*, 1984 and Ardeshana *et al.*, 1993). N is essential for pulse crops because it is the component of protein (BARC, 1997). Lentil is a rain fed crop in most countries, grown either during the wet season or on the residual soil moisture in the post-rainy season. Hence, in most circumstances irrigation is not applied but most varieties respond favorably to added water resulting in higher yields, especially when irrigation is given at the time of water stresses or during short drought periods (Lawn, 1978, Miah and Carangal, 1981). Irrigation during flowering stage helps for retention of flowers and pod development. Hence, the present study was carried out to determine the optimum N dose and appropriate time of N application along with irrigation for maximizing the seed yield of lentil.

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MATERIALS AND METHODS

The study was conducted at the Sher-e-Bangla Agricultural University farm, Dhaka, during the period from October 2006 to March 2007. The treatments tested were as follows**:**
T_1 = No fertilizer and no irrigation (Control)
T_2 = 20 kg N ha^{-1} as basal without irrigation
T_3 = 20 kg Nha^{-1} as basal with one irrigation at flower initiation stage
T_4 = 30 kg N ha^{-1} as basal without irrigation
T_5 = 30 kg N ha^{-1} as basal with one irrigation at flower initiation stage
T_6 = 40 kg N ha^{-1} as basal without irrigation
T_7 = 40 kg N ha^{-1} as basal with one irrigation at flower initiation stage
T_8 = 10 kg N ha^{-1} as basal and split 10 kg N ha^{-1} with one irrigation at flower initiation stage
T_9 = 15 kg N ha^{-1} as basal and split 15 kg N ha^{-1} with one irrigation at flower initiation stage
T_{10}=20 kg N ha^{-1} as basal and split 20 kg N ha^{-1} with one irrigation at flower initiation stage

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The size of each plot was 4.2 m × 2.5 m. The distance between two adjacent replications (block) was 1.5 meter and plot-to-plot distance was 0.75 meter. The intra block and plot spaces were used as irrigation and drainage channels. BARI mashur-4 (*Lens culinaris*) was used in this experiment as the test crop. The experimental plot was irrigated to remove its hard dryness before ploughing. Then at "zoe" condition five times ploughing, harrowing and laddering were done to have a desirable tilth. The plots were fertilized with Urea, Triple Super Phosphate (TSP), Muriate of Potash (MOP) and Zypsum as a source of N, phosphorous, potassium and sulpher respectively. N was applied as per treatment. TSP, MOP and Zypsum were applied as basal dose at the rate of 85 kg, 33 kg and 45 kg per hectare, respectively. Seeds were sown on 16 November, 2006 continuously in 30 cm apart rows having a depth of 2-3 cm. Two thinnings at 15 and 30 DAS were done to maintain optimum plant to plant distance of 10 cm. The crop was weeded twice at 20 DAS and 48 DAS. Flood irrigation was given as per treatment followed by mulching. Plant protection measures were taken as and when necessary. Harvesting was done on 6 March, 2007 at full maturity**.** The plants were collected from a pre demarcated area of six linear meters (1.8 m^2) at the center of each plot and data on growth characters were recorded.

Plant heights of pre-selected ten plants were measured with a meter scale from the ground level to the top of the plants and numbers of branches, and leaves (trifoliate) per plant were counted. Ten plants were randomly selected from each treatment and leaves, stems, and reproductive parts (flowers and pods) were separated from each plant, then dried separately in an oven at 70 ^{0}C for 48 hours and weight was taken carefully. The sum of the plant parts (leaves dry weight, stem dry weight and reproductive dry weight) constituted the above ground dry weight of plant. The seeds collected from 1.8 m^2 of each plot were sun dried properly and weighed and converted the yield in kg ha^{-1}. The collected data were analyzed by using the MSTAT-computer package program. The means were adjudged by least significant deference (LSD) at 0.05 level of significance.

RESULTS AND DISCUSSION

All the studied parameter differed significantly due to treatment variation. A progressive increase of plant height in each growth stage was found in T_{10}, which was significant from different treatments while minimum was found in $T_{1,}$ (Table 1). Irrespective of treatments plant height rapidly increased from 25 DAS to 50 DAS thereafter a slower rate of growth was noticed. But plant height with T_7, T_5, T_9, T_3, $T_{6,}$ and T_8 were almost similar at different stages (Table 1). Both N and irrigation probably increased cell division or cell elongation of lentil plants, thus increased plant height. The result is in agreement with Rathi (1995).

Table 1. Plant height of lentil as influenced by nitrogen and irrigation

Treatments	Plant height of lentil (cm)			
	25 DAS	50 DAS	85 DAS	110 DAS
T_1	9.5	20.2	24.5	25.1
T_2	9.9	20.7	25.2	25.6
T_3	9.35	22.7	27.3	28
T_4	9.9	20.1	24.93	25.53
T_5	12.2	23.02	27.1	28.4
T_6	10.5	22.5	26.53	27.2
T_7	12.3	22.7	27.93	28.53
T_8	10.3	21.8	26.1	27.2
T_9	10.5	22.6	27.1	28
T_{10}	9.35	24.5	28.4	29.87
$LSD_{0.05}$	1.031	2.132	1.408	1.802

($LSD_{0.05}$ =1.031, 2.132, 1.408 and 1.802 at 25, 50, 85 and 110 DAS respectively**)**

Number of branches per plant increased sharply from 25 DAS and reached pick at 85 DAS and thereafter it leveled off (Fig. 1). Branches per plant were the highest with T_{10} in each sampling except 25 DAS and lowest in T_1. The other treatments gave more or less similar number of branches at different growth stages. Michael (1985) found increased branches per plant with single irrigation. Treatment T_{10} resulted in maximum leaves per plant in each growth stage which was significantly different from other treatments with the lowest in T_1 (Fig. 2).

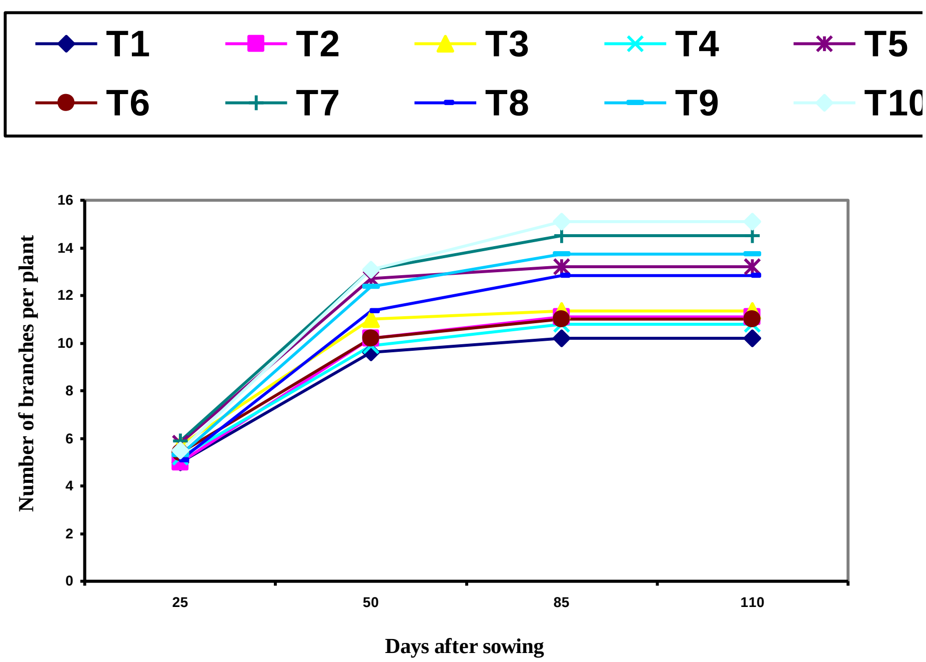

Figure 1. Number of branches per plant of lentil as influenced by N and irrigation ($LSD_{0.05}$ =1.35, 1.587, 2.835 and 2.191 at 25, 50, 85 and 110 DAS respectively)

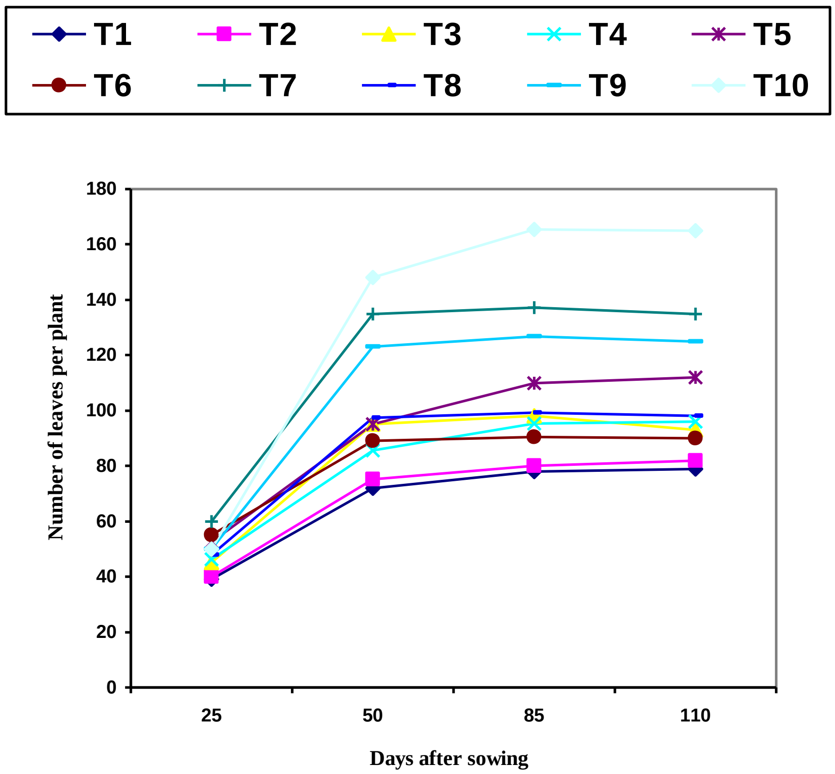

Figure 2. Number of leaves per plant of lentil as influenced by N and irrigation ($LSD_{0.05}$ =2.471, 5.908, 2.994 and 9.493 at 25, 50, 85 and 110 DAS respectively)

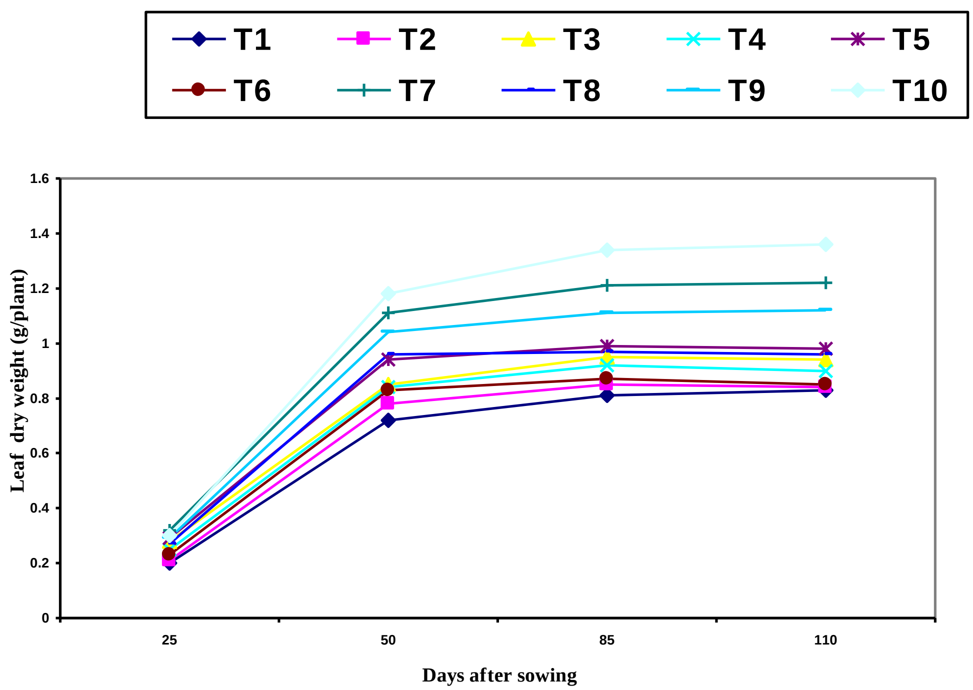

Figure 3. Leaf dry weight (g/ plant^{-1}) of lentil as influenced by N and irrigation ($LSD_{0.05}$ =0.05425, 0.1329, 0.217 and 0.1435 at 25, 50, 85 and 110 DAS respectively)

The treatment T_7 and T_9 showed second and third position from 50 DAS to 110 DAS. But other treatments gave intermediate number of leaves per plant at each growth stage. Dutt (1979) found similar results and Lopes *et al.* (1988) reported that moisture deficiency resulted in lower number of leaves, reduced plant height: root ratio in *Phaseolus vulgaris.* The accumulation of leaf dry matter was very slow at early growth stage (25 DAS), which increased significantly from 25 DAS to 85 DAS, and thereafter it leveled off (Fig. 3).

The treatment of 20 kg N ha^{-1} as basal + split 20 kg N ha^{-1} + one irrigation at flower initiation stage (T_{10}) was found superior to other treatments in respect to accumulation of dry matter in leaf that was statistically significant and T_1 without fertilizer and irrigation was inferior. Clark *et al.* (1980) showed the dry matter accumulation with increase in levels of N at all growth stages. Similar results were noticed in mungbean by Sadasivam *et al.,* 1988 and in soybean by Siowit and Kramer, 1977.

Accumulation of stem dry matter was very slow at initial stage (25 DAS), there after it increased sharply at 50 DAS and had slow rate up to 85 DAS and there after leveled off (Fig.4). Higher dry weights of stem were observed in T_{10} followed by T_7 and T_5 at each growth stage and the lowest was in control. Reduction in shoot dry matter in soybean due to water stress was reported by Siowit and Kramer, 1977. Dry weight of reproductive organs increased from 50 DAS and continued up to maturity (Fig. 5). Increase in dry weight of reproductive organ might be the resultant of remobilization of reserves from vegetative parts as well as translocation of assimilates towards the grains. The maximum dry weight of reproductive organ observed in the treatment T_{10} followed by T_7 and T_9 with the lowest in control. The rest of treatments were statistically similar. The results are in agreement with the report by Hamid *et al.,* 1990 on mungbean. The lag phase of growth of lentil was noticed up to 25 DAS, thereafter, rapid growth took place as indicated by the increased above ground dry matter which was measured after 25 DAS to 110 DAS (Table 2).

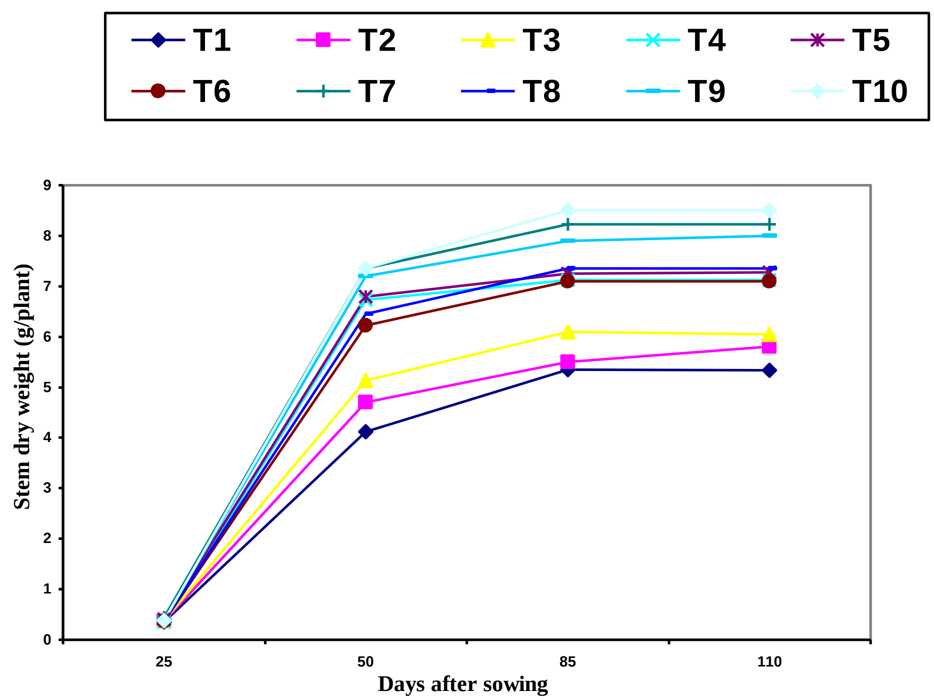

Figure 4. Stem dry weight (g $plant^{-1}$) of lentil as influenced by N and irrigation ($LSD_{0.05}$ =1.681, 1.06, 2.58 and 2.89 at 25, 50, 85 and 110 DAS respectively

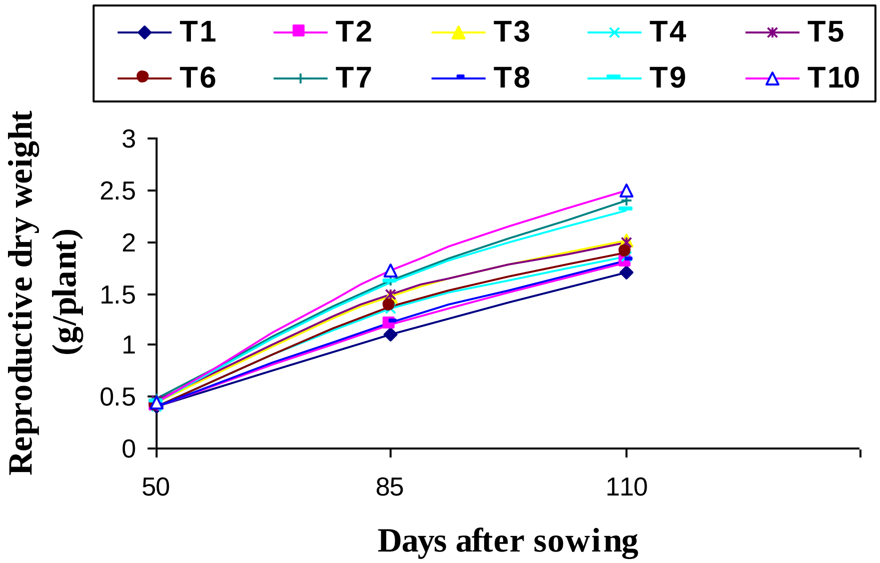

Figure 5. Reproductive dry weight of lentil as influenced by N and irrigation ($LSD_{0.05}$ =0.516, 1.16 and 1.36 at 50, 85 and 110 DAS respectively

Treatment T_{10} had greater influence on plant producing maximum above ground dry weight and that was noticed after 25 DAS till maturity. The maximum above ground dry matter (10.50 g) was found at 85 DAS in treatment $T_{10.}$ Treatment T_2 produce plants with minimum above ground dry matter up to 85 DAS but at harvesting time T_1 and T_6 produce lowest above ground dry weight (5.16g). Clark *et al.* (1980) showed greater dry matter accumulation with increase in levels of N at all growth stages. The split application of N fertilizer probably increased the rate of photosynthetic accumulation, leaf dry weight; stem dry weight which finally resulted in increased DM production by plant at each stage of growth. The result supported the finding of Kramer, 1988.

Table 2. Above ground dry weight (g plant^{-1}) and seed yield (Kg ha^{-1}) of lentil as influenced by N and irrigation ($LSD_{0.05}$ =0.203, 1.681, 1.892 and 1.885 at 25, 50, 85 and 110 DAS respectively

Treatments	Above ground dry weight (g plant^{-1})				Seed yield (kg ha^{-1})
	25 DAS	1222	85 DAS	110 DAS	
T_1	0.56	1254	7.26	7.87	1222
T_2	0.58	1266	7.55	8.49	1254
T_3	0.66	1262	9.03	9.57	1266
T_4	0.61	1272	9.01	9.8	1262
T_5	0.7	1275	9.74	10.26	1272
T_6	0.6	1344	9.35	9.84	1275
T_7	0.77	1302	11.06	11.85	1344
T_8	0.64	1308	9.53	10.11	1302
T_9	0.68	1496	10.62	11.42	1308
T_{10}	0.68	11.33	11.56	12.37	1496
$LSD_{0.05}$	0.203	1.681	1.892	1.885	11.33
CV (%)	-	-	-	-	10.51

Significant variation was also observed in seed yield due to treatment effect. The maximum seed yield (1496 kg ha^{-1}) was observed in T_{10} (Table 2), which was statistically higher than other treatments. The lowest yield (1222 kg ha^{-1}) was observed from the control treatment. Treatment T_{10} out yielded T_1 by 22.4%. Among other treatments, T_3 and T_4 (1266 and 1262 kg ha^{-1}, respectively) were statistically similar but significantly lower than the identical yields of T_5 and T_6 (1272 and 1275 kg ha^{-1}, respectively). Treatment T_7 produced the second highest seed yield 1344 kg ha^{-1} which was significantly higher than other treatments. These findings agreed well with Mozumder *et al*. (2002). Pannu and Singh (1988) found that total dry matter as well as grain yield was affected due to moisture stress in lentil. Lentil plant has a great demand of N nutrition during its reproductive development and it is optimized with irrigation. Application of N 40 kg ha^{-1} (Basal 20 kg ha^{-1} + split 20 kg ha^{-1} with single irrigation during flower initiation stage) is optimum for satisfactory growth and seed yield of lentil.

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