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STUDY ON EFFICACY OF INTEGRATED NUTRIENT MANAGEMENT [INM] ON PHYSIOLOGICAL PARAMETERS IN CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

Nutrients plays the major role along with water in the plant growth regulation. Here the experimentation conducted was about the "Study on Efficacy of Integrated Nutrient Management on physiological parameters in chickpea (*Cicer arietinum* L.)" that involved 7 different combinations of nutrients along with RDF i.e., T_1 (CONTROL (100 %) RDF), T_2 (50 % RDF + 50 % *Rhizobium*), T_3 (75 % RDF + 25% *Rhizobium*), T_4 (50 % RDF + 50 % *Azotobacter*), T_5 (75% RDF + 25 % *Azotobacter*), T_6 (50% RDF + 25% *Rhizobium* + 25% *Azotobacter*), T_7 (75% RDF + 12.5 % *Rhizobium* + 12.5 % *Azotobacter*) at Uttaranchal University, Premnagar, Dehradun. The studies revealed that the use of *Azotobacter* AND *Rhizobium* at 25% each and 50% of RDF resulted with the beneficial outputs in leaf area index, chlorophyll content, dry matter accumulation, protein estimation and leaf area per plant with maximum net returns in contrast to all 6 treatments that were used. Nitrogen application after flowering boosts nitrate reduction activity and yield, Phosphorus is crucial in plant physiological processes. Use of Azotobacter helps in the root growth. Rhizobium is the bacteria that helps in the Nitrogen fixation in soil.

KEYWORDS: INM ; Chickpea ; *Rhizobium; Azotobacter*; LAI, Chlorophyll, Dry matter.

1. INTRODUCTION

Chickpea is the most important fruit of the Rabi season in India, which is grown mainly under rain-fed conditions in the moisture that remains after the harvest of kharif crops. Chickpea (*Cicer arietinum* L.) belongs to the family Fabaceae. Chickpea is the fourth largest legume plant in the world. The southwestern regions of the world were selected 1 and Ethiopia as the second region for the diversity of *Cicer arietinum* L. **(Vavilov 1926)**, and later transferred to the Indian subcontinent and to the rest of the world **(Bouhadida *et al.*, 2015)**. Among the pulses, chickpea is a leading crop in India. It is cultivated in 10.17 million hectares with a total production of 11.35 million tonnes at average productivity of 1116 kg/ha **(Directorate of Economics and Statistics, 2020)**. Nitrogen application after flowering boosts nitrate reduction activity and yield **(Sekhon *et al.*, 1988)**. Phosphorus is crucial in plant physiological processes. The indiscriminate and imbalanced application of chemical fertilizers posing many danger which include lack of soil fertility, deterioration of soil health, degraded produce satisfactory, pollution of air, water and soil and so forth **(Hepperly *et al.*, 2009)**. To improve the productivity of this plant, the use of a balanced fertilizer with natural fertilizers, N, P, K and biofertilizers i.e., *Rhizobium*, and PSB is very important. However, sole application of organic manure cannot overcome the nutritional amounts of crops as it contain reduced and imbalanced amount of nutrients and constrained by access to sufficient organic inputs, high labour demand for preparation and transportation **(Jones and Healey 2010)**. For sustainable production system, incorporated use of chemical fertilizers, natural manures such as farmyard manure (FYM), vermicompost, or through the usage of bio fertilizers, along with *Rhizobium* and *phosphate solubilizing* micro organism (PSB) facilitates to satisfy the nutrient requirement of the crop and offering high productiveness **(Meena and Ram 2016).** Therefore, INM involving inorganic, biological and organic sources has potential to improve the crop productivity and soil fertility on a sustainable basis. Hence there is a need to study the effect of combined use of inorganic, organic and bio-fertilizers on growth and productivity of chickpea. considering these facts the present experiment was conducted to study of efficacy of integrated nutrient management [INM] on physiological parameters in chickpea (*Cicer arietinum* L.).

2. MATERIAL AND METHODS

A Field experiment was conducted at Crop Research Center, School Of Agriculture, Uttaranchal University, Dehradun, Uttarakhand, ($30^0$33'1N and $77^0$94'E) during *rabi* season of 2021-2022. The physiochemical properties of the soil had an organic carbon content of 0.90 %, PH of 8.0, available N of 256 kg/ha, available P of 25.8 kg/ha and available K of 205.2 kg/ha. The experiment was laid out in RBD with 7 treatments replicated thrice and every plot size was 3 m × 2 m. The treatments were T_1- Control (100 %) RDF, T_2- 50% RDF + 50% *Rhizobium*, T_3- 75% RDF + 25% *Rhizobium*, T_4- 50% RDF + 50% *Azotobacter*, T_5- 75% RDF + 25% *Azotobacter*, T_6- 50% RDF + 25% *Rhizobium* + 25% *Azotobacter*, T_7- 75% RDF + 12.5% *Rhizobium* + 12.5% *Azotobacter*). The Fertilizers as per the treatments were applied in required quantities. The doses of NPKs were applied in the form of Urea, Diammonium Phosphate and Murate Of Potash respectively before the sowing. Rhizobium and Azotobacter was applied as seed treatment @ 5g/kg seed. An inter-row spacing of 30 cm was used. A Chickpea variety Pusa 365 which is suitable to grow in this area was used with a seed rate of 60 kg ha^{-1}.

3. RESULTS AND DISCUSSION

Leaf area Index

At various stages of the crop's growth, various fertility treatments had a significant impact on the leaf area index (Table 1). Regarding LAI, all integrated nutrient management treatments were found to be noticeably better than the control treatment. After sowing, the treatments with 50 percent RDF + 25 percent *Rhizobium* + 25 percent *Azotobacter* were found to have the maximum leaf area index of 0.407, which was significantly better than the control *i.e.,* T_1 100% RDF (0.263) and found to have statistically identical effects with the rest of their treatments. *Rhizobium* helps in the synthesis of growth promoting substances like auxins, indole 1-3 acetic acid and *Azotobacter* helps in the synthesis of gibberellins **(Sarig *et al.*, 1986); (Brown and Walkar, 1970**) that helps in the nodulation process which leads to the increased nitrogen content **(Arora, 1971)** that improves the physiological activity that also plays the role in increase of leaf area index. Similar results are also found by **(Panjebashi *et al*., 2012).**

Chlorophyll Estimation (nm)

When compared to the control, the various integrated nutrient management treatments resulted in significant changes in chlorophyll estimation (Table 1). In comparison to the control 100% RDF (338.33 nm), the application of 50% RDF + 25% *Rhizobium* + 25% *Azotobacter* resulted in significantly higher estimates of chlorophyll at 348.67 nm followed by other treatments T_7 (345.66) and T_2 (345.66) . Given its importance as a component of photosynthesis, nitrogen has a greater impact on improving the production of chlorophyll **(Singhal *et al.*, 2000).** The combined combination of *Azotobacter* and Rhizobium along with RDF helps in increased nutrient availability that results in increased physiological activity that leads to the high chlorophyll synthesis. From all this preceding evidences treatment T_6 (50% RDF + 25% *Rhizobium* + 25% *Azotobacter*) has the justified chlorophyll synthesis. Similar results are also found by **(Rashmi et al., 2009).**

Protein Estimation

The data observed for the protein estimation has varied from the values of 24.30g to 23.20g and the total values were tabulated in the Table 1. Maximum protein content has been recognized in the plot treated with 50% RDF + 25% *Rhizobium* + 25% *Azotobacter* i.e., treatment T_6 (24.30g) followed by the treatments T_7 (23.56) and T_2 (23.43) as compared to the control i.e., Treatment T_1 100% RDF (23.20). The protein content present in chick pea is synthesized by the root nodules which are responsible for the leg-haemoglobin synthesis. Leg-haemoglobin present facilitates the diffusion of oxygen to the symbiotic bacteriods that facilitates the nitrogen fixation that also shows the relation between nitrogen synthesis to the protein content. Azotobacter is the biological nutrient that influences the root growth that provides the space for the inception of the Rhizobium bacteria that involves in the nitrogen synthesis **(Nosrati *et al.*, 2014)** which leads to the high protein synthesis. Similar findings were reported by **(El-Adawy, T.A. 2006)** with the variation of protein content due to the effect of nitrogen.

Leaf area per plant

The application of different levels of organic and inorganic fertilizers, as well as biofertilizers, resulted in significant differences in the number of leaves per plant (Table 1). The values of leaf area per plant have ranged from 50.39 to 47.50 cm^2. Maximum leaf area per plant has been recorded in the treatment T_6 (50% RDF + 25% *Rhizobium* + 25% *Azotobacter*) with the value of 50.39 cm^2 followed by the treatments T_7 (50.16) and T_2 (50.14) as comparison to control i.e., T_1 100% RDF (47.50). The addition of biofertilizers may have promoted the release of specific growth hormones such as IAA, GA3 and cytokines in the rhizosphere, resulting greater cell division and cell expansion, increasing leaf area **(Sing and Sing, 2009)** and higher uptake and accumulation of greater amount of photosynthetic, resulting in an increase in overall vegetative growth. All these attributes contributes the plant productivity which shows the increase in increased leaf area per plant with high photosynthetic activity as per the findings of **(Shende S.T *et al.*, 1975)**.

4. CONCLUSION

From the investigation and the supporting evidences we can conclude that treatment T_6 (50% RDF + 25% *Rhizobium* + 25% *Azotobacter*) is the effective combination of fertilizers that enhances the physiological parameters leaf area index, chlorophyll content, protein estimation, leaf area per plant was found significant with beneficial outputs when compared to all treatments that was involved in the investigation.

Table 1 : Leaf area index , Chlorophyll content , Protien content, Leaf area per plant of chickpea influenced by various treatments

Treatment no	Treatment	Leaf area index	Chlorophyll content	Protein content in seed	Leaf area per plant
T_1	CONTROL (100 %) RDF	0.263	338.33	23.20	47.50
T_2	50 % RDF + 50 % *Rhizobium*	0.340	344.67	23.43	50.14
T_3	75 % RDF + 25% *Rhizobium*	0.307	341.66	23.36	48.92
T_4	50 % RDF + 50 % *Azotobacter*	0.310	342.66	23.40	49.00
T_5	75% RDF + 25 % *Azotobacter*	0.303	341.00	23.30	48.40
T_6	50% RDF + 25% *Rhizobium* + 25% *Azotobacter*	0.407	348.67	24.30	50.39
T_7	75% RDF + 12.5 % *Rhizobium* + 12.5 % *Azotobacter*	0.343	345.66	23.56	50.16
	SEm±	**0.042**	**2.591**	**0.249**	**0.542**
	CD (5 %)	**0.125**	**7.766**	**0.747**	**1.626**
	CV	**3.169**	**0.187**	**0.262**	**0.273**

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