Int.J.Curr.Microbiol.App.Sci (2020) *9*(8): 3432-3439

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 9 Number 8 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.908.397

Assessment of Integrated Nutrient Management on Soil Properties and Yield Attribute of Chickpea (*Cicer arietinum* L.) Var. Samrat

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Keywords

Chickpea, Seed *Rhizobium*, FYM, Nitrogen, Phosphorus, and Potassium, Soil Health, Bio fertilizer, Manure etc

Article Info

Accepted:
26 July 2020
Available Online:
10 August 2020

A B S T R A C T

An experiment entitled "Assessment of Integrated Nutrient Management on Soil Properties and Yield Attribute of Chickpea **(***Cicer arietinum* L.)Var.-samrat" was conducted at central research farm, department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, Sam higginbottom University of Agriculture, Technology and Sciences, Prayagraj which is located at 25°58' North latitude and 81°52' East longitude with an altitude of 98 meter above mean sea level and is situated 5km away on the right, bank of yamuna river. The soil of the experimental field was sandy loam in texture. Randomized block design fallowed here with 9 treatment combinations replicated 3 times. Recommended dose of fertilizers *i.e.* Nitrogen, Phosphorus and Potassium, was applied @ 20:60:40 kg ha^{-1}as Di Ammonium phosphate (46%P_2O_5, 18%N), Di Ammonium phosphate (46%P_2O_5, 18%N), Muriate of Potash (60% K_2O), (*Rhizobium* 20g kg^{-1} seed), FYM 6 t ha^{-1}. The trial consist of nine treatments *viz.*, T_1 - (Control), T_2 - (N_2 + F_2) (@ 50% RDF + 3 t ha^{-1} FYM), T_3 - (N_1 + F_2) (@ 100% RDF + 3 t ha^{-1} FYM), T_4 -(N_2 + F_1) (@ 50% RDF + 6 t ha^{-1} FYM), T_5 - (N_1 + F_1) (@ 100% RDF + 6 t ha^{-1} FYM), T_6 - (N_2 + R_2) (@ 50% RDF + 10g kg^{-1} seed *Rhizobium*), T_7 - (N_1 + R_2) (@ 100% RDF +10g kg^{-1} seed *Rhizobium*), T_8 - (N_2 + R_1) (@ 50% RDF + 20g kg^{-1} seed *Rhizobium*), T_9 - (N_1 + R_1) (@ 100% RDF + 20g kg^{-1} seed *Rhizobium*). The result of a present investigation revealed that the application of low soil pH (6.88) by T_9 - (N_1 + R_1) (@ 100% RDF + 20g kg^{-1} seed *Rhizobium*), electrical conductivity (0.15 dS m^{-1}) by T_1 - Control, particle density (2.21 mg^{-3}) by T_8 - (N_2 + R_1) (@ 50% RDF + 20g kg^{-1} seed *Rhizobium*), and bulk density (1.06 mg^{-3}) by T_9 - (N_1 + R_1) (@ 100% RDF + 20g kg^{-1} seed *Rhizobium*), the higher organic carbon, available nitrogen, available phosphorus, available potassium, of 0.49:357.65:38.19:228.41 kg ha^{-1} was labelled in treatment T_9 -(N_1 + R_1) (@ 100% RDF + 20g kg^{-1} seed *Rhizobium*) comparison to control. The combined application of *Rhizobium* and FYM along with control, has led to improvement in soil health potential, nutrient availability and yield sustenance under Chick pea crop cultivation in which found that the treatment (T_9) consisting of (@ 100% RDF + 20g kg^{-1} seed *Rhizobium*) give best result among other treatments.

Introduction

Pulses are important source of dietary protein and have unique ability of maintaining and restoring soil fertility through biological nitrogen fixation as well as addition of ample amount of residues to the soil. Pulse crops leave behind reasonable quantity of nitrogen in soil to the extent of 30 kg ha^{-1}. In India pulses are grows nearly in 25.43 million

hectare with an annual production of 19.78 million tonnes and an average productivity of 679 kg ha^{-1} (Anonymous, 2013).

In 2017-18, chickpea was cultivated in about 106 Lakh hectare. The country harvested a record production of > 111 Lakh ton at the ever highest productivity level of 1056 kg ha^{-1}. As usual, MP has contributed a significant 34% of the total gram area and 41% of total gram production in the country, thereby ranking first both in area and production. Maharashtra (18%) and Rajasthan (13%) were the next in terms of area. More than 90 per cent of gram production of the country during the period under report has been realized by 10 states of MP, MS, Rajasthan, Karnataka, UP, AP, Gujarat, Jharkhand, CG and Telangana. Chickpea is the world's third most important food legume with 96% cultivation in the developing countries. Uttar Pradesh is the fifth rank in chickpea production. The study was conducted in the state of Uttar Pradesh (UP). The economy of U.P. is predominately agrarian. In this region there are sixteen districts, out of which Kanpur Dehat and Unnao were randomly selected for the present study. Uttar Pradesh state has a total area of 577 thousand ha, production of 475.4 thousand tones and yield 824 kg ha^{-1} under chickpea cultivation.

Chickpeas are a nutrient-dense food, providing rich content 20% or higher of the daily value (DV) of protein, dietary, fiber, folate and certain dietary minerals, such as iron and phosphorus in a 100 gram reference amount. Thiamin, vitamin, B_6, magnesium and zinc contents are moderate, providing 10–16% of the DV. Compared to reference levels established by the United Nation Food and Agriculture Organization and World Health Organization, proteins in cooked and germinated chickpeas are rich in essential amino acids such as lysine, isoleucine, tryptophan, and total aromatic amino acids.

A 100-gram (3 ½-ounce) reference serving of cooked chickpeas provides 686 kilojoules (164 kilocalories) of food energy. Cooked chickpeas are 60% water, 27% carbohydrates, 9% protein and 3% fat. 75% of the fat content is unsaturated fatty acids for which linoleic acid comprises 43% of the total fat. (Pulses Revolution - From Food to Nutritional Security).

Synchronizes the nutrient demand of the crop with nutrient supply from native and applied sources. Provides balanced nutrition to crops and minimizes the antagonistic effects resulting from hidden deficiencies and nutrient imbalance. Improves and sustains the physical, chemical and biological functioning of soil.

Organic manures *viz*., FYM, Vermicompost (VC), poultry manure (PM) and oilcakes help in the improvement of soil structure, aeration and water holding capacity of soil. Further, it stimulates the activity of microorganisms that makes the plant to get the macro and micro-nutrients through enhanced biological processes, increase nutrient solubility, alter soil salinity, solidity and pH (Alabadan *et al.*, 2009). Organic compost is a very important method of providing the plants with their nutritional requirements without having an undesirable impact on the environment (Haruna *et al.,* 2011*).*

Rhizobium inoculation increased the root nodulation through better root development and more nutrient availability, resulting in vigorous plant growth and dry matter production which resulted in better flowering, fruiting and pod formation and ultimately there was beneficial effect on seed yield (Sardana *et al*,. 2006). A judicious use of organic manures and biofertilizers may be effective not only sustaining crop productivity and in soil health, but also in supplementing chemical fertilizers of crop (Jaipal *et al.,*

2011). Among the various fertilizers, biofertilizers are important sources of nutrients. Biofertilizers are natural fertilizers containing micro-organism which help in enhancing the productivity by Biological nitrogen fixation or solubilization of insoluble phosphate or producing hormones, vitamins and other growth regulators required for plant growth *(*Bhattacharya, 2000).

Nitrogen also plays an important role in synthesis of chlorophyll and amino acid, which contributes to the building units of protein and thus the growth of plants. Insufficient nitrogen may reduce yield drastically and deteriorates the quality of produce.

Cluster bean being a legume crop which has the capacity to fix atmospheric nitrogen by its effective root nodules the major part of nitrogen is met through *Rhizobium* present in the root nodules hence, crop does not require additional nitrogen for its initial growth and development stage. The nitrogen application increased crude protein, crude fiber contents, ash percentage, carbohydrates, and leaf area per plant, dry matter and green fodder yield of cluster bean cultivars *(*Bakar *et al.,* 2010)

Organic manures is very good media for microorganisms growth and development also maintain the soil fertility status. It is that combination of organics and mineral fertilizers highly enhance the productivity of soil. Frequent use of inorganic fertilizer causes reduction in the crop yields and resulted in imbalance of nutrients in the soil, which has adverse effect on soil health. Combined use organic manures and alone application improve the soil physical, chemical and biological properties and proper utilization of applied fertilizers for improving seed yield and quality of crop (Patil *et al.,* 2012).

Phosphorus is critical to chickpea yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the *rhizobium*-legume symbiosis (Haruna and Aliyu, 2011).

The potassium is the third most important essential nutrient after nitrogen and phosphorus. The potassium activates more than 60 enzymes and enzymatically catalyzes the system involved in photosynthesis, metabolism and translocation of carbohydrates and proteins, membrane permeability, stomatal regulation and water utilization. Other benefits ascribed to K include resistance of plants against pests, disease and stresses caused by drought, frost, salinity, solidity and in assuring improved crop quality characteristics (Kherawat *et al.,* 2013).

Materials and Methods

The investigation was conducted on Assessment of Integrated Nutrient Management on Soil Properties and Yield Attribute of Chickpea (*Cicer arietinum* L.**)** Var. Samrat comprise of a field experiment which was carried out at the Soil Science Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during kharif season 2019-20. The details about the experiment site, soil and climate is described in this chapter together with the experimental design, layout plan, culture practice, particulars of treatments, planting material and techniques employed for the parameters. Itis located at 25°58’ North latitude and 81°52' East longitude with an altitude of 98 meter above mean sea level. The area of Prayagraj district comes under subtropical belt in the South east of UttarPradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^0C – 48^0C and seldom falls as low as

4^0C – 5^0C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually.

The treatment consisted of nine combination of inorganic source of fertilizers T_1 -(Control), T_2 - (N_2 + F_2) (@ 50%RDF + 3 t ha^{-1} FYM), T_3 - (N_1 + F_2) (@ 100%RDF + 3 t ha^{-1} FYM), T_4 - (N_2 + F_1) (@ 50%RDF + 6 t ha^{-1} FYM), T_5 - (N_1 + F_1) (@ 100%RDF + 6 t ha^{-1} FYM), T_6 - (N_2 + R_2) (@ 50%RDF + 10g kg^{-1} seed *Rhizobium*), T_7 - (N_1 + R_2) (@ 100%RDF +10g kg^{-1} seed *Rhizobium*), T_8 - (N_2 + R_1) (@ 50%RDF + 20g kg^{-1} seed *Rhizobium*), T_9 - (N_1 + R_1) (@ 100%RDF + 20g kg^{-1} seed *Rhizobium*). The trial was laid out in a randomized block design with three replication; plot size was 2 x 2 m for crop seed rate 75-100 kg ha^{-1}**(***cicer arietinum* L.) Var.-samrat. Samrat GNG-469 is a variety of Chickpea, having a source of RAU, Sriganganagar that were released/notified in the year 1997, into the area of adoption zone in the state of Punjab, Haryana, Delhi, North Rajasthan and west Uttar Pradesh which is having yield area 20-22 (Q/ha^{-1}) with 145-150 days of time period for maturity that have resistant of Ascochyta blight. Tolerance to wilt and root rot. Suitable for rainfed and irrigated areas (dpd.gov.in/VARIETIES). The source of Nitrogen, Phosphorus, Potassium, FYM, seed *Rhizobium* were DAP, MOP, *Rhizobium,* FYM respectively. Basal dose of fertilizer was applied in respective plots according to treatment allocation unfurrows opened by about 5 cm. All the agronomic practices were carried out uniformly to raise the crop. Soil samples were collected from the soil 0-15 cm depth and kept in an oven at 1050 C for 48 hrs. for drying, then pass through 2 mm sieve after that soils were analysis by using standard procedures as described for pH 1:2 (m\v) (Jackson 1958), electrical conductivity (dS m^{-1}) (Wilcox 1950), organic carbon % (Walkley and Black, 1947), available nitrogen kg ha^{-1} (Subbiah and Asija 1956), phosphorus kg ha^{-1} (Olsen *et al.*, 1954) and potassium kg ha^{-1} (Toth and Prince 1949). The physico-Chemical properties at the start of experiment are presented in table 1 and 2, respectively.

Results and Discussion

Physico-chemical properties of soil after Post harvest

The result in given table 3 indicates some of the important parameter on physical properties on Chick pea crop. Organic and inorganic fertilizers in conjunction on bulk density, particle density and pore space to be significant. The bulk density was 1.06 Mg m^{-3}. Similar were also reported by Kumar *et al.*, (2015). Particle density was 2.21 Mg m^{-3}. Similar were also reported by Kumar *et al.*, (2015) and pore space was 50.43%. Similar finding observed were Tiwari and Kumar (2009). The slight decreased in bulk density pore space and particle density may be due to tillage operations and plant growth.

As depicted in table 4 indicate some of the important parameter of chemical properties of soil pH 1:2 (w\v), Electrical conductivity was (0.24 dS m^{-1}). Similar results were also reported by Kumar *et al.*, (2015). Organic carbon was (0.46 %). Similar results were also reported by Martı´nez-Romero *et al.*, (2009). Available nitrogen was (357.65 kg ha^{-1}). Results were also reported by Zai *et al.*, (2012). Phosphorus was (38.19 kg ha^{-1}), Potassium was (228.41 kg ha^{-1}) found significant. Similar results were also reported by Datt *et al.*, (2013). There was a slight decrease in soil pH and increase in soil electrical conductivity (dS m^{-1}), organic carbon (%), available nitrogen (kg ha^{-1}), phosphorus (kg ha^{-1}) and potassium (kg ha^{-1}) it may be due to increase in levels of organic fertilizer and plant growth, which increase the plant residue into soil.

Table.1 Physical properties of soil (pre-sowing)

Particulars	Results	Method employed
Sand (%)	62.71	Bouyoucous (1927)
Silt (%)	23.10	
Clay (%)	14.19	
Textural class	Sandy loam	
Bulk density (Mg m^{-3})	1.20	Black (1965)
Particle density (Mg m^{-3})	2.28	Black (1965)
Pore space (%)	47.36	Black (1965)
Water holding capacity (%)	49.32	Black (1965)

Table.2 Chemical properties of soil (pre-sowing)

Particulars	Results	Method employed
Soil EC (dS m^{-1})	0.18	Wilcox (1950)
Soil pH	7.21	Jackson (1958)
Organic Carbon (%)	0.33	Walkley and Black (1947)
Available Nitrogen (kg ha^{-1})	275.18	Subbiah and Asija (1956)
Available Phosphorus (kg ha^{-1})	25.29	Olsen *et al.*, (1954)
Available Potassium (kg ha^{-1})	190.66	Toth and Prince (,1949)

Table.3 Effect of Nutrient Management, FYM and *Rhizobium* of soils physical after harvest of Chick pea

Treatment Combination	BD(Mg m^{-3})	PD (Mg m^{-3})	Pore space (%)	Water holding capacity (%)
T_1 -(Control)	1.18	2.24	50.43	47.72
T_2 -(N_2 + F_2) (@ 50%RDF + 3 t ha^{-1} FYM)	1.17	2.42	45.92	55.96
T_3 -(N_1 + F_2) (@ 100%RDF + 3 t ha^{-1} FYM)	1.16	2.47	44.49	55.24
T_4 -(N_2 + F_1) (@ 50%RDF + 6 t ha^{-1} FYM)	1.14	2.39	45.30	51.48
T_5 -(N_1 + F_1) (@ 100%RDF + 6 t ha^{-1} FYM)	1.12	2.28	46.84	51.02
T_6 -(N_2 + R_2) (@ 50%RDF + 10g kg^{-1} seed *Rhizobium*)	1.09	2.36	43.82	57.18
T_7 -(N_1 + R_2) (@ 100%RDF +10g kg^{-1} seed *Rhizobium*)	1.1	2.33	44.88	53.39
T_8 -(N_2 + R_1) (@ 50%RDF + 20g kg^{-1} seed *Rhizobium*)	1.08	2.21	46.65	49.59
T_9 -(N_1 + R_1) (@ 100%RDF + 20g kg^{-1} seed *Rhizobium*)	1.06	2.23	45.30	58.62
F- test	S	**S**	**S**	**S**
S. Em. (±)	0.02	**0.05**	**1.11**	**2.09**
C.D. at 5%	0.06	**0.14**	**2.36**	**6.26**

Table.4 Effect of Nutrient Management, FYM and *Rhizobium* of soil chemical properties after harvest Chick pea

Treatment Combination	pH 1:2 (w\v)	EC (dS m^{-1})	O.C (%)	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
T_1 -(Control)	7.23	0.15	0.32	270.42	23.24	188.39
T_2 -(N_2 + F_2) (@ 50%RDF + 3 t ha^{-1} FYM)	7.09	0.18	0.38	278.69	26.78	197.37
T_3 -(N_1 + F_2) (@ 100%RDF + 3 t ha^{-1} FYM)	6.95	0.20	0.40	301.47	27.48	208.37
T_4 -(N_2 + F_1) (@ 50%RDF + 6 t ha^{-1} FYM)	7	0.16	0.33	317.47	31.7	212.42
T_5 -(N_1 + F_1) (@ 100%RDF + 6 t ha^{-1} FYM)	7.17	0.22	0.42	346.19	31.71	204.29
T_6 -(N_2 + R_2) (@ 50%RDF + 10g kg^{-1} seed *Rhizobium*)	7.11	0.21	0.35	290.65	32.2	215.25
T_7 -(N_1 + R_2) (@ 100%RDF +10g kg^{-1} seed *Rhizobium*)	7.1	0.18	0.42	347.61	35.92	222.1
T_8 -(N_2 + R_1) (@ 50%RDF + 20g kg^{-1} seed *Rhizobium*)	6.99	0.23	0.43	293.05	34.87	224.46
T_9 -(N_1 + R_1) (@ 100%RDF + 20g kg^{-1} seed *Rhizobium*)	6.88	0.24	0.49	357.65	38.19	228.41
F-test	**S**	**S**	**S**	**S**	**S**	**S**
S. Em. (±)	**0.05**	**0.02**	**0.03**	**7.71**	**1.60**	**1.97**
C. D. at 5%	**0.14**	**0.05**	**0.08**	**23.11**	**4.80**	**5.91**

The soil texture observed was sandy loamy. The soil colour in dry condition was light yellowish brown and wet condition was olive brown. In this experiment evaluated soil physical characters: BD, PD, Pore space, WHC, pH, EC, O.C, N, P_2O_5 and K_2O. Bulk Density (BD) found to be lowest in T_9 (1.06Mg m^{-3}) and found to be highest in T_1 (1.18 Mg m^{-3}). Particle Density (PD) found to be lowest in T_8 (2.21 Mg m^{-3}) and found to be highest in T_3 (2.47 Mg m^{-3}). Pore space found to be highest in T_1 (50.43 %) and found to be lowest in T_6 (43.82 %). Water Holding Capacity (WHC) found to be highest in T_9 (58.62 %) and found to be lowest in T_8 (49.59 %). pH found to be lowest in T_9 (6.88) and found to be highest in T_1 (7.23). Electrical Conductivity (EC) found to be highest in T_9 (0.24dS m^{-1}) and found to be lowest in T_1 (0.15 dS m^{-1}). Organic Carbon (O.C) found to be highest in T_9 (0.49 %) and found to be lowest in T_1 (0.32 %). Nitrogen (N) found to be highest in T_9 (357.65kg ha^{-1}) and found to be lowest in T_1 (270.42 kg ha^{-1}). Phosphorus (P_2O_5) found to be highest in T_9 (38.19 kg ha^{-1} and found to be lowest in T_1 (23.24 kg ha^{-1}). Potassium (K_2O) found to be highest in T_9 (228.41 kg ha^{-1}) and found to be lowest in T_1 (188.39 kg ha^{-1}).

In conclusion the present investigation, it was apparent that application of Nutrient Management, FYM and *Rhizobium*. The combined application of Nutrient Management, FYM and *Rhizobium*, has led to improvement in soil health potential, nutrient availability and yield sustenance under Chickpea cultivation in which found that the

treatment T_9 - (N_1 + R_1) (@ 100% RDF + 20g kg^{-1} seed *Rhizobium*) give best result among other treatments.

Acknowledgements

The authors are grateful to the Vice Chancellor, Departmental Head & Staff of SSAC, SHUATS, Prayagraj for taking their keen interest and encouragement to carry out the research work.

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How to cite this article:

Lokender Singh, Arun Alfred David, Narendra Swaroop and Tarence Thomas. 2020. Assessment of Integrated Nutrient Management on Soil Properties and Yield Attribute of Chickpea (*Cicer arietinum* L.) Var. Samrat. *Int.J.Curr.Microbiol.App.Sci.* 9(08): 3432-3439.
doi: https://doi.org/10.20546/ijcmas.2020.908.397