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Effect of organic sources of nitrogen on physiological parameters of king chilli (*Capsicum chinense* Jacq.) under poly house condition

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Abstract
A study was conducted in *rabi* season 2019-20 in the poly-house, Department of Horticulture, CAU, Imphal to observe the effect of organic sources of nitrogen on net assimilation rate, relative growth rate and plant growth efficiency of king chilli (*Capsicum chinense* Jacq.) under poly house condition. The layout of the experiment was RBD (Randomized Block Design) with three replications under 8 different treatments. Results of the present experimentation revealed that the application of 100% RDF (T_8) registered significant values for net assimilation rate (0.0232 g/m^2/day), relative growth rate (0.0574 g/g/day) and plant growth efficiency (57.41%) at 60-90 DAT stage. However, among the organic sources, application of 100% RDN through vermicompost (T3) had significant effect on the physiological parameters of the crop which was comparable with that of inorganics treatment.

Keywords: King chilli, net assimilation rate, relative growth rate, plant growth efficiency, poly house

Introduction

King chilli (*Capsicum chinense* Jacq.) or Ghost pepper also known as Umorok in Manipuri, Bhut Jolokia in Assamese and Naga Mircha in Nagamese, is chiefly cultivated in the north-eastern region of India, broadly in Manipur, Assam and Nagaland. King chilli is regarded as hottest chilli of India and was formerly recognized as world's hottest pepper with a Scoville Heat Units (SHU's) rating of 1,001,304 (Bosland and Baral, 2007) [1].

The crop has a soaring demand in both domestic and foreign markets. In September 2013, the staggering price of fresh king chilli weighing one kilogram received 50,000 INR in Japan. This was noted by the Chief Secretary of Commerce and Industries (Government of Manipur) in his Japan-China visit.

The production of king chilli is affected by various biotic and abiotic factors, but the foremost is of nutrition. King chilli is an exhaustive crop and being a heavy feeder responds very well to nutrient application. The plant growth is an intricated and dynamic process. Several workers disclosed that increased physiological parameters are correlated with significant yield in many crops. The plant growth development, production of fruits and seed quality are dependent upon efficient use of all available resources, including competition which affect the efficiency of photosynthesis in plant and thereby fruit yield and quality. The chemical fertilizer application helps in increased production but has also led to negative impact on the environment and wellbeing of human. Contrarily, organic farming system revamps soil health, keeps biological life cycle alive and helps in achieving considerable levels in yield. The produces obtained under organic farming are considerably more nutritious and healthy. Today, most farmers for this reason are seeking to organic farming practices to sustain agriculture production.

Given the significance and huge potentiality of king chilli in national and international market, the study focused on revealing the effect of organic sources on physiological growth of king chilli under poly house condition.

Materials and Methods

The experimentation was conducted in Randomized Block Design (RBD) with eight different treatments in three replications which are as follows: T_1: 100% RDN through FYM, T_2: 100% RDN through Poultry Manure, T_3: 100% RDN through vermicompost, T: 50% RDN through

FYM + 50% RDN through vermicompost, T_5: 50% RDN through vermicompost + 50% RDN through poultry manure, T_6: 50% RDN through FYM + 25% RDN through vermicompost +*Azospirillum*, T_7: 50% RDN through poultry manure + 25% RDN through vermicompost +*Azospirillum* and T_{8z}: RDF (120:50:50 kg NPK/ha). For each treatment, the quantity of equivalent organic manures were worked out according to the recommended dosage (120:50:50 NPK kg/ha). *Azospirillum* was incorporated in the soil at the time of transplanting by mixing it with FYM @ 2.5 kg/ha. The inorganic fertilizers (Urea, SSP and MOP) were applied along the ridges @ 120:50:50 kg/ha. Full dose of phosphorus and potassium were applied at time of planting as basal application. Half of urea was applied as a basal dose (60 kg N/ha) at transplanting time and remaining half later as top dressing, at two times, 30 kg N/ha each time, at 30 and 60 days after transplanting.

Net assimilation rate: was calculated by using the following formula given by Vernon and Allison (1963) [8] at 60-90 DAT and 90-120 DAT stage.

$$NAR = (w_2 - w_1) (\log_e L_2 - \log_e L_1)/ (t_2 - t_1) (L_2 - L_1)$$

Where, L_1 and L_2 are the leaf area of plants at times t_1 and t_2, w_1 and w_2 are dry weight of plants at times t_1 and t_2 and $t_2 - t_1$ = time interval.

Relative Growth Rate: was given by Reddy and Reddi (2008) [5] and calculated at 60-90 DAT and 90-120 DAT stage using the formula,

$$RGR = \ln w_2 - \ln w_1 / t_2 - t_1$$

Where, ln = natural log, w_1 = dry weight of the whole plant body recorded at time t_1, w_2 = dry weight of the whole plant body recorded at time t_2 and $t_2 - t_1$ = time interval.

Plant growth efficiency: was calculated at 60-90 DAT and 90-120 DAT stage by using the following formula,

$$PGE = D_2 - D_1/D_m \times 100$$

Where, D_m = maximum dry weight at harvest, D_1 = dry weight of plant at time 1 and D_2 = dry weight of plant at time 2.

Statistical analysis

Significance of difference in the treatment effect was tested through 'F' test at 5% level of significance and CD (critical difference) was calculated, wherever the results were significant (Sunderaraj *et al*., 1972). [7]

Results and discussion

It was observed that all the physiological parameters studied i.e. NAR, RGR, and PGE declined with an advancement in crop growth from 60-90 DAT to 90-120 DAT in all the treatments (Table 1).

Net assimilation rate (NAR), a measure of increased dry weight per unit leaf area tended to decrease with increase in crop growth. In the analysis, significant difference for net assimilation rate was observed at the stage of 60-90 DAT, where the NAR values ranged from (0.0162g/m^2/day) to (0.0232 g/m^2/day). However, at 90-120 DAT, the values for NAR had no significant differences. The NAR exhibits a behavior previously noted by Monte *et al.*, (2013) [4], i.e., initially increases and then decreases with plant age. At 60-90 DAT, the highest net assimilation rate (0.0232 g/m^2/day) was recorded in T_8 (100% RDF), but remained at par with T_3 (0.0225 g/m^2/day), T_4 (0.0218 g/m^2/day) and T_6 (0.0210 g/m^2/day). Higher NAR at 60-90 DAT stage under T_8 is presumably due to higher leaf area. The present study demonstrated that split application of urea increases the NAR, which may be attributed to the increased N concentration in the leaf, which in turn results in an increase in photosynthetic capacity. This finding is also supported by Segura *et al*., (2006) [6] who observed that in the early phenological stages, there is a constant increase in leaf area with the development of new leaves, which are more exposed to radiation and are more efficient at capturing CO_2 (Carranza *et al*., 2009) [2]. Consequently, the production rate of photoassimilate increases (the product of photosynthesis). Therefore, the NAR is increased in the vegetative stage.

Relative growth rate (RGR), a measure of increased mass per above ground biomass per day tended to decrease with increase in crop growth. Data analysis (Table 1) disclosed that significant variation for RGR was observed at the stage of 60-90 DAT, where the values for RGR ranged from (0.0419 g/g/day) to (0.0574 g/g/day). However, at 90 -120 DAT, the values for RGR had no significant differences. At 60-90 DAT, the maximum relative growth rate (0.0574 g/g/day) was found in T_8 (100% RDF), but remained at par with T_3 (0.0549 g/g/day), T_4 (0.0538 g/g/day) and T_6 (0.0527 g/g/day). Higher RGR at 60-90 DAT stage under T_8 might be due to higher net assimilation rate and leaf area of the crop observed during the same period. The RGR presented the same behavior as the NAR (Fig. 1) because both are dependent on photosynthesis, respiration, leaf area, and plant architecture (Gardner *et al.*, 1985) [3].

In the course of analysis, plant growth efficiency at 60-90 DAT stage was significantly influenced by organic sources of nitrogen, but was found non significant at 90-120 DAT stage. At 60-90 DAT, the maximum plant growth efficiency (57.41%) was found in T_8 (100% RDF), but remained at par with T_3 (54.98%),T_4 (52.71%) and T_6 (51.48%). Plant growth efficiency increases as relative growth increases in shoots or roots of the plant. From the data (Table 1), it can be stated that during vegetative stages, the growth efficiency was kept more at about >40% and decreased thereafter. This is possibly due to the utilization of photosynthates for new organs production that led to increase in growth efficiency at the early growth stages (60-90 DAT). However, after the vegetative stage, the respiratory rate is kept relatively high, while the photosynthetic rate decreases and the plant growth efficiency decreases. This finding is in agreement with the study of Carranza *et al*., (2009) [2] who noted that increased photosynthesis promotes greater plant efficiency.

Table 1: Effect of organic sources of nitrogen on net assimilation rate, relative growth rate and plant growth efficiency

Treatments	NAR (g/m^2/day)		RGR (g/g/day)		PGE (%)	
	60-90 DAT	90-120 DAT	60-90 DAT	90-120 DAT	60-90 DAT	90-120 DAT
T_1	0.0162	0.0128	0.0419	0.0361	42.00	39.41
T_2	0.0177	0.0130	0.0472	0.0347	46.69	37.52
T_3	0.0225	0.0143	0.0549	0.0313	54.98	36.21

T_4	0.0218	0.0141	0.0538	0.0320	52.71	37.12
T_5	0.0165	0.0129	0.0455	0.0367	42.04	39.65
T_6	0.0210	0.0135	0.0527	0.0341	51.48	37.17
T_7	0.0180	0.0132	0.0496	0.0357	48.07	38.10
T_8	0.0232	0.0137	0.0574	0.0308	57.41	35.32
S.Em(±)	0.0013	0.0008	0.0022	0.0017	3.06	2.24
CD(0.05)	0.0039	NS	0.0067	NS	9.28	NS

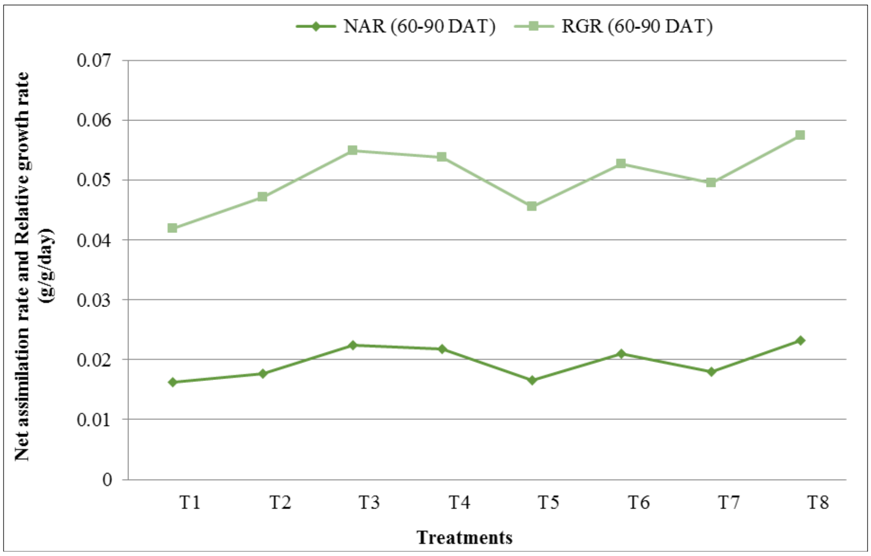

Fig 1: Diagrammatic representation of net assimilation rate and relative growth rate at 60-90 DAT (Vegetative stage)

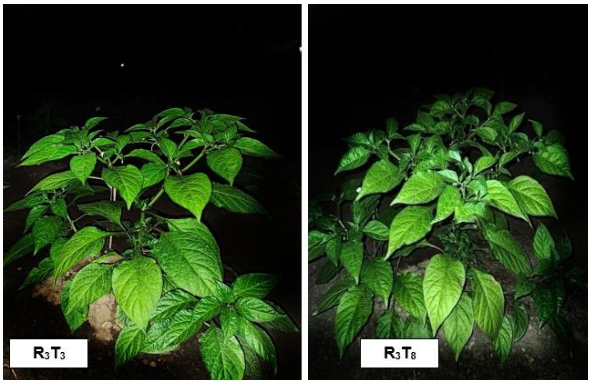

Plate 1: King chilli plants under T_3 (100% RDN through vermicompost) and T_8 (100% RDF) at vegetative stage

Plate 2: King chilli plants under T_3 (100% RDN through vermicompost) and T_8 (100% RDF) at reproductive stage

Conclusion

Positive effects on physiological parameters of king chilli were observed with application of 100% NPK treatment. However, among the different organic sources of nitrogen, substitution of 100% RDN through vermicompost (T_3) had significant effect on the physiological growth of king chilli under poly house condition. Thus, the present study revealed that substitution of nitrogen through organic sources such as vermicompost can be an effective alternative as a source of nutrients.

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