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Influence of chemical vs. organic farming modules on growth, yield and economics of summer groundnut (*Arachis hypogaea* L.) under organic farming

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Abstract
A field experiment was conducted to study the influence of chemical input module vs. organic farming modules on growth, yield and economics of summer groundnut under organic farming at the Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during summer seasons of 2014 and 2015. The experiment was conducted with two organic farming modules *viz*; OFM-I and OFM-II and chemical input module (CIM). Among the different modules under testing, organic input packages module II (OFM-II) which consists soil application of 25 kg N/ha through FYM + *Trichoderma harzianum* @ 1.5 kg/ha + seed inoculation with *Rhizobium* and PSB @ 30 g/kg seed, along with installation of 50 bird perches and 8 pheromone traps/ha + spray of neem based product @ 30 ml/10 lit of water when *Helicoverpa armigera* larval population exceeds 5 larvae/m row length + spraying of HaNPV @ 450 LE/ha in 500 lit water + spraying of Spinosad @ 75 g a.i./ha when *Helicoverpa* population exceeds 5 larvae / meter row resulted in drastic improvement of growth and yield attributes, pod and haulm yields and net returns of summer groundnut closely followed by organic farming module I (OFM- I) as compared to chemical input module (CIM).

Keywords: Groundnut, organic farming module, pod yield, haulm yield

Introduction
Groundnut is one of the most important oil seed / cash crops of India. Groundnut kernel contains about 50 % edible oil. Remaining 50 % of the seed has high qualities of protein (21.4-36.4 %), carbohydrates, minerals and vitamins (Das, 1997) [2]. The world wide groundnut is grown in 26.4 million hectares with a total production of 37.1 million metric tonnes and an average productivity of 1400 kg/ha. Developing countries constitute 97% of the global area and 94% of the global production of this crop. The production of groundnut is concentrated in Asia and Africa with 56% and 40% of the global area and 68% and 25% of the global production, respectively.
The major constraint limiting the growth and development of this crop is the poor fertility status of Indian soils. Moreover, most of the soils of Gujarat are low in organic carbon and available nitrogen, medium in available phosphorus and medium to high in available potash. The organic matter content in the soil has to be built up with the help of bulky organic manures (i.e. farm yard manure and vermicompost), the use of organic manures held a prestigious position among the farmers. It is well documented that addition of organic manures has shown considerable increase in the crop yield and has exerted a significant influence on physical, chemical and biological properties of soil.
Conventional agriculture has made an adverse impact on soil and plant health. This eventually, leads to high demand for organic farming to protect soil and plant health. Organic farming in recent years is gaining impetus due to realization of inherent advantages as it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment (Lokanath and Parameshwarappa, 2006) [4]. Very little research work has been reported on integration of all management practices on growth and yield of organically grown groundnut and its effect on soil health under North Gujarat condition. Considering the above facts in view, an experiment was carried out to evaluate the impact of chemical input module and different organic farming modules on productivity of groundnut during summer season.

Materials and Methods
A field experiment was conducted during summer seasons of 2014 and 2015 at the Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural

University, Sardarkrushinagar, District Banaskantha (North Gujarat) to study the influence of chemical input module vs. organic farming modules on growth, yield and economics of summer groundnut (*Arachis hypogaea* L.) under organic farming in North Gujarat. The soil of experimental plot was loamy sand in texture and neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorous and high in available potash.

An experiment was conducted on fixed site by using large plot techniques. Each module having 0.40 ha area. The test of significance of variation due to treatments were analyzed using simple 't-Test'. Each module had 0.40 ha area. Total 10 quadrates (5.0 m x 4.50 m) were randomly demarcated in each module. The quadrates are treated as replication. In present experiment, both organic farming modules were undertaken in organic plot and chemical input module in adjoining plot. Buffer strip of 2.5 m was maintain between two organic farming modules to check outflow of nutrients and reduce the border effect. Nitrogen content in FYM and vermicompost was determined on dry weight basis for each year separately and applied in respective module based on N-equivalent (dry weight basis). N content in the FYM and vermicompost are 0.50 and 0.75 % during 2014 and 0.57 and 0.69 % during 2015, respectively. Both FYM and vermicompost were uniformly broadcasted in the demarcated area of respective module before last tillage operation of land preparation and properly incorporated in the soil. For chemical input module the full dose of nitrogen and phosphorus were applied in furrows at the time of sowing as basal through urea and single super phosphate, respectively.

The groundnut variety GG 2 was sown by maintaining inter row spacing of 30 cm using seed rate of 120 kg/ha. It was sown for two successive years on 25th February, 2014 and 23rd February, 2015 and harvested on 20th June, 2014 and 24th June, 2015. Total five plants were tagged in each demarcated quadrate to record different growth and yield attributes. Pod and haulm yields were recorded from all 10 quadrates demarcated in each module. The experiments were conducted under assured irrigation facilities and need based irrigations were applied to groundnut. Need based cultural operations were followed. The crop was not infested by any major insect-pests and diseases in module under test. Economics was calculated by considering the prevailing market price of groundnut pod and haulm (without considering the premium price of organic produce) and various inputs. Three modules of which two organic input modules and one chemical input module were studied in present experiment. Each module consists of integration of input packages are given below.

Input packages of different modules

Module	Description
Organic Farming Module-I (OFM-I)	a) Application of 25 kg N/ha through vermicompost + *Trichoderma viride* @ 1.5 kg/ha b) Seed inoculation with *Rhizobium* and PSB @ 30 g/kg seed c) Planting of Marigold as interspersing d) Installation of 50 bird perches and 8 pheromone traps/ha e) Spray neemoil @ 30 ml/10 liter of water when *Helicoverpa armigera* larval population exceeds 5 larvae/m row length f) Spray SNPV @ 250 LE / ha in 500 liter water
Organic Farming Module-II (OFM-II)	(a) Application of 25 kg N/ha through FYM + *Trichoderma harzianum* @ 1.5 kg/ha (b) Seed inoculation with *Rhizobium* and PSB @ 30 g/kg seed (c) Installation of 50 bird perches and 8 pheromone traps/ha (d) Spray neemoil @ 30 ml/10 liter of water when *Helicoverpa armigera* larval population exceeds 5 larvae/m row length (e) Spray of HaNPV @ 450 LE/ha in 500 liter water (f) Spray Spinosad @ 75 g a.i./ha when *Helicoverpa* population exceeds 5 larvae/meter row length
Chemical Input Module (CIM)	(a) Application of 25-50 kg N-P_2O_5/ha (from inorganic fertilizers) (b) Seed treatment with carboxin + thiram @ 3 g/kg seed + quinalphos @ 25 ml/kg seed for control of white grub (c) Spray prophenophos 50% EC @ 0.05% when *Helicoverpa / Spodoptera* population exceed 5 larvae / meter row length (d) Spray mencozeb + carbendazim 0.2 % to control early and late leaf spot, if observed

Results and Discussion

Growth parameters

In organic farming module II (OFM-II), an application of 25 kg N/ha through FYM + *Tricoderma harzianum* @ 1.5 kg/ha + seed treatment with *rhizobium* and PSB + installation of 50 bird perches and 8 pheromone traps/ha resulted significantly taller plants as well as plant spread during 2014 and 2015 (Table 1) than chemical input module (CIM). However, the plant height and plant spread at harvest in organic farming module I (OFM-I) and OFM II were similar. Significantly lower plant height and plant spread was recorded in chemical input module (CIM) where all inputs were added from inorganic chemicals as mentioned in this module. This may be owing to continuous availability of nutrients to groundnut plants because of their slow release of nutrients from FYM during crop season. Moreover, application of organic manures supply all essential plant nutrients i.e. major as well as micro nutrients to plant and biofertilizers perform better when the soil is fertilized with organic manure. Thus, integration of organic manure and biofertilizers in OFM II resulted in significantly taller plants. Similar findings have been reported by Kausale *et al.* (2009) [3] and Akbari *et al.* (2010) [1] in groundnut.

Yield attributes and yield

Majority of the yield attributes of summer groundnut were significantly influenced by different organic and chemical package modules (Table 1). Significantly higher number of filled pods per plant, weight of filled pods and shelling percentage were recorded significantly higher with organic package modules viz., OFM-I and OFM-II as compared to CIM during both the years. Further, results indicated that both the organic package modules i.e. OFM I and OFM II did not differ significantly. Different modules under testing did not

differ significantly during both the years with respect to kernel weight except during 2014 where OFM II remarkably increased 100 kernels weight over chemical input module.

Significant increase in pod and haulm yield of summer groundnut was observed in OFM I and OFM II modules over CIM module (Table 2). Organic farming module I and Organic farming module II registered higher pod yield to the tune of 35.82 and 44.12% during 2014 and 41.02 and 57.34% during 2015 over CIM module, respectively. Similarly haulm yield was increased by 23.16 and 27.11% during 2014 and 21.72 and 22.88% during 2015, respectively over chemical input module. However, both organic farming modules did not differ significantly between themselves with respect to pod and haulm yield. Harvest index was not significantly influenced during first year by different modules, but organic farming packages modules OFM I and OFM II registered numerically higher harvest index over application of various inputs through inorganic chemicals during 2015.

Greater root extension under organic application might have helped in greater uptake of other nutrients especially micronutrients and Ca which have greater role in pod setting. Further, higher photosynthates produced under organic modules due to better N and P availability, better translocation of photosynthates within plants in favours of reproductive system, might have collectively led to heavier kernel and high shelling percent. Similar conclusion was also drawn by Murthy *et al.* (2009) [5], Patra *et al.* (2011) [7] and Narayanaswamy *et al.* (2013) [6] in groundnut. Continuous supply of nutrients in balanced quantity for prolonged period throughout the growth stages enables the plants to assimilate sufficient photosynthetic product and thus increased dry matter accumulation. Therefore, organic package modules OFM I and OFM II showed outstanding performance and produced more number of filled pods and weight of filled pods per plant, shelling percentage with increased test weight resulting into higher pod yield of groundnut during summer season. Our findings confirm the results of Sajid *et al.* (2011) [8], Patra *et al.* (2011) [7], Sujanya and Chandra (2011) [9] and Veeramani *et al.* (2012) [10] in groundnut.

Table 1: Effect of different modules on growth and yield attributes of summer groundnut (Year 2014, 2015 and mean of two years)

Year	Treatments								
	OFM I	OFM II	t- Proba.	OFM I	CIM	t- Proba.	OFM II	CIM	t- Proba.
	Plant height (cm)								
2014	34.5	36.5	0.404,NS	34.5	28.8	0.0019,**	36.5	28.8	0.0022,**
2015	36.1	39.0	0.083,NS	36.1	30.9	0.005,**	39.0	30.9	2.97E-4,**
Mean	35.3	37.8		35.3	29.9		37.8	29.9	
	Plant spread at harvest (cm)								
2014	40.5	42.8	0.148,NS	40.5	37.1	0.064,NS	42.8	37.1	0.004,**
2015	41.8	43.5	0.260,NS	41.8	38.1	0.045,*	43.5	38.1	0.006,**
Mean	41.2	43.2		41.2	37.6		43.2	37.6	
	Number of filled pods per plant								
2014	24.3	25.1	0.592,NS	24.3	16.2	1.84E-6,**	25.1	16.2	1.07E-6,**
2015	25.1	26.0	0.437,NS	25.1	20.9	0.0021,**	26.0	20.9	9.79,E-4**
Mean	24.7	25.6		24.7	18.6		25.6	18.6	
	Number of unfilled pods per plant								
2014	2.2	1.6	0.003,**	2.2	2.4	0.471,NS	1.6	2.4	4.67E-4,**
2015	5.1	5.2	0.736,NS	5.1	4.9	0.589,NS	5.2	4.9	0.247,NS
Mean	3.7	3.4		3.7	3.7		3.4	3.7	
	Weight of filled pods per plant (g)								
2014	23.12	23.58	0.736,NS	23.12	14.60	1.21E-7,**	23.58	14.60	6.51E-8,**
2015	26.78	27.80	0.449,NS	26.78	19.40	1.41E-5,**	27.80	19.40	3.24E-5,**
Mean	24.95	25.69		24.95	17.00		25.69	17.00	
	Weight of unfilled pods per plant (g)								
2014	0.64	0.28	1.51,E-5,**	0.64	0.68	0.574,NS	0.28	0.68	1.60E-7,**
2015	0.85	1.00	0.069,NS	0.85	0.91	0.453,NS	1.00	0.91	0.091,NS
Mean	0.75	0.64		0.75	0.80		0.64	0.80	
	Shelling percentage								
2014	72.5	72.9	0.710,NS	72.5	70.9	0.047,*	72.9	70.9	0.095,NS
2015	74.7	75.2	0.509,NS	74.7	72.6	0.023,*	75.2	72.6	0.0046,**
Mean	73.6	74.1		73.6	71.8		74.1	71.8	
	100 seeds weight (g)								
2014	44.05	45.37	0.419,NS	44.05	41.19	0.089,NS	45.37	41.19	0.028,*
2015	51.18	51.17	0.994,NS	51.18	48.84	0.114,NS	51.17	48.84	0.130,NS
Mean	47.62	48.27		47.62	45.02		48.27	45.02	

* indicates significant at 5% level

** indicates significant at 1% level

Economics

Amongst different modules, maximum net return of Rs 51171/ha and BCR of 2.44 were obtained under OFM II module followed by module OFM I with net return of Rs 40461/ha and BCR of 2.02 in mean data of 2 years (Table 2). This might be owing to higher productivity of groundnut under these two modules. Minimum net return as well as BCR was noticed in CIM module.

Table 2: Effect of different modules on pod and haulm yield and economics of summer groundnut (Year: 2014, 2015 and mean of 2 years)

Years	Treatments								
	OFM I	OFM II	t- Proba.	OFM I	CIM	t- Proba.	OFM II	CIM	t- Proba.
	Pod yield (kg/ha)								
2014	1733	1839	0.382,NS	1733	1276	6.4E-4,**	1839	1276	2.51E-4,**
2015	1633	1822	0.026,*	1633	1158	8.75E-6,**	1822	1158	2.28E-7,**
Mean	1693	1831		1693	1217		1831	1217	
	Haulm yield (kg/ha)								
2014	4116	4248	0.547,NS	4116	3342	1.58E-3,**	4248	3342	3.57E-4,**
2015	4533	4756	0.239,NS	4533	3724	1.85E-4,**	4756	3724	3.18E-4,**
Mean	4325	4502		4325	3533		4502	3533	
	Gross realization (Rs/ha)								
2014	81651	86286	0.370,NS	81651	61061	5.1E-4,**	86286	61061	1.5E-4,**
2015	78937	87143	0.028,NS	78937	57488	4.5E-6,**	87143	57488	3.3E-7,**
Mean	80294	86715		80294	59275		86715	59275	
	Net realization (Rs/ha)								
2014	41818	50742	0.933,NS	41818	29073	0.018,*	50742	29073	6.5E-4, **
2015	39103	51599	1.9E-3,**	39103	25500	6.8E-4,**	51599	25500	1.9E-6, **
Mean	40461	51171		40461	27287		51171	27287	
	B:C ratio								
2014	2.05	2.43	0.012,*	2.05	1.91	0.327,NS	2.43	1.91	3.8E-3,**
2015	1.98	2.45	8.4E-5,**	1.98	1.80	0.072,NS	2.45	1.80	1.6E-5,**
Mean	2.02	2.44		2.02	1.86		2.44	1.86	

Sale price: Pod @ Rs 40/kg and haulm @ Rs 3/kg

Conclusion

From the present study, it is concluded that adoption of organic farming package viz, OFM II consists of application of 25 kg N/ha through FYM + *Trichoderma harzianum* @ 1.5 kg/ha, seed inoculation with *Rhizobium* and PSB each @ 30 g/kg seed, install 50 bird perches and 8 pheromone traps/ha proved the most effective for securing higher pod and haulm yields and net returns in summer groundnut raised under organic farming.

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