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Short Communication

Impact of solar eclipse on sugarcane crop

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Solar eclipse is an area which has attracted the attention of researchers. The impact of solar eclipse causes effects on many aspects like meteorological parameters, boundary layer physics, gravity waves, *etc.,* and even on plants (Deena and Bruner, 1933) and animals (Zirker, 1985). It is well known that different wavelengths are utilized for different purposes in growth and development processes of the plant. Changes in solar radiations during solar eclipse influenced several plants to respond differently. Influence of eclipse on plants is associated with the limitation of light during this phenomenon. Generally, plant leaves are exposed to variable light effects occurring naturally, however, when solar eclipse takes place there is a sudden drop in solar radiation that causes changes in plant behavior (Economou *et al*., 2008). The photosynthesis and transpiration rates have been measured in a number of trees (Harberle *et al*., 2001) as well as in cereals and leguminous plants (Economou *et al*., 2008).

During a solar eclipse, radiations having short wavelength had the more probability of reaching the earth's surface due to the heat balance disorder along with the gravity waves induced because of the travel of the moon in the path of sun. It results in reduction of ozone concentration in stratosphere. When such phenomenon occur in nature, the short wave radiation (350 nm) are more influenced as as compared to long wave radiation and this slowly decreases when the solar eclipse is at its peak (Kazantzidis *et al*., 2007). This shorter wavelength emitted by sun has an effect on plants and animals. Various other wavelengths also showed effect on the crops although emitted lesser during the phenomenon at initial. 450 nm wavelengths facilitate cytochromes and phototropins to arbitrate the responses of plants like phototropic curvature and inhibition of several responses like growth elongation, opening of stomata, seedling growth regulation and chloroplast movement. 500-550 nm wavelengths also effect plant response but in a very specific manner like environmental signaling, phototropism, photomorphogenic growth and stomatal control. 640-680 nm wavelength affects the most essential process in plants, the photosynthesis, flowering and regulation of fruit, however, these wavelength facilitate chlorophyll production, flowering and fruit production and stem growth (https://www.illumitex.com/impacts-colored-light-plants/, 09.5.2016). No study has been reported in case of sugarcane crop. Thus, this paper aims to study the impact of solar eclipse on sugarcane crop.

This experiment was conducted at ICAR-Indian Institute of Sugarcane Research, Lucknow to study the effect of solar eclipse on relative water content, photosynthetic rates, reducing contents of two sugarcane varieties (CoSe 92423 and CoS 96268), a day before and a day after the complete solar eclipse occurred on July 22, 2009 (on July 22, 2009 which lasted for 6 min 39 sec, https://en.wikipedia.org/wiki/Solar_eclipse_of_July_22,_2009). Reducing sugars were evaluated by Nelson-Somoygi method (Somogyi, 1952). Nitrate reductase activity, *in vivo*, was assayed as described by Jaworski (1971). Relative water content (%) was measured by the method described by Barrs and Weatherley (1962). Chlorophyll contents (a and b and its ratio) and carotenoids was determined in the last transverse mark (LTM) leaf in both the varieties by DMSO method (Barnes *et al.,* 1992). Besides, photosynthesis rates were determined before and after the solar eclipse by the Infra-red gas analyzer (Li Cor LI-6400XT Portable Photosynthesis System).

The data showed (Table 1) that after solar eclipse, in cane variety CoSe 92423, chlorophyll a was increased to greater extent while chlorophyll b was marginally increased. Similar pattern in chlorophyll a and b was found in cane variety CoS 96268. However, there is higher increase in chlorophyll a in the former variety as compared to the latter one. Contrastingly, in some Portulaceae plants, *Portulaca oleracea* and *Phyla nodiflora,* a slight decrease in chlorophyll levels (Sambandan *et al*., 2012) was reported after the solar eclipse. Carotenoids invariably increased in both the cane varieties, after the solar eclipse. However, the

Table 1: Average of chlorophyll content, carotenoids, relative water content (%) and moisture (%) day before solar eclipse and day after solar eclipse

Parameters	Chlorophyll content				Carotenoids		Relative water content %		Moisture (%)	
	Chlorophyll a		Chlorophyll b							
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Day before solar eclipse	1.2	1.5	0.44	0.49	3.0	4.0	73.4	75.8	73.9	72.3
Day after solar eclipse	1.9	2.3	0.67	0.64	7.2	9.2	75.6	87.0	71.2	68.7

where, V_1 = COSE 92423 and V_2 = COS 96268

Table 2 : Average of reducing sugars, nitrate reductase activity, PAR and Pn day before solar eclipse and day after solar eclipse

Parameters	Reducing sugars (mg/ml)				Nitrate reductase activity		PAR(µmol/t)		Pn(µmol/t)	
	In leaf		In juice							
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
Day before solar eclipse	3.8	4.1	11.2	12.9	452.5	391.2	859.0	859.0	24.5	19.3
Day after solar eclipse	3.7	4.6	13.2	15.4	1091.2	492.5	1053.0	1053.0	27.2	26.6

where, V_1 =COSE 92423, V_2 =COS 96268

carotenoid level increased nearly two times in variety CoS 96268 as compared to CoSe 92423. In other plants like *Portulaca oleracea* and *Phyla nodiflora,* increase in carotenoid levels was only marginal (Sambandan *et al.,* 2012). Even the relative water content increased in both the varieties after solar eclipse, however, increase was rather more perceptible in CoS 96268. Moisture per cent decreased in both the varieties after solar eclipse; however, the pattern of decrease was somewhat different; the increase being perceptibly more in sugarcane variety CoS 96268 (Table 1).

The biochemical data revealed that reducing sugars in leaf and in juice increased after solar eclipse in both the varieties, with increase being perceptibly more in CoS 96268 as compared to CoS 92423. In contrast to reducing sugars of the leaf, reducing sugars in the juice showed different pattern as it was increased by 2.5 and 2.0 units, respectively. Another biochemical parameter, the nitrate reductase activity is one of the key enzymes of nitrogen metabolism. In fact, NO_3^- N is the principal form of N available to the green plants. Its activity determines N status of the plant and is often associated with its growth and yield (Srivasatava, 1980). Our study revealed that nitrate reductase activity, *in vivo*, increased after solar eclipse in both the sugarcane varieties; however, in CoSe 92423, the increase was rather higher (638.7 units) as compared to only 101.3 units in CoS 96268. It was interesting to observe that there was an increase in photosynthetically active radiation (PAR) after the solar eclipse. This indicates that (may be during) after the solar eclipse, better conditions for photosynthesis prevailed for sugarcane plant. As per the photosynthetic rate (Pn) was concerned, there was also an increase in Pn after eclipse in both the varieties (Table 2).

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