Impact of Long term Integrated Nutrient Management on Groundnut Yield, Soil Properties and Organic Carbon Stocks in Scarce Rainfall Zone of Andhra Pradesh, India.

Article *in* Indian Journal of Ecology · January 2016

Vijay Sankar Babu Malayanur
Acharya N. G. Ranga Agricultural University

K.C. Nataraja
Acharya N. G. Ranga Agricultural University

B. SAHADEVA REDDY
Acharya N. G. Ranga Agricultural University

Indian Journal of Ecology (2016) 43 (Special Issue-1): 452-454

Manuscript Number: 2227
NAAS Rating: 4.47

Impact of Long Term Integrated Nutrient Management on Groundnut Yield and Soil Properties in Scarce Rainfall Zone of Andhra Pradesh, India

M. Vijaysankar Babu, K. C. Nataraja, A. Srihari, B. Sahadeva Reddy, G. Ravindrachary and Ch. Srinivasa Rao

Agricultural Research Station, Acharya NG Ranga Agricultural University, Anantapur -515 001, India
E mail: vijay7970@rediffmail.com

Abstract: The impact of long-term integrated nutrient management on groundnut yield, soil properties and organic carbon stocks were higher soil organic carbon with application of organics alone and with chemical fertilizers. The initial available phosphorous content 44 kg ha^{-1} increased to 103 kg ha^{-1} with continuous application of chemical fertilizers, while depleting the P content in the control. Significantly higher organic carbon stocks of 12.31 t ha^{-1} recorded in the treatment with 50% RDF+FYM @ 4t ha^{-1}. The soil bulk density reduced over a period of time. Significant higher pod yield was recorded in half RDF+ FYM @ 4 t ha^{-1} (937 kg ha^{-1}).

Key Words: Groundnut yield, INM, Organic carbon stock, Soil properties

Indian agriculture comprise of 58 per cent of the net cultivated as rainfed farming. The rainfed farming is practiced in arid, semi-arid and sub-humid climatic zones, with annual rainfall of 500–1500 mm (Singh *et al.,* 2004). It is estimated that by 2020 about 600 million people would be living in regions of predominantly rainfed farming. Thus, the per capita land availability in these regions is projected to decrease from 0.28 ha in 1999 to 0.12 ha by 2020 (CRIDA 2004). These regions are characterized by erratic rainfalls with uneven periodicity and distribution, poor infrastructure, degraded soils of low organic matter and plant nutrient contents, and low soil moisture reserves (Srinivasarao *et al*., 2012).

In this context of rainfed farming, the predominant system of groundnut mono-cropping in red sandy loam soils of Anantapur district of Andhra Pradesh is needs better nutrient management strategies to sustain the yield levels. The groundnut productivity in this area reached the lowest plateau of 0.8 t ha^{-1}. Low soil fertility is one of the reasons for the low productivity besides low rainfall and frequent occurrence of dry spells. The nutrient use efficiency (NUE) in rainfed ecosystem may be improved through integrated nutrient supply system. Loss of organic matter either by erosion or high temperatures in this ecosystem aggravates nutrient deficiencies. Judicious use of organic manures such as FYM and farm wastes along with chemical fertilizers improves soil physical, chemical and biological properties and improves groundnut productivity. It is essential to identify such practices which bring more sustainability to the production system besides improving the productivity (Balaguraviah. *et al*., 2005). The limited availability of crop residues is the major constraint for practicing INM, which is also exacerbated by low biomass productivity and numerous competing uses (feed, cooking fuel, fencing, etc.). Yet, some crop by-products such as groundnut shells (GNS) are available for use as soil amendments because of a fewer alternate uses. The GNS, containing 1.0, 0.25 and 1.1 % of N, P and K, respectively, almost higher than in farm yard manure (FYM), can be an important component of INM system especially in communities with large area under groundnut. Thus, availability of GNS can be used as a soil amendment to increase pod yields (Srinivasarao *et al.,* 2012). The objective of the present study was to examine the long-term effects of recycling of farm wastes along with or without chemical fertilizers on soil properties and crop yield in a semiarid agro ecosystem.

MATERIAL AND METHODS

A long-term experiment was initiated in the 1985 rainy season (June–October) at the Agricultural Research Station, Anantapur, Andhra Pradesh, India (77° 40' longitude, 14° 42'; latitude, 350 MSL). The climate of the site is arid tropical, with a mean annual rainfall of 526 mm, of which the major portion is received during *kharif* season (June–October). Soil of the experimental site is classified as Rhodostalfs (Voyalpadu soil series). The landscape is characterized by <1% slope, sandy loam in texture, low in organic carbon and available nitrogen, medium in phosphorus, (P_2O_5; 20 kg ha^{-1}) and Potassium (K_2O; 155 kg ha^{-1}). The test crop was groundnut (TMV-2) mono-cropping (1985–2014). The treatments were T_1: Control (no fertilizer); T_2:100 % RDF (20:40:40 N, P_2O_5, K_2O); T_3: 50 % RDF; T_4:

GNS @ 4 t ha^{-1}; T_5: FYM @ 4 t ha^{-1}; T_6 :T_3 + T_4; T_7 :T_3 + T_5; T_8 :T_2 + $ZnSO_4$ @50 kg ha^{-1} (once in three years); T_9 :FYM @ 5 t ha^{-1} replicated thrice in Randomised Block Design. The soil samples were analyzed for physical, physico-chemical and chemical properties by following the standard procedures. The quantity of carbon stock in each depth was calculated by following the method described by Batjes (1996). The procedure follows the multiplying bulk density (t m^{-3}) and thickness of particular horizon (m) with the total carbon (g C g^{-1} soil) of that layer. Soil samples were also analyzed for SOC concentration (Nelson and Sommers, 1996), Organic C stock (t ha^{-1}) = Soil Organic C (g g^{-1}) in that horizon x Bulk density (t m^{-3}) x depth (m) and expressed on a per hectare basis (Srinivasa Rao *et al.,* 2013).

RESULTS AND DISCUSSIONS

Long term application of organic manures, significantly increased soil organic carbon (Table 1), when applied with organics alone or with RDF. The initial available phosphorous content (44 kg ha^{-1}) increased with only 100% RFD (103 kg ha^{-1}). In the control plot, initial available phosphorous levels of 44 kg ha-1was reduced to 23 kg ha^{-1}over 30 years. Mean differential groundnut pod yield of half recommended fertilizer dose (HRFD) + FYM @ 4t ha^{-1} (937 kg ha^{-1}) was at par with recommended fertilizer dose (RFD) applied through inorganics alone (920 kg ha^{-1}). Significantly higher organic carbon (Fig.1) and organic carbon stocks of 12.31t ha^{-1} recorded in the treatment with 50% recommended fertilizers along with FYM @ 4t ha^{-1} and least was in control (4.81Mg ha^{-1}). Subehia *et al.* (2005) observed that application FYM and lime along with chemical fertilizers maintained better nutrient availability (N, P and K) over the soils where only chemical fertilizers were applied. In view of soil inherent nutrient status, the treatment with half recommended dose (10-20-20 N, P_2O_5, K_2O kg ha^{-1}) along with FYM @ 4 t ha^{-1} will be the best option, which not only giving sustainable yields but also enhancing the soil health (Fig. 2).

The soil organic carbon concentration depends largely on the annual turnover of root residues, root exudates and stubbles (Srinivasarao *et al.*, 2012). Thus the increase in SOC concentration during the experiment in the plots treated with 100 % RDF and INM treatments over the control may be explained by the greater yields through fertilization and manuring and associated greater amounts of root residues and stubbles and higher C input. Increase in SOC concentration under complete dose of NPK fertilizers and INM as compared to unfertilized control has also been reported in other long-term studies (Swarup and Wanjari, 2000).

A judicious combination of chemical fertilizers and organic amendments can improve soil fertility and enhance sustainability. In addition, the amount of rainfall and its

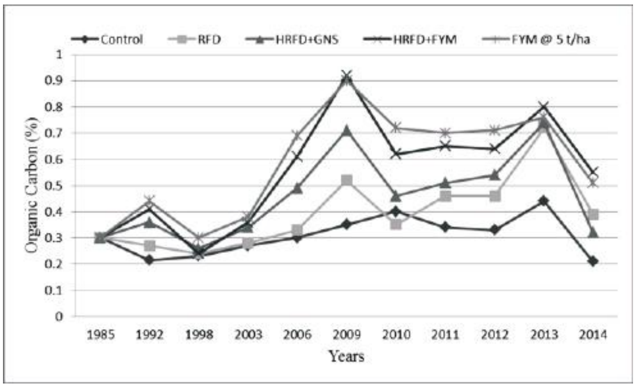

Fig. 1. Effect of INM on organic carbon (%) over years

Table 1. Effect of long term integrated nutrient management on soil properties, organic carbon stocks and mean groundnut pod yield

Treatment	pH	Organic carbon (%)	Avail. P_2O_5 (kg ha^{-1})	Avail. K_2O (kg ha^{-1})	Bulk Density (Mg m^{-3})	Organic carbon stock (Mg ha^{-1})	Groundnut pod yield kg ha^{-1} (30 years mean)
Control	5.67	0.21	23	210	1.53	4.81	713
RFD	5.03	0.39	103	382	1.57	9.20	920
Half RFD	5.37	0.36	80	345	1.58	8.54	855
GNS @ 4 t ha^{-1}	5.67	0.39	46	355	1.55	9.20	819
FYM @ 4 t ha^{-1}	6.43	0.42	48	409	1.51	9.51	879
T_3 + T_4	5.30	0.32	83	494	1.52	7.30	850
T_3 + T_5	6.50	0.55	85	393	1.48	12.31	937
T_2 + $ZnSO_4$ @50 kg ha^{-1}	5.63	0.39	107	388	1.42	8.33	896
FYM @ 5 t ha^{-1}	6.07	0.51	47	433	1.51	11.57	874
CD (p=0.05)	0.89	0.20	17.2	66.08	0.06	1.66	
Initial values	6.6	0.3	44	155	-	-	

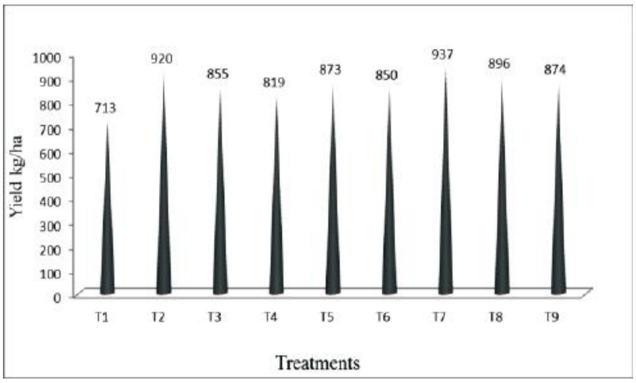

Fig. 2. Effect of long term (1985-2014 integrated nutrient management (INM) on groundnut pod yield

distribution are important to harnessing the benefits of improved soil fertility. Performance of groundnut shells (GNS) is equally good as FYM in terms of increasing yield and improving soil fertility. So it can be a viable alternative as soil amendment/organic nutrient source for improving soil fertility. Benefits of improved soil fertility with nutrient management can only be harnessed when proper distribution of rainfall is received during the growing season, or the drought stress is alleviated with application of supplementary irrigation. The P buildup in all the treatments except control, suggests the possibility of reduction of P dose or skipping P application in alternate year. However, application of organics alone could not sustain high crop yield and application of recommended dose of fertilizer alone could not sustain the soil health for sustainable groundnut yields in rain shadow regions.

REFERENCES

Balaguravaiah D, Adinarayana G, Pratap S and Yellamanda Reddy T 2005. Influence of long-term use of inorganic and organic manures on soil fertility and sustainable productivity of rainfed groundnut in alfisols. *Journal of the Indian Society of Soil Science* **53 (4):** 608-611.

Batjes NH 1996. Total carbon and nitrogen in the soils of the world. *European Journal of Soil Science* **47**:151–163.

Central Research Institute for Dryland Agriculture (CRIDA) 2004. Vision 2020, Hyderabad, India.

Nelson DW and Sommers LE 1996. Total carbon, organic carbon and organic matter. In: Sparks DL, Page AL, Helmke PA, Loeppert RH, Soltanpour PN, Tabatabai MA, Johnson CT, Sumner ME (eds) Methods of soil analysis. Part 3: chemical methods. *Soil Science Society America* book series **5**. SSSA, Madison, WI, pp 961–1010.

Singh HP, Sharma KD, Subba Reddy G and Sharma KL 2004. Dryland Agriculture in India. In: Challenges and strategies for dryland agriculture. *Crop Science of America and American Society of Agronomy,* Madison, USA. Publication No. **32**: 67–92.

Srinivasa Rao Ch, Prasad JVNS, Naresh K, Naga jyothi Ch, Sangeetha Lenka NK, Purkayastha TJ, Pathak H, Ganesh Murthy AN, Singh R, Arunachalam, Subba Rao A, Gangawar B, Venkateswarlu B and Sikka AK 2013. Assesment of carbon sequestration in agriculture and agro forestry systems, NICRA Manual series 3. CRIDA, Hyderabad, Andhra Pradesh. Pp: 43.

Srinivasarao Ch, Vankateswarlu B, Lal R, Singh AK, Kundu S, Vittal KPR, Balaguruvaiah G, Vijaya Shankar Babu, M. Chary GR, Prasadbabu MBB and Yellamanda Reddy T 2012. Soil carbon sequestration and agronomic productivity of an Alfisol for a groundnut-based system in a semiarid environment in southern India. *European Journal of Agronomy* **43**:40–48.

Subehia SK, Verma S and Sharma SP 2005. Effect of long-term use of chemical fertilizers with and without organics on forms of soil acidity, phosphorus adsorption and crop yields in an acid soil. *Journal of the Indian Society of Soil Science* **53**: 308-314.

Swarup A, Wanjari RH 2000. Three decades of All India Coordinated Research Project on long-term fertilizer experiment to study changes in soil quality, crop productivity and sustainability. Indian Institute of Soil Science, Bhopal, India.

Received 18 November, 2015; Accepted 07 January, 2016