International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(3): 391-395

Received: 10-03-2018
Accepted: 11-04-2018

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Yield and economics of green gram and black gram as influenced by nutrient management under organic farming

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Abstract
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 with two crops of green gram and black gram were tested in Randomized Block Design with four replications. Among the organic nutrient management, NM_4 produced significantly (p=0.05) higher pods per plant (25.93 and 20.67), seeds per pod (11.47 and 7.93) as well as seed yield (785.54 and 419.90 kg/ha) in green gram and black gram, respectively. The Gross monetary returns (GMR), Net monetary returns (NMR) and B: C in green gram were maximum under NM_4 (Rs 60446/ha, Rs 36506/ha and 2.52 respectively) and the values were minimum (Rs 35443/ha, Rs 16863/ha and 1.91 respectively) under NM_5. The GMR, NMR and B: C in black gram were maximum under NM_4 (Rs 39332/ha, Rs 15392/ha and 1.64, respectively) and the values were minimum (Rs 20585/ha, Rs 2005/ha and 1.11, respectively) under NM_5.

Keywords: FYM, Organic nutrient management, PSB, Rhizobium, Vermicompost

Introduction
Pulses play a vital role in Indian Agriculture. India is one of the largest pulses producing countries in the World. In India, total production of pulses is 23.95 million tons (Anonymous, 2017-18). Pulses are the major source of dietary proteins in the vegetarian diet of our country. Besides being the source of proteins, they maintain soil fertility through biological nitrogen fixation and thus play a vital role in furthering sustainable agriculture (Kannaiyan, 1999).Green gram (*Vigna radiata* L. Wilezek) is one of the most important pulse crops grown in India. Its seed contains 24.7% protein due to its supply of cheaper protein source, it is designated as "poor man's meat" (Potter and Hotchkiss, 1997) [9].Black gram (*Vigna mungo* L. Hepper) is grown as a cover crop as well as catch crop due to short duration. Black gram seeds are highly nutritious containing higher amount of protein (24-26%) and are reported to be rich in potassium, phosphorus and calcium with good amount of sodium. It is also reported to be rich in vitamin A, B1, B3 besides nutritionally rich proteins, important mineral and vitamins. (Selvakumar *et al*., 2012) [12].

Although, chemical fertilizers 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. In the process of finding an alternative to chemical agriculture, the organic farming is gaining a gradual momentum. 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 harmones 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) [10].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) [3]. Vermicompost contains micro site rich in available carbon and nitrogen (Sudhakar *et al*., 2002) [14]. 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) [14], which encourages better plant growth yield.

In the present study use of microorganisms as biofertilizer were rhizobium and phosphate solubilizing bacteria (PSB), in which rhizobium fixes atmospheric nitrogen whereas, 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). Therefore, both activities are important for the growth and development of crop plants to enhance the crop yield. Keeping the points in view the present experiment was under taken with the object to find out the yield and economics of green gram and black 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 and black gram as influenced by nutrient management under organic farming at Research Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *kharif* season, 2016.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. 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 27.00C to 33.00C and 15.40C to 24.50C 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.

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., NM1 (100% nitrogen through FYM), NM2 (100% nitrogen through vermicompost), NM3 (50% nitrogen through FYM + 50% nitrogen through vermicompost + PSB @3 ml/l), NM4 (25% nitrogen through FYM + 25% nitrogen through vermicompost + rhizobium +PSB @5ml/l) and NM5 (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.

Crop establishment and management

Seeds of green gram (Var. PDM-139 or Samrat) and black gram (Var. LBG-20 or Teja) crops 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. Crops were sown on July 16th, 2016 and harvested on September 21th, 2016 (green gram) and October 25th 2016 (black gram). 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 fulfil 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. 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 @10mlper 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. 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 per hectare basis. Data pertaining to various parameters were tabulated and subjected to statistical analysis for interpretation of results.

Results and Discussion

Effect of different organic nutrient management treatments on growth attributes

An organic nutrient management practices showed significant (p=0.05) effect on plantheight, primary branches, total dry matter of green gram and black gram crops.

Plant height of green gram and black gram was significantly influenced by various organic nutrient management treatments at harvest (Table1). 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 higher (8.3% and 32%) at harvest in green gram and black gram respectively and minimum under control (NM_5) treatment in both the crops. These results are in collaborated with those of Selvakumar *et al*., (2012) [12], Bahadur and Tiwari (2014) [1] and Hussain *et al*., (2014).

Table 1: Effect of different organic nutrient management treatments on plant height and primary branches of green gram and black gram.

Treatment	Plant height (cm) at harvest		Primary branches per plant at harvest	
	Green gram	Black gram	Green gram	Black gram
NM_1 (100% Nitrogen through FYM)	62.08	60.76	5.75	6.87
NM_2 (100% Nitrogen through Vermicompost)	63.04	63.45	6.09	7.47
NM_3 (50% Nitrogen through FYM + 50% Nitrogen through VC + PSB @3 ml/l)	64.41	64.23	6.38	7.92
NM_4 (25% Nitrogen through FYM + 25% Nitrogen through VC+ *Rhizobium* +PSB @5ml/l)	66.32	74.37	6.65	8.47
NM_5 (Control)	61.21	56.19	5.25	6.65
SEm±	0.39	1.01	0.09	0.19
C.D. (P=0.05)	1.20	3.16	0.28	0.59

The number of primary branches/plant was significantly higher (26.7% and 27.4%) in green gram and black gram respectively withNM_4 at harvest followed by 21.5% and 19.1% higher (in green gram and black gram respectively) with application of 50% nitrogen through FYM, 50% nitrogen through vermicompost and inoculation with PSB@3ml/l (NM_3) over NM_5 (Table 1). The integrated use of organic manures with biofertilizer under the NM_4 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) [1].

All the organic nutrient management treatments significantly affected the total dry biomass recorded at 30, 45 and 60 DAS. The NM_4 recorded significantly more dry weight plant^{-1} followed by application ofNM_3, the significantly lowest dry weight plant^{-1} with NM5 (control) at 30, 45 and 60 DAS respectively (Table 2). Murugan *et al*., (2011), Selvakumar *et al*., (2012) [12], Hussain *et al*., (2014) and Bahadur and Tiwari (2014) [1] also reported similar results.

Table 2: Effect of different organic nutrient management treatments on total dry matter (g plant^{-1}) of green gram and black gram.

Treatment	Total dry matter (g plant^{-1})					
	Green gram			Black gram		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
NM_1 (100% Nitrogen through FYM)	1.76	4.74	9.31	1.63	6.45	10.80
NM_2 (100% Nitrogen through Vermicompost)	2.09	4.95	10.66	1.94	6.78	11.45
NM_3 (50% Nitrogen through FYM + 50% Nitrogen through VC + PSB @3 ml/l)	2.36	5.19	10.86	2.06	7.08	11.83
NM_4 (25% Nitrogen through FYM + 25% Nitrogen through VC+ *Rhizobium* +PSB @5ml/l)	2.60	5.66	12.61	2.43	7.49	12.17
NM_5 (Control)	1.44	4.38	8.04	1.45	6.07	10.04
SEm±	0.04	0.01	0.01	0.02	0.02	0.02
C.D. (P=0.05)	0.12	0.02	0.02	0.08	0.07	0.05

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 and black gram crops study (Table 3). The significantly highest number of pods per plant (25.93 and 20.66 in green gram and black gram respectively) were recorded with NM_4 followed by (24.67 and 19.06) NM_3 and (23.53 and 18.40) in NM_2whereas these were significantly lowest (22.27and 16.00) under control (NM_5) treatment. Pod per plant was recorded 16.23% and 29.19% higher (in green gram and black gram respectively) 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}).These findings are in close conformity with the results of Murugan *et al*., (2011) and Bahadur and Tiwari (2014) [1].

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

Treatment	Green gram			Black gram		
	Pods per plant	Seeds per pod	Seed yield(kg/ha)	Pods per plant	Seeds per pod	Seed yield(kg/ha)
NM_1 (100% Nitrogen through FYM)	23.13	10.53	634.60	17.20	6.87	290.85
NM_2 (100% Nitrogen through Vermicompost)	23.53	10.73	664.87	18.40	7.33	335.21
NM_3 (50% Nitrogen through FYM + 50% Nitrogen through VC + PSB @3 ml/l)	24.67	11.00	724.25	19.07	7.60	370.39
NM_4 (25% Nitrogen through FYM + 25% Nitrogen through VC+ *Rhizobium* +PSB @5ml/l)	25.93	11.47	785.54	20.67	7.93	419.90
NM_5 (Control)	22.27	10.13	449.83	16.00	6.07	187.79
SEm±	0.26	0.13	2.10	0.28	0.11	4.01
C.D. (P=0.05)	0.81	0.40	6.53	0.87	0.34	12.50

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 and 7.93) in green gram and black gram respectively. The significantly 11.68% and 30.64% lower (in green gram and black gram respectively) was recorded in control as compared to 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}).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) [1].
Seed yield recorded significantly higher (785.54 and 419.90 kg ha^{-1}in green gram and black gram respectively) withNM_4followed by 724.25 and 370.39 kg ha^{-1}(in green gram and black gram respectively) in NM_3. The significantly lowest seed yield (449.83 and 187.79 kg ha^{-1}in green gram and black gram respectively) was recorded in control (NM_5) than other treatments (Table 3). Seed yield recorded 74.63% and 123.6% higher (in green gram and black gram respectively) with NM_4 compared control. Irrespective of treatments seed yield of green gram black 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) [7], Murugan *et al*., (2011), Bahadur and Tiwari (2014) [1] and Sardar *et al*., (2016) [11].

Table 4: Effect of different organic nutrient management treatments on economics of green gram and black gram

Treatments	Green gram			Black gram		
	Gross monetary returns(Rs/ha)	Net monetary returns (Rs/ha)	B: C ratio	Gross monetary returns(Rs/ha)	Net monetary returns(Rs/ha)	B: C ratio
NM_1 (100% Nitrogen through FYM)	49381	24501	1.98	28603	3723	1.15
NM_2 (100% Nitrogen through Vermicompost)	51597	26037	2.02	32072	6512	1.25
NM_3 (50% Nitrogen through FYM + 50% Nitrogen through VC + PSB @ 3ml/l)	55993	29303	2.10	34876	8186	1.31
NM_4 (25% Nitrogen through FYM + 25% Nitrogen through + *Rhizobium* +PSB @5ml/l)	60446	36506	2.52	39332	15392	1.64
NM_5 (Control)	35443	16863	1.91	20585	2005	1.11
Mean	50572	26642	2.11	31094	7164	1.29

Effect of different organic nutrient management treatments on economics

In green gram crop the maximum gross monetary returns (Rs 60446/ha) recorded with 25% 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 NM_5 (control). The Net monetary returns was maximum (Rs35506/ha) with NM_4 followed by (Rs 29303/ha) NM_3 and (Rs26037/ha) plots receiving 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 B-C 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) [7].
In black gram crop, the plots receiving with NM4 fetched the maximum gross monetary returns (Rs 39332/ha). In all the treatment combinations, minimum gross monetary returns (Rs 20585/ha) was noted with NM5 (control). The Net monetary returns was maximum (Rs 15392/ha) with the application of NM4 followed by (Rs 8186/ha) NM3 and (Rs 6512/ha) plots receiving in NM2. The profitability was maximum (1.64) under NM4 due to lower cost of cultivation under this treatment in comparison to different organic nutrient management treatments. The B: C ratio was minimum (1.11) 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) [7].

Acknowledgements

We also acknowledge the financial support and facilities provided by College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) to carry out this research. Author is grateful to all those who contributed directly and indirectly during the course of his M. Sc. research.

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