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Yield and Economics Performance of Green Gram as Influenced by Nutrient Management under Organic Farming

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A B S T R A C T

A field experiment was conducted at research farm, Department of Agronomy, JNKVV, Jabalpur (M.P.) during, *kharif* season of 2016. A set of five organic nutrient management [NM_1 (100 % nitrogen through FYM), NM_2 (100 % nitrogen through vermicompost), NM_3 (50 % nitrogen through FYM + 50% nitrogen through vermicompost + PSB @3 ml/l), NM_4 (25 % nitrogen through FYM + 25% nitrogen through vermicompost + *Rhizobium* +PSB @5ml/l) and NM_5 (control)] were tested in Randomized Block Design with four replications. An organic nutrient management practices showed significant (p=0.05) effect on plant height, primary branches, total dry matter of green gram crop. The results revealed that yield attributing characters and yields were significantly influenced by the application of different organic nutrient management. Among the organic nutrient management, NM_4 produced significantly higher pods per plant (25.93) and seeds per pod (11.47) as well as seed yield (785.54 kg/ha) in green gram. The minimum values of yield attributes and yield were observed under NM_5 (control). The Gross monetary returns (GMR), Net monetary returns (NMR) and B: C in green gram were maximum under NM_4 (Rs 39332/ha, Rs 15392/ha and 1.64 respectively) and the values for GMR, NMR and B: C were minimum (Rs 35443/ha, Rs 16863/ha and 1.91, respectively) under NM_5.

Introduction

Green gram (*Vigna radiata* L. Wilezek) is one of the most important pulse crops grown in India. Green gram is short duration, drought tolerant pulse crop which also commonly known as "Mungbean". Its seed contains 24.7% protein as well as sufficient quantity of calcium, phosphorus and important vitamins. Due to its supply of cheaper protein source, it is designated as "poor man's meat" (Potter and Hotchkiss, 1997). Green gram is considered as a substitute of animal protein and forms a balanced diet when used with cereals.

Although, chemical fertilizer are playing a crucial role to meet the nutrients need of the crop. The imbalance and continuous use of chemical fertilizers has adverse effect on soil physical, chemical and biological properties thus affecting the sustainability of crop production, besides causing environmental pollution. The increased dependence on agro-chemicals including fertilizers has led to several ill effects on the environment. In the process of finding an alternative to chemical agriculture, the organic farming is gaining a gradual momentum. Organic farming seems to be more appropriate because it considers the important aspects like sustainability of natural resources and environment. Organic agriculture is healthier not only to human and animals but also to environment, because they are produced without the use of synthetic inputs such as chemical fertilizers, pesticides and hormones etc. Among the means available to achieve sustainability in agricultural production, organic manures and biofertilizers play an important and key role because they exert beneficial effect on the soil physical, chemical and biological properties of soil for sustenance of soil quality and future agricultural productivity (Ramesh *et al.*, 2008).

The farmyard manure (FYM) itself contains reasonable amounts of nutrients which become available to plants upon decomposition besides enhancing availability of native as well as applied nutrients (Chand and Subhash (2007).Vermicompost contains micro site rich in available carbon and nitrogen (Sudhakar *et al.,* 2002). Worm cast incorporated soils are also rich in water soluble P (Gratt, 1970) and contained two to three times more available nutrients than surrounding soils (Sudhakar *et al.,* 2002), which encourages better plant growth yield.

The phosphate solubilizing microorganisms (Pseudomonas) play an important role in conversion of unavailable inorganic P (Ca-P, Fe-P and Al-P) into available inorganic P forms through secretion of organic acids and enzymes (Singh M V 1999). Keeping the points in view the present experiment was under taken with the object to find out the Productivity and profitability of green gram as influenced by nutrient management under organic farming.

Materials and Methods

Experimental site, soil and Climate characteristics

Field experiment was conducted to study yield and economic performance of green gram as influenced by nutrient management under organic farming during *kharif*, 2016 Research Farm, Department of Agronomy, Jawaharlal Nehru KrishiVishwaVidyalaya, Jabalpur (M.P.) during *kharif* season 2016.Jabalpur comes under the agro-climatic zone classified as “Kymore Plateau and Satpura Hills” as per norms of National Agriculture Research project (ICAR) New Delhi.

The soil of the experimental field was sandy clay loam, neutral in reaction with medium OC contents, normal in EC and analyzing low in available N, medium in available P and medium in available K contents. The initial soil characteristics of the experimental field are presented in table 1. Experimental site represented the arid climate average annual rainfall of about mm. More than 80 per cent of rainfall is received in *kharif* season (July-September) by the south west monsoon. During growing season, total rainfall received during the crop season was 1135.5 mm, which was distributed in 45 rainy days. Maximum and minimum mean temperature ranged between 27.0^{0}C to 33.0^{0}C and 15.4^{0}C to 24.5^{0}C respectively. The relative humidity ranged between 82 to 94 % in morning and 29 to 91% in evening. The sunshine hours varied between 0.0 to 9.3 hours/day (Fig. 1).

Treatments and experimental design

The experiment was laid out in randomized block design with four replications. Each replication consists of five treatments of organic nutrient management *viz.*, NM_1 (100 % nitrogen through FYM), NM_2 (100 % nitrogen through vermicompost), NM_3 (50 %

nitrogen through FYM + 50% nitrogen through vermicompost + PSB @3 ml/l), NM_4 (25 % nitrogen through FYM + 25% nitrogen through vermicompost + rhizobium +PSB @5ml/l) and NM_5 (control). Treatments were randomized separately in each replication. Each plot measured 9.0m x 4.5m with distance between row to row was 0.45m. Different combination of organic nutrients was applied as per treatment requirement with control (no use of fertilizer).FYM and vermicompost were applied basal after final field preparation.

Crop establishment and management

Seeds of black gram (Var. PDM-139 or Samrat) crop were inoculated with *Rhizobium* culture (as per treatment requirement). Crop was sown in rows 45 cm apart manually by using kudali. Seed were sown @ 15 kg/ha. Crop was sown on July 16th, 2016 and harvested on October 25th 2016. Foliar spray of PSB was applied per treatment requirement at 20, 25 and 30 DAS. The plots were supplied with different proportions of FYM and Vermicompost as per treatment were applied only to fulfill the need of major nutrient (N) in the crop as per recommendation on per hectare area basis. FYM and Vermicompost were applied basal after final field preparation. Seed inoculation (*Rhizobium* culture) required quantity of the cultures, *i.e.* @ 200 g culture per 10 kg seed was mixed to 10% sugar solution to form slurry. The slurry was sprinkled on seeds and mixed with hand to make a uniform coating over the seeds and then the seeds were spread on a polythene sheet in shade to avoid direct sunlight. Seeds were sown immediately (Tilak, 1991). The infestation of seasonal weeds was controlled twice with the help of *khurpi* at 20 and 40 days growth stages. Three spray of cow urine @80ml per litre of water was given in forenoon, first at 25 DAS and rest was repeated on weekly interval for control of sucking pest. Three spray of Neem oil @10ml per litre of water was given in afternoon, first at 25 DAS and rest was repeated on weekly interval as insect repellent. The physiological maturity of all the treatments was judged visually before the crop was harvested.

Sampling technique, observations and analysis

Five plants were selected randomly from each plot for sampling purposes and observations were recorded. Dry matter production/plant (g) with the help of three plants were uprooted at 30, 45 and 60 DAS respectively from each plot and allowed to dry in an oven at 65°C till to reach at constant weight and finally mean was computed. In order to eliminate the border effects, one outer row and 50 cm from both the ends were removed first from each plot keeping net plot 8.0 m X 3.6 m. Before harvesting the net plots, five randomly marked plants were removed for post-harvest studies. The threshing was done plot wise by labour with the help of sticks.

The weight of cleaned grains from each net plot was recorded in kg per plot and then converted into kg per hectare. The observations on yield attributes (pods per plant and seeds per pod) and yields were recorded. The harvest index is the ratio of economic (seed) yield out of total biological (seed + straw) yield which is expressed in percentage. It estimates the partitioning of the dry matter between seed and straw. Finally, economic viability of the treatments was also determined in terms of cost of cultivation, gross monetary returns, net monetary returns and B: C ratio on/hectare basis. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results.

Results and Discussion

An organic nutrient management practices showed significant (p=0.05) effect on plant height, primary branches, total dry matter of green gram crop study.

Effect of different organic nutrient management treatments on growth attributes

Plant height of green gram was significantly influenced by various organic nutrient management treatments at harvest (Table 2). Among all the organic nutrient management, under application of 25 % nitrogen through FYM, 25% nitrogen through vermicompost inoculation with *Rhizobium* and PSB (NM_4) plant height was significantly 8.3 % higher at harvest and minimum in under control (NM_5) treatment, respectively. These results are in collaborated with those of Selvakumar *et al.*, (2012), Bahadur and Tiwari (2014) and Hussain *et al.,* (2014).

The number of primary branches/plant was significantly higher (26.7%) with 25 % nitrogen through FYM, 25% nitrogen through vermicompost, inoculation with Rhizobium and PSB@5ml/l (NM4) at harvest followed by 21.5% higher with application of 50 % nitrogen through FYM, 50% nitrogen through vermicompost and inoculation with PSB@3ml/l (NM3) over control (NM5) (Table 2). The integrated use of organic manures with biofertilizer under the NM4 treatment would have facilitated better growth and development ultimately results more number of branches per plant. These results are in with close agreement those of Murugan *et al.*, (2011) and Bahadur and Tiwari (2014).

All the organic nutrient management treatments significantly affected the total dry biomass recorded at 30, 45 and 60 DAS. The 25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (NM_4) recorded significantly more dry weight plant^{-1} followed by application of 50 % nitrogen through FYM, 50% nitrogen through vermicompost and PSB spray @ 3ml/l (NM_3), the significantly lowest dry weight of nodules plant^{-1} with NM_5 (control) at 30, 45 and 60 DAS respectively (Table 2). Murugan *et al.*, (2011), Selvakumar *et al.*, (2012), Hussain *et al.*, (2014) and Bahadur and Tiwari (2014) also reported similar results.

Effect of different organic nutrient management treatments on Yield and Yield attributes

An organic nutrient management practices showed significant (p=0.05) effect on yield parameters and yield in green gram crop study (Table 3). The significantly highest number of pods per plant(25.93)were recorded in the plots applied 25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (NM_4) followed by (24.67) in application of 50 % nitrogen through FYM, 50% nitrogen through vermicompost and PSB spray @ 3ml/l (NM3) and (23.53) in NM_2 (100% nitrogen through vermicompost) whereas these were significantly lowest (22.27)under control (NM_5) treatment. Pod per plant was recorded 16.23 % higher under NM_4 compared control (NM_5). Number of seeds (pod^{-1}) was significantly affected by different organic nutrient management treatments and followed the same trend as in number of pods (plant^{-1}).

The 25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (NM_4) registered significantly higher number of seeds per pod (11.47). The significantly 11.68% lower was recorded in control compared NM_4. The poor growth of plants under control plots was observed. This was might be due more intra species competition for utilization of available native nutrients from the soil, which leads to lesser number of pods (plant^{-1}), number of seeds (pod^{-1}).

Table.1 Initial status (kharif, 2016) of soil properties at the experimental site

Soil properties	Value (0-15 cm)	Soil properties	Value (0-15 cm)
A. Mechanical Composition		**C. Chemical properties**	
Sand (%)	46.0	Organic carbon (%)	0.71
Silt (%)	24.0	Available N (kg ha^{-1})	287.83
Clay (%)	30.0	Available P_2O_5 (kg ha^{-1})	12.69
Texture	Sandy clay loam	Available K_2O (kg ha^{-1})	278.3
B. Physical properties			
Bulk density ($Mg\ m^{-3}$)	1.45	EC ($dS\ m^{-1}$) (1:2 soil water suspension at 25^0C)	0.28
Particle density ($Mg\ m^{-3}$)	2.51		
Porosity (%)	42.23	Soil pH (1:2 soil water suspension at 25^0C)	7.3

Table.2 Effect of different organic nutrient management treatments on plant height, primary branches, total dry matter of green gram

Treatments	Plant height (cm)	Primary branches ($plant^{-1}$)	Total dry matter (g $plant^{-1}$)		
	At harvest		30 DAS	45 DAS	60 DAS
NM_1 (100 % Nitrogen through FYM)	62.08	5.75	1.76	4.74	9.31
NM_2 (100 % Nitrogen through Vermicompost)	63.04	6.09	2.09	4.95	10.66
NM_3 (50 % Nitrogen through FYM + 50% Nitrogen through VC + PSB @3 ml/l)	64.41	6.38	2.36	5.19	10.86
NM_4 (25 % Nitrogen through FYM + 25% Nitrogen through VC+ *Rhizobium* +PSB @5ml/l)	66.32	6.65	2.60	5.66	12.61
NM_5 (Control)	61.21	5.25	1.44	4.38	8.04
SEm±	0.39	0.09	0.04	0.01	0.01
C.D. (P=0.05)	1.20	0.28	0.12	0.02	0.02

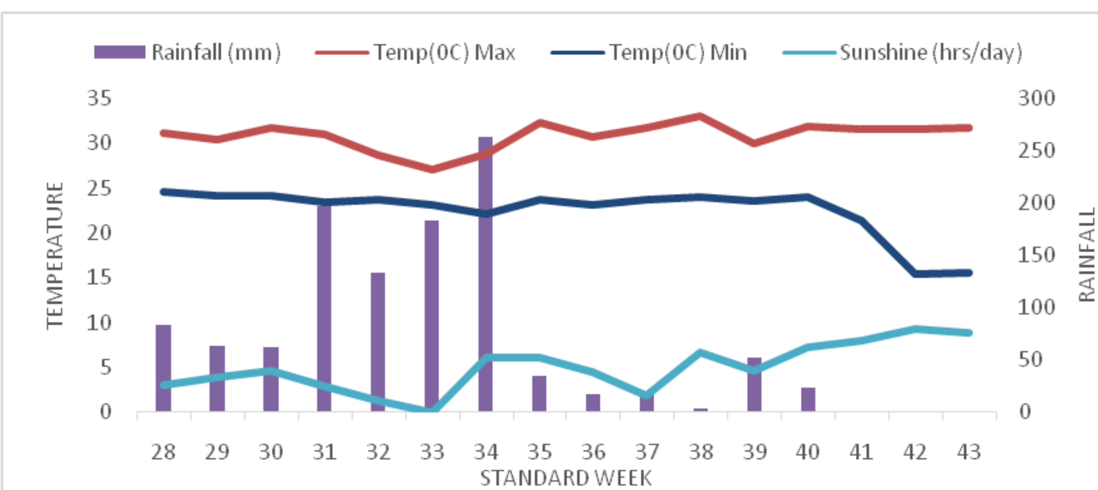
Table.3 Effect of different organic nutrient management treatments on yield attributes and yield in green gram

Treatments	Pods per plant	Seeds per pod	Seed yield (kg/ha)
NM_1 (100 % Nitrogen through FYM)	23.13	10.53	634.60
NM_2 (100 % Nitrogen through Vermicompost)	23.53	10.73	664.87
NM_3 (50 % Nitrogen through FYM + 50% Nitrogen through VC + PSB @3 ml/l)	24.67	11.00	724.25
NM_4 (25 % Nitrogen through FYM + 25% Nitrogen through VC+ *Rhizobium* +PSB @5ml/l)	25.93	11.47	785.54
NM_5 (Control)	22.27	10.13	449.83
SEm±	0.26	0.13	2.10
C.D. (P=0.05)	0.81	0.40	6.53

Table.4 Effect of different organic nutrient management treatments on economics of green gram

Treatments	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	B: C ratio
NM_1 (100 % Nitrogen through FYM)	49381	24501	1.98
NM_2 (100% Nitrogen through Vermicompost)	51597	26037	2.02
NM_3 (50 % Nitrogen through FYM + 50% Nitrogen through VC + PSB @ 3ml/l)	55993	29303	2.10
NM_4 (25 % Nitrogen through FYM + 25% Nitrogen through + *Rhizobium* +PSB @5ml/l)	60446	36506	2.52
NM_5 (Control)	35443	16863	1.91
Mean	**50572**	**26642**	**2.11**

Fig.1 Mean weekly meteorological data recorded during crop growing season, 2016



Whereas just reverse case was observed in the treatment receiving maximum nutrients (NM_4). These findings are in close conformity with the results of Murugan *et al.,* (2011) and Bahadur and Tiwari (2014).

Seed yield recorded significantly higher with 25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (785.54 kg ha^{-1}) followed by 724.25 kg ha^{-1}in plots given 50 % nitrogen through FYM, 50% nitrogen through vermicompost and PSB spray @ 3ml/l (NM_3). The significantly lowest seed yield (449.83 kg ha^{-1}) was recorded in control (NM_5) than other treatments (Table 3). Seed yield recorded 74.63% higher with NM_4 compared control. Irrespective of treatments seed yield green gram was reduced in all the treatments uniformly due to rainfall at flowering and severe incidence of powdery mildew. These findings are in accordance with those of Kumawat *et al.,* (2009), Murugan *et al.*, (2011), Bahadur and Tiwari (2014) and Sardar *et al.*, (2016).

Effect of different organic nutrient management treatments on economics

The maximum gross monetary returns (Rs 60446/ha) recorded with25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (NM_4) (Table 4). In all the treatment combinations, minimum gross monetary returns (Rs 35443/ha) was recorded with NM5 (control). The Net monetary returns was maximum (Rs35506/ha) with the application of 25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (NM_4) followed by (Rs 29303/ha) 50 % nitrogen through FYM, 50% nitrogen through vermicompost and PSB spray @ 3ml/l (NM3) and (Rs26037/ha) plots receiving 100% nitrogen through vermicompost (NM_2). The profitability was maximum (2.52) under the plots receiving 25 % nitrogen through FYM, 25% nitrogen through vermicompost, *Rhizobium* inoculation and PSB spray @ 5ml/l (NM_4). The ratio was minimum (1.91) in case of control (NM5) where no any nutrient was applied. These results are in close agreements to the findings of Kumawat *et al.*, (2009).

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