Journal of Agrometeorology 23 (3) : 340-343 (September 2021)

Short communication

Effect of canopy temperature on physiological processes of grass pea as influenced by seed priming and foliar fertilization

PURABI BANERJEE*, ANANYA GHOSH, V.VISHA KUMARI and RAJIB NATH

Dept of Agronomy, BCKV Mohanpur, West Bengal, India
**Corresponding Author : itsmepurabi1@gmail.com*

Variations in atmospheric temperature have become a major concern with respect to agricultural production. Plants being poikilothermic in nature, any change in temperature summons change in canopy temperature, inevitably affecting their growth and productivity (Basu *et al*., 2014). Measurement of canopy temperature is necessary to understand the plant-water status at a particular phenophase of a crop. Interestingly, plant-water status has a direct role in controlling stomatal activity of leaves. In fact, stomata are the site for moisture and gaseous exchange in plants. Thus, the photosynthesis and transpirational characteristics are strongly influenced by stomatal behaviour (Li *et al*., 2017). However, moisture status of a crop can be explained more prominently with the estimation of stress degree day index (SDDI), derived from the difference between canopy temperature and atmospheric temperature. The higher the value of SDDI, greater is the stress. Canopy temperature beyond optimum often drops the potential for physiological processes of crop plants with special reference to pulse crops, hampering their production (Tzudir *et al*., 2018).

The rich nutritional composition, minimum requirements of inputs and outstanding tolerance to environmental adversities have popularized the cultivation of grass pea (*Lathyrus sativus* L.) among the resource poor Indian farmers (Dixit *et al*., 2016). To achieve better growth and production of pulse crops through need based and timely supply of nutrients, seed priming and foliar fertilization are two incredible cost effective interventions (Banerjee *et al*., 2019). This experiment was framed to address the lacuna of systematic research on impact of canopy temperature on rate of photosynthesis and transpiration in grass pea in lights of seed priming and foliar spray.

The field experiment was conducted during winter seasons of 2017-18 and 2018-19 at District Seed Farm, Bidhan Chandra Krishi Viswavidyalaya, West Bengal in factorial RBD comprising two seed priming levels (S_1: No priming and S_2: Seed priming with Ammonium molybdate @ 0.5 g kg^{-1} seed) and five foliar spray levels (F_1: No foliar spray, F_2: 2% Urea spray at 30 Days After Sowing (DAS), F_3: 2 per cent Urea spray at pre flowering stage (35 DAS) + 15 days after 1^{st} spray, F_4: 0.5% NPK (19:19:19) spray at 30 DAS and F_5: 0.5 per cent NPK (19:19:19) spray at 30 DAS + 15 days after 1^{st} spray). Grass pea [*var*. Ratan (Bio L-212)] seeds were broadcasted at a rate of 80 kg ha^{-1} in standing rice [*var*. Satabdi (IET 4786)] on October 12^{th}, 2017 and October 20^{th}, 2018. Flowering started on November 24^{th}, 2017 and November 30^{th}, 2018 and harvesting was done on February 24^{th}, 2018 and February 27^{th}, 2019 during the 1^{st} and 2^{nd} year of experimentation, respectively. Rice crop was harvested 7-10 days after sowing of grass pea in both the years under investigation. Application of basal dose of fertilizers and irrigation were excluded.

Rate of photosynthesis and transpiration were recorded with the help of Cl-340 hand-held photosynthesis system (ClD Company, Camas, USA) during 1130 to 1230 hours on sunny days. Canopy temperature was measured at the same hours with Infrared tele-thermometer (AG-42 Telatemp infra-red thermometer, Australia). Stress Degree Day Index (SDDI) was computed with the following formula (Idso *et al*., 1977) :

$$SDDI = (T_c - T_a)$$

Where, T_c = Canopy temperature at mid-day and T_a = Air temperature at mid-day

The overall statistical analysis was done by using SPSS 7.5 software, (SPSS 7.5 copyright, 1997 by SPSS Inc., USA Base 7.5 Application guide).

Effect of seed priming and foliar nutrition on rate of photosynthesis and transpiration

The rate of photosynthesis and transpiration in the above-ground parts of relay grass pea grown

Table 1: Rate of photosynthesis (P_N) (µmol m^{-2} sec^{-1}) at different growth stages of grass pea

Treatment	30 DAS			60 DAS			90 DAS		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
S_1	5.89	6.04	5.97	13.68	13.79	13.73	5.06	5.22	5.14
S_2	7.89	8.06	7.98	16.17	16.37	16.27	6.05	6.19	6.13
S.Em(±)	0.14	0.14	0.12	0.17	0.16	0.15	0.20	0.20	0.19
C.D. (P=0.05)	0.42	0.42	0.37	0.50	0.49	0.46	0.60	0.59	0.58
F_1	6.49	6.82	6.66	9.10	9.07	9.09	3.25	3.45	3.35
F_2	6.95	7.40	7.18	16.00	16.35	16.18	5.45	5.54	5.49
F_3	6.82	6.89	6.86	16.69	16.95	16.82	6.93	7.09	7.06
F_4	7.12	7.17	7.15	14.57	14.76	14.67	5.15	5.32	5.24
F_5	7.05	6.95	7.00	18.25	18.25	18.25	6.99	7.11	7.06
S.Em(±)	0.22	0.22	0.20	0.27	0.26	0.25	0.32	0.31	0.30
C.D. (P=0.05)	NS	NS	NS	0.80	0.77	0.73	0.96	0.93	0.91
Interaction									
S.Em(±)	0.31	0.31	0.28	0.38	0.36	0.35	0.45	0.44	0.43
C.D. (P=0.05)	NS	NS	NS	NS	1.09	1.04	NS	NS	NS

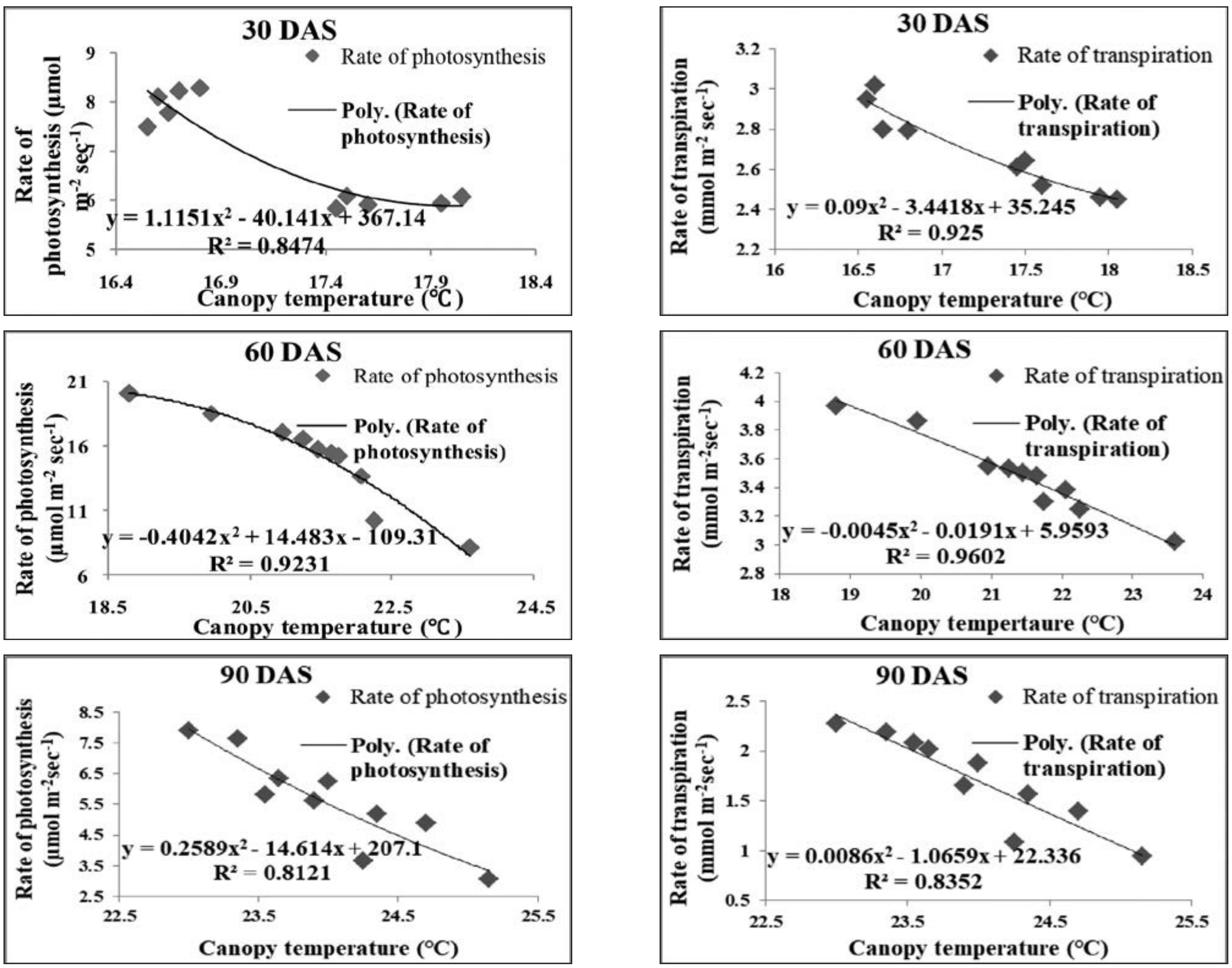

Fig. 1: Relationship of mean canopy temperature with pooled values of rate of photosynthesis and transpiration of grass pea

progressively increased upto 60 DAS and afterwards a gradually declined (Table 1 and 2). This increment in rate of photosynthesis from 30 DAS to 60 DAS might be due to greater availability of photosynthesizing site through leaves/canopy enlargement. Pooled analysis revealed that highest rate of photosynthesis was attained under the treatments S_2 and F_5 i.e., seed priming (16.27 and 6.13 µmol m^{-2} sec^{-1}) and twice foliar spray of NPK (19:19:19) (18.25 and 7.06 µmol m^{-2} sec^{-1}) at 60 and 90 DAS, respectively. This trend was clearly identified

Table 2: Rate of transpiration (T_N) (mmol m^{-2} sec^{-1}) at different growth stages of grass pea

Treatment	30 DAS			60 DAS			90 DAS		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
S_1	2.54	2.44	2.49	3.32	3.35	3.33	1.51	1.61	1.56
S_2	2.87	2.80	2.84	3.60	3.67	3.64	1.87	1.83	1.85
S.Em(±)	0.10	0.09	0.09	0.07	0.06	0.06	0.07	0.05	0.06
C.D. (P=0.05)	0.31	0.26	0.27	0.22	0.18	0.18	0.22	0.16	0.17
F_1	2.63	2.63	2.63	3.19	3.13	3.16	1.00	1.02	1.01
F_2	2.69	2.63	2.66	3.41	3.46	3.44	1.75	1.91	1.83
F_3	2.88	2.62	2.62	3.65	3.69	3.67	2.03	2.04	2.03
F_4	2.70	2.52	2.70	3.32	3.48	3.40	1.54	1.51	1.52
F_5	2.63	2.70	2.70	3.72	3.78	3.75	2.15	2.13	2.15
S.Em(±)	0.16	0.14	0.14	0.11	0.09	0.10	0.12	0.08	0.09
C.D. (P=0.05)	NS	NS	NS	0.34	0.28	0.29	0.35	0.25	0.27
Interaction									
S.Em(±)	0.23	0.19	0.20	0.16	0.13	0.14	0.16	0.12	0.13
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS- Non-significant; S_1- No priming; S_2- Priming with Amm. molybdate; F_1- No spray; F_2- Urea (once); F_3- Urea (twice); F_4- NPK 19:19:19(once); F_5- NPK 19:19:19(twice)

Table 3: Correlation of canopy temperature and SDDI with rate of photosynthesis (P_N) and transpiration (T_N) at different stages of grass pea

Stages	Canopy temperature		SDDI	
	P_N	T_N	P_N	T_N
30 DAS	-0.89	-0.87	-0.92	-0.89
60 DAS	-0.93	-0.98	-0.87	-0.81
90 DAS	-0.90	-0.91	-0.77	-0.85

by the advances in study of leaf photosynthesis which revealed that maximum photosynthetic efficiency was positively correlated with leaf nitrogen and phosphorus and potassium content (Walker *et al.*, 2014). The crop again attained the maximum rate of transpiration at 60 and 90 DAS, respectively in S_2 (3.78 and 2.15 mmol m^{-2} sec^{-1}) and F_5 (3.67 and 2.27 mmol m^{-2} sec^{-1}). Most of the cases exhibited non-significant interactions. The role of potassium in modulating the internal water balance was supposed to lower down canopy temperature by maintaining transpirational cooling even under moisture stress.

Effect of canopy temperature and SDDI on physiological parameters and yield

In all the cases, pooled values of these physiological parameters were found to be polynomial functions of canopy temperatures at respective phenophases (Fig. 1). About 84.74, 92.31 and 81.21 per cent variations in rate of photosynthesis and 92.5, 96.02 and 83.52 per cent variations in rate of transpiration could be contributed to the variation in mean canopy temperature at 30, 60 and 90 DAS respectively. Both the canopy temperature and SDDI were negatively correlated with the rate of photosynthesis and transpiration (Table 3). Evidently, the transpiration of grass pea exhibited increasing rate from 30 DAS to 60 DAS simultaneously with the rise in canopy temperature. This increment might be explained with the theory of Baligar *et al.* (2012) describing the incremental rate of transpiration with escalated leaf temperature as the leaf diffusive resistance increased. However, the declining trend in rate of photosynthesis and transpiration after 60 DAS might be linked with the non-stop rise in ambient and canopy temperature beyond optimum level which compelled the stomata to close partially with greater stomatal diffusion resistance due to moisture deficit, curtailing the photosynthetic efficiency and transpiration (Basu *et al.*, 2013).

A regression equation for pooled data of canopy temperature (T) at 1130 hour and seed yield was developed:

$$Yield_{pooled} = 6228.89 - 199.8T_{90}$$

R^2= 0.72*; Adj R^2=0.68, S.E(est)=46.16

which thereby explained 72 per cent variation in yield due to canopy temperature (*significant at 5 % level). Lower canopy temperature and SDDI have been reported to enhance the seed yield in chickpea (Summy *et al*., 2015), in groundnut (Chakravarti *et al*., 2010) and in mungbean (Tzudir *et al*., 2018).

The study revealed that seed priming with Ammonium molybdate @ 0.5 g kg^{-1} seed along with twice spraying of 0.5 per cent NPK (19:19:19) spray were effective in modulating canopy temperature and physiological attributes. Canopy temperature significantly but negatively influenced the rate of photosynthesis and transpiration at different phenophases as well as seed yield of grass pea.

Conflict of Interest Statement : The author(s) declare(s) that there is no conflict of interest.

Disclaimer : The contents, opinions, and views expressed in the research article published in the Journal of Agrometeorology are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

Publisher's Note : The periodical remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

REFERENCES

Baligar, V.C., Bunce, J.A., Elson, M.K. and Fageria, N.K. (2012). Photosynthetic Photon Flux Density, Carbon Dioxide Concentration and Temperature Influence Photosynthesis in Crotalaria Species. *Open Plant Sci J*., 6: 1-7.

Banerjee, P., Visha Kumari, V., Nath, R. and Bandyopadhyay, P. (2019). Seed priming and foliar nutrition studies on relay grass pea after winter rice in lower Gangetic plain. *J. Crop Weed*., 15(3): 72-78.

Basu, S., Dutta, S.K., Fangzauva, D., Jena, S., Maji, S., Nath, R. and Chakraborty, P.K. (2013). PAR interception and dry matter accumulation in groundnut (*Arachis hypogaea* L.) cultivars sown at different time periods in the Gangetic Plains of West Bengal. *J. Agrometeorol*., 15(1): 201-204.

Basu, S., Parya, M., Dutta, S.K., Maji, S., Jena, S., Nath, R. and Chakraborty , P.K. (2014). Effect of canopy temperature and stress degree day index on dry matter accumulation and grain yield of wheat (*Triticum aestivum* L.) sown at different dates in the Indo-Gangetic plains of eastern India. *Indian J. Agric. Res*., 48(3): 167-176.

Chakravarti, A.K., Moitra, R., Mukherjee, A., Dey, P. and Chakraborty, P.K. (2010). Effect of planting methods and mulching on the thermal environment and biological productivity of groundnut. *J. Agrometeorol*., 12: 77-80.

Dixit, G.P., Parihar, A.K., Bohra, A. and Singh, N.P. (2016). Achievements and prospects of grass pea (*Lathyrus sativus* L.) improvement for sustainable food production. *Crop J*., 4: 407-416.

Idso, S.B., Jackson, R.D. and Reginato, R.J. (1977). Remote sensing of crop yields. *Science*, 196: 19-25.

Li, Y., Li, H., Li, Y. and Zhanga, S. (2017). Improving water-use efficiency by decreasing stomatal conductance and transpiration rate to maintain higher ear photosynthetic rate in drought resistant wheat. *Crop J*., 5: 231-239.

Summy, Sharma, K.D., Boora, K.S. and Kumar, N. (2015). Plant water status, canopy temperature and chlorophyll fluorescence in relation to yield improvement in chickpea (*Cicer arietinum* L.) under soil moisture stress environments. *J. Agrometeorol*., 17(1): 11-16.

Tzudir, L., Maji, S., Basu, S., Bera, P.S., Nath, R., Mazumdar, D. and Chakraborty, P.K. (2018). Investigating relationship between canopy temperatures and biomass of mungbean in sub-humid tropics. *J. Agrometeorol*., 20(1): 114-119.

Urban, J., Ingwers, M.W., McGuire, M.A. and Teskey, R.O. (2017). Increase in leaf temperature opens stomata and decouples net photosynthesis from stomatal conductance in *Pinus taeda* and *Populus deltoides* x *nigra*. *J. Exp. Bot*., 68(7): 1757-1767.

Walker, A.P., Beckerman, A.P., Gu, L., Kattge, J., Cernusak, L.A., Domingues, T.F., Scales, J.C., Wohlfahrt, G., Wullschleger, S.D. and Woodward, F.I. (2014). The relationship of leaf photosynthetic traits - *V* and *J* - to leaf nitrogen, leaf phosphorus, and specific leaf area: A meta-analysis and modeling study. *Ecol. Evol*., 4: 3218-3235.

Received : July 2020 : Accepted : May 2021