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Effect of inorganics, organics and biofertilzers on growth and yield of *rabi* groundnut (*Arachis hypogaea* L.) in coastal sands

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Abstract
A field experiment was carried out at Agricultural College farm, Bapatla during *rabi* season 2022-2023. The experiment was laid out in Randomized Block Design and replicated thrice, consisting of eight treatments to evaluate the effect of inorganics, organics and biofertilizers on growth and yield of *rabi* groundnut in coastal sands. The treatments comprised of T_1 – Farmer's practice, T_2 – 75% RDN, T_3 – 100% RDN, T_4 – 75% RDN + 25% N through FYM + consortium (*Rhizobium* + PSB + KSB), T_5 – 75% RDN + 25% N through vermicompost + consortium(*Rhizobium* + PSB + KSB), T_6 – 100% RDN + 25% N through FYM+ consortium(*Rhizobium* + PSB + KSB), T_7 – 100% RDN + 25% N through vermicompost + consortium(*Rhizobium* + PSB + KSB), T_8 – Control. The results indicated that the combined application of inorganics, organics and biofertilizers proved significantly superior over all the other treatments in obtaining better growth and higher yield of groundnut was increased with the application of 100% RDN + 25% N through vermicompost + consortium (*Rhizobium* + PSB + KSB).

Keywords: Groundnut, RDN, vermicompost, FYM, biofertilizers

Introduction
Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of India known as the "King of Oil Seeds" supports farm families in terms of access to nutrient- dense groundnut kernels, which are high in protein and energy, and also fodder (haulm) to cattle. Groundnut kernels contain 40-50% edible oil, 20-30% digestible protein, 10-20% carbohydrates and 5% fiber and ash makes a sustainable contribution to human nutrition (Fageria *et al.*, 1997). The area and production of groundnut in India are 6.02 million hectares and 6.70 million metric tones. In Andhra Pradesh area under Groundnut crop is about 0.87 million hectares and production 0.78 million tonnes (Agricultural statistics at a glance 2021).
Nitrogen is an important constituent of protein, chlorophyll, amino acids and nucleic acids is required for vegetative and reproductive growth. It plays an active role in enzyme reaction and energy metabolism. As groundnut takes up to 180 kg N ha^{-1} from atmosphere through fixation, the demand for mineral nitrogen is low. The nitrogen fixation at 25-30 days after sowing (Basu and Dayal, 2003). Continuous use of chemical fertilizers has deleterious effect on soil which in turn cause decline in productivity. Furthermore, it caused low nutrientrecovery and increase in cost of production and environmental pollution (Sarkar *et al*., 1997). Therefore, the current tendency is to explore the possibilities of supplementing organic manures like vermicompost, FYM and biofertilizers. FYM supplies all major (N, P, K, Ca, Mg, S) as well as micronutrients (Fe, Mn, Cu and Zn). It improves soil properties and maintains soil health. Vermicompost also improves soil physical properties and it restores microbial population includes nitrogen fixers, phosphate solubilizers and cellulose decomposing organism. Biofertilizers are low cost and eco-friendly inputs and have tremodous potential for supplying nutrients.

Materials and Methods
A field experiment was conducted at Agricultural college farm, Agricultural College, Bapatla during *Rabi*, 2022. TCGS-1694 (Visishta) was seeded on sandy clay loam with a spacing of 30 cm x 10 cm in a Randomised Block Design with three replications. The experimental soil was sandy clay loam in texture, neutral in nature, low in organic carbon, low in available nitrogen, medium in available phosphorus and high in available potassium and sufficient in all micronutrients (Zn, Fe, Mn and Cu).

The experiment consisted of eight treatments *viz.*, T_1 – Farmer's practice, T_2 – 75% RDN, T_3 – 100% RDN, T_4 – 75% RDN + 25% N through FYM +consortium (*Rhizobium* + PSB + KSB), T_5 – 75% RDN + 25% N through vermicompost + consortium (*Rhizobium* + PSB + KSB), T_6 – 100% RDN + 25% N through FYM+ consortium (*Rhizobium* + PSB + KSB), T_7 – 100% RDN + 25% N through vermicompost + consortium (*Rhizobium* + PSB + KSB), T_8-Control. A recommended dose of 40 kg P_2O_5 and 50 kg K_2O applied as SSP and MOP. Nitrogen @ 30 kg ha^{-1} was applied in form of urea in two equal splits *i.e.*, half as basal and half at 30 days after sowing. A dose of 35 kg N, 87 kg P_2O_5 and 35 kg K_2O ha^{-1} was applied to farmer's practice plot as per dose applied by farmers in and around bapatla. Biofertilizers *viz.*, *Rhizobium* @1.25 L ha^{-1}, PSB @ 1.25 L ha^{-1} and KSB @ 1.25 L ha^{-1} were mixed with FYM (10 t ha^{-1}) and vermicompost (5 t ha^{-1}) and incubated overnight and applied as per treatments before sowing.

Plant height was taken from the base of the plant to top of main shoot of five labeled plants in net plot at 30, 60 DAS and harvest of groundnut crop. Dry matter accumulation (kg ha^{-1}) was obtained by taking five plants uprooted at random, they were dried in shade and then in hot air oven at 65° C till a constant weight was obtained. Then dry weights were recorded and dry matter was expressed in kg ha^{-1}. Haulm yield (kg ha^{-1}) was obtained by plants from the net plot area after harvesting were sundried till constant weight was obtained and their weight was recorded as per plot basis. Pod and kernel yield (kg ha^{-1}) was obtained by pods and kernels from the net plot were cleaned and pod weight was recorded based on dry pod and kernel yield kg per plot. Later yields per net plot was computed on a hectare basis and expressed in kg ha^{-1}. Shelling percentage was obtained by a random sample of 0.2 kg of pod was taken from net plot produce, shelled and the kernel weight was recorded to work out the shelling percentage and expressed in terms of percentage (%) (Singh and Oswalt. 1995).

$$\text{Shelling percentage} = \frac{\text{Kernel weight}}{\text{Pod weight}} \text{ x } 100$$

Test weight (100 kernel no) was obtained by a hundred kernels were taken randomly from the net plot of each kernels were taken randomly from the net plot of each treatment and their weight was recorded in grams.

All the data recorded in the study were subjected to statistical analysis using Panse and Sukhatme (1978) adopted in this study. Statistical significance was tested by applying F-test at 0.05 level of probability and critical differences were calculated for those parameters, which were found significant (p<0.05) to compare the effects of different treatments.

Results and Discussion

Plant height (cm)

Plant height significantly increased progressively up to the harvest. Significantly highest plant height (11.30, 21.80 and 31.83 cm) were recorded at 30, 60 days after sowing and harvest of groundnut crop with application of 100% RDN + 25% N through vermicompost + consortium (*Rhizobium* + PSB + KSB) (T_7) over the other treatments except T_6 (100% RDN + 25% N through FYM+ consortium (*Rhizobium* + PSB + KSB)(Table -1). The increase in the plant height with higher level of nitrogen might be due to increased cell division and cell elongation as promoted by nitrogen and combined use if inorganics, organics and biofertilizers might increase the fertilizer use efficiency and availability of nutrients leading to growth of plants (Zalate and Padmini, 2009). The microorganisms involved in decomposition of cellulose, production of antibiotics, vitamins and hormones that also adds the positive impact to produce larger cells with thinner cell wall and influence cell division and cell elongation which enhanced vegetative growth and eventually enlarge plant height (Mohanty *et al*., 2022).

Drymatter Accumulation

Significantly increase in drymatter accumulation at flowering (2743 kg ha^{-1}) was recorded with the application of 100% RDN + 25% N through vermicompost + consortium (*Rhizobium* + PSB + KSB) and it was on par with T_6 (100% RDN + 25% N through FYM+ consortium (*Rhizobium* + PSB + KSB) (2698 kg ha^{-1}) and significantly superior over all the other treatments. The treatments 75% RDN + 25% N through vermicompost + consortium (T_5) (2483 kg ha^{-1}), 75% RDN + 25% N through FYM + consortium (T_4) (2453 kg ha^{-1}) and 100% RDN (2404 kg ha^{-1}) were on par with each other and significantly superior over the 75% RDN (2186 kg ha^{-1}) followed by farmer's practice (1895 kg ha^{-1}) at flowering stage.(Table -2).

Significant increase in drymatter accumulation while combined application of inorganics, organics and biofertilizers might be due to steady release and balanced supply of nutrients throughout that growth period favouring the plants to increase the photosynthetic rate which in turn, led to higher translocation of metabolisms from leaf and stem to reproductive part during reproductive phase of crop growth and accumulation of dry matter. The biofertilizers has the capacity to reduce the leaching losses by fixation of nutrients and converts the unavailable forms to available forms which has positive influence on dry matter accumulation in plant. Same results were observed by Iwuagwu *et al.* (2013) and Gowsalya *et al*. (2023).

Haulm Yield

The highest (3778 kg ha$^{-1)}$ haulm yield was recorded with the application of 100% RDN + 25% N through vermicompost + consortium (*Rhizobium* + PSB + KSB) and it was on par with T_6 (100% RDN + 25% N through FYM + consortium) (3708 kg ha^{-1}) and they were significantly superior over all the other treatments. The lowest haulm yield was recorded in the treatment T_8 *i.e.*, control (1815 kg ha^{-1}) (Table 2). The immediate supply of nutrients from inorganic sources especially at the early stage of crop which led to meristematic activities of the plant and steady supply of nutrients through combination of inorganics, organic and biofertilizer throughout the crop growth period increased sufficient biomass production which led to higher haulm yield.

Pod Yield

The highest pod yield was recorded in the treatment T_7 *i.e.*, 100% RDN + 25% N through vermicompost + consortium (2690 kg ha^{-1}) and it is on par with T_6 (100% RDN + 25% N through FYM + consortium) (2646 kg ha^{-1}) and they were significantly superior over all the other treatments. (Table -2).The significant response of pod yield might be due to supply of all plant essential nutrients by translocation of photosynthates accumulated under the influence of source of

organic nutrients. Further the translocation and accumulation of photosynthates in economic sinks thus increase nitrate reductase activity resulted in pod yield (Patel *et al.*, 2022) .The nitrifying bacteria, P solubilizer also helped in increasing better root development which increases absorption of nutrients which resulted in increased pod yield (Chavan *et al.*, 2014).

Kernel Yield

The highest kernel yield was recorded in the treatment T_7*i.e.*, 100% RDN + 25% N through vermicompost + consortium (1911 kg ha^{-1}) and it is on par with T_6 (100% RDN + 25% N through FYM + consortium) (1882 kg ha^{-1}) and significantly lowest kernel yield was recorded in the treatment T_8*i.e.*, control (864 kg ha^{-1}).The significantly increase in kernel yield was mainly due to the application of sufficient levels of fertilizers might enhanced carbohydrate and protein metabolism, which in turn increase the translocation of photosynthates, for better seed setting. The highest supply of nutrients along with conducive physical environment leading to higher nutrient absorption, resulted in more growth in plants.

Shelling Percentage

The shelling percentage showed that there was no significance difference observed among the treatments. The highest shelling percentage (71.04%) recorded with the application of 100% RDN + 25% N through vermicompost + consortium (T_7)and lowest value (67.98%) was recorded in T_8 (Control).

Test Weight

The highest test weight (43.09g) was recorded with the application of 100% RDN + 25% N through vermicompost + consortium (T_7) and it is on par with T_6 (100% RDN + 25% N through FYM + consortium) (42.99 g). The lowest was recorded in the treatment T_8*i.e.*, control (29.03 g). This might be due to providing adequate and balanced nutrition that promote plant growth and development positively impact the test weight. Healthy soil ecosystem with improved organic matter content and beneficial microbial activity can enhance nutrient availability which improve the kernel development.

Table 1: Combined effect of inorganics, organics and biofertilizers on plant height at 30, 60 DAS and at harvest of groundnut

Treatments	30 DAS(cm)	60 DAS(cm)	Harvest(cm)
T_1: Farmers practice	8.77	16.70	26.20
T_2: 75% RDN	9.30	17.07	26.57
T_3: 100% RDN	10.10	19.20	27.37
T_4:75% RDN + 25% of N throughFYM +consortium (*Rhizobium* + PSB + KSB)	10.20	19.50	29.33
T_5:75% RDN+25% of N throughVermicompost+ consortium (*Rhizobium* + PSB + KSB)	10.50	19.80	29.70
T_6:100% RDN +25% of N through FYM +consortium (*Rhizobium* + PSB + KSB)	10.97	21.20	31.33
T_7: 100% RDN + 25% of N through Vermicompost+ consortium (*Rhizobium* + PSB + KSB)	11.37	21.77	31.87
T_8: Control	8.40	16.07	25.97
S.Em (±)	0.17	0.27	0.23
CD (P = 0.05%)	0.51	0.82	0.69
CV (%)	6.09	6.38	6.16

Table 2: Combined effect of inorganics, organics and biofertilizers on dry matter accumulation and yield of groundnut

Treatments	Dry matter accumulation (kg ha^{-1})			Kernel yield (Kg ha^{-1})	Shelling percentage	100 kernel weight (g)
	Flowering	Harvest				
		Haulm yield	Pod yield			
T_1: Farmers practice	1895	2601	1830	1257	68.72	32.08
T_2: 75% RDN	2186	3009	2119	1459	68.87	35.13
T_3: 100% RDN	2404	3316	2334	1613	69.11	38.55
T_4:75% RDN + 25% of N throughFYM + consortium (*Rhizobium* + PSB + KSB)	2453	3407	2402	1701	70.82	39.03
T_5:75% RDN+25% of N throughVermicompost + consortium (*Rhizobium* + PSB + KSB)	2483	3450	2417	1706	70.56	39.53
T_6:100% RDN +25% of N through FYM +consortium (*Rhizobium* + PSB + KSB)	2698	3708	2646	1882	71.15	42.99
T_7: 100% RDN + 25% of N through Vermicompost+ consortium (*Rhizobium* + PSB + KSB)	2743	3778	2690	1911	71.04	43.09
T_8: Control	1338	1815	1272	864	67.98	29.03
S.Em (±)	67.58	92.18	68.21	36.42	2.35	0.92
CD (P = 0.05%)	204.98	279.60	206.90	110.46	NS	2.79
CV (%)	6.14	7.09	7.34	6.00	-	6.01

Conclusion

The combined application of inorganics, organics and biofertilizers improved the growth and yield of groundnut crop. The growth and yield was increased with the application of 100% RDN + 25% of N through Vermicompost + consortium (*Rhizobium* + PSB + KSB) followed with application of 100% RDN +25% of N through FYM +consortium (*Rhizobium* + PSB + KSB) which farmers can use without much reduction of yield.

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