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Variation in Chlorophyll Content, Growth and Yield of Short-Duration Pigeonpea *(Cajanus cajan* L.) Genotypes Applied with Phosphorus and Sulphur

Seema Pandey* and Abhilasha Shrivastava

Department of Botany, Govt. P.G. Science College, Rewa, M.P., India

**Corresponding author*

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A B S T R A C T

A field experiment was carried out during cropping seasons of 2021-22 and 2022-23 at the Private Research Farm, Beenda-Semaria road, Rewa (M.P.) to study the variation in chlorophyll content and growth and yield of short-duration pigeonpea genotypes applied with phosphorus and sulphur. The chlorophyll content in leaves was found to increase between 60 and 120 DAS growth period, thereafter it tended to decline up to at 150 DAS stage. It was the general trend irrespective of the applied treatments. Amongst the genotypes, TJT-501 recorded also significantly higher chlorophyll formation at different stages over other genotypes. Chlorophyll was 3.91 and 3.49 mg/g at 120 and 150 DAS under TJT-501 as against 3.32 and 2.94 mg/g, respectively in case of ICPL-87. The genotype IJPAS-120 proved the second best genotype to produce incised chlorophyll. Consequently the growth (plant height, branches, leaves/plant and dry matter) and yield of both these genotypes were increased in the same order. The seed and straw yield from TJT-501 was recorded up to 12.15 and 45.49 q/ha, respectively. The harvest index (HI) was 21.20%. Similarly the P_{60} S_{45} recorded maximum chlorophyll content, growth parameters, seed and straw yield of pigeonpea. The seed and straw yield under P_{60} S_{45} was 12.94 and 57.70 q/ha, respectively. The HI was 21.98%.

Introduction

Chlorophyll, a green colour pigment, in plants is of utmost importance in the process of photosynthesis which is a very important process in the overall plant performance and contributes substantially in their growth and development (Ashraf and Harris, 2013). Being a principal photoreceptor in the process of photosynthesis, it absorbs sunlight energy in the form of electromagnetic radiations especially blue and red wave lengths of the spectrum to synthesize carbohydrates and oxygen from CO_2 and water (Mishra *et al.*, 2013).

Crop productivity is a result of interaction of physiological processes of genotypes with environment and availability of nutrients. Leaf is the principal site of plant metabolism and the changes in nutrient supply are reflected in the composition of leaf. Leaf and chlorophyll content are important parameters for photosynthesis of any crop which ultimately affect the crop productivity. In fact, leaf is the factory for conversion of solar energy into chemical energy by the process of photosynthesis. Phosphorus is an essential nutrient for grain legumes, as it helps in improving nodulation, seed yield and seed protein (Gadi *et al.,* 2018). Phosphorus plays a vital role in photosynthesis, respiration, energy storage, energy transfer, cell division, cell elongation and several other processes within plant system.

It promotes early root formation, growth and improves harvest index of crops. (Nyekha *et al.,* 2015). Sulphur improves the quality of food crops, particularly of legumes. It plays an important role in the formation of S-containing amino acids like cystine (27 % S), Cystein (26 % S), methionine (21 % S), which act as building blocks in the synthesis of proteins. It has a role to play in increasing chlorophyll formation and aiding photosynthesis. Sulphur also plays a role in the activation of enzymes, nucleic acids and forms a part of biotin and thiamine (Singh *et al.,* 2017).

Materials and Methods

A field experiment was conducted during cropping seasons 2021-22 and 2022-23 at the Private Agriculture-cum-Research Farm, Beenda-Semaria Road, Rewa (M.P.). The soil of the experimental field was silty clay-loam having ph *7.1-7.3,* electric conductivity 0.26-0.33 d S/m, organic carbon 6.35-6.53 g/kg, available N 230-238 kg/ha, available P_2O_5 22.4-25.3 kg/ha, available K_2O 330-349 kg/ha and available 13.0-13.8 kg/ha. The rainfall received during cropping period was 760 mm 2021-22. The treatments comprised four pigeonpea genotypes (ICPL-87, ICPL-157, IJPAS-120 and TJT-501) in the main-plots and six P x S levels in the sub-plots (Table 1). The experiment was laid out in split-plot design with three replications. The pigeonpea genotypes, inoculated with *Rhizobium*, were sown during 3rd week of July in both the years @ 20 kg seed/ha at 30 cm row spacing. The P and S levels were applied as basal through diammonium phosphate, urea and single superphosphate. An uniform dose of 20 kg K_2O/ha was applied as basal through muriate of potash in all the treatments. The crop was grown as per recommended package of practices. The crop was harvested during last week of December to first week of January in both the years. The chlorophyll content in leaves was determined by acetone extraction method (Writham *et al.,* 1971).

Results and Discussion

Chlorophyll content in leaves

The data (Table 1) indicate that the chlorophyll content in leaves was enhanced between 60 and 120 DAS growth period, thereafter it started declining as observed at 150 DAS stage. It was the general trend irrespective of the applied treatments. Chlorophyll content in leaf varies with species, age of plants and growth seasons. Increase in chlorophyll content with age of plants is a general phenomenon, which is due to high magnesium and protein contents of leaves (Srivastava *et al.,* 2012).

Amongst the pigeonpea genotypes, TJT-501 recorded almost significantly higher chlorophyll content in leaves (3.31, 3.62, 3.91 and 3.49 mg/g leaf weight at 60, 90, 120 and 150 DAS stages respectively). Whereas the chlorophyll formation in case of ICPL-87, was found lowest (2.82, 3.18, 3.32 and 2.94 mg/g, lead weight at the respective stages). UPAS-120 proved the second best genotype this may be due to rapid plant growth and development of new leaves in TJT-501 and UPAS-120 which were photosynthetically more active. Thus, the maximum leaf area in these genotypes induced competition for light and shadding of leaves.

The significant differences in physiological parameters in different genotypes might be owing to their genetic variability, (Singh *et al.,* 2013; Sheikh *et al.,* 2017). Similarly the maximum chlorophyll content in leaves was also observed under higher fertility level (P_{60} S_{45}). This was followed by P_{60} S_{30} and then P_{60} S_{15}. The increased supply of phosphorus and sulphur resulted in enhanced chlorophyll synthesis and photosynthetic process.

Table.1 Chlorophyll content in leaves growth and yield of pigeonpea as influenced by genotypes and fertility levels

Treatments	Chlorophyll in fresh leaves (mg/g leaf wt.)				Plant height (cm)	Total braches /plant	Trifoliate leaves/ plant	Dry matter/ plant (g)	Seed yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
	60 DAS	90 DAS	120 DAS	150 DAS							
Genotypes											
ICPL-87	2.82	3.18	3.32	2.94	147.3	64.3	227	30.56	9.48	47.50	16.72
ICPL-157	2.97	3.31	3.49	3.08	148.8	66.4	238	32.92	10.49	46.82	18.37
UPAS-120	3.14	3.49	3.67	3.25	149.6	71.3	241	34.72	11.54	45.66	20.28
TJT-501	3.31	3.62	3.91	3.49	150.4	72.3	243	35.93	12.15	45.49	21.20
CD(P=0.05)	0.09	0.14	0.11	0.14	0.58	0.80	0.91	0.19	0.28	0.38	0.26
Fertility levels(kg/ha)											
P_0 S_0	2.83	3.22	3.36	2.95	143.6	61.9	231	29.70	9.21	37.43	19.74
P_{30} S_0	2.92	3.30	3.45	3.04	145.1	34.6	234	31.32	9.78	39.06	20.02
P_{60} S_0	3.03	3.36	3.55	3.14	147.3	67.2	236	32.54	10.62	43.81	19.54
P_{60} S_{15}	3.11	3.43	3.64	3.23	150.9	69.8	239	34.30	11.05	47.85	18.76
P_{60} S_{30}	3.19	3.50	3.74	3.33	152.9	72.6	241	35.96	11.89	52.36	18.52
P_{60} S_{45}	3.28	3.58	3.83	3.44	154.4	75.3	244	37.40	12.94	57.70	18.33
CD (P=0.05)	0.06	0.10	0.07	0.09	0.38	0.53	0.60	0.12	0.19	0.25	0.17
Interaction	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.

Sig.= Significant

The applied nutrients favourably influenced the physiological and biochemical activities of crop plants, growth of young leaves which helped in the synthesis of carbohydrates, proteins etc. for building up new tissues. These results are in close agreement with those of Singh *et al.,* (2013); Singh *et al.,* (2017); Das (2017); Saket *et al.,* (2017); Masu *et al.,* (2019).

Growth and yield parameters

The genotype TJT-501 recorded almost significantly higher plant height (150.4cm), total branches (72.3/plant), trifoliate leaves (243 /plant) and dry matter (35.93 g/plant). This was followed by UPAS-120 and then ICPL-157 with the lowest values from ICPL-87. Consequently the seed yield (12.15 q/ha) and straw yield (45.49 q/ha) as well as harvest index (21.20 %) were found in the maximum range under TJT-501 genotype. UPAS-120 stood the second best genotype. Whereas ICPL-87 produced lowest seed yield (9.48 q/ha) but straw yield was highest (47.50 q/ha), consequently lowest harvest index (16.72 %). The better development of growth and yield with P and S fertilizers might be due to their key role in root development, energy transformation and metabolic processes of plant through which increased translocation of photosynthates towards sink development might have occurred. (Saket *et al.,* 2017). The variations in these parameters among the genotypes are mainly due to the fact that such parameters are genetically governed. The productivity parameters are based on the cumulative effect of the genetic ability and production efficiency of the genotypes, their fertility management and the agro-climatic conditions where the genotypes are grown. The present findings are in consonance with those of other researchers (Singh *et al.,* 2013; Singh *et al.,* 2017; Sheikh *et al.,* 2017 and Gadi *et al.,* 2018). The heights fertility level (P_{60} S_{45}) resulted in almost significantly higher plant height (154.4cm), total branches (75.3 /plant), trifoliate leaves (244 /plant) and dry matter (37.4 g/plant). Consequently the highest seed yield was 12.94 q/ha. Straw yield 57.70 q/ha and harvest index 18.33 %. The second best fertility level was $P_{60}S_{30}$ and then $P_{60}S_{15}$. The higher fertility levels resulted in greater chlorophyll synthesis energy transformation, accumulation of carbohydrates, proteins and their translocation to the reproductive organs (Solanki and Sharma, 2016; Saket *et al.,* 2017; Singh and Singh, 2017; Singh *et al.,* 2017; Mishra *et al.,* 2018 and Masu *et al.,* 2019).

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