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Influence of different modules on yield, nutrient uptake and soil physico-chemical properties of mothbean [*Vigna aconitifolia* (Jacq.) Marchel]

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ABSTRACT

A field experiment was carried out at Regional Research Station, SDAU, Bhachau, Kachchh to study the influence of different modules on yield, uptake and physio- chemical properties of soil after harvest of mothbean (Vigna aconitifolia L.) Experiment was consisting of five different modules among three are organic modules, one chemical module and control, under randomized block design. The results of the experiments are differed significantly. The significant improvement in yield was recorded with the chemical module T_4. In organic modules T_2 and T_3 recorded the more yield as compared to control. Modules T_2 and T_3 also recorded the good nutrient content and uptake. Available nutrients in the soil after harvest are best in the organic modules (T_2 and T_3).

***Keyword*:** Chemical module, mothbean, organic module, yield, nutrient uptake and physico-chemical property

Mothbean (*Vigna aconitifolia* L.) is a draught resistant legume, belonging to the family Fabaceae, commonly grown in arid and semiarid regions of India. It is exceptionally hardy legume and known by various other names including mat bean, matki, Turkish gram, or dew bean. In India, it is mostly confined to Gujarat, Karnataka, Rajasthan, Maharashtra and Haryana. Pulses are becoming major crops growing under Kachchh region. Kachchh is the largest district and covers one third part of the Gujarat. Compared to other parts of Gujarat, Kachchh contains highest amount of degraded lands. Main cause for the degradation of land are the arid and semi-arid climatic condition, salinization, alkalinization, light texture soil with low organic carbon content and poor water holding capacity.

The soils of arid and semi-arid regions have very low inherent productivity potential due to physical and nutritional constraints and are highly vulnerable to various degradation processes. Mothbean is minor *kharif* pulse crop and considered as one of the most drought tolerant among the grain legumes (Arunakumar and Uppar, 2007).

Chemical fertilizers play an important role to meet nutrient requirement of the crops but continuous use of these on lands will have deleterious effects on physical chemical and biological properties of soil, which in turn reflects on yield (Sarkar *et al.*, 1997). In recent years organic farming is becoming great importance for sustainable agriculture to stop deterioration of the agricultural lands and environment, to get yield safer for human beings and animals and to encourage the natural enemies of harmful insects and soil borne diseases (Gomaa *et. al.*, 2005).

Legumes are phosphorus loving plants, they require phosphorus for growth and seed development and most especially in nitrogen fixation which is an energy- driving process. Legumes can fix up to 11-20kg N ha^{-1} (Sanginga *et al.,* 2000), but this is not achievable in the tropics because of low soil fertility and poor farming practices. PROM is Phosphate Rich Organic Manure, produced by composting various organic wastes with high grade rock phosphate in fine size. It contains 10.4 per cent phosphorous, 7.9 per cent organic carbon and 0.4 per cent nitrogen, acts as alternative to DAP fertilizer and makes soil soft and enriched with nutrients for long time, which plays an important role in maintaining soil fertility and productivity. FYM and Vermicompost are known to play an important role in improving the fertility and productivity of soils through its positive effects on soil physical, chemical and biological properties and balanced plant nutrition (Kumar *et al.*, 2011). It improves the structure and water holding capacity of soil.

Yield of mothbean is much less as compared to other pulse crops. Hence, there is a need to enhance the production potential of this crop by use of organic manures, biofertilizers and micronutrients in combination. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase the usage of organic manures which are known to improve physico-chemical properties of soil and supply the nutrients in available form to the plants. Hence the present study on influence of different modules on yield, nutrient uptake and soil physico-chemical properties after harvest of mothbean [*Vigna aconitifolia* (Jacq.) Marchel] has been conducted.

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MATERIALS AND METHODS

The experiment was conducted at Regional Research Station, SDAU, Bhachau during the *Kharif* season from 2009-10 to 2014-15. The experiment was laid out in randomized block design. Manures and fertilizers were applied as per the treatment. Mothbean variety GM-2 was sown at the seed rate of 15-20 Kg ha^{-1} with the spacing of 45 × 10cm. Gross plot size was 14.5 × 20.5m. Further observations were recorded and statistical analysis was done. The BCR value was computed by dividing net return by total expenditure of each module. The soil was sandy loam and low in organic matter. The soil pH was 8.03 and having organic carbon (0.27 %), available nitrogen (172.48kg ha^{-1}) and available phosphorus (36.60kg ha^{-1}) and medium in potassium (308.40kg ha-1). The treatments comprised of three organic modules, one chemical module and control, the details of the module are presented in the following table.

Treatments	Module details
T1 (Module1)	**Organic Module-I (OFM-I)**
	• Soil application of 20 Kg N ha^{-1} through FYM + *Trichoderma viride* @ 1.5 Kg ha^{-1}
	• Soil application of phosphorus through enriched compost through PROM @ 40 Kg ha^{-1}
	• Seed treatment with *Rhizobium* @ 30 g Kg^{-1} seed
	• Install 50 bird perches ha^{-1}
	• Application of bio pesticides as per need
T2(Module 2)	**Organic Module-II (OFM-II)**
	• Soil application of 20 Kg N ha^{-1} through Vermicompost + *Trichoderma viride* @ 1.5Kg ha^{-1}
	• Soil application of phosphorus through enriched compost through PROM @ 40Kg ha^{-1}
	• Seed treatment with *Rhizobium* @ 30 g Kg^{-1} seed
	• Install 50 bird perches ha^{-1}
	• Application of bio pesticides as per need
T3(Module 3)	**Organic Module-III (OFM-III)**
	• Soil application of 20 Kg N ha^{-1} through FYM + *Trichoderma viride* @ 1.5Kg ha^{-1}
	• Soil application of phosphorus through enriched compost through PROM+VAM @ 40Kg ha^{-1}
	• Seed treatment with *Rhizobium* @ 30 g Kg^{-1} seed
	• Install 50 bird perches ha^{-1}
	• Application of bio pesticides as per need
T4(Module 4)	**Chemical Module-I**V **(CM-IV)**
	• Seed treatment with Carbendazim + Thiram @ 3 g Kg^{-1} seed
	• Apply 20 Kg N and 40 Kg P_2O_5 ha^{-1} in the form of chemical fertilizer
	• Apply prophenophos 50% EC @ 0.05% when *Helicoverpa* population exceeds 5 larvae/meter row length
	• Spray mancozeb 0.2% if incidence of Aschochyta leaf blight is observed
T5(Module 5)	Control

For estimation of nitrogen, phosphorus and potassium content and uptake composite samples of whole plant were taken after harvest and ground to powder which was used for the chemical analysis. Nitrogen was estimated by Kjeldahl's method (Jackson, 1967), phosphorus was estimated by Vanadomolydo phosphoric acid yellow colour method (di-acid extract), potassium was estimated by using the flame photometer (Jackson, 1967) and sulphur was estimated by Turbidimetric method (Chaudhary and Cornfield, 1966). The total uptake of nitrogen, phosphorus, potassium and sulphur were calculated by using given formula.

The soil samples were randomly drawn from different spots of experimental site upto 30 cm depth composite sample was prepared after proper mixing, drying and sieving. Soil physico-chemical properties were analyzed by using the following methods

$$\text{Nutrient uptake}\left(\text{kg ha}^{-1}\right) = \frac{\text{Nutrient content (\%) x Yield}\left(\text{kg ha}^{-1}\right)}{100}$$

Methods used for estimation of physico-chemical properties of the soil

Soil pH (1:2.5)	Potentiometric method	Jackson (1967)
EC (dSm^{-1})(1:2.5) at 25 ^{0}C	Conductometric method	Jackson (1967)
Bulk density(Mg /m^3)	Core method	Piper (1950)
Available N (kg ha^{-1})	Alkaline Potassium permanganate	Subbiah and Asija (1956)
Available P_2O_5 (kg ha^{-1})	Extraction with0.5 M $NaHCO_3$(pH 8.5)	
	Colorimetric method	Olsen *et al*.(1954)
Available K_2O(kg ha^{-1})	Flame photometeric method	Richards (1954)
Available sulphur (mg kg^{-1})	1% NaCl extraction method	Williams and Steinberg (1959)

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following headings:

Effect of different modules on yield of mothbean

Results from the Table 1 showed that there is significant difference among the different treatments for seed and straw yield. The maximum seed and straw yield were recorded in module T_4 in both individual years and pooled data as compared to organic module and control. The increase in seed yield might be due to higher number of pods plant^{-1}, more number of seeds pod^{-1}, maximum pod length. In case of organic modules T_2 followed by T_3 were found best for seed and straw yield, due to improvement of soil physical, chemical and biological properties cumulatively benefited the mothbean crop, results are in agreement with the findings of Gopinathan and Prakash (2015). Sitaram *et. al.* (2014) reported that Vermicompost improves the physical, chemical and biological properties of the soil including supply of almost all the essential plant nutrients for the growth and development of plant. Humic acid in Vermicompost enhances the availability of both native and added micro-nutrients in soil and thus plant growth, yield attributes and yield increases.

Effect of different modules on content and nutrients uptake by the mothbean

Results from the table 2 (pooled data) indicate that nitrogen, phosphorus, potassium and sulphur content were differed significantly with the treatments. The highest nitrogen, phosphorus, potassium and sulphur content in both seed and straw were recorded in the modules T_4 and T_2 and both are at par with each other, followed by module T_3 and least nutrients content in both seeds and straw was recorded with the control (module T_5). The higher level nutrients content in the plant analysis in T_4 module is due to readily available nutrients which are applied through fertilizers. In organic module T_2 has recorded the maximum nutrients content with the application of Vermicompost and PROM this due to well-developed root system which helps in increased nitrogen fixation and its availability to plant along with other nutrients and PROM has provided the phosphorus to the plants. It contains 10.4 per cent phosphorous, 7.9 per cent organic carbon and 0.4 per cent nitrogen.

Results from the table 2 (pooled data) indicates that highest nitrogen uptake was recorded in module T_4 in seed with 44.21 kg ha^{-1} and straw with 34.14 kg ha^{-1} and in T_2 module, 42.64 kg ha^{-1} in seed and 33.40 kg ha^{-1} in straw and both are at par with each other, followed by module T_3 and least content was recorded with the control. Highest phosphorus uptake in seed (7.457 kg ha^{-1}) and straw (6.252 kg ha^{-1}) was recorded in the T_4 module and T_2 has recorded the 7.135 kg ha^{-1} in seed and 6.270 kg ha^{-1} P uptake in straw. Module T_4 (16.34 kg ha^{-1} in seed and 25.13 kg ha^{-1} in straw) and T_2 (15.76 kg ha^{-1} in seed and 24.20 kg ha^{-1} in straw) recorded the highest potassium uptake in both seed and straw and both are at par with each other. Similar trend has been observed for sulphur (T_4-3.090 kg ha^{-1} in seed and 3.284 in straw kg ha^{-1} and T_2 - 2.974 kg ha^{-1} in seed and 3.202 kg ha^{-1} in straw). Module T_4 and T_2 recorded the highest nutrients uptake followed by module T_3 and least nutrients uptake for all the nutrients were recorded in control treatment (Module T_5). This might be due to higher level of nutrient contents and yield in both T_4 and T_2 modules resulted in higher uptake. The present study indicates that more nutrients uptake was recorded in the application of recommended doses of fertilizers, this is due to readily available nutrients. Application of FYM and Vermicompost along with PROM also recorded the good nutrients uptake as compared to control this is due to better mineralization of nutrients and greater availability of phosphorous by the PROM. These results are in accordance with the findings of Kumar *et al*. (1994) and Waigwa *et al*. (2003).

Effect of different modules on physico-chemical properties of soil

Treatments are differed significantly for available nitrogen, phosphorus, sulphur, EC and bulk density after harvest of mothbean (Table 3, pooled data). There is no significance difference between the treatments for the

Table 1: Effect of different modules on yield and nutrient content of mothbean (Pooled Data)

Treatment	Yield (kg ha^{-1})		N Content (%)		P Content (%)		K Content (%)		S Content (%)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Module-1	1176	1626	3.288	1.843	0.527	0.336	1.224	1.345	0.228	0.168
Module-2	1253	1762	3.387	1.880	0.567	0.353	1.253	1.368	0.236	0.189
Module-3	1180	1652	3.334	1.851	0.544	0.343	1.238	1.354	0.233	0.175
Module-4	1316	1828	3.401	1.889	0.574	0.357	1.257	1.390	0.238	0.182
Module-5	879	1192	3.219	1.822	0.514	0.330	1.201	1.336	0.219	0.158
SEm (±)	**29.168**	**37.25**	**0.018**	**0.007**	**0.006**	**0.003**	**0.006**	**0.005**	**0.220**	**0.002**
LSD (0.05)	**80.85**	**103.25**	**0.05**	**0.02**	**0.02**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**
CV%	**12.72**	**11.99**	**2.83**	**2.03**	**5.84**	**4.01**	**2.46**	**2.05**	**4.32**	**6.76**

Table 2: Effect of different modules on nutrient uptake of mothbean (Pooled Data)

Treatment	N Uptake (kg ha^{-1})		P Uptake (kg ha^{-1})		K Uptake (kg ha^{-1})		S Uptake (kg ha^{-1})	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Modules-1	39.33	30.34	6.309	5.549	14.60	22.13	2.710	2.772
Modules-2	42.64	33.40	7.135	6.270	15.76	24.20	2.974	3.202
Modules-3	39.70	30.90	6.483	5.730	14.73	22.62	2.770	2.911
Modules-4	44.21	34.14	7.457	6.252	16.34	25.13	3.090	3.284
Modules-5	28.29	21.76	4.529	3.934	10.56	15.96	1.923	1.883
SEm (±)	**1.046**	**0.719**	**0.183**	**0.141**	**0.378**	**0.536**	**0.069**	**0.072**
LSD (0.05)	**2.90**	**1.99**	**0.51**	**0.39**	**1.05**	**1.49**	**0.19**	**0.20**
CV%	**13.42**	**12.15**	**14.34**	**12.86**	**13.02**	**12.37**	**12.65**	**12.73**

Table 3: Effect of different modules on available nutrients and physico-chemical properties of soil after harvest of mothbean (Pooled Data)

Treatment	Available N	Available P	Available K	Available S	EC	PH	Bulk Density
Module-1	178.02	42.14	315.86	9.11	0.79	8.27	1.60
Module-2	176.90	40.90	315.06	8.95	0.80	8.28	1.61
Module-3	179.56	42.22	316.66	9.30	0.80	8.26	1.60
Module-4	174.20	40.14	313.89	8.74	0.82	8.38	1.64
Module-5	169.54	37.50	311.76	8.61	0.80	8.34	1.63
SEm (±)	**0.994**	**0.404**	**2.099**	**0.115**	**0.007**	**0.051**	**0.013**
LSD (0.05)	**2.760**	**1.120**	**NS**	**0.340**	**0.020**	**NS**	**0.030**
CV%	**2.960**	**5.140**	**3.640**	**3.840**	**4.120**	**3.320**	**4.160**

pH. Among the different modules tested, module T_3 (179.56 kg ha^{-1}) and module T_1 (178.02 kg ha^{-1}) recorded the highest available nitrogen in the soil. Module T_3 recorded the 42.22 kg ha^{-1} and module T_1 recorded the 42.14 kg ha^{-1} available phosphorus in the soil after harvest and both are at par with each other. Module T_3 recorded the highest sulphur content (9.30 kg ha^{-1}) followed by module T_1 (9.11 kg ha^{-1}). For the available nutrients in the soil after harvest, modules T_3 and T_1 were found best, followed by module T_2 and least was observed with the control (T_5) and chemical module (T_4). Module T_1 and T_3 contains FYM application, farm yard manure is known to maintain soil productivity longer than inorganic fertilizers. Module T_1 and T_3 contains all micro and macro nutrients its effect will be retained in the soil for longer period of time. FYM and Vermicompost were applied along with PROM. PROM is Phosphate Rich Organic Manure it contains 10.4 per cent phosphorous, 7.9 per cent organic carbon and 0.4 per cent nitrogen, which plays an important role in maintaining soil fertility and productivity. Least bulk density was recorded in the Modules T_1, T_2 and T_3 and maximum was recorded in modules T_4 and T_5. All the organic manures were significantly reduced the bulk density, this due to increase in the porosity and addition of organic carbon to the soil through manures. These results regarding physico-chemical properties of the soil are in line with the findings made by Vyas *et al.* (2003) and Katkar *et al.* (2005). Reddy *et al*. (2007) reported that application of FYM balances the availability of nutrients in the soil.

CONCLUSION

From the present study it can be concluded that T_4 module was found best for yield. Among all the organic modules T_2 followed by T_3 recorded the maximum yield and yield attributes. Organic modules also maintained the soil fertility and productivity, T_2 module can be recommended to the farmers this helps in the realization of environmental friendly and sustainable agriculture.

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