Bulletin of Environment, Pharmacology and Life Sciences

Bull. Env. Pharmacol. Life Sci., Vol 2 (4) March 2013: 70-76

Online ISSN 2277-1808

Original Article

Physiological Effects of Nitrogen and Growth Regulators on Crop Growth Attributes and Yield of Black Gram (*Vigna mungo* L.)

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ABSTRACT

Field experiment was conducted in the department of crop physiology at TNAU during 2006 to 2007 to study the effect of basal application of nitrogen in combination with foliar spray of urea and plant growth regulators. Among the treatments, the basal application of nitrogen 25kg ha^{-1} with foliar spray of urea 2% and 0.1 ppm brassinolide significantly expressed the higher values in growth attributes viz., Leaf area index, Crop growth rate, Net assimilation rate and Specific leaf weight by showing higher accumulation of total dry matter production with increased yield.

Key Words: *Nitrogen, plant growth regulators, growth attributes, yield.*

Received 24/02/2013 Accepted 21/03/2013

INTRODUCTION

Black gram (*Vigna mungo*) is a widely grown grain legume and belongs to the family fabaceae and assumes considerable importance from the point of food and nutritional security. It is a short duration crop suitable for multiple cropping systems and intercropping. The average productivity of pulses in Tamil Nadu is about (432kg ha^{-1}) which is very low when compared to Indian average of 610 kg ha^{-1}. Black gram is basically indeterminate in habit of flowering and fruiting and there is a continuous competition for available assimilates between vegetative and reproductive sinks through out the growth period. Since, the source is highly limited in pulses with lowering translocation of assimilates to the growing reproductive sinks. Hence, leaf area is a important parameter to obtain higher source in terms of higher assimilation production. Apart from this, major physiological constraints are flower drop and fruit drop [1]. Therefore, present study was conducted to study the effect of nitrogen and plant growth regulators as a soil and foliar applications on growth attributes and yield of black gram.

MATERIALS AND METHODS

The experiment was carried out at Tamil Nadu Agricultural University, Coimbatore during July to October, 2007. The soil was sandy loam in texture with N,P,K of 207, 21, 554 kg ha^{-1}. The experiment consist of nine treatments were laid out in randomized block design with three replications. The treatments are, T_1 (control), T_2 (N 25 kg ha^{-1} + Urea 2% + NAA 40ppm), T_3 (N 50 kg ha^{-1} + CCC 200 ppm), T_4 (N 25 kg ha^{-1} + Urea 2% + CCC 200ppm), T_5 (N 25 kg ha^{-1} + Urea 2% + Humic acid 0.1%), T_6 (N 25 kg ha ha^{-1} + Urea 2% + Salicylic acid 100 ppm), T_7 (N 25 kg ha ha^{-1} + Urea 2% + Brassinosteriod 0.1 ppm), T_8 (N 25 kg ha ha^{-1} + Urea 2% + $ZnSO_4$ 0.5% + $FeSO_4$ 0.5% + Borax 0.2%), T_9 (N 25 kg ha^{-1} + water spray), were imposed at 25 DAS and 10 days after the first spray.

Leaf area was recorded by using leaf area meter (Model LICOR 3100). The samples were oven dried at 70^{o}C for about 72 hours and dry weight was recorded. Leaf Area Index, Crop Growth Rate, Net Assimilation Rate, Specific Leaf Weight were calculated by employing the formula [2-5].

RESULT AND DISCUSSION

Leaf area

The leaf area was increased from vegetative stage to pod filling stage and declined thereafter. Among the treatments T_7 performed its superiority and had higher leaf area (102.8, 246.1, 567.0 and 494.4 mg g^{-1}) at vegetative stage, flowering stage, pod filling stage and harvest stage respectively. This treatment was followed by T_3 (96.8, 236.9, 560.1 and 484.9) recorded higher leaf area as compared to other treatments. The percent increase recorded by T_7 over the control showed 42.6 at vegetative stage, 39.8 at pod filling stage. 40.5 at harvest stage (Table 1).

The present study indicated that the increase in leaf area was observed with basal application of nitrogen 25 kg ha^{-1} along with foliar spray of Brassinosteriod 0.1 ppm and urea 2%. Sakurai and Fujioka [6] had opined that the, Brassinosteriod showed favourable influence on leaf area due to its relationship with phytochrome, which mediated regulation of growth and also induced the cell enlargement. The findings were in conformity with the results of soybean which showed an higher leaf area in Brassinosteriod treated plant was attributed to delay in leaf senescence of abscission [7] which may again be a manifestation of increased chlorophyll content [8].

Leaf area index

The LAI was varied significantly by the basal application of nitrogen along with foliar spray of plant growth regulators. The highest value was recorded in T_7 from vegetative stage (0.34) to harvest stage (1.65) as compared to control (0.28 to 1.18) followed by T_3 (0.32 to 1.62). The LAI increased upto pod filling stage and declined in harvest stage.

The normal recommended dose of nitrogen along with foliar spray of urea 2% and Brassinosteriod 0.1 ppm resulted in a remarkable improvement in LAI with 35 and 40 per cent increase during flowering and pod filling stages of the crop. This finding was close conformity with the results of Nithila [9] in groundnut with 31 per cent increased in LAI. As per the report of Braun and Wild [10], high LAI at the time of pod formation stage of mustard was associated with high rate of current photosynthesis with better translocating efficiency of the crop, which intimately reflected on pod yield. Kelaiya *et al.* [11] further explained that Brassinolide promoted the leaf area development in crop plants due to increase in leaf number.\

Crop growth rate

The results on crop growth rate implied that both treatments registered increased values upto flowering stage to pod filling stage and the values decreased at pod filling stage to harvest stage. Among the treatments T_7 was found effective in registering higher crop growth rate (0.78, 1.84 and 1.36 g m^{-2} day^{-1}) than control (0.54, 1.22 and 1.02 g m^{-2} day^{-1}). This treatment was followed by T_3 (0.71, 1.62 and 1.20 g m^{-2} day^{-1}).

Crop production is determined by crop growth rate as a function of light interception by the leaf area of a crop [12]. Since CGR is the product of NAR and LAI, this trend indicated that in black gram CGR is closely related to LAI rather than NAR. In supporting this finding, Shibles and Weber [13] observed a strong positive correlation between CGR and LAI in soybean. Plant growth hormones played a significant role on CGR as observed in the present study. Brassinolide 0.1 ppm + Urea 2% foliar spray in addition to recommended dose of nitrogen (25 kg ha-1) strongly influenced in CGR with more than 50 per cent increase over control, particularly between flowering and pod filling stages. This finding is in close conformity with the results of Prakash [14] in sesamum. This enhancement in CGR was due to fast development of the sources as well as sink.

Net assimilation rate

Net assimilation rate was recorded at different phonological stages of the crop and significant differences were observed in all the treatments. The highest content of NAR recorded in the treatment T_7 (0.66, 0.65 and 0.63 mg cm^{-2} day^{-1}) at vegetative stage and flowering stage, flowering stage and pod filling stage, pod filling stage and harvest stage over control. This treatment was followed by T_3 (0.65, 0.64 and 0.61 mg cm^{-2} day^{-1}).

The net assimilation rate is a measure of net photosynthesis of leaves in crop community. Watson [15] suggested that the cause for the decrease in NAR with increased leaf area in crop plants, was due to mutual shading of the leaves, which would decrease the leaf photosynthesis. Briggs *et al*. [16], however, viewed that the decreased NAR with age was due to losses in respiration in all parts of the plants. NAR was significantly influenced by hormonal manipulation, particularly brassinolide.

Specific leaf weight

The results on specific leaf weight implied that all the treatments varied significantly at all the growth stages. Among the treatments T_7 was found effective in registering higher specific leaf weight (6.01, 13.52, 13. 68 and 13.08 mg cm^2) than control (4.76, 12.06, 12.55 and 10.90 mg cm^2). This treatment was followed by T_3 (5.99, 13.46, 13.65 and 12.78 mg cm^2).

Specific leaf weight, a measure of leaf thickness, has been reported to have a strong positive correlation with leaf photosynthesis of several crops as reported by Bowes *et al*. [17]. Thicker leaves would have more number of mesophyll cells with high density of chlorophyll and, therefore, have a greater photosynthetic capacity than thinner leaves [18]. SLW is highly correlated with the development of reproductive organs [19]. The beneficial effect of BR in improving the thickness of the leaf was revealed by Bindu Joseph [20] in cotton. As per the result Braun and Wild [10], BR application increased the thickness of the 3rd leaf of wheat. Dornhoff and Shibles [21] presumed that higher SLW might be associated with higher cell surface to volume ratio and hence lower mesophyll resistance to CO_2 entry and increase in photoassimilates accumulation in soybean. Krizek and Mandaya [22] also quoted the favourable effect of BR on increasing the specific leaf weight of primary leaves in bean plants.

Correlation studies with yield

The final yield of crop is the cumulative effects of growth attributes and such of those treatments which manipulate the favourable parameters could result in the positive relationship with higher productivity. The relationships of leaf area, specific leaf weight, net assimilation rate and total dry matter production were correlated with the final yield presented in the Fig 1, Fig 2, Fig 3 and Fig 4. Based on the results arrived from the correlation revealed that the correlation between leaf area, specific leaf weight, net assimilation rate and total dry matter production were showed significant positive correlation with yield.

Yield and yield components

A close correlation between the number of flowers produced during the early reproductive phase and productivity was reported in pulses . In this study, number of flowers per plant was greatly influenced by the effective role of nutrients and plant growth hormones. The number of flowers was enhanced by about 34 percent over control (table 3). Pod number was greatly influenced by the nutrients and g worth hormones. In this present study the treatmental combination (N 25 kg ha^{-1} + Urea 2% + BR 0.1 ppm) caused more than 50 percent improvement in setting of pods. Number of seeds per pod was effectively influenced by the treatmental combination of nutrients and plant growth hormones. Urea with brassinosteroid spray maintained highest number of seeds per pod as compared to urea with CCC. The production of higher seed yield due to growth regulators may be attributed to the fact that plants treated with growth regulators remained physiologically more active to build up sufficient food reserves for developing flowers and seeds. The result of the present study indicated that the treatment combination (N 25 kg ha^{-1} + BR 0.1 ppm + Urea 2%) was found to be the most effective treatment in improving the grain yield by 27 percent over control. The overall results as revealed that basal application of nitrogen 25 kg ha^{-1} with foliar spray of urea 2% and 0.1 ppm brassinolide is advantageous and can be recommended for adoption by the farmers.

Table 1. Effect of nitrogen nutrition and growth regulators on TDMP, LAI and SLW in black gram

Treatments	TOTAL DRY MATTER PRODUCTION (g $plant^{-1}$)				LEAF AREA (mg g^{-1})				LEAF AREA INDEX (LAI)			
	VS	FS	PFS	HS	VS	FS	PFS	HS	VS	FS	PFS	HS
T_1	1.83	3.83	8.89	13.68	84.9	182.2	403.5	353.7	0.28	0.61	1.35	1.18
T_2	1.94	4.2	10.05	15.52	95.3	213.3	510.0	415.2	0.32	0.71	1.70	1.38
T_3	1.96	4.42	10.31	15.65	96.8	236.9	560.1	484.9	0.32	0.79	1.87	1.62
T_4	2.06	4.71	10.43	16.16	95.9	228.0	541.0	475.4	0.32	0.76	1.80	1.59
T_5	1.88	3.97	9.54	15.44	92.9	197.8	476.2	447.7	0.31	0.66	1.59	1.49
T_6	1.87	3.96	9.79	14.68	94.3	208.3	491.3	421.7	0.31	0.69	1.64	1.41
T_7	2.12	4.84	10.58	17.14	102.8	246.1	567.0	494.4	0.34	0.82	1.89	1.65
T_8	1.92	4.14	9.4	14.43	95.7	217.1	526.6	449.0	0.32	0.72	1.76	1.50
T_9	1.85	4.16	9.29	14.58	90.2	195.3	451.0	397.6	0.30	0.65	1.50	1.33
Mean	**1.94**	**4.25**	**9.81**	**15.28**	**94.2**	**213.5**	**502.2**	**437.0**	**0.31**	**0.71**	**1.67**	**1.46**
SEd	**0.08**	**0.17**	**0.41**	**0.64**	**3.97**	**8.94**	**20.90**	**18.25**	**0.01**	**0.02**	**0.06**	**0.06**
CD (P=0.05)	**0.17**	**0.37**	**0.87**	**1.36**	**8.42**	**18.96**	**44.32**	**38.69**	**0.03**	**0.06**	**0.14**	**0.12**

VS-Vegetative Stage, FS-Flowering Stage, PFS-Pod Filling Stage, HS-Harvest Stage.

Table 2. Effect of Nitrogen nutrition and Growth Regulators on yield and yield components in black gram

Treatments	No. of flowers plant-1	No. of pods plant-1	No. of seeds plant-1	100 seed weight (g)	Grain yield kg ha-1
T_1	73.0	18.0	5.2	3.5	705.0
T_2	85.2	25.4	6.4	4.2	719.5
T_3	85.3	27.8	6.5	4.3	845.8
T_4	89.4	28.1	6.7	4.9	867.9
T_5	78.8	21.7	5.4	4.4	729.5
T_6	82.4	24.6	5.8	4.5	738.0
T_7	97.5	28.5	7.2	5.1	893.3
T_8	82.6	26.7	5.3	4.0	732.5
T_9	74.5	20.7	5.2	3.7	710.3
Mean	**78.51**	**24.23**	**5.95**	**4.05**	**770.0**
SEd	**3.29**	**1.00**	**0.25**	**0.17**	**32.56**
CD (0.05)	**6.98**	**2.13**	**0.53**	**0.36**	**69.02**

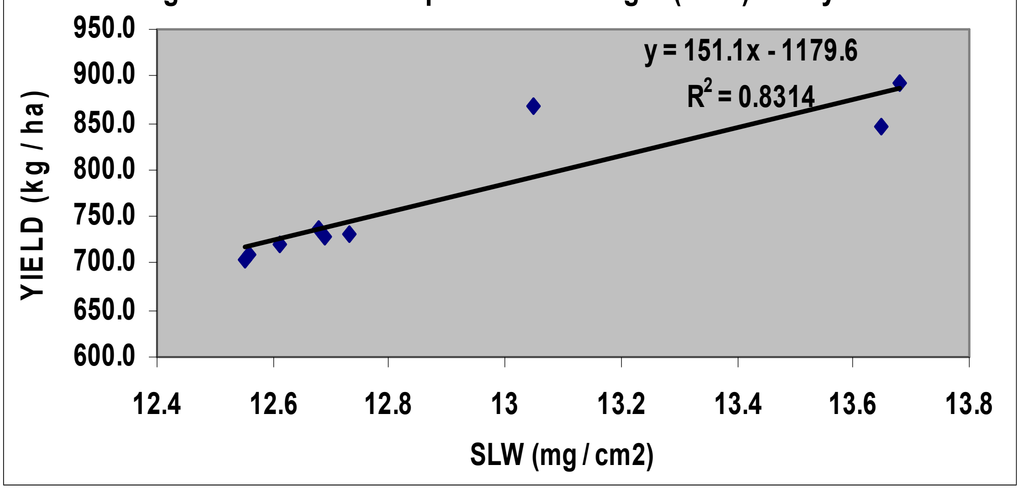


Fig. 1. Correlation of specific leaf weight (SLW) with yield

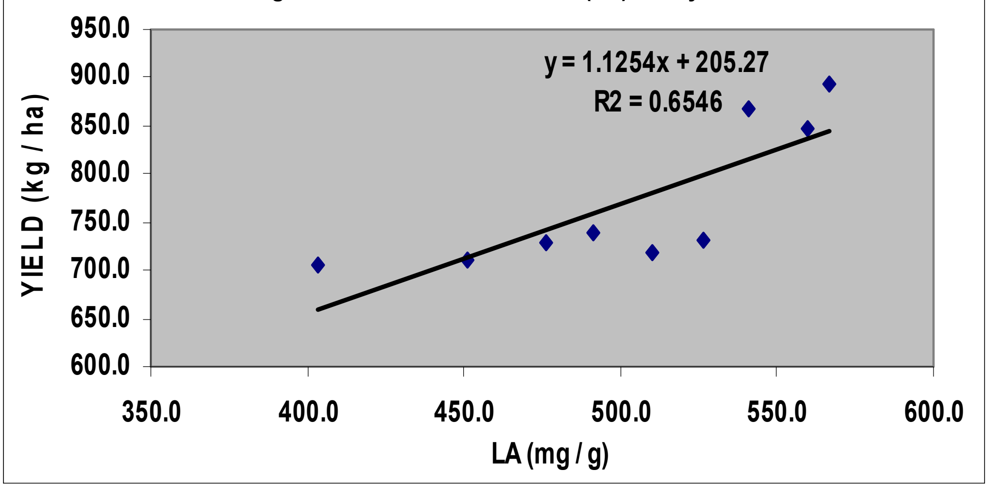


Fig. 2. Correlation of leaf area (LA) with yield

Fig. 3. Correlation of net assimilation rate (NAR) with yield

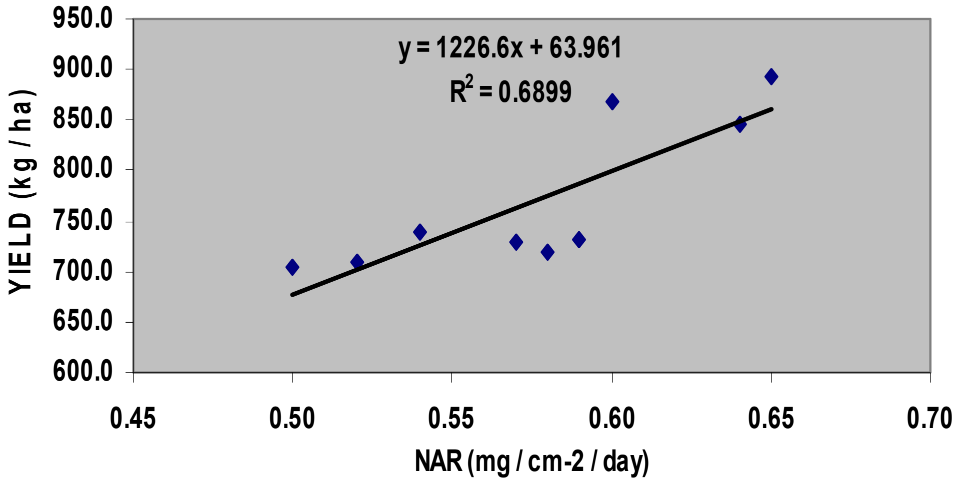


Fig. 4. Correlation of total dry matter production (TDMP) with yield

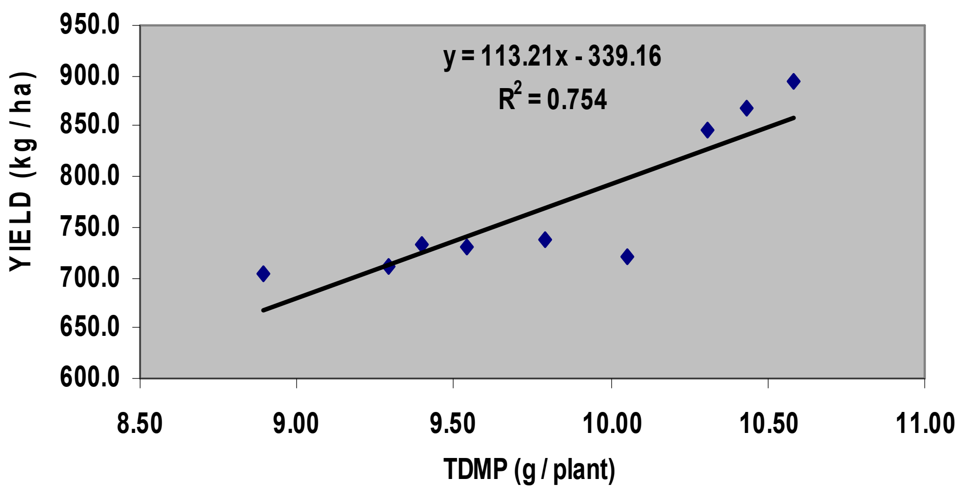
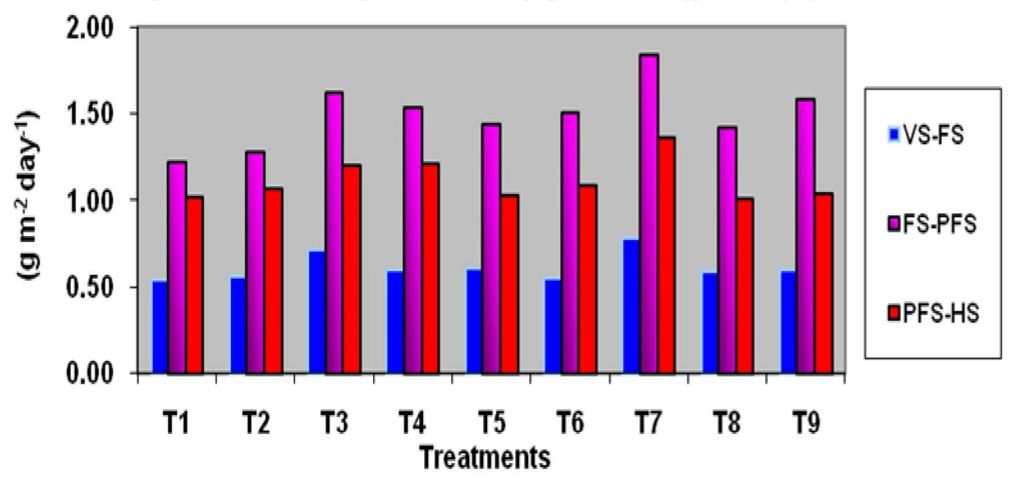
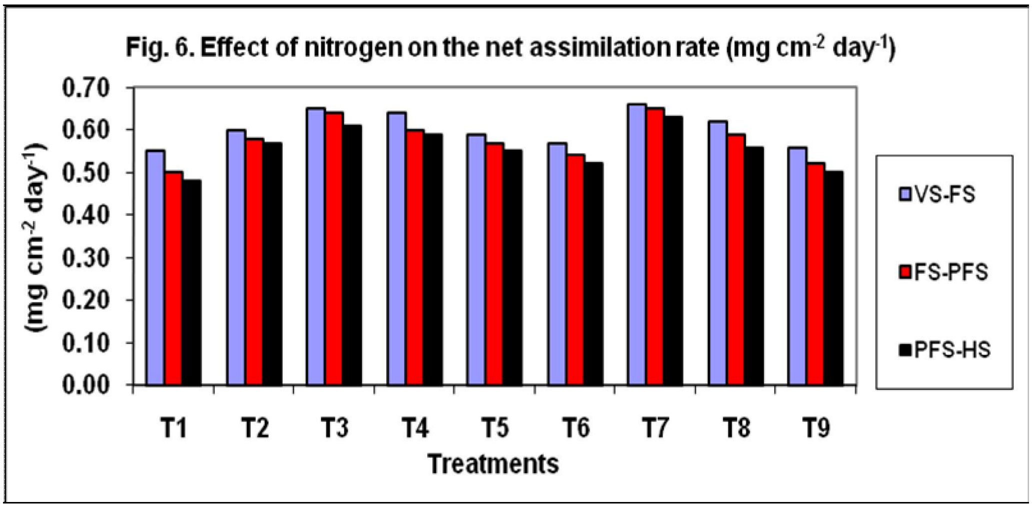
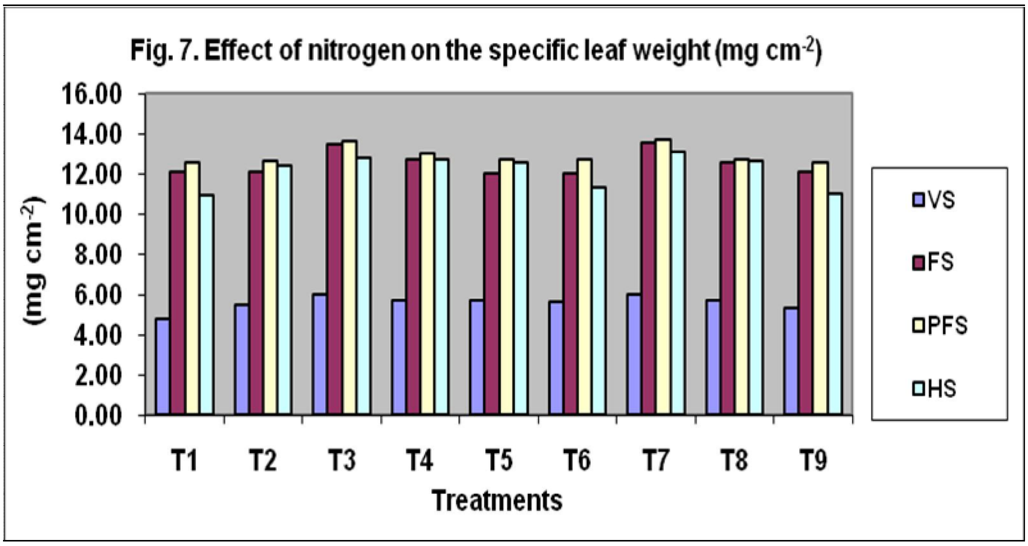


Fig. 5. Effect of nitrogen on the crop growth rate (g m^{-2} day^{-1})







ACKNOWLEDGEMENT

The authors are grateful to Tamil Nadu Agricultural University, Coimbatore for providing the necessary facility.

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