International Journal of Applied Engineering Research ISSN 0973-4562 Volume 17, Number 4 (2022) pp. 412-415
 https://dx.doi.org/10.37622/IJAER/17.4.2022.412-415

Effect on Yield of Pigeon Pea (*Cajanus cajan*) Crop with Changing Chlorophyll

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Abstract:

Chlorophyll is the important component of plant cell, participating an important role in the generation of food in presence of sunlight which is responsible for the production of food grains in the crops. For study of the effect on yield of Pigeon pea (*Cajanus cajan*) crop with changing chlorophyll, the sampling locations were selected as nearby area of M/s HeidelbergCement India Limited (HCIL), Narsinagrh, Damoh, Madhya Pradesh. Because of pollutants released by the HCIL, Narsingarh, the chlorophyll contents of *Cajanus cajan* were varied at several sampling locations, Similarly, the yield of food grain was also varied.

Keywords: *Cajanus cajan,* Chlorophyll, Yield, Damoh, HCIL, Narsingarh

INTRODUCTION

Photosynthesis is performing by chlorophyll of plant cell is responsible for producing food grains in crops. During research work, it was the objective to identify the effect on yield of Pigeon pea (*Cajanus cajan*) crop with changing chlorophyll contents. For sampling, locations were selected as nearby area of M/s HeidelbergCement India Limited (HCIL), Narsinagrh, Damoh, Madhya Pradesh, India. HCIL, Narsingarh is a clinkrization plant which is emitting pollutants like Particulate Matter from stacks and fugitive dust from loading, unloading and other industrial activities. Due to pollutants (dust), chlorophyll contains of crop may varies, consequently, crop yield may also vary. As *Cajanus cajan* is the most widely grown food crop in the world and also cropping at Damoh location in wide range as a major crop of the area, therefore, this area and plant was selected for the research work.

Chlorophyll estimation was done during the seedling of the crops during December & January and yield was estimated during cutting of the crop in February and March months. Three sampling location was selected in every four directions of HCIL, Narsinagrh (Reference point Line-I Pre-heater) first within 1 Km, second within 1 to 3 Km and third within 3 to 5 Km distance and selected a Controlled area (Suhave village) at a distance of around 10 Km far from Plant in upwind direction (West) to compare the samples data of sampling area with a controlled area. Then the Total number of sampling points have become 13 numbers. Sampling locations names were coded as SE-1 (1 Km), SE-2 (1 to 3 Km) and SE-3 (3 to 5 Km) SW for the West direction including SW-1 (1 Km), SW-2 (1 to 3 Km) and SW-3 (3 to 5 Km), SN for North direction including SN-1 (1 Km), SN-2 (1 to3 Km) and SN-3 (3 to 5 Km) and SS for South direction including SS-1 (1 Km), SS-2 (1 to 3 Km) and SS-3 (3 to 5 Km). The crop sample from the control area was coded as SC.

REVIEW OF LITERATURES

Indian economy is based on Agriculture, it is providing livelihood security as well as economic development of the country. Reduction in crop yield causes direct economic losses of the country by air pollutants (Mina et al., 2013). Phytotoxic air pollutants frequently exceed the threshold limit of toxicity to vegetation in India (Pandey et al., 1992). Substantial damage caused to vegetation by the particulate matter shows the harm of leaves resulting due to the deposition of dust, reduction of photosynthetic and protein synthesis process and susceptibility of infection of microorganisms and insects causing injuries (Saha and Padhy, 2011). There are three major ways in which air pollutants may damage agricultural production:

- **Directly visible injury:** It is affecting mostly leaf tissue. If widespread, this can affect crop yield and apparent damage can make the crop less attractive look.
- **Direct effects on growth and yield:** Experiments prove that different pollutants have shown that yields are generally reduced with the increasing pollutant exposure on the crop, sometimes no visible injury are appearing.
- **Indirect effects:** Sometimes, when air pollutants are in lesser concentration it may cause a range of indirect physiological, anatomical and chemical changes that is difficult to detect yield reductions under optimal growth conditions. However, these changes may increase the sensitivity of the crop with subject to other stresses, thereby causative to substantial yield losses.

Pigeon pea (*Cajanus cajan*) is a perennial legume crop belonging to the family Leguminacae (Fabaceae). The other common names of pigeon pea are Arhar and Red gram in India. It is of perennial which can grow into a small tree. It is a rich

source of proteins that contains around 22% lysine, riboflavin, thiamine, niacin and iron (Swami Y.P., 2021). Therefore, it is providing protein rich diet to human beings (Anonymous, 2014). Pigeon pea (*Cajanus Cajan*) was farm more than 3,500 years ago from its wild ancestor *Cajanus cajanifolius* in peninsular India (Kassa, 2012). The genus of *Cajanus* collected 34 species (Lewis et al., 2005), amongst which *Cajanus cajan* is the only cultivated member (Rathinam, 2019).

Pigeon pea (*Cajanus cajan*) is grown in around 50 countries of the world and accounts for approx. 5% of total global pulse production. In Asia, *Cajanus cajan* is grown in 4.33 million hectares of land with an annual production of 3.8 million tonnes. India cultivated *Cajanus cajan* in the largest area 3.38 million hectares followed by Myanmar, China and Nepal (Parthasarathy et al., 2010). The Indian subcontinent is contributing almost 92% of the total *Cajanus cajan* production of the world (Singh and Singh, 2018).

In India, the Productivity of the *Cajanus cajan* remains almost static during the last 50 years (Reddy et al., 2007). Pigeon pea benefited to soil several benefits as a soil ameliorant, for example, it is known that it adds 40 to 50 kg Nitrogen per hectare to the soil by the mechanism of biological nitrogen fixation and leaf fall (Ahlawat, 2005).

It has been detected that the cultivation of long-duration pigeon pea (250 to 280 Days) that inhabit fields for nearly whole of the year, on the other hand, cultivation of short-duration (130 to 145 Days) high yielding cultivars enable a second crop like wheat, mustard, chickpea etc in rabi season (Majumdar, 2011). Pigeon pea crop is planted in the rainy (Kharif) season in North, Western and Central India. Sowing is generally done in flatbeds, therefore, waterlogging resulting in plant mortality and higher cases of Phytophthora blight and Fusarium wilt (Singh et al., 2016).

MATERIEALS & METHODOLOGY

(a) Sampling location: Clinkrisation unit of M/s Heidelberg Cement India Limited is located at Village & Post-Narsingarh, Block-Patharia District-Damoh, State-Madhya Pradesh, Country-India, its nearby area in all four direction of plants was selected as monitoring location as per the Table-1.

Table-1: Geographical co-ordinates of Chlorophyll & Yield Sampling & estimation Point on Google Map

Sampling Point	The location from HCIL Plant	Latitude	Longitude
HCIL	Line-I Pre-heater	23°59'25.0"N	79°23'30.0"E
SE-1	0-1 Km in the East direction	23°59'05.5"N	79°23'51.9"E
SE-2	1-3 Km in the East direction	23°58'38.0"N	79°23'55.6"E
SE-3	3-5 Km in the East direction	23°58'14.1"N	79°25'13.9"E
SW-1	0-1 Km in the West direction	23°58'58.7"N	79°22'28.3"E
SW-2	1-3 Km in the West direction	23°59'00.1"N	79°21'45.3"E
SW-3	3-5 Km in the West direction	23°59'14.1"N	79°20'58.2"E
SN-1	0-1 Km in North direction	23°59'55.2"N	79°23'26.7"E
SN-2	1-3 Km in the North direction	24°00'35.1"N	79°23'57.1"E
SN-3	3-5 Km in the North direction	24°01'30.2"N	79°24'29.8"E
SS-1	0-1 Km in South direction	23°58'56.1"N	79°23'10.3"E
SS-2	1-3 Km in South direction	23°58'41.0"N	79°22'37.6"E
SS-3	3-5 Km in the South direction	23°58'14.8"N	79°21'17.9"E
SC	Controlled area (10 Km far from HCIL, Narsingarh in West direction)	23°58'24.4"N	79°17'33.5"E

Fig.1: Sampling location for Chlorophyll & Yield Sampling & estimation Point on Google Map

(b) Sampling:

(i) Sampling of crop leaf for Chlorophyll: Crop leaf samples were collected from crop during seedling. In each sampling locations, total 5 samples collected, one sample each from all four corners and one sample from the centre of the field were collected and made one representative sample by all samples by cutting leaves in small pieces for estimation of chlorophyll.

(ii) Sampling of crop's grain: Identifying plot and take 5 numbers of sampling points in each location out of which four locations at corners (One location at each corner) and one at centre taken quadrate of size 0.25 m^2 area. Harvesting the crop comes within Quadrate at each sampling point of the Plot. Drying the crop to standard conditions. Weigh the output of each five samples and calculate its average. Computing the yield by dividing the product obtained by subplot area.

(c) Analysis: Analysis work was done at a site lab of a NABL accredited laboratory named M/s Ecomen Laboratories Private Limited, Lucknow by the following methods

(i) Estimation of Chlorophylls in crop leaves: Chlorophyll was estimated as per the chlorophyll estimation method published by Arnon, 1949. In this method chlorophyll gets dissolved in acetone (80%), when the samples are macerated in acetone. At 663 and 645 nm wavelengths of spectrophotometer optical density of the extract is measured, because of maximum absorption of chlorophyll "a" and "b" respectively, by using the absorption coefficients, chlorophyll contents can calculated.

(i) Estimation of Yield in crops: Yield was estimated as per the method of Sampling for harvest unit by Rosenstock et al., 2016. Sampling for Harvest unit is quite similar to the total harvest, but, in this method few samples are harvested and weighted in selected field area. Some harvest units are randomly/planned selected and weighed to obtain an average unit weight by multiplying the average weight of the grain of sample area in respect of total field area.

RESULT

Chlorophyll and yield was estimated at every direction of the Plant and controlled area as per the Graph of Fig-1 & 2 respectively for the Year of 2019-20 and 2020-21.

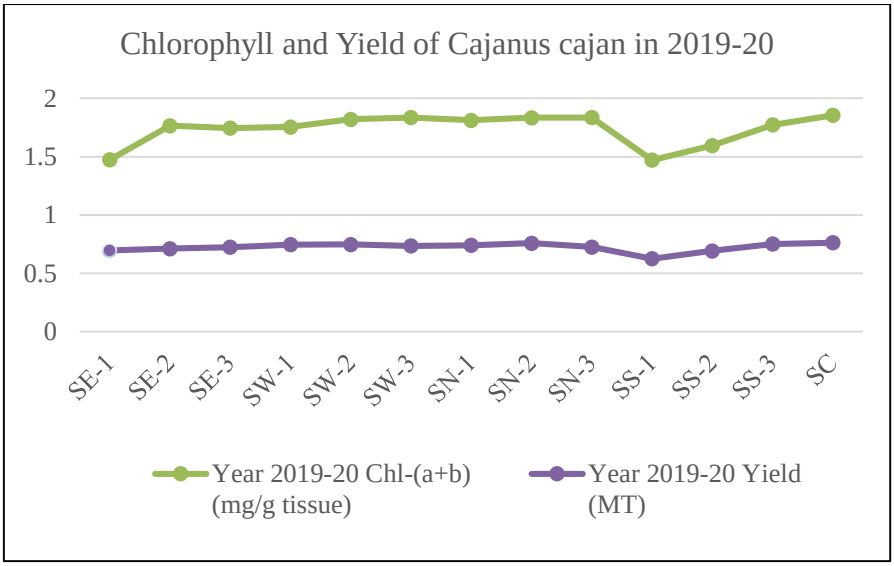

Fig-2: Graph showing Correlation between Chlorophyll and Productivity of *Cajanus cajan* in Year 2019-20

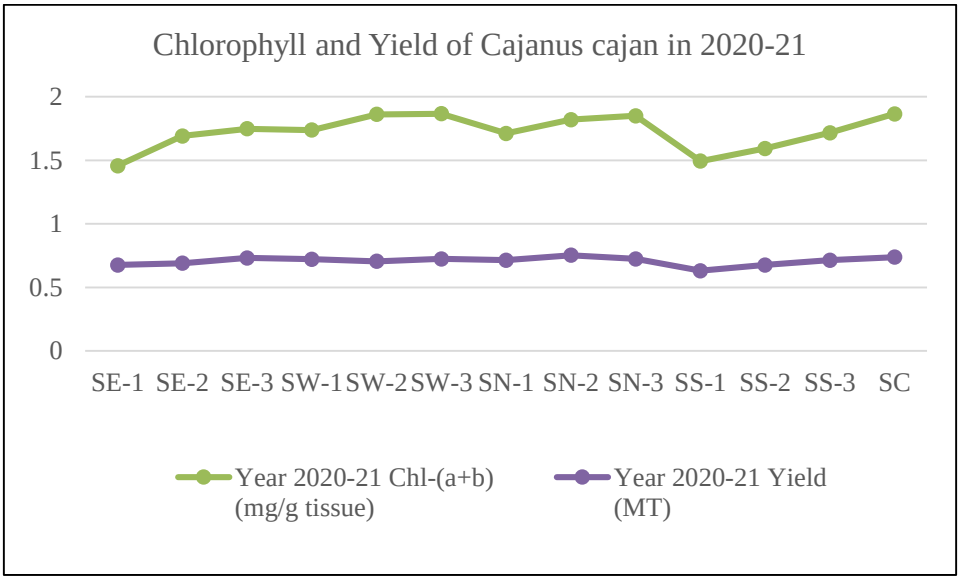

Fig-3: Graph showing Corelation between Chlorophyll and Productivity of *Cajanus cajan* in Year 2020-21

DISCUSSION & CONCLUSION:

Chlorophyll contents of *Cajanus cajan* for sampling areas were varying between 1.457 to 1.867 mg/gram tissue and its average mean was 1.719 ± 0.03 mg/gram tissue and in controlled area Total Chlorophyll (a+b) contents were varying between 1.855 to 1.866 mg/gram tissue and its average mean was 1.861 ± 0.03 mg/gram tissue. As compared to the average mean of the sampling area with the controlled area, Chlorophyll contents in the leaf of the Sampling area were 7.63 % less than the controlled area.

Yield of *Cajanus cajan* for sampling areas were varying between 0.625 to 0.758 Tonne/Acre and its average mean was 0.714 ± 0.016 Tonne/Acre and in the controlled area Yield of *Cajanus cajan,* crop leaves were varying between 0.738 to 0.762 Tonne/Acre tissue and its average mean was 0.750 ± 0.016 Tonne/Acre tissue Tonne/Acre. The yield of crops in the Sampling area with the controlled area was 4.80 % less in *Cajanus cajan*.

Fig-2 & 3 showing the regular trained of changing of chlorophyll resulting with yield it means that chlorophyll & yield showing positive correlation. When chlorophyll contains was higher than yield was also higher and its vice versa and 7.63% loss of chlorophyll in sampling areas with controlled area showing the loss of yield 4.80%.

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