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RESEARCH ARTICLE

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Performance of Green Gram Varieties under Organic Production System

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Abstract

Background: Indiscriminate use of chemical fertilizers causes' harmful impact on soil, environment and human being, hence demand of organic food products has shot up recently. Organic farming aims to optimization of crop productivity rather than its maximization through renewal and strengthening of ecological processes and functions of whole ecosystem. Limited varieties information is available on long term performance of pulse crop varieties under organic cultivation system so far. Therefore, this experiment was conducted to investigate the growth and yield performance of green gram varieties under organic production system.

Methods: Eight varieties of green gram were studied under organic production system. Experiment was laid out in randomized block design with three replications. The recommended dose of nutrients for green gram is 15:40:00 kg ha^{-1} and manures were applied on nitrogen equivalent basis through organic sources. The observations on growth and yield parameters of green gram were recorded at the time of harvesting. Soil and plant samples were collected at time of harvest and analyzed for available nutrients in soil and nutrient content in seed samples.

Result: The maximum plant height at harvest (62.47cm), number of primary branches per plant (5.18), number of pods per plant (27.27), number of seeds per pod (11.27) with highest seed yield (809.80 kg ha^{-1}) exhibited by variety MUM-2 followed by RMG-975 (802.47 kg ha^{-1}) and lowest seed yield (617.80 kg ha^{-1}) was found in the variety MSG-118. MUM-2 variety recorded highest plant nutrient status as compared to other varieties. Among eight varieties of green gram MUM-2 and RMG-975 found better for organic farming in terms of growth, seed yield and quality aspects.

Key words: Green gram varieties, Organic production, Plant growth, Seed yield.

Introduction

Green gram (*Vigna radiate* L.) is one of the most vital and third important pulse crop cultivated throughout India (after chickpea and pigeon pea) for its versatile uses as vegetable, pulse, fodder and green manure crop. It contains protein, carbohydrates, fat and fibres in the range of 21-26%, 60-65%, 1-1.5% and 3.5-4.5%, respectively. It is the main source of protein particularly for vegetarians and contributes about 14% of the total protein of average Indian diet. Generally productivity of pulses in the country is low and does not fulfil the daily dietary requirement. In India, pulses are grown on nearly 28.34 m ha area with production of 23.15 million tonnes (Agricultural Statistics, 2020). Green gram is mainly cultivated in state of Rajasthan, Madhya Pradesh, Punjab, Haryana, U.P., Maharashtra, Karnataka Andhra Pradesh and Tamil Nadu. In recent times organic agri-commodity demand has increases especially vegetables and pulses. The major key factors of consumer demand for organic food are the health consciousness and the willingness of the public to pay for the high-priced produce. In general, consumers of organic products are a wealthy, educated and health conscious group spurred by strong consumer demand, generous price premium and concerns about the environment. Because of these hidden benefits, conventional growers are turning to organic farming. Excess and imbalanced use of nutrients has caused nutrient mining from the soil, deteriorated crop productivity and ultimately soil health. Replenishment of these nutrients through organic has a direct impact on soil health and crop productivity for long time. Integrated approach of nutrient supply by organic sources combination *i.e* FYM, vermicompost, caster cake and biofertilizers is gaining importance because they not only reduces the use of inorganic fertilizers but completely stopped the dependence of inorganic fertilizer, sustaining the crop productivity by improving soil health and is also an human and environment friendly approach Lal *et al.* (2019a). Pulse crops have unique feature of maintaining the soil health by ability of symbiotic N_2 fixation, leaf shedding habits at maturity, deep root system and mobilization of insoluble soil nutrients.

Organic farming system is self-sufficient and self-dependent as compared to modern chemical farming with

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principle of nutrient capturing and relying more on organic inputs is need of the hour. Organic farming minimizes the use of external inputs and aims to optimization of crop productivity rather than its maximization through renewal and strengthening of ecological processes and functions of farm ecosystem (Shukla *et al.* 2011). Limited information is available on the cultivation of different varieties of green gram in organic system so far. Hence, the present investigation was carried out to know the growth and yield performance of green gram varieties under organic production system.

MATERIALS AND METHODS

A field experiment was carried at ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer (Rajasthan) for 04 year during 2016 to 2019 to identify suitablegreen gram varieties under organic management system. Eight varieties (*viz.,* RMG-975, RMG-62, MSG-118, RMG-492, SML-668, GANGA-1, IPM-02-3 and MUM-2) of green gram were tested under organic production management system Soil of experimental site is sandyloam in nature and the experimental block was maintainedas per the organic production requirements from 2011. Soil fertility status of experimental site is having organiccarbon (0.3%), available nitrogen (130.4 kg ha^{-1}), available phosphorus (12.06 kg ha^{-1}) and available potassium (359.07 kg ha^{-1}). The recommended dose of nutrients for green gram is 15:40:00 kg ha^{-1} and manures were applied on nitrogen equivalent basis through organic sources (50% by FYM, 25% by vermicompost and 25% by caster cake). Nitrogen content of farm yard, vermicompost and castor cake is 0.5%, 1.0% and 4.0%, respectively. Experiment was laid out in randomized blockdesign with three replications with plot size of 20 m^2. Seedswere sown during last week of June by maintainingspacing of 30 cm × 10 cm. with seed rate of 15 kg ha^{-1} after treating seeds with *Trichoderma virdae* at rate of 10 g kg^{-1}. Irrigation and intercultural operations carried out as per standard practices. The observations on growth and yieldparameters of green gram were recorded atthe time of harvesting on 10 plants selected randomly. Soil and plant samples were collected at time of harvest and analyzed for available nutrients in soil and nutrientcontent in seed samples. Data obtained were subjectedto statistical analysis for F test as suggested by (Panse and Sukhatme 1985).

Plant sampling

Ten plants, randomly sampled from each plot, were tagged and plant height was measured from the base of the stem to the tip of the longest branch at harvest. The yield parameters of green gram number of pods/plant, number of seeds/pods, grain yield and Stover yield were recorded at harvest. The harvest index (HI) was determined by the following formula and expressed as percentage (%).

$$HI = (\text{Economic yield}/\text{biological yield}) \times 100$$

$$\text{Economic yield} = \text{Seed/Grain yield}$$

$$\text{Biological yield} = \text{Grain yield} + \text{Stover yield}$$

Soil analysis

Initial as well as after completion of the cropping system composite soil samples were collected (500 g composite sample, one sample from each plot) from 0-15 cm depth. The soil samples were air dried, processed using 2 mm sieve and analyzed for soil pH by Piper (1950), SOC by Nelson and Sommers (2005), available N by the alkaline permanganate method (Subbiah and Asija 1956); available P by Bray method (Bray and Kurtz 1945) and available K by neutral normal NH_4OAC extraction method (Knudsen *et al.* 1982).

RESULTS AND DISCUSSION

Growth attributes

Based on the analysis of data selected differ significantly under green gram varieties to organic production system. The results revealed that the (Table 1) variety MUM-2 showed significant influence on plant height at harvest (62.47 cm) followed by RMG-975 (62.06 cm) and lowest plant height (50.88 cm) was recorded in the variety SML-668 among the tested varieties. The number of primary branches also showed the similar trends and responded positively underorganic production system. The highest number of primary branches (5.18) recorded in MUM-2 followed by RMG-975 (4.97) might be owingto fulfilment of nutrient

Table 1: Performance of green gram varieties under organic management practices on growth and yield attributing characters and seed yield (04 years pooled data).

Varieties	Plant height (cm)	No. of primary branches $plant^{-1}$	No. of pods $plant^{-1}$	No. of seeds pod^{-1}	Seed yield (kg ha^{-1})
RMG-975	62.06	4.97	26.70	11.18	802.47
RMG-62	61.72	4.66	21.83	10.86	696.27
MSG-118	55.90	4.29	24.96	9.14	617.80
RMG-492	58.23	4.55	23.83	10.26	685.40
SML-668	50.88	4.25	20.42	10.15	625.90
GANGA-1	60.50	4.66	24.99	10.23	649.13
IPM-02-3	56.14	4.65	22.90	10.83	674.87
MUM-2	62.47	5.18	27.27	11.27	809.80
SEm±	0.58	0.26	0.58	0.58	0.58
CD (P= 0.05)	2.31	0.35	1.39	0.77	0.72

requirement of the varieties at initial growth period leads to improved branching. Organic manures and bio-fertilizers influence the soil nutrient availability through better microbial activity and by releasing the nutrients from the soil, which helps in ample absorption and utilization of nutrients by the plants (Kuar, 2016). The increase in growth parameters might be due to sufficient nutrients supply to plant continuously for various metabolic processes. Balanced and regular supply of nutrients increased the uptake of nutrients also which had possibly contributed to more vegetative growth as well asnumber of branches. Application of organic manures alongwith bio-inoculants increased germination and growth of roots and shoots. It might be probably due to their genetic characters of varieties. The similar findings were also supported by Chadha *et al*. (2013), Dwivedi *et al*. (2018) in pea, Lal *et al*. (2017) in coriander, Lal *et al*. (2019b) in fennel.

Yield and yield attributes

The results revealed that significant variation was recorded in yield and yield attributes in green gram varieties grown under organic production system. The yield attributes (Table 1) such as number of pods per plant (27.27) and number of seeds per pod (11.27) and seed yield (809.80 kg ha^{-1}) was also recorded highest in variety MUM-2 followed by RMG-975 (number of pods per plant (26.70) and number of seeds per pod (11.18) and seed yield (802.47 kg ha^{-1}) and lowest seed yield was recorded in MSG-118 (617.80kg ha^{-1}) and SML-668 (625.90 kg ha^{-1}). The variation in yield and yield attributes might be due to the varietal differences and reflects clearly indicates that MUM-2 and RMG-975 green gram varieties were found suitable for organic farming. Attainments of particularly higher or lower yield attributing character among the different varieties are the genetically controlled phenomenon (Sadeghipur 2008, Gorade *et al.* 2014 and Patel *et al*. 2020). Such variations in yield attributes among the mungbean varieties have also been observed by Goswami *et al.* (2010).

Yield components *viz*. number of pod per plant, number of seed per pod and 1000 seed weight showed significant variation among the different varieties (Table 1). Higher value of these characters ensure better crop yield, which in turn are governed by various plant metabolic functions *viz.* phloem transportthat determine how efficiently photosynthates are made available to the harvestable plant parts (Thavaprakash *et al.* 2006).

Higher crop yield under organic plant management indicated the favourable impact of activated plant metabolic functions considering the positive correlation between enhanced photosynthesis, biomass and yield. When other genetic factors are not altered, increasing photosynthesis leads to yield increase (Guney *et al.* 2016) as higher rates of photosynthesis may be caused by greater N allocation to and higher mesophyll conductance, Rubisco. Rubisco is the primary CO_2 fixation enzyme and the amount and kinetic properties of this enzyme strongly affect the photosynthetic rate (Makino *et al.* 1992). Also pointed towards the need for developing healthy plants; efficient nutrient absorption, photosynthesis and assimilation being the sole key for enhancing crop productivity. Apart from this medium duration nature and high biomass yielding varieties such as MUM-2, RMG-975 performed better due to availability of nutrients to the crop throughout the crop growth period. Organic manures act as nutrient reservoir and upon decomposition produces organic acids; there by absorbed ions are released slowly during entire growth period leading to higher seed yield and yield components (Maheshbabu *et al.* 2008).

Productivity of the crop during the initial year in an organically managed field is lower than in subsequent years as soil fertility levels increase over time as organic materials are added in the organic management system. Similarly, (Surekha, 2007) revealed that a gradual increase in grain yield with the use of organic fertilizers over a period of time was observed (Chan *et al.* 2008). Organic manures usually supply the nutrientsin later stages as they need time to decompose and release the nutrients to soil solution. This may be the reason to better performance of MUM-2 and RMG-975 to organic management. The similar findings were also supported by Maheshbabu *et al.* (2008), Lal *et al.* (2017), Dwivedi *et al.* (2018), in coriander, Lal *et al*. (2019b) in fennel.

Harvest index

The harvest index determines how much photosynthates are transformed into economic yield. The harvest index was recorded significant among the varieties. However, the highest harvest index was found in the variety SML-668 (23.82%) followed by GANGA-1 (23.65%). Whereas, the minimum harvest index was found in the local variety RMG-492 (20.13%). As harvest index indicates the ratio between the economic parts (*i.e.,* in this case seeds) and total biomass production, varieties producing higher seed yield have recorded higher harvest index as compared to others (Layek *et al.* 2014).

Qualitative characters

Data in Table 2 show that the significant difference recorded in seed quality parameters such as nitrogen and protein percentage of all tested varieties under organic management system. The highest test weight (1000 seed weight) was obtained in variety SML-668 (45.99 gm) followed by RMG-975 (37.07 gm) and minimum test weight recorded in local variety RMG-492 (27.97 gm). The reason may be attributed towards the genetic variability and bold grain size in case of SML-668. Similar result about seed test weight was reported by Uddin *et al.,* (2009) and Yadav *et al*. (2007). The maximum nitrogen and protein percentage was found in variety SML-668 (4.17% and 26.06%) followed by MUM-2 (4.12% and 25.75%) at par with RMG-492 and RMG-975 and minimum was found in variety RMG-62 (3.40% and 21.27%). It is noted that MUM-2 and RMG-975 are the one of the top performing varieties of green gram in organic farming practices. Higher nutrient content in plant tissue favours the higher growth and yield characters. The higher nutrient accumulation at initial growth stages of crop with recommended nutrients is due to availability of nutrient along with faster dry matter accumulation. But in later stages of crop growth organic source released nutrient for longer period which facilitated more nutrient absorption resulting in higher nutrient accumulation. These results are in close conformity with that of Henri *et al.* (2008), Uma and Malathi (2009) and Dhakal *et al.* (2016).

Soil fertility status of green gram varieties

Soil fertility and nutrient status of green gram crop after harvest the *Rabi* crop in fennel-green gram cropping system was significantly influenced under organic production system (Table 3). The highest amount of nutrients N was found in the variety MSG-118 (176.03 kg ha^{-1}) and PK was found in the variety IPM-02-3 (27.10 and 325.29 kg ha^{-1}) followed by MUM-2 (174.78, 26.97 and 324.65 kg ha^{-1}). The lowest nutrient NPK content of soil was found variety RMG-62 (156.80, 24.05 and 309.23 kg ha^{-1}). Evaluation of soil quality under different treatments pre and post experimentation revealed considerable changes in soil pH and EC. However, slight increase in organic carbon was noted in all plots. Available N, P, K showed increasing trend under all treatments. In each plots, comparative higher value of available-N may be due to efficient fixation of atmospheric N through symbiotic legume-*Rhizobium* association Bohlool *et al.* (1992). Legume crops add large amount of organic residues through leaf fall and rhizodeposition and the intermediate acids produced during organic residue decomposition also solubilise fixed forms of nitrogen and phosphorus in soil resulting in increased available nitrogen and phosphorus (Henri *et al.* 2008). Soil micro-organisms play a significant role in regulating the dynamics of organic matter decomposition and availability of plant nutrients (Chen 2006). An important feature of green gram crop is its ability to establish a symbiotic partnership with specific bacteria, setting up biological N_2-fixation in its root nodules that supply the plant's needs for N_2 (Mahmood and Athar 2008).

This is mainly due to early maturity of crop leads to more residual soil fertility in the respective plots which is attributed by less removal of nutrients. Similar trend was observed in phosphorus and potassium fertility of the soil. Nutrient use efficiency will vary with the efficiency of variety to utilize the applied nutrients. High yielding varieties are always efficient enough to absorb more nutrients since these are metabolically more active. The results are in confirmation with Chhibba *et al.* (2000) in fenugreek and Basu *et al.* (2008) in fenugreek.

Table 2: Performance of green gram varieties under organic management practices on quality and quality attributing characters (04 years pooled data).

Varieties	Biomass yield (kg ha^{-1})	Harvest index	Test weight (g)	Nitrogen %	Protein %
RMG-975	2888.41	22.43	37.07	3.78	23.64
RMG-62	2506.81	22.10	34.08	3.40	21.27
MSG-118	2125.13	22.75	32.71	3.54	22.13
RMG-492	2774.21	20.13	27.97	3.86	24.09
SML-668	2037.24	23.82	45.99	4.17	26.06
GANGA-1	2128.38	23.65	33.70	3.57	22.32
IPM-02-3	2276.47	23.04	34.49	3.51	21.94
MUM-2	2849.08	22.74	32.85	4.12	25.75
SEm±	132.42	0.58	0.58	0.58	0.58
CD (P= 0.05)	389.93	0.72	27.50	2.42	2.41

Table 3: Soil fertility status influenced by different varieties of green gram (at initiation and after 04 years).

Varieties	N (kg ha^{-1})		P (kg ha^{-1})		K (kg ha^{-1})		Organic carbon (%)	
	Initial (2016)	After crop harvest (2020)	Initial (2016)	After crop harvest (2020)	Initial (2016)	After crop harvest (2020)	Initial (2016)	After crop harvest (2020)
RMG-62	130.46	156.80	12.06	24.05	359.07	309.23	0.26	0.32
MSG-118	130.46	176.03	12.06	26.63	359.07	317.75	0.26	0.32
IPM-02-3	130.46	170.18	12.06	27.10	359.07	325.29	0.26	0.34
MUM-2	130.46	174.78	12.06	26.97	359.07	324.65	0.26	0.32
GANGA-1	130.46	158.05	12.06	24.62	359.07	312.34	0.26	0.32
RMG-492	130.46	169.34	12.06	23.92	359.07	317.53	0.26	0.33
RMG-975	130.46	163.91	12.06	25.31	359.07	323.89	0.26	0.34
SML-668	130.46	169.34	12.06	24.68	359.07	322.83	0.26	0.32
SEm±	0.77	1.29	0.01	0.32	3.77	7.78	0.01	0.01
CD (P= 0.05)	NS	3.90	NS	0.97	NS	23.61	NS	NS

Conclusion

From the 04 years study it can be concluded that there is great potential for cultivation of high yielding varieties of green gram under organic production system. Selection of proper and responsive variety in any crop under organic production system plays a vital role. MUM-2 and RMG-975 are most suitable varieties under organic management system as these are responded to high yield and produced more biomass which can be recycled to produce compost. Application of 50% FYM, 25% vermicompost and 25% castor cake on nitrogen equivalent basis along with *Trichoderma virdae* and phosphorus solubilising bacteria seed treatment is sufficient to meet out the demand of green gram varieties for achieving sustainable higher seed yield with quality produce.

Conflict of interest: None.

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