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Growth parameters and yield of groundnut as influenced by integrated nutrient management at coastal zone of Karnataka

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Abstract
A field experiment was conducted to study the of integrated nutrient management in groundnut during *Rabi* 2015 at Zonal Agricultural and Horticultural Research Station, Brahmavar, Udupi district, Karnataka. The results of the experiment revealed that at 80 DAS recommended nutrient practice + 50 per cent RDN through vermicompost applied treatment resulted in significantly higher number of nodules (61.13) followed by POP + 50 per cent RDN through poultry manure (60.37). At 90 DAS, POP + 50 per cent RDN through poultry manure recorded significantly higher leaf area per plant (2089 cm^2) followed by POP + 50 per cent RDN through vermicompost (1921 cm^2) as compared to other treatments. Recommended nutrient practice + 50 per cent RDN through poultry manure recorded significantly higher dry matter production (88.36, g $plant^{-1}$), followed by POP + 50 per cent RDN through vermicompost (85.88, g $plant^{-1}$). During 90 DAS to at harvest, treatments of POP + 50 per cent RDN through poultry manure recorded significantly higher values of CGR *viz.,* 0.0057 g cm^{-2} day^{-1} and followed by POP + 50 per cent RDN through vermicompost (0.0056 g cm^{-2} day^{-1}). Whereas, at 90 DAS to harvest higher NAR values of 0.00239 and 0.00226 g cm^{-2} day^{-1} were registered in POP + 50 per cent RDN through vermicompost and poultry manure treatments, respectively.

Keywords: Vermicompost, poultry manure, RDN, CGR, NAR

Introduction

India requires around 20.3 million tonnes of edible oil. It is essential to enhance the productivity of prominent crops of the country like paddy, wheat, pulses and groundnut through location- specific nutrient management practices. To augment major food crops production, Food and Agriculture Organization (FAO) conceptualized the idea of plant nutrients in a crop and cropping system for better resource use. It is not only a reliable way of obtaining fairly higher yields with substantial fertilizer economy, but also a concept that is ecologically sound leading to sustainable agriculture. None of the sources of nutrient alone can meet the total plant nutrients. Integration of from chemical, organic and biological sources of nutrients is the most efficient way to supply plant nutrients for sustained crop productivity and improved of soil fertility (Singh and Singh, 2002) [1]. Among problematic soils, acid soils less availability of nutrients (N, P, Ca, S, and B) besides inadequate organic matter. Paddy and groundnut being, exhaustive crops, removes large amount of macro and micro nutrients from soil. None of the sources of nutrient alone can meet the total plant nutrients. Integration of from chemical, organic and biological sources of nutrients is the most efficient way to supply plant nutrients for sustained crop productivity and improved of soil fertility

It is therefore necessary to judiciously manage the inflow of organic sources of nutrients, and their integration with fertilizers, biofertilizers and organic manure. Application of organic materials along with inorganic fertilizers leads to increased productivity of the system and sustained soil health for a longer period (Gawai and Pawar, 2006) [2]. Due to escalation of fertilizer prices and associated environment problem the crisis has necessitated in search for alternative sources of manures for integrated nutrient management, which includes organic manures, biofertilizers and inclusion of legume (groundnut) to sustain the cereal based cropping system.

Materials and Methods

A field experiment was conducted during *rabi* season of 2015 at Zonal Agricultural and Horticultural Research Station, Brahmavar, Udupi district, Karnataka, to study the of integrated nutrient management in groundnut. The experimental site is situated between 74^0 45' to 74^0 46' East longitude and 13^0 24' 45'' to 13^0 25' 30'' North latitude and an altitude of 10 meters above mean sea level. Soil type is sandy loam in texture and pH was acidic (4.78).

The soil was medium in available nitrogen (362.84 kg ha^{-1}), high in available phosphorus (56.28 kg ha^{-1}) and medium in available potassium (113.61 kg ha^{-1}). The organic carbon content was high (1.32%) in range. TMV-2 a popular variety was sown in January with a spacing of 30 cm X 10 cm in paddy fallow. Experiment included twelve treatments consisted of T_1 – Package of practice (POP- FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1}), T_2- POP + 25 per cent RDN through eupatorium, T_3- POP + 25 per cent RDN through gliricidia, T_4- POP + 25 per cent RDN through vermicompost, T_5- POP + 25 per cent RDN through poultry manure, T_6- POP + 25 per cent RDN through goat manure, T_7- POP + 50 per cent RDN through eupatorium, T_8 - POP + 50 per cent RDN through gliricidia, T_9- POP + 50 per cent RDN through vermicompost, T_{10}- POP + 50 per cent RDN through poultry manure, T_{11}- POP + 50 per cent RDN through goat manure and T_{12}- Control were laid out in Randomized Complete Block Design (RCBD) with three replications. All organics were applied 25 days before transplanting of paddy. Yield (biological and economical) was recorded from individual plots at harvest and converted to kg/ha. Standard statistical methods were used for comparing the treatment means. CGR and NAR were calculated by using the following formulas.

Crop growth rate (CGR)

Crop growth rate is defined as the rate of dry matter production per unit ground area per unit time (Watson, 1952) [3]. It was worked out by the following formula and is expressed as g per cm^2 per day.

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{S}$$

Where,

W_2 and W_1= Dry matter per plant (g) at time t_2 and t_1, respectively

S= Area occupied per plant

3.6.1.11 Net assimilation rate (NAR):

Net assimilation rate is the rate of increase in dry weight per unit leaf area per unit time (Watson, 1952) [3] and is expressed as g per dm2 per day (g/cm^2/day). It was calculated by applying the following formula suggested by Gregory (1926) [4].

$$NAR = \frac{(W_2 - W_1)\,(\log_e L_2 - \log_e L_1)}{(t_2 - t_1)\,(L_2 - L_1)}$$

Where,

NAR= Net assimilation rate in g per dm^2 per day

L_1 and W_1= Leaf area in dm^2 and dry weight of plant in g at time t_1, respectively

L_2 and W_2= Leaf area in dm^2 and dry weight of plant in g at time t_2, respectively

Log_e= Logarithm to the base ‘e’ (Naperian constant)

Results and Discussion

Nodules per plant

At 80 DAS recommended nutrient practice + 50 per cent RDN through vermicompost applied treatment resulted in significantly higher number of nodules (61.13) followed by POP + 50 per cent RDN through poultry manure (60.37), POP + 50 per cent RDN through goat manure (59.22), POP + 50 per cent RDN through gliricidia (58.81) and eupatorium *i.e.* T_7 (58.81, respectively) (Table 1). The poultry manure is relatively a cheap source of both macronutrients (N, P, K, Ca, Mg, S) and can increase soil carbon and N content, soil porosity and enhances soil microbial activity (Thorave and Dhonde, 2007) [5]. Integrated application of vermicompost with inorganic fertilizers contributed to the better nutritional conditions that prevailed during crop growth period which lead to better metabolic and physiological activity of the plant and put up more growth by assimilating more amount of nutrients. Similar results were obtained by Krishna Murthy *et al.* (2009) [6] and Solanki *et al*. (2006) [7].

Leaf area and dry matter production

At 90 DAS, POP + 50 per cent RDN through poultry manure recorded significantly higher leaf area per plant (2089 cm^2) followed by POP + 50 per cent RDN through vermicompost (1921 cm^2) as compared to other treatments and package of practice (1554 cm^2) (Table 2). Recommended nutrient practice + 50 per cent RDN through poultry manure recorded significantly higher dry matter production (88.36, g $plant^{-1}$), followed by POP + 50 per cent RDN through vermicompost (85.88, g $plant^{-1}$), POP + 50 per cent RDN through goat manure (83.69 g $plant^{-1}$) and POP + 50 per cent RDN through gliricidia applied treatments (79.96) (Table 3). The increase in leaf area could be attributed to increased cell division and increased leaf expansion. More number of leaves was recorded due to beneficial influence of organic manures which release growth promoting substances along with enhancement of nitrogen availability (Araei and Mojaddam, 2014). In general, the leaf area increased with the increasing of nutrient quantity and advancement of crop growth period. The highest leaf area was obtained might be due to the effect of higher or optimum nutrient added, especially nitrogen and added extra nutrient through organic manures (Biswas, 2011) [8]. This higher dry matter accumulation may be due to higher photosynthetic ability of the crop as reflected through higher dry matter accumulation in leaf and higher translocation of metabolites from leaf and stem to reproductive part during reproductive phase of crop growth. Many research workers also reported higher TDMP and dry matter accumulation in capsule by safflower with the addition of leguminous green manures (Karle *et al.*, 2007 and Biradar, 2008) [9, 10].

Crop growth rate (CGR) and net assimilation rate (NAR)

During 90 DAS to at harvest, treatments of POP + 50 per cent RDN through poultry manure recorded significantly higher values of CGR *viz.*, 0.0057 g cm^{-2} day^{-1} and followed by POP + 50 per cent RDN through vermicompost (0.0056 g cm^{-2} day^{-1}) and POP + 50 per cent RDN through goat manure (0.0055 g cm^{-2} day^{-1}) (Table 4). Whereas, at 90 DAS to harvest higher NAR values of 0.00239 and 0.00226 g cm^{-2} day^{-1} were registered in POP + 50 per cent RDN through vermicompost and poultry manure treatments, respectively (Table 5).

Combined application of organic manures had an important role in increasing durability of photosynthetic organs. Zalate and Padmani (2009) [11] reported increase in CGR with application of organic manures may be due to the acceleration of photosynthesis activity and the positive response of crop plants. NAR fairly gives a good idea of photosynthetic capacity of the crop plant which is dependent on LAI. Araei and Mojaddam (2014) [12] reported that increase in LAI up to 60 DAS in groundnut crop was due to better nitrogen fixation and readily available of phosphorus by the application of poultry manure. Combined exposure of chemical fertilizer, biofertilizer and compost have significantly contributed towards the crop morpho physiological parameters *viz.*, LAI, CGR and NAR thus contributing towards the vegetative growth of the plant body (Chand *et al.*, 2006) [13].

Yield of groundnut

Pod yield was significantly superior in POP + 50 per cent RDN through poultry manure (2272 kg ha^{-1}) followed by POP + 50 per cent RDN through vermicompost (2162 kg ha^{-1}) and POP + 50 per cent RDN through goat manure (2018 kg ha^{-1}). The former treatment (T_{10}), followed by POP + 50 per cent RDN through vermicompost POP + 50 per cent RDN through goat manure and POP + 50 per cent RDN through gliricidia resulted in significantly higher haulm yield (2900, 2771, 2653 and 2598 kg ha^{-1}, respectively) (Table 6). Higher economical and biological yields in poultry manure might be due to ammonium-N (NH_4-N) is a significant part of total N in poultry manure, which additionally contains uric acid. Uric acid metabolizes rapidly to NH_4-N in most soils, and the net result of the high NH_4-N and uric acid contents in poultry waste is that a large percentage of N can be converted to nitrate-N (NO_3-N) within a few weeks. Poultry manure improves the number of pods per plant, pod yield and haulm yield in groundnut (Veeramani *et al.*, 2012) [14]. Application of vermicompost and FYM might have provided sufficient and balanced nutrients in readily available from throughout the growth period of the crop and the increased availability of plant nutrients, their uptake leading to the greater photosynthesis production of metabolites and enzymatic activities which might have influenced into increased nodulation and extensive root system and the greater production of metabolites and their translocation to various sinks especially the productive strictures (pods and seeds) could have helped to increase into the number of pods per plant besides increasing the overall growth. Results of the present investigation were in similar line with those of Sharma *et al.* (2005) [15]. Further, application of goat manure increased concentrations of labile inorganic P fractions (resin P and $NaHCO_3$ P) following the application of goat manure indicated that net mineralization of P occurred, possibly because the goat manure contained 2.4 g P kg^{-1}, which was greater than the critical P content of 2 g kg^{-1} reported by Floate (1970) [16] as necessary for plant material to mineralize P.

Table 1: Number of nodules per plant at different growth stages of groundnut as influenced by integrated nutrient management.

Treatments	40 DAS	60 DAS	80 DAS	At harvest
T_1 – POP (FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1})	28.76	42.69	45.28	20.08
T_2 - POP + 25% RDN through eupatorium	32.38	45.30	48.00	24.72
T_3 - POP + 25% RDN through gliricidia	33.47	46.03	50.06	27.49
T_4 - POP + 25% RDN through vermicompost	36.31	48.79	54.16	31.36
T_5 - POP + 25% RDN through poultry manure	35.29	48.09	52.45	32.55
T_6 - POP + 25% RDN through goat manure	34.22	47.68	53.65	29.38
T_7 - POP + 50% RDN through eupatorium	37.18	51.86	56.56	36.10
T_8 - POP + 50% RDN through gliricidia	37.59	52.65	58.81	43.10
T_9 - POP + 50% RDN through vermicompost	41.50	55.38	61.13	42.30
T_{10} -POP + 50% RDN through poultry manure	40.21	54.96	60.37	43.77
T_{11} -POP + 50% RDN through goat manure	40.28	54.30	59.22	40.50
T_{12} – Control	12.81	31.63	33.45	14.04
S. Em±	1.80	2.37	3.05	2.24
CD (P=0.05)	5.30	6.96	8.98	6.59

Table 2: Leaf area (cm^2 $plant^{-1}$) at different growth stages of groundnut as influenced by integrated nutrient management

Treatments	30 DAS	60 DAS	90 DAS	At harvest
T_1 – POP (FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1})	261	1299	1554	488
T_2 - POP + 25% RDN through eupatorium	271	1332	1576	593
T_3 - POP + 25% RDN through gliricidia	275	1406	1598	686
T_4 - POP + 25% RDN through vermicompost	280	1507	1725	654
T_5 - POP + 25% RDN through poultry manure	288	1536	1665	814
T_6 - POP + 25% RDN through goat manure	287	1445	1618	710
T_7 - POP + 50% RDN through eupatorium	298	1556	1677	753
T_8 - POP + 50% RDN through gliricidia	292	1608	1712	906
T_9 - POP + 50% RDN through vermicompost	291	1784	1921	1042
T_{10} -POP + 50% RDN through poultry manure	308	1877	2089	989
T_{11} -POP + 50% RDN through goat manure	311	1622	1772	865
T_{12} - Control	256	733	886	274
S. Em±	10.75	91.27	106.54	76.25
CD (P=0.05)	32.0	269	314	225

Table 3: Total dry matter production (g $plant^{-1}$) at different growth stages of groundnut as influenced by integrated nutrient management.

Treatments	30 DAS	60 DAS	90 DAS	At harvest
T_1 – POP (FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1})	5.41	23.18	36.14	61.70
T_2 - POP + 25% RDN through eupatorium	4.90	24.59	37.84	64.39
T_3 - POP + 25% RDN through gliricidia	5.20	26.95	39.18	67.28
T_4 - POP + 25% RDN through vermicompost	5.24	28.38	41.61	71.76
T_5 - POP + 25% RDN through poultry manure	5.02	29.22	42.26	73.74
T_6 - POP + 25% RDN through goat manure	5.32	26.19	40.52	69.11
T_7 - POP + 50% RDN through eupatorium	5.60	31.08	44.02	76.18
T_8 - POP + 50% RDN through gliricidia	5.38	31.84	45.58	79.96

T_9 - POP + 50% RDN through vermicompost	6.02	33.14	48.61	85.88
T_{10} -POP + 50% RDN through poultry manure	6.45	34.80	50.23	88.36
T_{11} -POP + 50% RDN through goat manure	5.80	33.01	47.06	83.69
T_{12} - Control	3.87	14.96	23.92	39.17
S. Em±	0.71	2.73	3.59	5.71
CD (P=0.05)	NS	8.04	10.58	16.25

Table 4: Crop growth rate (g cm^{-2} day^{-1}) at different growth stages of groundnut as influenced by integrated nutrient management

Treatments	30-60 DAS	60-90 DAS	90 DAS-at harvest
T_1 – POP (FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1})	0.0018	0.00130	0.0038
T_2 - POP + 25% RDN through eupatorium	0.0020	0.00132	0.0040
T_3 - POP + 25% RDN through gliricidia	0.0022	0.00122	0.0042
T_4 - POP + 25% RDN through vermicompost	0.0023	0.00132	0.0045
T_5 - POP + 25% RDN through poultry manure	0.0024	0.00130	0.0047
T_6 - POP + 25% RDN through goat manure	0.0021	0.00143	0.0043
T_7 - POP + 50% RDN through eupatorium	0.0025	0.00129	0.0048
T_8 - POP + 50% RDN through gliricidia	0.0026	0.00137	0.0052
T_9 - POP + 50% RDN through vermicompost	0.0027	0.00155	0.0056
T_{10} -POP + 50% RDN through poultry manure	0.0028	0.00154	0.0057
T_{11} -POP + 50% RDN through goat manure	0.0027	0.00141	0.0055
T_{12} – Control	0.0011	0.00090	0.0023
S. Em±	0.0002	0.0002	0.0006
CD (P=0.05)	0.0006	NS	0.0016

Table 5: Net assimilation rate (g cm^{-2} day^{-1}) at different growth stages of groundnut as influenced by integrated nutrient management

Treatments	30-60 DAS	60-90 DAS	90 DAS-at harvest
T_1 – POP (FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1})	0.000411	0.000250	0.00150
T_2 - POP + 25% RDN through eupatorium	0.000445	0.000252	0.00151
T_3 - POP + 25% RDN through gliricidia	0.000464	0.000230	0.00147
T_4 - POP + 25% RDN through vermicompost	0.000461	0.000230	0.00159
T_5 - POP + 25% RDN through poultry manure	0.000473	0.000236	0.00150
T_6 - POP + 25% RDN through goat manure	0.000433	0.000266	0.00137
T_7 - POP + 50% RDN through eupatorium	0.000495	0.000232	0.00148
T_8 - POP + 50% RDN through gliricidia	0.000496	0.000254	0.00166
T_9 - POP + 50% RDN through vermicompost	0.000459	0.000243	0.00239
T_{10} -POP + 50% RDN through poultry manure	0.000454	0.000232	0.00226
T_{11} -POP + 50% RDN through goat manure	0.000503	0.000242	0.00179
T_{12} - Control	0.000490	0.000329	0.00122
S. Em±	0.00004	0.0001	0.0008
CD (P=0.05)	NS	NS	NS

Table 6: Pod yield, kernel yield, haulm yield and harvest index of groundnut as influenced by integrated nutrient management

Treatments	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index
T_1 – POP (FYM 10 t + 25:50:25 kg $N:P_2O_5:K_2O$ ha^{-1})	1725	1163	2223	**0.439**
T_2 - POP + 25% N through eupatorium	1683	1199	2262	0.426
T_3 - POP + 25% N through gliricidia	1732	1214	2345	0.424
T_4 - POP + 25% N through vermicompost	1809	1269	2456	0.424
T_5 - POP + 25% N through poultry manure	1913	1341	2501	0.434
T_6 - POP + 25% N through goat manure	1821	1262	2367	0.436
T_7 - POP + 50% N through eupatorium	1832	1325	2435	0.428
T_8 - POP + 50% N through gliricidia	1932	1366	2598	0.427
T_9 - POP + 50% N through vermicompost	2162	1574	2771	0.438
T_{10} -POP + 50% N through poultry manure	2272	1665	2900	0.439
T_{11} -POP + 50% N through goat manure	2018	1458	2653	0.432
T_{12} - Control	810	319	1195	0.405
S. Em±	105.12	90.89	123.34	0.019
CD (P=0.05)	308	267	362	NS

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