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Effect of different organic materials and chemical fertilizer on yield and quality of bitter gourd (*Momordica charantia* L.)

Muhammad Arfan-ul-Haq*, Nisar Ahmad, Umar Farooq, Hafsa Zafar and Muhammad Azhar Ali
Biochemistry Section, Post Harvest Research Centre, Ayub Agricultural Research Institute, Faisalabad

Abstract

A field experiment was conducted at Biochemistry Section, Post Harvest Research Center, Faisalabad to evaluate the effect of different organic materials and chemical fertilizers on yield and quality of bitter gourd. Six treatments viz. Control (without fertilizer/organic material), Chemical fertilizer (NPK 50:75:60 kg ha^{-1}), Press mud (PM), Farm yard manure (FYM), Poultry manure (PoM) and Composite organic materials (1/3 PM + 1/3 FYM + 1/3 PoM) were applied using randomized complete block design with three replications. Organic materials were added on nitrogen equivalent basis. Fresh bitter gourd samples were analyzed for quality parameters. Results revealed that chemical fertilizers gave maximum yield during all the three years of study (6.69, 7.84 and 8.01 t ha^{-1} during 2010, 2011 and 2012, respectively) while poultry manure was found the best regarding all quality parameters. When effect of organic materials was compared; it was evident that poultry manure produced the highest yield. During the year 2010, poultry manure gave yield (5.77 t ha^{-1}), dry matter (8.56%), crude protein (1.74%), crude fat (2.01%), crude fiber (1.74%) and mineral matter (1.06%) while during 2011, it gave yield (6.92 t ha^{-1}), dry matter (8.84%), crude protein (1.59%), crude fat (2.06%), crude fiber (1.55%) and mineral matter (1.65%). In the third year (2012), poultry manure produced 7.56 t ha^{-1} yield, 8.72% dry matter, 1.88% crude protein, 1.54% crude fiber, 2.26% crude fat and 1.24% mineral matter.

Keywords: Organic materials, nitrogen, quality, bitter gourd

Introduction

Bitter gourd (*Momordica charantia*), locally known as "Karaila" in Pakistan is one of the most popular summer vegetables. It is a member of the cucurbits family. Bitter melon has been used for a long time in various Asian and African traditional medicines (Paul and Raychaudhuri, 2010). Due to depletion in soil fertility, the interest of using organic manures has been growing day by day (Delate and Camberdella, 2004). The continuous use of chemical fertilizers has resulted in creating a potential threat of environmental pollution (Oad *et al.,* 2004). Cattle and poultry manures provide slow release of nutrients, development of roots and improvement in soil structure leading to higher yield of crops. (Samman *et al*., 2008). Low fertilizer use efficiency (FUE), and synthesis of chemical fertilizers consumes a large amount of energy and money. It seems that possible solution for these situations is the use of organic manures with or without chemical fertilizers (Prabu *et al.,* 2003).

Although organic manures are important for improving soil conditions like soil aeration, water holding capacity, structure and crop yield yet use of inorganic fertilizer is compulsory to obtain yield potential. Hammad *et al.* (2011) observed that recommended NPK gave maximum yield (3.84 t ha^{-1}) as compared to organic sources. Cheema *et al.* (2010) found that grain yield of spring maize was significantly affected by application of urea and poultry manure. While maximum grain yield (5.6 t ha^{-1}) was observed with the application of 50% N from urea + 50% N from poultry manure.

Poultry manure is an excellent organic fertilizer, in contrast to chemical fertilizers; it adds organic matter to soil that improves soil physical, chemical and biological/microbial properties of soil like soil structure, nutrient retention, aeration, soil moisture holding capacity, water infiltration and P availability to plants (Garg and Bahla, 2008). Application of poultry manure has increased N level of the soil up to 53% (Boateng *et al*., 2006).

Press mud is another waste product which can be used as organic manure (Bokhtiar *et al.,* 2001). Press mud contains N, P, K and other micronutrients which can in turn, improve crop nutrients and organic matter can ameliorate soil properties (Razzaq, 2001). Similarly, farm yard manure is also a good source of organic matter and nutrients. Ng'etich *et al.* (2012) showed that application of farmyard manure resulted in better growth and higher yield in spider plant as compared to control (without any fertilizer).

Keeping in view the importance of organic wastes/materials as a source of plant nutrients, present

*Email: acbiochem@hotmail.com

study was planned to investigate the effect of various organic materials and chemical fertilizer (NPK) on the yield and quality of bitter gourd.

Materials and Methods

A field experiment was conducted during the years 2010-12 at Biochemistry Section, Post Harvest Research Center, AARI, Faisalabad. The treatments plan was as under;

T1 = Control (without any fertilizer/organic material)
T2 = Chemical Fertilizer (NPK 50:75:60 kg ha^{-1})
T3 = Press Mud (PM)
T4 = Farm Yard Manure (FYM)
T5 = Poultry Manure (PoM)
T6 = Composite Organic Material (COM) [1/3 N from each of the materials; PM, FYM and PoM]

Organic materials were applied on nitrogen equivalent basis. Phosphorus and potassium were also compensated by adding extra amount of P and K from chemical fertilizers in the treatments receiving organic materials. Chemical composition of various organic materials is given in Table 1. Experimental design was randomized complete block design (RCBD) with three replications. Experiment was repeated for three years 2010, 2011 and 2012 with same set of treatments. Fresh yield was recorded and composite fresh bitter gourd samples were collected and analyzed for quality parameters (Dry matter, crude protein, crude fiber, crude fat and mineral matter). Dry matter, crude protein (Kjeldahl N x 6.25), crude fat (Solvent extraction), crude fiber and mineral matter were determined according to the standard testing methods of AOAC (2000). The data were analyzed statistically by using analysis of variance techniques (Steel *et al.,* 1997) and the differences between treatment means were determined by using LSD test at 5 percent probability level.

Table 1: Chemical composition of organic materials used in experiment

Organic material	N	P	K	Dry matter
	(%)			
Poultry manure	2.00	1.90	1.70	70
Press mud	1.80	1.06	0.85	75
Farmyard manure	0.90	0.30	0.60	45

Results and Discussion

Fresh yield

Results presented in Table 2, 3 and 4 showed that the highest bitter gourd yield was recorded in plots which were supplied with chemical fertilizer i.e. NPK during the 1st, 2nd and 3rd years of experiment. When three organic materials were compared, poultry manure (PoM) proved the best among press mud (PM), farm yard manure (FYM) and the combination of these materials (COM). Maximum yield (6.69 t ha^{-1}) was observed in the treatment where recommended dose of NPK was applied. It was followed by the treatments receiving PoM, COM, PM and FYM giving yield 5.77, 5.52, 4.93 and 4.43 t ha^{-1}, respectively, while minimum fresh yield (3.54 t ha^{-1}) was recorded in the control during the year 2010. During 2011 and 2012, the yields observed were 7.84 and 8.01 t ha^{-1} (NPK), 6.92 and 7.56 t ha^{-1} (PoM), 6.61 and 7.10 t ha^{-1} (COM), 6.13 and 6.50 t ha^{-1} (PM), 5.33 and 5.90 t ha^{-1} (FYM) and 3.81 and 3.90 t ha^{-1} (control), respectively. The findings of Khalid *et el.*, 2014, Okoli and Nweke, 2015 and Sylestre *et el.*, 2015 are in accordance with the present study.

A keen look at the results revealed that the effect of organic sources became more and more prominent and significant with the passage of time. For example, PoM application produced 63% more bitter gourd yield during the first year (2010), 82% more in 2nd year (2011) and 92% more in 3rd year (2012) over control. This trend of higher yields in proceeding years as compared to previous years was also true for PM, FYM and COM. This trend of beneficial effect clearly indicated that organic sources of nutrients had a long lasting effect. In contrast, the NPK application produced 89, 106 and 105% more yield over control during the years 2010, 2011 and 2012, respectively, showed no residual effect of NPK during last two years. The better yield in succeeding years with PoM, PM, FYM and COM might be due to the reason of more availability of nutrients throughout the growing season as well as their residual effect. Channabasanagowda *et al.* (2008) used organic and inorganic source for NPK in wheat crop and their findings supported the above results.

The increase in the total yield resulting from organic manuring may be attributed to that organic manuring enhanced soil aggregation, soil aeration, water holding capacity and offered good soil conditions for the root system of plants (Abou El- Magd *et al.*, 2005). In addition, organic manures are slow releaser and provide nutrients throughout growth period (Arisha *et al.*, 2003). Adesodun *et al.* (2005) found that application of poultry manure to soil increased soil organic matter, N and P and aggregate stability. In a field experiment, Farhad *et al.* (2009) found that grain yield and biological yield of maize were significantly affected by application of press mud and maximum values for these parameters were recorded with the application of 12 t ha^{-1} press mud.

Dry matter

Dry matter was significantly affected by the application of organic materials and chemical fertilizers

(Table 2-4). In general, application of organic materials resulted in an increase in dry matter as compared to control. The highest dry matter was observed by application of poultry manure whereas the lowest dry matter was observed in control during all the three years of study. Dry matter varied from 6.99 to 8.56, 7.23 to 8.84 and 6.53 to 8.72% during 2010, 2011 and 2012, respectively; highest in poultry manure and lowest in control. Higher dry matter indicated that the total uptake of nutrients was more in the treatment where poultry manure was applied. The increase in dry matter with PoM as compared to other organic materials was mainly due to the reason of more availability of nutrients by PoM throughout the growing season. These results are in accordance with the findings of Mitchell and Tu (2005) and Warren *et al.* (2006).

Crude protein

Crude protein was significantly increased by the application of organic materials and chemical fertilizer. The highest crude protein was found in the treatment where PoM was applied during all the three years of trial while minimum protein was found in control. Crude protein contents ranged from 1.02 to 1.74, 1.07 to 1.59 and 1.15 to 1.88% in the years 2010, 2011 and 2012, respectively (Table 2-4). The maximum crude protein contents (1.74, 1.59 and 1.88%) were obtained by PoM during the years 2010, 2011 and 2012, respectively, followed by the

Table 2: Effect of organic materials and NPK on fresh yield and quality parameters of bitter gourd grown during the year 2010

Treatment	Fresh yield	Dry matter	Crude Protein	Crude fiber	Crude fat	Mineral matter
	t ha^{-1}			%		
Control	3.54 e	6.99 c	1.02 e	1.21 e	1.38 c	0.94 e
Chemical fertilizer (NPK)	6.69 a	8.03 b	1.45 c	1.60 c	1.79 b	1.04 b
Press mud (PM)	4.93 c	8.14 ab	1.50 c	1.62 bc	1.81 b	1.04 b
Farm yard manure (FYM)	4.43 d	7.96 b	1.35 d	1.52 d	1.46 c	0.99 c
Poultry manure (Po M)	5.77 b	8.56 a	1.74 a	1.74 a	2.01 a	1.06 a
Composite organic materials (COM)	5.52 b	8.38 ab	1.64 b	1.66 b	2.00 a	1.05 ab

Table 3: Effect of organic materials and NPK on fresh yield and quality parameters of bitter gourd grown during the year 2011

Treatment	Fresh yield	Dry matter	Crude Protein	Crude fiber	Crude fat	Mineral matter
	t ha^{-1}			(%)		
Control	3.81 e	7.23 c	1.07 d	1.14 e	1.22 e	1.18 e
Chemical fertilizer (NPK)	7.84 a	8.16 b	1.38 c	1.36 c	1.75 c	1.46 d
Press mud (PM)	6.13 c	8.34 ab	1.47 b	1.40 c	1.84 c	1.50 c
Farm yard manure (FYM	5.33 d	8.12 b	1.30 c	1.27 d	1.55d	1.44 d
Poultry manure (Po M)	6.92 b	8.84 a	1.59 a	1.55 a	2.06 a	1.65 a
Composite organic materials (COM)	6.61 b	8.6 ab	1.57 a	1.47 b	1.95b	1.61 b

Table 4: Effect of organic materials and NPK on fresh yield and quality parameters of bitter gourd grown during the year 2012

Treatment	Fresh yield	Dry matter	Crude Protein	Crude fiber	Crude fat	Mineral matter
	t ha^{-1}			(%)		
Control	3.90 f	6.53 b	1.15 d	0.99 d	1.29 d	0.84 c
Chemical fertilizer (NPK)	8.01 a	8.43 a	1.50 c	1.29 c	1.69 c	1.11 b
Press mud (PM)	6.50 d	8.45 a	1.68 b	1.37 b	1.88 b	1.16 ab
Farm yard manure (FYM)	5.90 e	8.22 a	1.46 c	1.23 c	1.58 c	1.03 b
Poultry manure (Po M)	7.56 b	8.72 a	1.88 a	1.54 a	2.26 a	1.24 a
Composite organic materials (COM)	7.10 c	8.53 a	1.74ab	1.50 a	1.99 b	1.23 a

treatments COM, PM, NPK, FYM and control. Control was ranked at the lowest position. These results are in line with those of Ghani *et al*. (2000), Abdelrazzag (2002) and Magnusson (2002) on several vegetable crops. A higher value of leaf N content of crops could be attributed to the ability of organic manure to supply nutrients during mineralization and improvement in the physical and chemical properties of soil and the ability of organic fertilizer to release nutrients gradually throughout the growing season (Adediran *et al.,* 2004; Bokhtiar and Sakurai, 2005).

Crude fiber

Crude fiber content was significantly affected by the application of organic materials as well as chemical fertilizer. The highest crude fiber was found in treatment where PoM was applied while minimum crude fiber was found in control. It ranged from 1.21 to 1.74, 1.14 to 1.55 and 0.99 to 1.54% in the years 2010, 2011 and 2012, respectively (Table 2-4). Poultry manure gave the highest crude fiber (1.74%) followed by COM (1.66%), PM (1.62%), NPK (1.60%), FYM (1.52%) and control (1.21%) during the year 2010. The values of crude fiber for the year 2011 and 2012 were 1.14 and 0.99% (control), 1.36 and 1.29% (NPK), 1.40 and 1.37% (PM), 1.27 and 1.23% (FYM), 1.55 and 1.54% (PoM) and 1.47 and 1.50% (COS), respectively. Oyedeji *et al.,* (2014) found maximum crude fiber in *Amaranthus cruentus* with poultry manure application as compared to NPK and control.

Crude fat

Crude fat significantly increased by the application of organic materials as well as chemical fertilizer (NPK). The impact of press mud and FYM in enhancing the crude fat in bitter gourd was found at par with NPK, while poultry manure gave the highest crude fat (Table 2-4). Crude fat contents ranged from 1.38 to 2.01% in 2010, 1.22 to 2.06% in 2011 and 1.29 to 2.26% in 2012; the highest in treatment where poultry manure was applied and the lowest in control. Akande and Adediran (2004) found that poultry manure at 5 t ha^{-1} significantly increased nutrient uptake. This high uptake of nutrient might increase fat contents in bitter gourd. Abau EL-Magd *et al.,* (2006) found that poultry manure produced high quality broccoli. The results of present study were in accordance with the results of Munir *et al.* (2007) who found that poultry manure and farm yard manure gave higher oil contents in sunflower as compared to NPK (100-75-50 kg ha^{-1}) fertilization. Results are contrary to the results of Steer and Seilar (1990) who reported that N supply rates affected fatty acid composition and oil percentage negatively.

Mineral matter

Mineral matter was significantly increased by the application of NPK and organic materials (Table 2-4). Minimum mineral matter was found in control and maximum in the treatment where poultry manure was applied during all the three years of experiment. Mineral matter ranged from 0.94 to 1.06, 1.18 to 1.65 and 0.84 to 1.24% during the years 2010, 2011 and 2012, respectively. In 2010, the highest mineral matter (1.06%) was observed by application of PoM, whereas the lowest was observed in control (0.94%). Composite organic material produced 1.05, PM and NPK 1.04, and FYM 0.99% mineral matter in bitter gourd. Similar trend was also found in the crop raised during 2011 and 2012. The best results were obtained by the application of PoM.

These results are analogous to Hussain *et al.* (2007) who reported an increase in mineral contents with increasing dose of organic manure. Ewulo *et al.* (2008) also concluded that poultry manure gave higher mineral contents (P, K, Ca and Mg) in tomato leaves as compared to control (No fertilizer application).

Conclusion

It is concluded that chemical fertilizer (NPK) gave maximum yield during all the three years of study while all quality parameters were found to be the best by the application of poultry manure. When organic materials were compared, it was found that poultry manure performed the best as a source of nitrogen to enhance yield as well as quality of bitter gourd as compared to press mud, farm yard manure and combination of press mud, poultry manure and farm yard manure.

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