Effect of different ~~legume~~ green manuring cropses ~~and~~ fertilizer doses on growth and yield of chickpea (C*icer arietinum* ~~L~~L.).

ABSTRACT

A field experiment was conducted at Mahanandi, Nandyal during *rabi* season of 2021-22 to evaluate the effect of different green manure crops on growth and yield of succeeding chickpea. Four green manure crops along with one control were grown *in situ* and incorporated into the soil before sowing of chickpea crop in respective treatments and different levels of fertilizers were applied to study their interaction effect on growth and yield attributes, nutrient uptake and economics of succeeding chickpea. Growth attributes like plant height (40.7 ~~&~~ and 41.2 cm), number of branches plant^{-1} (26.1 ~~&~~ and 27.1), dry matter accumulation (3873 & 3642 kg ha^{-1}) and earlier days to 50 % flowering (53.3 & 53.8 days); grain (876 & 874.6 kg ha^{-1}), haulm (884.3 & 873.2 kg ha^{-1}) yield was found to be highest in the treatment with incorporation of cowpea as preceding green manure and with the application of 100 % RDF. The treatment was at par with greengram and pillipesara green manuring and with application of 75 % RDF.

Keywords: Chickpea, Cowpea, Fertilizers, Green manuring, Greengram, Pillipesara

Comment [SC1]: add names

Comment [SC2]: elucidate

Comment [SC3]: correct

Comment [SC4]: ?

Comment [SC5]: ?

Comment [SC6]: ?

I. Introduction

Chickpea, commonly known as gram or bengal gram, is an important *rabi* pulse crop cultivated in India for its economic purpose besides maintaining soil fertility. In India, chickpea is cultivated in 9.69 million hectares of area with a production of 11.07 million tonnes and with a productivity of 1142 kg ha^{-1} (*www.indiastatagri.com*, 2020-21). In Andhra Pradesh, it is cultivated in 0.45 million hectares of area with a production of 0.55 million tonnes and with a productivity of 1218 kg ha^{-1} (*www.apdes.ap.gov.in.* 2020-21).

Comment [SC7]: This isn't a proper citing style

Comment [SC8]: check

The rampage use and complete dependence on inorganic nutrient sources to fulfil nutritional requirement of chickpea, not only increases the cost of cultivation but also makes the soil infertile and less productive due to the absence of the organic matter. Hence, serious attention must be taken in nutrient management of chickpea. The integrated application of organic manures and inorganic fertilizers maintain optimum crop yields and long term soil productivity. Legumes, as a restorative crops, gained most of the importance as green manures due to higher biomass productivity and biological fixation leads to sustainable agriculture development Leguminous plants like greengram, cowpea, pillipesara and horsegram are largely used for green manuring due to their biological nitrogen-fixing ability, drought tolerance, quick growth and adaptation to adverse environmental conditions.

Though chickpea is a legume that is capable of fixing atmospheric nitrogen, a proper starter dose is essential for the growth and development of the plant (Namvar *et al.*, 2011).

An adequate supply of phosphorous is important for the development of roots as well as seed formation and yields up the soil fertility by fixing a large amount of atmospheric nitrogen through root nodules (Singh *et al.*, 2018).

Comment [SC9]: Needs reorganization of the paragraphs. better to combine in one. Please improve then justification of the study

Growing of green manure crops in *kharif* and their incorporation into the soil before sowing chickpea can minimise the nutrient requirement of the crop and also sustains soil health and productivity. In this context, the present experiment was proposed to evaluate effect of different green manures, to optimize the fertilizer dose for the enhanced yield of chickpea and to study the interaction effect between green manures and fertilizers.

II. MATERIALS AND METHODS

A field experiment was carried out at college farm of Agricultural College, Mahanandi on "Effect of different green manure crops in minimizing the nutrient use in chickpea (*Cicer arietinum* L.)" under scare rainfall zone of Andhra Pradesh during *rabi* 2022. The experimental site was located at 15^0.51' N latitude and 78^0.61' E longitude and the soils of the experimental field was sandy loam in texture, slightly alkaline in pH (7.33), low in organic carbon (0.49 %) and available nitrogen (258 kg ha^{-1}), medium in available P_2O_5 (48.3 kg ha^{-1}) and high in available K_2O (584 kg ha^{-1}). The experiment was laid out in split-plot design and replicated three times with a plot size of 24 m^2 comprising of five main plots *viz.*, M_1: control (no green manure), M_2: cowpea, M_3: greengram, M_4: horsegram, M_5: Pillipesara and four sub plots with S_1: 25 % RDF (5 kg N ha^{-1} + 12.5 kg P ha^{-1}), S_2: 50 % RDF (10 kg N ha^{-1} + 25 kg p ha^{-1}), S_3: 75 % RDF (15 kg ha^{-1} + 37.5 kg ha^{-1}) and S_4: 100 % RDF (20 kg N ha^{-1} + 50 kg P ha^{-1}). Green manure crops *viz.*, cowpea, greengram, horsegram and pillipesara were seeded respectively during the last week of June 2021 except in the control plot. The green manures were allowed to grow upto flowering stage *i.e.*, 45 DAS and the residues were incorporated into the soil with the help of rotovator. Proper care was taken to avoid mixing of residues from one plot to another plot. The residues were allowed to decompose for about a month. In *rabi*, 2021-22 chickpea variety (NBeG-3) was sown on 16-10-2021 in all the treatment plots. Before sowing, fertilizer doses was applied basally to the treatments as required. Both nitrogen and phosphorous was applied in the form of urea and SSP basally in sub plots as prescribed. All the recommended package of practices were followed for chickpea. Pre harvest observations like plant height (cm), number of branches, dry matter accumulation (kg ha^{-1}), days to flowering were recorded at regular intervals and post harvest observations like number of pods per plant, number of seeds per pod, grain and haulm yield, harvest index was recorded after the harvest of the crop. Before sowing, the soil organic matter, soil pH, soil available nitrogen, phosphorus and potassium were determined by using soil analysis methods (Table 1).

Comment [SC10]: How the data were analysed. Elaborate.....

Table 1. Chemical properties of soil before sowing

S. No.	Particulars	Value	Method of analysis
I. Chemical characteristics			
a.	Soil pH (1:2.5 Soil water suspension)	7.33	Glass electrode pH meter (Jackson, 1973)
b.	Electrical Conductivity (dS m^{-1})	0.24	Conductivity bridge (Jackson, 1973)
b.	Organic carbon (%)	0.49	Wet digestion method (Walkley and Black, 1934)
c.	Available N (kg ha^{-1})	258	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
d.	Available P_2O_5 (kg ha^{-1})	49	Olsen's method (Olsen *et al*., 1954)
e.	Available K_2O (kg ha^{-1})	584	Flame photometry method (Jackson, 1973)

RESULTS AND DISCUSSION

Effect of Green manures

Growth parameters

Growth attributes like plant height (cm), number of branches, dry matter accumulation, days to 50 % flowering of chickpea were significantly influenced by legume green manuring. Table 2.

Plant height

Taller plants was observed with cowpea (M_2) (40.7 cm) green manuring which was at par with greengram (M_3) (39.3 cm) and pillipesara (M_5) (39.6) green manuring and differs significantly with horsegram (M_5) (38.9) green manuring. Shorter plants were observed with control (M_1) (37.1 cm).

Number of branches

Chickpea recorded more number of branches with *in situ* green manuring of cowpea (M_2) (26.1) with no significant difference between greengram (M_3) (24.4) and pillipesara(M_4) (25.9) but differs significantly with horsegram (M_5) (23.4) green manuring. Significantly lower number of branches were observed in control (M_1) (22).

Dry matter accumulation

Dry matter accumulation of chickpea was higher in green manuring with cowpea (M_2) (3873.3 kg ha^{-1}) which was at par with greengram (M_3) (3665 kg ha^{-1}), green manuring. Significantly lower dry matter accumulation was observed in control (M_1) (2921 kg ha^{-1}).

Days to 50 % flowering

Chickpea plants without green manuring i.e., control (M_1) (54.7) was at par with greengram (M_3) (54.1), pillipesara (M_5) (54.6) and horsegram (M_4) (54.6) green manuring and took significantly more days to 50 % flowering over cowpea (M_2). The least number of days to 50 % flowering was recorded under cowpea (M_2) (53.3) green manuring.

The predictable reasons for recording higher growth attributes in chickpea might be due to incorporation of legume biomasses have mobilized and enhanced the availability of macro and micro nutrients during early stages of crop growth as reported by **Rani *et al*. (2022).** The other reason might be increased availability of growth nutrients enhanced cell division and enlargement, photosynthesis that supported for a quantitative increase in growth (Panwar 2008).

Comment [SC11]: Discussion should be attribute specific. Needs improvement.

YIELD ATTRIBUTES

Yield attributes like number of pods per plant, grain and haulm yield, harvest index was significantly influenced by different green manure incorporation except number of seeds per pod of chickpea.

Number of pods per plant

Higher number of pods per plant^{-1} of chickpea was with cowpea (M_2) (34.3) green manuring but it was comparable in green manuring with greengram (M_3) (32.7) and pillipesara (M_5) (31.9), which were found to be significant over horsegram (M_5) (30.3). Significantly, less number of pods per plant was recorded in control (M_1) (27.7).

Grain and haulm yield

Grain yield ad haulm yield of chickpea were influenced significantly with in situ incorporation of legume green manures. Higher grain and haulm yield was observed with cowpea (M_2) (876.3 & 884.3 kg ha^{-1}) as a green manure which was significantly superior over horsegram (M_4) (799.7 & 725.9 kg ha^{-1}) green manuring, but it was at par with greengram (M_3) (831.3 and 861 kg ha^{-1}) and pillipesara (M_5) (810.5 & 836.6 kg ha^{-1}) green manuring. Significantly lower yields were observed in control (M_1) (571.5 & 624.8 kg ha^{-1}).

Harvest index

Significantly higher harvest index of chickpea was recorded with cowpea (M_2) (49.6 %) green manuring over control (M_1) (45.7 %) (without green manuring). Green manuring with greengram (M_3) (48.7 %), pillipesara (M_5) (48.0 %) was at par with cowpea (M_2) and differs significantly with horsegram (M_4) (47.4 %) green manuring. Significantly, lower harvest index was recorded in control (M_1) (45.7 %).

Higher yield attributes were recorded with legume green manures, this might be due to addition of green biomass to the soil before sowing of chickpea might enhanced microbial activity in the soil which triggered the release of unavailable form of nutrients to available form to the soil nutrient pool thus increasing nutrient concentration in the soil that finally lead

to plant uptake that enhanced plant metabolic process, enzyme activity, translocation of nutrients from source to sink with effective portioning of photosynthates to economic parts eventually led to increase in grain and haulm yield as reported by Nikita *et al*. (2015), Rani *et al*. (2022), Ramanjaneyulu *et al.* (2021).

EFFECT OF FERTILIZER LEVELS

Growth parameters

Plant height

Application of 100 % RDF (S_4) (41.2 cm) recorded taller plants which was corresponding to application of 75 % RDF (S_3) (40.2 cm) but differs significantly with 50 % RDF (S_2) application (38.6 cm). Shorter plants were observed with 25 % RDF (S_1) (36.9 cm).

Number of branches per plant

Significantly greater number of branches per plant in chickpea were recorded with the application of 100 % RDF (S_4) (27.1) over 25 % (S_1) (21.5) and 50 % RDF (S_2) (22.9) but which was at par with 75 % of RDF (S_3) (26).

Dry matter accumulation

Application of 100 % RDF (S_4) (3642.9 kg ha^{-1}) resulted significantly high dry matter accumulation of chickpea which was near to 75 % RDF (S_3) (3483.6 kg ha^{-1}) than 25 % (M_1) (3064.9 kg ha^{-1}) and 50 % RDF (M_2) (3327.5 kg ha^{-1}). Significantly lower dry matter was accumulated in control (M_1) (3064.9 kg ha^{-1}).

Days to 50 % flowering

Days to 50 % flowering was decreased substantially with increase in fertilizer levels. Significantly, earlier days to 50 % flowering was recorded with 100 % RDF (S_4) (53.8) than with 75 % (S_3) (54.2), 50 % (S_2) (54.6) and 25 % RDF (S_1) (54.6).

Growth attributes were pronounced more positively with the application of higher doses of fertilizers this might be due to improvement in quantity of the nutrient pool of the soil. Addition of nutrients through inorganic source to the soil coupled with addition of nutrients with green manure incorporation boosted vigorous growth stature of crop that resulted in greater photosynthesis that eventually led to crop growth and development. Rani and Krishna (2016) reported, with the application of 40 kg N ha^{-1} have increased growth parameters when compared to lower doses of fertilizer application. The results were in conformity with the findings of Suresh Goyal et al. (2010), Neenu et al. (2014), Das et al. (2016), Nawange et al. (2018), Navya et al (2020),

Table 2: Effect of different green manures and fertilizer doses on growth attributes of chickpea

Treatments	Plant height (cm)	Number of branches	Dry matter accumulation (kg ha^{-1})	Days to 50 % flowering
Green manures (M)				
M_1 - Control	37.10	22.01	2921.07	54.75
M_2 - Cowpea	40.70	26.13	3873.32	53.33
M_3 - Greengram	39.96	24.45	3665.57	54.16
M_4 - Horsegram	38.97	23.45	3031.28	54.66
M_5 - Pillipesara	39.65	25.99	3407.43	54.66
SEm±	0.491	0.601	80.787	0.263
CD (P=0.05)	1.62	1.99	267.54	0.87
Fertilizer doses (S)				
S_1 – 25 % RDF	36.97	21.51	3064.79	54.66
S_2 – 50 % RDF	38.62	22.90	3327.55	54.66
S_3 – 75 % RDF	40.29	26.06	3483.64	54.13
S_4 – 100 % RDF	41.22	27.16	3642.96	53.80
SEm±	0.807	0.738	97.692	0.222
CD (P=0.05)	2.34	2.14	283.51	0.64
Green manures (M) x Fertilizer doses (S)				
M at S				
SEm±	1.638	1.551	205.707	0.504
CD (P=0.05)	NS	NS	NS	NS
S at M				
SEm±	0.981	1.203	161.574	0.526
CD (P=0.05)	NS	NS	NS	NS

Yield parameters

Application of higher doses of fertilizers significantly improved yield attributes of chickpea viz., number of pods per plant, grain and haulm yield, harvest index significantly except for number of seeds per pod in chickpea. (Table 3).

Number of pods per plant

Among different doses of fertilizer application, application of 100 % RDF (S_4) (34.2) resulted in significantly higher number of pods plant^{-1} which was equivalent with application of 75 % of RDF (S_3) (32.9). Difference between 75 % RDF (S_3) (32.9) and 50 % RDF (S_2) (30.5) in producing number of pods per plant was found to be non significant. The least number of pods plant^{-1} was recorded with 25 % RDF (S_1) (27.9).

Grain and haulm yield

Higher grain yield of chickpea was recorded with the application of 100 % RDF (S_4) (874.6 & 873.2 kg ha^{-1}) followed by application of 75 % RDF (S_3) (830.3 & 805.1 kg ha^{-1}) which differs significantly with the application of 50 % RDF (S_2) (740.8 & 748.5 kg ha^{-1}). Significantly lower grain and haulm yield was recorded with the application of 25 % RDF (S_1) (665.4 & 718.5 kg ha^{-1}).

Harvest index

Application of 100 % RDF (S_4) resulted in high harvest index (49.2 %) which was at par with the application of 75 % RDF (S_3) (48.6 %) and was found to be significant with the application of 50 % RDF (S_2) (47.0 %). Significantly lower harvest was observed with the application of 25 % RDF (S_1) (46.8 %).

Better yield attributes of chickpea were pronounced with application of 100 % RDF which might be due to application of higher doses of fertilizers increases nutrient concentration that promotes development of all growth parameters like plant height, number of branches, dry matter accumulation etc., which increased economic yield of the crop. Increase in application of phosphorous helps in cell division, development of root nodules and helps in nitrogen fixation (Neenu *et al.,* 2014) which mobilized nutrients from soil to plant and thus increased grain and straw yield in chickpea. Similar findings were reported by Devendra and Harendra (2012), Hussen *et al.* (2015), Das *et al*. (2016), Rani *et al.* (2016) and Singh *et al.* (2018),

Table 3: Effect of different green manures and fertilizer doses on yield attributes of chickpea

Treatments	Number of pods plant^{-1}	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
Green manures (M)				
M_1 - Control	27.76	571.59	624.81	45.72
M_2 - Cowpea	34.33	876.03	884.32	49.60
M_3 - Greengram	32.70	831.35	861.04	48.71
M_4 - Horsegram	30.38	799.75	725.09	47.48
M_5 - Pillipesara	31.90	810.55	836.64	48.08
SEm±	0.873	22.612	23.914	0.627
CD (P=0.05)	2.89	74.885	79.19	2.07
Fertilizer doses (S)				
S_1 – 25 % RDF	27.94	665.49	718.52	46.84
S_2 – 50 % RDF	30.50	740.87	748.57	47.02
S_3 – 75 % RDF	32.96	830.37	805.18	48.61
S_4 – 100 % RDF	34.25	874.69	873.24	49.28
SEm±	1.009	17.796	23.191	0.661
CD (P=0.05)	2.92	51.648	67.30	1.91
Green manures (M) x Fertilizer doses (S)				
M at S				
SEm±	2.140	41.218	50.879	1.425
CD (P=0.05)	NS	NS	NS	NS
S at M				
SEm±	1.746	45.224	47.828	1.254
CD (P=0.05)	NS	NS	NS	NS

Interaction effect between green manures and fertilizer doses

The interaction effect between green manures and fertilizer doses on growth and yield attributes was found to be statistically non significant.

Conclusion

Incorporation of green manures like cowpea, greengram or pillipesara as pre green manuring during *kharif* season and cultivation of chickpea in *rabi* along with the application of 100 % RDF resulted in higher growth and yield attributes of chickpea on sandy loam soils of Kurnool, Andhra Pradesh. Instead of leaving land fallow green manuring with legumes protect soil from erosion and loss of nutrients and also helps in development in physical, chemical and biological properties of the soil.

References:

Namvar, A. and Sharifi, R.S. 2011. Phenological and morphological response of chickpea (*Cicer arietinum* L.) to symbiotic and mineral nitrogen fertilization. *Zemdirbyste Agriculture.* **98** (2): 121-130.

Singh, R., Singh, D., Pratap, T., Abhinav Kumar, S., Singh, H and Dubey. 2018. Effect of different levels of phosphorus, sulphur and biofertilizers inoculation on nutrient content and uptake of chickpea (*Cicer arietinum* L.). *International Journal of Chemical Studies.* **6** (6): 2574-2579.

Rani, Y.S. Jamuna, P., Triveni, U. Patro, T.S.S.K and Anuradha, N. 2022. Effect of *in situ* incorporation of legume green manure crops on nutrient bioavailability, productivity and uptake of maize. *Journal of Plant Nutrition.* **45** (7): 1004-1016.

Panwar, A. S. 2008. Effect of integrated nutrient management in maize (Zea mays)-mustard (*Brassica compestrisvar toria*) cropping system in mid hills altitude. *Indian Journal of Agricultural Sciences* **78**: 27–31.

Nikita, C., Patel, P.H and Patel, A.G. 2015. Growth, Yield and Economics of *Rabi* Sweet Corn (*Zea mays*) as affected by green Manuring crops and nitrogen Management. *Trends in Biosciences.* **8** (8): 1943-1949.

Ramanjaneyulu, A.V., Sainath, N., Swetha, D., Reddy, R.U and Jagadeeshwar, R. 2021. Green manure crops-a review. *Biological Forum – An International Journal*. **13** (2): 445-455.

Suresh Goyal., Verma, H.D. and Nawange, D.D. (2010) studies on growth and yield of kabuli chickpea (Cicer arietinum l.) genotypes under different plant densities and fertility levels. *Legume Research.* **33:** 221 – 223.

Navyasree, C., Umesha, C., Prasanthi, M and Sai Kumar, B. 2020. Effect of phosphorus and iron levels on growth and economics of chickpea (*Cicer arietinum* L.). *International Journal of Chemical Studies.* **8** (6): 2295-2297.

Neenu, S., Ramesh, K., Ramana, S., Biswas, A.K and Subba Rao, A. 2014. Growth and yield of different varieties of chickpea (*Cicer arietinum* L.) as influenced by the phosphorus nutrition under rainfed conditions on vertisols. *International Journal of Bio-Resource and Stress Management.* **5** (1): 53-57.

Das, S.K., Biswas, B and Jana, K. 2016. Effect of farmyard manure, phosphorus and sulphur on yield parameters, yield, nodulation, nutrient uptake and quality of chickpea (*Cicer arietinum* L.). *Journal of Applied and Natural Science*. **8** (2): 545-549.

Nawange, D.D., Verma, H and Hemlata, V. 2018. Growth and yield performance of kabuli chickpea (*Cicer arietinum* L.) genotypes under different planting geometry and fertility levels in Vindhya Plateau Region. *International Journal of Agricultural Sciences.* **10** (5): 5291-5293.

Devendra, S. and Harendra, S. 2012. Effect of phosphorus and zinc nutrition on yield, nutrient uptake and quality of chickpea. *Annals of Plant and Soil Research.* **14** (1): 71-74.

Hussen, S., Yirga, F and Tibebu, F. 2015. Effect of phosphorus fertilizer on yield and yield components of chickpea (*Cicer arietinum* L.) at Kelemeda, South Wollo, Ethiopia. *International Journal of Agricultural Extension and Rural Development Studies.* **1** (1): 29-35.