"IMPACT OF FERTILITY LEVELS AND BIOFERTILIZERS ON CHICKPEA YIELD, SOIL FERTILITY AND ECONOMIC RETURNS"

ABSTRACT

A field experiment was conducted for two*rabi*seasons (2019-20 & 2020-21) at Regional Agricultural Research Station, Nandyala, Andhra Pradesh to study biofertilizers of PSB and inorganic fetilizers on growth, yield and quality Chickpeacrop for Kurnool district of Andhra Pradesh. Afetr two years of the study, Significantly highest available soil Nitrogen (188 kg ha^{-1}), Phosphorous (66.9 kg ha^{-1}) and Potassium (484 kg ha^{-1}) were recorded in treatment T_8 (100% RDF + PSB in liquid form). Significantly highest chickpea yield of 2156 kg ha^{-1} was recorded with T_8 (100% RDF + PSB (liquid form), the lowest yield was recorded with control (1839 kg ha^{-1}). However,this treatment yielded results comparable to all treatments except the controlduring the two *rabi* seasons of 2019-20 and 2020-21. The economic evaluation of biofertilizers and chemical fertilizers application in chickpea crop revealed that maximum net returns (Rs 1,02,675) and higher B: C ratio (3.45) were obtained with application of 50% RDF plus PSB application .The present study was done to study to evaluate the influence of bio fertilizers on growth and yield of chickpea.

Key words : Chickpea crop, Biofertilizers, Soil Fertilityand Benefit cost Ratio

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the world's third most important winter (*rabi*) food legume with 96% cultivation in the developing countries and in India, it occupies 9.18 million ha area, with a production of 8.22 million tonnes registering the productivity of 900 kg/ha (Anonymous, 2017).In India, chickpea was cultivated in an area of 10.74 million ha with a production of 13.54 million tonnes and average productivity was 1261 kg ha-1 in 2021-22 (AIRCP Report 2023).The farmers here uses traditional method and production practices with lack of balanced use of fertilizers that leads to deficiency of nutrient to crops, this acts as a major reason for lacking behind for production compared to other Indian states. Chickpea is the rich source of better quality protein in human diet more than any other pulse crop, it also consist of various nutrients like carbohydrates, proteins, iron, zinc, calcium and magnesium (Jukanti*et al*., 2012). Protein content in thispulse crop varies from 17% to 23% . In soils these plants are the higher consumer of phosphorus (P) because this nutrient is one of the major supporters of biological nitrogen fixation which is done by all leguminous crops. The addition of phosphorus in these crops also provides shoot hardiness, photosynthesis regulation, enhances nodulation, improved grain quality and plant growth, ultimately superior yields (Akansha Singh *et al*., 2021).

Chickpea can fix 140 kg of atmospheric nitrogen per hectare with its ability of symbiotic nitrogen fixation. However, excessive cultivation and growing of nutrientexhausting crops have caused the soil deficient in macro- as well as in micronutrients due to nutrient mining. Nowadays, the use of only nitrogenous fertilizers has contributed to soil nutrient imbalance, notably in terms of the availability of micronutrients. The nutrient application must be adjusted for agricultural production because unbalanced use lowers crop yields. Nonetheless, a little amount of nitrogenous fertilizer is needed during the early stages of crop establishment because grams is a leguminous crop and can meet a large portion of its nitrogen needs by fixing atmospheric nitrogen. Phosphorus (P) is known to be one of the important elements involvedin plant nutrition because of its role in several functions related to the growth, development, and metabolism of the plant.

It is also known as the "energy currency" of the plants (Dey *et al*. 2017) as it controls many metabolic activities within the plants. It plays an important role in root growth and development, stalk strength, formation of flower and seed, hastens crop maturity, and stimulates biological activities like nodulation and N2 fixation, thereby improving the yield of crops (Singh and Singh 2016). Phosphorus aids in healthy root growth, which increases root nodules and then speeds up the organic process. The deficiency of P is one of the major limitations in crop production (Lynch and Brown 2008). In India, the majority of the soils are low to medium in available P status (Pathak 2010) and most of the P applied to the soil in the form of chemical fertilizers gets fixed and becomes unavailable to the plants for utilization (Aman Parashar *et al*. 2024).

Bio fertilizers have been identified as an alternative to chemical fertilizers to increase soil fertility and crop production in sustainable farming. Bio-fertilizer are inexpensive and ecofriendly. Biggest challenge in the bio-fertilizer is the survival of organisms up to time of field application. In Carrier-Based (Solid) Organic Fertilizers; there is only six months shelf life in microorganisms. Liquid bio-fertilizer technology is an alternative solution to (Solid) carrier based bio-fertilizers. These liquid bio fertilizers microbes shelf life is higher than carrier based bio-fertilizers without considerable loss in viable counts. Liquid formulation of bio-fertilizer plays a vital role in helping to solve the increasing shelf life in microorganisms. In current study the liquid bio-fertilizer is best way of sustainable agriculture for crop production.

MATERIALS & METHODS:

The field experiments were conducted during the *rabi* seasons of crop years, 2019-20 & 2020-21 at Regional Agricultural Research Station, Nandyala, Andhra Pradesh, under rainfed conditions. The soil of experimental site was medium deep black, low in organic carbon (0.36%), low in Nitrogen (142 kg/ha) high in available P_2O_5 (58.2 kg ha^{-1}) and available K_2O (488 kg ha^{-1}). A composite soil sample was collected from 0-20 cm depth during the study years, processed and analysed in laboratory for pH and Electrical Conductivity(EC) (1:2 soil : water suspension), by pH and Ec meters, respectively (Jackson 1973) . Organic Carbon percentage (O.C) was estimated by rapid titration method (Walkley and Black method 1934) .Available nitrogen was estimated by alkaline permanganate method (Subbaiah and Asija 1956). Available phosphorus by Olsens method (Olsen *et al.*1954). Available potassium by ammonium acetate extraction method (Jackson 1973). The experiment was laid out in randomized block design with 08 treatments and replicated in three times. Chickpea (NBeG-3) was sown during second week of October, by adopting 30x10 cm spacing and fertilizers applied as per the treatments protocol. The crop cultural practices were carried out according to the standard practices in the chcikpea fields and harvested at 120 days after sowing. The data related to plant height and yield attributes was recorded on five randomly selected plants in each plot. Net seed and haulm yield were recorded for net plot and computed as kg ha^{-1}. Soil and plant samples were collected in each treatment and analysed by following standard procedures. All the data was subjected to statistical analysis. The details of treatments were depicted below.

T_1 - Control

T_2 - 100% RDF (20-40-0 N,P_2O_5 and K_2O Kg/ha)

T_3 - 50% RDF + PSB (lignite form)

T_4 - 50% RDF + PSB (liquid form)

T_5 - 75% RDF +PSB (lignite form)

T_6 - 75% RDF + PSB (liquid form)

T_7-100% RDF + PSB (lignite form)

T_8 - 100% RDF + PSB (liquid form)

RESULTS & DISCUSSION

YIELD AND YIELD ATTRIBUTES

The data pertaining to two years mean pooled data of chickpea crop yield and yield attributes were presented in Table 1.Significantly highest chickpea yield of 2156kgha^{-1} was recorded with T_8 (100% RDF + PSB (liquid form), the lowest yield was recorded with control (1839 kg ha^{-1}).However, this treatment yielded results comparable to all treatments except the controlduringthe 2019-20 and 2020-21. This might be due to the fact that phosphorus being an energy bond compound and its major role is transformation of energy essential for almost all metabolic processes viz., photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis of protein and carbohydrate metabolism which ultimately increase all the growth attributes and dry weight of plants. More solubility of P and other nutrients which increased the nutrient availability resulted in sufficient formation of photosynthates which promotes the metabolic activities, accelerates cell division and formation of meristem. Similar findings were reported by Chandra and Pareek (2002), Tiwari *et al*. (2005) and Jarande*et al*. (2006).The application of 100% RDF + PSB increases the fresh and dry weight of root nodule plant^{-1}, plant height, no of pods per plant and test weight of chickpea crop when compared to control. The inoculation of PSB increases the availability of enzymes and vitamins in soil and due to this enzyme activity the number of microbial population increases and this increased population of bacteria, and actinomycetes recharge the soil with conditioner. The inoculation of PSB both in liquid and lignite forms works as a soil conditioner which enhance the nutrient availability.

Yield attributes which determine yield, is resultant effect of the vegetative development of crop. Yield attributes, viz. number of branches/ plant, number of pods/ plant and number of seeds/ pod in significantly affected by different fertility levels except 100-seed weight. This increase in number of seeds/pod due to application of higher dose of fertilizers might have resulted from optimum fertilization of flowers and increased pollen grain viability and there by increased number of seeds/ pod (Gaurav Verma*et al*. 2019).

Treatments haveinfluenced the yield attributes, viz. Plant height, number of branches/plant, number of pods per plant and numbers of seeds/podand 100-seed weight (Table 1).PSB helps in nodule formation because PSB increases the phosphorus availability and this available phosphorus has direct role in biological nitrogen fixation in legumes which ultimately increase the activity of microorganism and this increased microorganism which help in nodule formation. Sufficient amount of nodule formation increases the weight of nodule. The increases in fresh and dry weight of root nodule were highest in treatment T8 (Rhizobium, PSB and azotobacter). Similar results are also reported by Singh *et al*., (2007).Application of biofertilizer increased seed, stover and biological yield this was due to marked improvement in dry matter accumulation, yield attributes and greater nutrient content and their uptake by chickpea. The probable reasons for such results could be because of certain growth promoting substances secreted by the microbial inoculants, which is turn might have led to better root development, better transpiration of water, uptake and deposition of nutrients (Gaurav Verma*et al*. 2019).

AVAILABLE SOIL NUTRIENTS AFTER HARVEST OF THE CROP

The data regarding the available plant nutrient after the harvest of the crop (Table 2) revealed that the build-up of available N, P and K increased with the application in increasing levels of P up to 50 kg ha^{-1}. Significantly highest available soil Nitrogen (188 kg ha^{-1}), Phosphorous (66.9 kg ha^{-1}) and Potassium (484 kg ha^{-1}) were recorded in treatment T_8 (100% RDF + PSB in liquid form). In general, N status increased with an increase in the levels of P and biofertilizers (PSB). This might be attributed to the application of P and biofertilizers which enhanced and established betterroot system. Nutrients possibly stimulate the nodulating bacteria for more fixation of atmosphere Nitrogen resulting in an increase (25.53 %) of its contents in the soil over control. Available P content of soil increased after harvesting of chickpea crop by 16.0 per cent over Initial soil P, with increasing the levels of P and biofertilizers application which might be due to favourable condition for availability of nutrients in the soil. Available K content of soil increased (11.9 % over control) after harvesting of chickpea with increasing levels of RDF and biofertilizers application might be due to better establishment of crop which improved the availability of most of the nutrients including K. These results are also in agreement with those obtained by Kumar *et al*. (2019).

ECONOMICS

The economic evaluation of biofertilizers and chemical fertilizers application in chickpea crop revealed that maximum net returns (Rs 1,02,675)and higher B: C ratio(3.45)were obtained with application of 50% RDF plus PSB application. This could be due to higher economic yields obtained in these treatments and lower cost of cultivation. The lower cost incurred on PSB application increased the net returns and B: C ratio (3.45) in 50% RDF + PSB treatment. But the application of 100 % RDF plus PSB (T8) recorded lowest B: C ratio (1.29) mainly due to higher cost of cultivation. Similar results were found by Swaminathan *et al*. (2007) andPrabhu*et al*. (2010) and Sandeep Yadav*et al*. (2021)in chickpea crops.

CONCLUSIONS:

Afetr two years of the study, Significantly highest available soil Nitrogen (188 kg ha^{-1}), Phosphorous (66.9 kg ha^{-1}) and Potassium (484 kg ha^{-1}) were recorded in treatment T_8 (100% RDF + PSB in liquid form). Significantly highest chickpea yield of 2156 kgha^{-1} was recorded with T_8 (100% RDF + PSB (liquid form), the lowest yield was recorded with control (1839 kg ha^{-1}).However, this treatment yielded results comparable to all treatments except the controlduringthe two*rabi* seasons of 2020-21 and 2021-22.The economic evaluation of biofertilizers and chemical fertilizers application in chickpea crop revealed that maximum net returns and higher B: C ratiowere obtained with application of 50% RDF plus PSB application (Rs 1,02,675)& (3.45).

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Table 1: Influence of biofertilizers and Fertilizers on yield attributes and yield of Chickpea crop for two years (2019-20 & 2020-21)

Treatment	Plant height (cm)	No.of pods plant^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Harvest Index (%)
T_1: Control	37.2	37.2	27.2	1839	43.30
T_2: 100% RDF	39.3	42.4	28.7	2081	48.45
T_3: 50% RDF + PSB (lignite form)	37.3	42.0	28.0	2047	48.33
T_4: 50% RDF + PSB (liquid form)	38.7	41.9	28.2	1981	48.83
T_5: 75% RDF +PSB (lignite form)	38.2	44.4	29.0	2062	43.82
T_6: 75% RDF + PSB (liquid form)	38.4	45.7	28.9	2072	43.12
T_7: 100% RDF + PSB (lignite form)	37.9	46.5	29.3	2028	43.06
T8: 100% RDF + PSB (liquid form)	39.0	47.4	29.3	**2156**	48.31
SE.m=/-	1.74	3.1	1.40	108.7	
CD at 5%	**NS**	**8.2**	**NS**	**266.2**	
C. V. (%)	7.25	27.73	8.80	10.47	

Table 2: Soil fertility status after harvest of Chickpea crop

Treatments	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
T_1: Control	138	49.5	426
T_2: 100% RDF	162	55.85	449
T_3: 50% RDF + PSB (lignite form)	161	61	419
T_4: 50% RDF + PSB (liquid form)	141	56.6	402
T_5: 75% RDF +PSB (lignite form)	162	61.45	469
T_6: 75% RDF + PSB (liquid form)	151	53.35	418
T_7: 100% RDF + PSB (lignite form)	153	56.35	434
T8: 100% RDF + PSB (liquid form)	188	66.9	484
SE.m=/-	8.25	3.01	21.14
CD at 5%	20.7	8.75	NS
C. V. (%)	8.6	9.0	8.4
Soil initial properties	140	56.2	480

Table 3. Economics of Chickpea crop as influenced by chemical fertilizers and biofertilizers

Treatments	Seed yield (kg ha^{-1})	Haulm Yield (kg ha^{-1})	Biological Yield (kg ha^{-1})	Cost of cultivation (Rs)	Gross returns (Rs)	Net returns (Rs)	B:C Ratio
T_1: Control	1838	2132	3970	52400	100600	48200	1.08
T_2: 100% RDF	2081	2214	4295	58500	134517	76017	1.29
T_3: 50% RDF + PSB	2047	2188	4236	29750	132425	102675	3.45
T_4: 50% RDF + PSB	1980	2075	4056	30100	127699	97599	3.24
T_5: 75% RDF +PSB	2061	2643	4705	45300	137753	92453	2.04
T_6: 75% RDF + PSB	2071	2732	4804	45800	139182	93382	2.03
T_7: 100% RDF + PSB	2028	2682	4710	59300	136333	77033	1.29
T8: 100% RDF + PSB	2155	2821	4976	59800	144610	84810	1.41

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