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Original Research Article

Effect of Inorganic and Organic Nutrients on Growth and Yield of Summer Green Gram (*Vigna radiata* L. wilczek)

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A B S T R A C T

A field experiment was carried out during the summer season of the year 2019 at the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat), with a view to study the inorganic and organic nutrients on growth and yield of summer green gram (*Vigna radiata* L. wilczek). The experiment was laid out in a Randomized Block Design with eight treatments and four replications. The results revealed that growth parameters *viz.*, plant population, plant height, dry weight of nodules, plant dry biomass, No. of branches. Yield parameters *viz.*, No. of pods, seed yield, haulm yield, test weight, harvest index were recorded higher in treatment with 50% RDF + 0.5 t ha^{-1} vermicompost + seed treatment with BioNP + jeevamrut spraying. The plant population does not influenced by any treatment in green gram. Treatment with RDF (20-40-00 kg NPK ha^{-1}) was found superior by recording maximum BCR followed by treatment with 50% RDF + 0.5 t ha^{-1} vermicompost + seed treatment with BioNP.

Keywords

Green gram, Vermicompost, BioNP, Jeevamrut

Introduction

Pulses are commonly known as food legumes which are secondary to cereals in production and consumption in India. Pulses play an important source of dietary protein, energy, minerals and vitamins for the mankind. Pulses provide 25% of protein requirements of predominantly vegetarian population. United Nations declared 2016 as "International Year of Pulses" (IYP) to heighten public awareness of nutritional benefits of pulses as part of sustainable food security and nutrition. Pulses account for around 20% of the area under food grain and contribute around 7-10% of total food grains production in the country (Mohanty and Satyasai, 2015) as well as build up soil fertility by adding atmospheric nitrogen (average 30-50 kg ha^{-1}) in soil so, it's called as mini fertilizer factory. Pulses are called as "Marvel of Nature". Pulses are cheaper than meat; they are often referred to as "Poor man's meat" in developing countries like India. India is the largest producer and consumer of pulses in the world accounting for 32% of world area and 25% of production. Nearly 8% of the pulse area is occupied by green gram, which is the third most important pulse crop of India in terms of area cultivated and production next to

chick pea and pigeon pea. Against the production of 24.60 Mt during 2018-19 (from 25.21 M ha area), consumption of pulses in India has been around 26-27 Mt. Green gram grown usually as rainfed crop and can also be grown as pre-monsoon (summer) and late monsoon crop. In India, it occupied an area of 3.019 M ha having total production of 1.44 Mt of grain with the productivity of 461 kg ha^{-1} (Anonymous, 2018).

Foliar feeding of nutrients is an effective method for improving soil deficiencies and overcoming the soils inability to transfer nutrients to the plant. It has been reported that, foliar feeding is more effective than soil feeding and up to 90% of a foliar fed nutrient solution can be found in the smallest root of a plant within 60 minutes of application. The organic manures provides a good source of nutrients and can serve as alternative practice to mineral fertilizers for plants. In plant nutrition, manure and compost play important role, as they act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. Organic manures help to maintain physical, chemical and biological properties of soil.

Vermicompost is also another commonly used organic manure which is rich in both macro and micronutrients, besides having plant growth promoting substances, humus forming microbes and nitrogen fixers (Bano *et al*.1987). Jeevamrut consists of five products *viz.,* cow dung, cow urine, pulse flour, jaggery and rich soil, it is used in widely for agriculture and horticultural crops. Use of organic manures and bio-fertilizers to enhance the crop production as these are gentler on the soil as compared with the chemical fertilizers. Soil microorganisms play an important role in soil processes that determine plant productivity. In the present study, the use of microorganisms as bio-fertilizer was *Rhizobium* and phosphobacteria, in which *Rhizobium* fixes atmospheric nitrogen whereas, phosphobacteria solubilizes the insoluble phosphorus and converts it in soluble form to crop plants.

Materials and Methods

A field experiment was carried out during the summer season of the year 2019 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. The soil of experimental site was loamy sand in texture, having low in organic carbon (0.29%) and available nitrogen (219.50 kg ha^{-1}) and medium in available P_2O_5 (35.45 kg ha^{-1}) with slightly alkaline (pH 7.96) in reaction. Green gram variety Gujarat Anand Mungbean 5 (GAM 5) was used as a test crop in the study. Crop was sown on 7th march, 2020. The experiment was arranged in randomized block design with four replications, consisting of eight treatments *viz.,* T_1 [100% RDF (20-40-00 kg NPK ha^{-1})], T_2 [50% RDF (10-20-00 kg NPK ha^{-1}) + 0.5 t ha^{-1} vermicompost], T_3 [Seed treatment with BioNP @ 5 ml kg^{-1} seed (*Rhizobium* + PSB)], T_4 [Jeevamrut spraying at 30 & 45 DAS (500 lit ha^{-1})], T_5 [T_3 + T_4], T_6 [T_2 + T_3], T_7 [T_2 + T_4], T_8 [T_2 + T_5], each plot being 3.60 m × 5.00 m. Inorganic sources of N & P is urea and DAP respectively, while organic sources are vermicompost, BioNP (*Rhizobium* + PSB) and jeevamrut. The seeds were inoculated with respective strains of *Rhizobium* + PSB according to the treatment. Crop was harvested (3 consecutive picking of pods) on 10th, 18th and 25th May, 2020. The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Cochran and Cox, 1957).

Results and Discussion

Effect on growth attributes

Plant population

A perusal of data given in Table 1 revealed that plant population was found non-significant by application of inorganic and organic sources of nitrogen and phosphorus recorded at 20 DAS and harvest.

Plant height (cm)

The results presented in Table 1 indicated that non significant effect on plant height recorded at 30 DAS. Different treatments exhibited their significant effect on plant height recorded at 60 DAS and at harvest. Higher plant height at 60 DAS and at harvest (44.73 cm and 46.25 cm) was recorded under treatment T_8. The increase in the plant growth in terms of plant height by application of treatment (T_8) might be due to nitrogen and phosphorus from chemical fertilizer enhances formation of new cells, promote plant vigour and quickens leaf development, which help towards higher plant height. While, *Rhizobium* based BioNP consortia and jeevamrut help in availability of nitrogen and phosphorus throughout the crop period and exudates some plant growth regulating constituents (PGRs) *viz.,* plant hormones, Auxin, Gibberellins and Cytokines in considerable quantities, which help in increase of plant height. The contemporary findings are in close accordance with those reported by Bajracharya and Rai (2009), Tyagi *et al.,* (2014), Gohain and Kikon (2017) and Thesiya *et al.,* (2019).

Dry weight of nodules plant^{-1} (mg)

The data on effect of various treatments on dry weight of nodules plant^{-1} (mg) of green gram crop recorded at 45 DAS are furnished in Table 1. Data pertaining to dry weight of root nodules plant^{-1} was found significant due to different treatments. Treatment T_8 recorded significantly higher dry weight of root nodules plant^{-1} (45.20 mg plant^{-1}). Higher nodulation due to application of various treatments which stimulates nodule formation in legumes. Hence the application of inorganic and organic nutrients along with BioNP consortia (*Rhizobium* + PSB) and jeevamrut showed superiority in nodulation activity and was observed that efficiency of N is increased due to more P application and microorganisms helps in conversion of organic nutrients in to inorganic form of nutrients. The additional supply of N and P through jeevamrut helped in formation of new cell and thus, proliferation of growth. The bacteria *Rhizobium* have the capacity to fix atmospheric N in soil and make it available to plant. The results are in accordance with the results of Barik and Gulati (2009), Kundu *et al.,* (2013), Biswash *et al.,* (2014) and Dhakal *et al.,* (2016).

Plant dry biomass plant^{-1} (g)

Data on plant dry biomass plant^{-1} (g) presented in Table 1 indicated that significantly higher plant dry biomass plant^{-1} (29.25 g) was recorded with treatment T_8. Plant dry biomass plant^{-1} was recorded higher in treatment T_8 it was might be due to increases availability of nutrients in soil profile and their efficient transaction to sink from the source. Also, application of *Rhizobium* based BioNP consortia resulted in better root nodulation, PSB which is helped in better root development and enriched carbohydrate metabolism which resulted in enhanced source-sink relationship. All these resulted in increased nutrient availability and uptake was increased resulting in vigorous plant growth and plant dry biomass. Similar line of results was also reported by Baskaran *et al.,* (2009), Tyagi *et al.,* (2014), Sindhi *et*

al., (2016), Kalasaria *et al.,* (2017) and Onte *et al.,* (2019).

Number of branches plant^{-1}

The outcome of the statistical analysis corresponding to number of branches per plant of green gram is furnished in Table 1 and graphically presented in Fig. 1. The mean data on number of branches plant^{-1} recorded under different treatments was found significant wherein, significantly higher number of branches plant^{-1} (8.13) was recorded under treatment T_8. The increase in number of branches plant^{-1} at harvest under treatment T_8 could be attributed to constructive effect of nitrogen and phosphorus in form of inorganic and organic nutrients on plant growth. As nitrogenous fertilizer through several sources might have helped and the enhanced the development of strong cell walls and therefore stiffer branches which might resulted into profuse branches of green gram. Application of nitrogen and phosphorus might have also affected the number of branches as phosphorus predisposed overall improvement in plant growth, vigour and production of sufficient photosynthates. These results are already in agreement with the findings by Ghosh *et al.,* (2013), Mohanty *et al.,* (2014), Verma *et al.,* (2014), Gohil *et al.,* (2017) and Thesiya *et al.,* (2019).

Effect on yield attributes

Number of pods plant^{-1}

The results of number of pod plant^{-1} as influenced due to different treatments are presented in Table 2. The result revealed that significantly higher number of pod plant^{-1} (33.50) was observed under treatment T_8. Application of nitrogen and phosphorus fertilizer along with inoculation of BioNP (*Rhizobium* + PSB) consortia and jeevamrut showed significant response in respect with yield attributes and yield than sole application of chemical fertilizer or bio-fertilizer due to increased concentration of N and P ions of soil solution and ultimately lead to enthusiastic root development, better N fixation and better development of plant growth chief to higher photosynthetic activity and translocation of photosynthates from source to the sink which in turn resulted in better development of yield attributes *i.e.,* better pod formation and number of branches plant^{-1} in green gram. These results were in close conformity with the reports of Choudhary *et al.,* (2010), Sharma and Guled (2012), Tak *et al.,* (2014), Shariff *et al.,* (2015) and Gohain and Kikon (2017).

Seed yield (kg ha^{-1})

Perusal of data presented in Table 2 and also graphically depicted in Fig. 2 revealed that significantly higher seed yield (1353 kg ha^{-1}) was recorded when crop was sown with an application of T_8. Seed yield was significantly higher with treatment T_8 might be due to the combine application of inorganic, organic and bio-fertilizer over other treatments this may also due to increased availability of major nutrients to plant which enhanced early root growth with deep rooted system and cell multiplication leading to more absorption of other nutrients from deeper layers of soil ultimately resulting increased growth parameters, seed and haulm yields. Integrated use of organic, inorganic and bio fertilizer resulted in better growth of plants associated with increased availability of nutrients might have resulted in greater translocation of photosynthates from source to sink site that resulted higher yield. Application of bio-fertilizer with jeevamrut which must also have facilitated in improving nodulation and N fixation by supplying assimilates to the roots which increased the seed production. The results are in close

agreement with those of Jat *et al.,* (2010), Varia and Sadhu (2011), Meena *et al.,* (2013), Mohanty *et al.,* (2014), Lakshmi *et al.,* (2015), Dhakal *et al.,* (2016), Gohil *et al.,* (2017) and Kalaiyarasi *et al.,* (2019).

Haulm yield (kg ha^{-1})

Data on haulm yield were found significant by different treatments are furnished in Table 2 and graphically in Fig. 2, wherein significantly higher haulm yield (2104 kg ha^{-1}) was recorded under treatment T_8. Moreover, the positive influence of these treatments through instantaneous supply of nutrients from inorganic sources especially at the early stage of the crop commanded to more meristematic activities of the plant. Slow and steady supply of nutrients through combination of inorganic fertilizer along with BioNP and jeevamrut throughout the crop growth period improved suitable biomass production which resulted into higher pod and haulm yield and as *Rhizobium* + PSB strains enhanced greater amount of availability of N and P which enabled the plant to absorb more N and P resulting in increased biomass production and their translocation in plants which improve haulm yield. These results were in close conformity with results reported by Sharma and Guled (2012), Mohanty *et al.,* (2014), Lakshmi *et al.,* (2015), Sipai *et al.,* (2016), Gohil *et al.,* (2017), Saha *et al.,* (2017) and Kalaiyarasi *et al.,* (2019).

Test weight (g)

The results (Table 2) revealed that test weight was found to be non significant under the influence of different treatments.

Harvest index (%)

It is evident from the results provided in Table 2 indicated that different treatments did not exert their significant effect on harvest index.

Table.1 Effect of inorganic and organic nutrients on plant population and growth attributes of summer green gram (*Vigna radiata* L. wilczek)

Treatment	Plant population		Plant height (cm)			Dry weight of nodules plant^{-1} (mg)	Plant dry biomass plant^{-1} (g)	No. of branches plant^{-1}
	20 DAS	At harvest	30 DAS	60 DAS	At harvest			
T_1	9.78	8.90	14.83	42.00	43.35	41.93	24.50	7.10
T_2	9.70	8.55	14.70	41.25	42.40	40.65	22.75	6.73
T_3	9.50	8.55	14.55	37.10	38.75	35.30	18.75	5.93
T_4	9.55	8.48	14.60	37.55	39.78	36.63	19.25	6.05
T_5	9.63	8.58	14.65	40.38	41.40	39.45	20.75	6.58
T_6	10.15	9.55	15.85	43.18	45.05	44.08	27.00	7.75
T_7	9.85	9.25	15.05	42.83	44.38	43.33	25.50	7.28
T_8	10.20	9.75	16.05	44.73	46.25	45.20	29.25	8.13
S. Em. ±	0.51	0.46	0.74	1.70	1.64	1.85	1.10	0.33
C.D. at 5%	NS	NS	NS	4.99	4.82	5.45	3.22	0.96
C.V.%	10.39	10.21	9.91	8.25	7.67	9.08	9.34	9.45

Table.2 Effect of inorganic and organic nutrients on yield attributes and economics of summer green gram (*Vigna radiata* L. wilczek)

Treatment	No. of pods plant^{-1}	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Test weight (g)	Harvest index (%)	Net realization (Rs. ha^{-1})	BCR
T_1	30.25	1201	2043	39.25	37.01	50975	3.20
T_2	29.50	1155	1965	39.89	37.01	45962	2.82
T_3	26.25	855	1540	38.94	35.94	32054	2.54
T_4	27.75	950	1711	37.91	35.70	36695	2.67
T_5	28.25	1093	1750	39.13	38.44	45302	3.06
T_6	32.25	1300	2015	41.13	39.11	54699	3.16
T_7	31.00	1270	2031	42.00	38.44	51685	2.95
T_8	33.50	1353	2104	42.91	39.53	56725	3.14
S. Em. ±	1.49	58.77	106.32	1.74	1.75	-	-
C.D. at 5%	4.37	173	313	NS	NS	-	-
C.V.%	9.96	10.25	11.22	8.66	9.29	-	-

Fig.1 Effect of various treatments on number of branches plant^{-1}

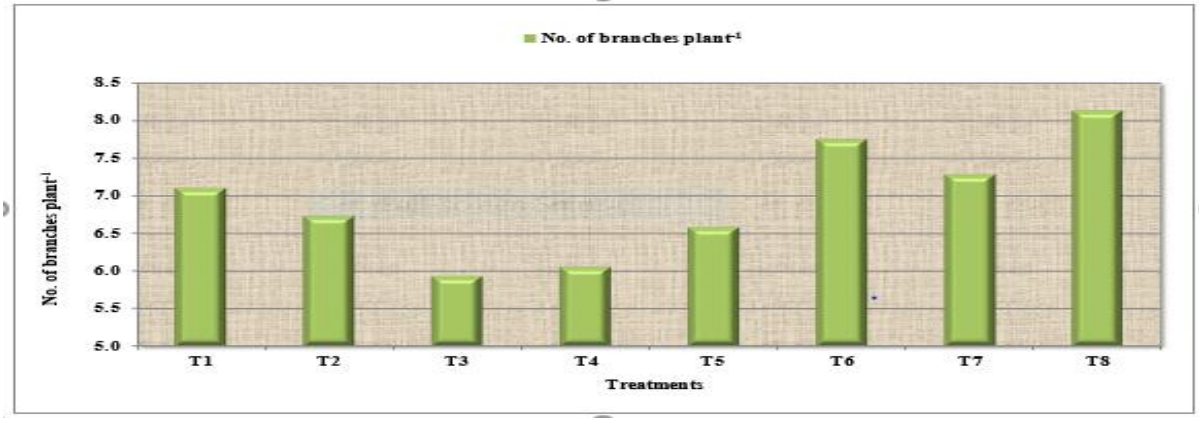
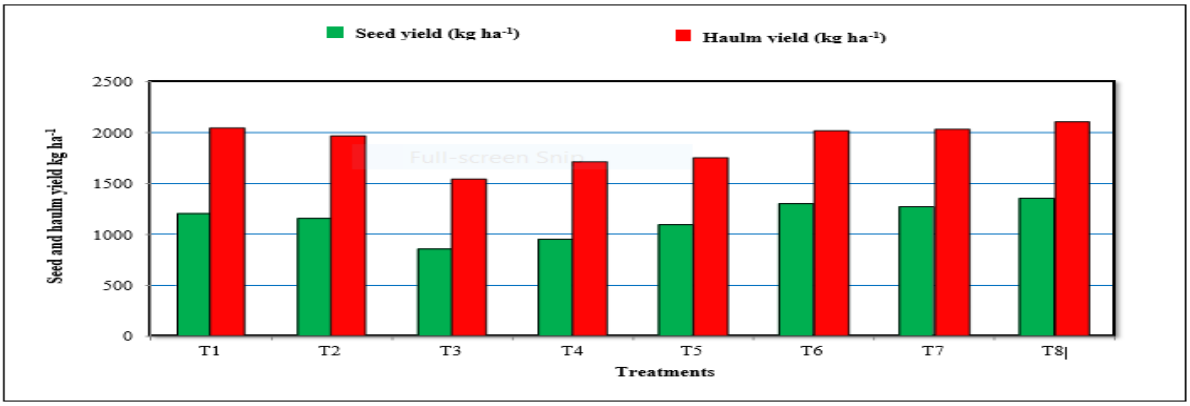


Fig.2 Effect of various treatments on seed yield and haulm yield of crops



Economic evaluation

Net realization (Rs. ha^{-1})

Application of 50% RDF + 0.5 t ha^{-1} vermicompost + seed treatment with BioNP + Jeevamrut spraying (T_8) recorded highest net realization of Rs. 56725 ha^{-1}.

Benefit Cost Ratio (BCR)

Data pertaining to BCR indicate that various treatments have influenced on BCR. Maximum BCR of 3.20 was witnessed under application of T_1 (100% RDF (20-40-00 kg NPK ha^{-1}).

In light of results obtained from the ongoing field experiment, it could be concluded that the crop should be fertilized with 50% RDF + 0.5 t ha^{-1} vermicompost + seed treatment with BioNP + Jeevamrut spraying securing the higher growth and yield attributes as well as net realization of summer green gram.

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