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Effect of different levels of organic and inorganic fertilizers on growth, yield and quality of summer groundnut (*Arachis hypogaea* L.) grown on inceptisol

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Abstract

The experiment on effect of different levels of organic and inorganic fertilizers on yield and quality of summer groundnut (*Arachis hypogaea* L.) grown on Inceptisol was carried out at Agricultural Research Station, Kasbe Digraj, Dist: Sangli (MS) during summer 2019. The experimental soil was alkaline, calcareous, clay in texture, low in available nitrogen, medium in available phosphorus and very high in available potassium. The experiment was laid out in randomized block design with eight treatments and three replications. The treatment consist of T₁-absolute control, T₂-GRDF (25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹), T₃-100% RDN through FYM, T₄-100% RDN through press mud compost (PMC), T₅-100% RDN through vermicompost, T₆-50% RDN through FYM + 50% RDN through PMC, T₇-50% RDN through FYM + 50% RDN through vermicompost and, T₈-33% RDN through FYM + 33% RDN through PMC + 33% RDN through vermicompost. Biofertilizers – *Rhizobium*, PSB- 25 g kg⁻¹ of seed were inoculated to all treatments except T₁, which recommended dose of P – fertilizer (50 kg P₂O₅ ha⁻¹) were applied to T₃ to T₈. The results revealed that the significantly maximum number of pods and weight of pods per plant (39.28 plant⁻¹) and 72.33 g) were obtained in applied of GRDF (25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) as compare to rest of the treatments. The T₂ was at par with T₃ (36.38 plant⁻¹), T₅ (38.86 plant⁻¹) and T₇ (36.53 plant⁻¹) for number of pods per plant. The treatment GRDF (T₂) was at par with treatment T₅ (71.33 g) to weight of pods per plant of groundnut. The treatment T₂ recorded higher 100 kernel weight (44.75 g) as compare to rest of the treatments. The treatment T₂ was noticed significantly higher in dry pod yield (27.75 q ha⁻¹) and dry haulm yield (49.86 q ha⁻¹). The treatment GRDF (T₂) was at par with T₅ (26.94 q ha⁻¹) regarding dry pod yield of groundnut. The shelling percentage (71.88%) and harvesting index (29.82%) were higher in T₂. The application of GRDF recorded the significantly higher oil content (51.10%) and oil yield (1003.33 kg ha⁻¹) over the rest of treatments and GRDF (T₂) was at par with T₅ regarding oil content (49.95%) and oil yield (945.56 kg ha⁻¹) of groundnut. The significantly higher protein content (29.60%) and protein yield (549.85 kg ha⁻¹) were noticed in T₂ which was at par with T₅ (27.97%), T₇ (27.76%) for protein content and T₅ (529.60 kg ha⁻¹) for protein yield of groundnut. It can be concluded from the study for biofertilizer treated groundnut seed, application of GRDF (25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) or 100% RDN through vermicompost along with 50 kg P₂O₅ ha⁻¹ (as SSP) to groundnut recorded higher growth, yield and quality parameters of groundnut.

Keywords: Organic and inorganic fertilizers, quality, summer groundnut and yield

Introduction

Groundnut is also known as poor man's almond. Groundnut has a useful role in offspring deficiencies as a rich source of edible oil and protein which hold an important position in Indian diet. Hence, groundnut is known as king of oilseed crops (Sathya Priya *et al.* 2013) [18] and important food legume of tropical as well as subtropical part of the world. Groundnut is one of the most popular and universal crops cultivated in more than 120 countries. The uses of groundnut are diverse; all parts of plant can be used. It's seed contain high quality of 45-50 percent edible oil, 25-30 percent digestible protein, 20 percent carbohydrates and 5 percent fiber and ash which make a sustainable contribution to human nutrition (Fageria *et al.* 1997) [6].

The oil is primarily used for cooking, manufacture of margarine, shortening and soaps. Seeds are consumed directly raw or roasted, chopped in confectionaries or grounded into peanut butter. Young pod may be consumed as vegetables. The use of organic sources such as traditional, generally helpful for improving soil aggregation, structure and fertility improving the moisture holding capacity and increasing crop yield (Marinari *et al.* 2000) [9]. The application of organic manure help in mitigating multiple nutrient deficiencies and at same time provides better environment for growth and development by improving in physical, chemical and biological properties of soil (Avitoli *et al.* 2012) [12]. In this context use of organic manure such as farm yard manure (FYM), vermicompost (VC), press mud cake (PMC) may supply sufficient number of micronutrients in available form to crops and improve the quality of the agricultural produces (Maynard, 1993) [10].

Due to prohibitive cost of chemical fertilizers, farmers do not apply the recommended doses of nutrients to this energy-rich legume crops. Indigenously available organic sources of nutrients have enhanced the efficiency and reduced the requirements of chemical fertilizers (Bhat *et al.* 2007) [3]. Hence, it is necessary to integrate different sources of nutrients to meet the crop requirement. Sustainable yields in groundnut can be achieved through the conjunctive use of organic and inorganic fertilizers (Singh *et al.* 1990) [20]. In this context, the field experiment was undertaken to study the effect of different levels of organic and inorganic fertilizers on yield and quality of summer groundnut grown on Inceptisol.

Material and Methods

Experimental site and soils

The field experiment was conducted at Agricultural Research Station, Kasbe Digraj, Dist: Sangli during summer season of the year 2019. The site was selected on the basis of suitability of soil for growing of summer groundnut. The soil samples were collected from 0-30 cm depth from each plot at the time sowing. The soil samples were air dried and pulverized to pass through 2 mm sieve for analysis. These soils samples were analysed for various soil properties by using standard methods. The experimental soil was alkaline, calcareous, clay in texture, low in available nitrogen, medium in available phosphorus and very high in available potassium.

Experimental details

The field experiment was laid out in a randomized block design with eight treatments and three replications. The treatments were T₁-absolute control, T₂-GRDF (25:50:00 N:P₂O₅:K₂O kg ha⁻¹+ 10 t FYM ha⁻¹), T₃-100% RDN through FYM, T₄-100% RDN through press mud compost (PMC), T₅-100% RDN through vermicompost, T₆-50% RDN through FYM + 50% RDN through PMC, T₇-50% RDN through FYM + 50% RDN through vermicompost and, T₈-33% RDN through FYM + 33% RDN through PMC + 33% RDN through vermicompost. Biofertilizers – *Rhizobium*, PSB- 25 g

kg⁻¹ of seed were inoculated to all treatments except T₁, which recommended dose of P – fertilizer (50 kg P₂O₅ ha⁻¹) were applied to T₃ to T₈. The FYM 10 t ha⁻¹ was applied half month before sowing of groundnut for treatment T₂ as well as vermicompost, FYM and PMC was applied as per the treatments. The groundnut crop was fertilized with 25 kg N and 50 kg P₂O₅ ha⁻¹ and for treatment GRDF (General Recommended Dose of Fertilizer) full dose of N, P₂O₅ was applied through urea, single super phosphate to treatment T₂ at the time of sowing. The application of 50 kg P₂O₅ ha⁻¹ was applied through single super phosphate to treatments T₃ to T₈. The irrigation water was used for irrigating of groundnut. The first irrigation was applied immediately after sowing to ensure better germination, later on second irrigation applied 7 DAS to get good emergence. Subsequently, total 12 irrigations were applied at an interval of 8 to 10 days as per requirement of crop. The standard agronomic packages of practices were adopted in groundnut crop. The number of branches and height of plant of groundnut were counted. The yield and yield contributing characters observations were taken by adopting standard methods. For determination of oil content (%) in kernel, sufficient quantity of groundnut kernel was taken from each treatment and determined by using Soxhlet apparatus (A.O.A.C, 2019). The protein content in the kernel was analyzed by indirect method. First, the per cent nitrogen content of the sample was estimated by microkjeldahl method (Parkinson and Allen, 1975) [13]. Then the nitrogen value was multiplied by a factor 6.25 to get the protein content of the sample and expressed in percentage. (F.A.O., 2003). The statistical analysis was carried out by procedure suggested by Panse and Sukhatme (1985) [12].

Results and Discussion

Effect of organic and inorganic fertilizers on growth parameters of groundnut

The maximum numbers of branches per plant and plant height of groundnut were noticed in T₂ followed by 100% RDN through vermicompost (Table 1). However, the treatment T₅ was at par with T₃ for the number of branches (12.2 plant⁻¹) of groundnut and T₃ was at par with T₄ (12.1 plant⁻¹). An early stage crop accumulates more amounts of constituents and nutrients which results to stimulate the cell division in the meristematic tissue and increase in vegetative growth of plant (Patil and Udumale, 2016) [14, 16]. Among 100% RDN through different sources of organic manure, the application of 100% RDN through vermicompost (T₅) was recorded the significantly highest plant height (37.46 cm) as compare to 100% RDN through FYM and 100% RDN through press mud compost (35.56 cm). The application of 100% RDN through vermicompost showed highest plant height, it might have accelerated the metabolic and physiological activity of the plant and put up more growth by assimilating more amounts of major nutrients and ultimately increased the plant height. Similar results were also found by Thirunavukkarasu and Vinoth (2013) [21].

Table 1: Effect of different levels organic and inorganic fertilizers on growth of groundnut

Tr. No.	Treatments	Number of branches per plant	Height of the plant (cm)
T ₁	Absolute control	8.7	30.56
T ₂	GRDF (25:50:00 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹ + 10 t FYM ha ⁻¹)	13.4	39.66
T ₃	100% RDN through FYM	12.2	36.40
T ₄	100% RDN through PMC	12.1	35.56
T ₅	100% RDN through Vermicompost	12.6	37.46
T ₆	100% RDN (50% RDN through FYM + 50% RDN through PMC)	11.1	34.46

T ₇	100% RDN (50% RDN through FYM + 50% RDN through Vermicompost)	11.0	34.16
T ₈	100% RDN (33% RDN through PMC + 33% RDN through Vermicompost + 33% RDN through FYM)	10.5	33.53
	S.Em +	0.13	0.18
	CD at 5%	0.42	0.54

Effect of organic and inorganic fertilizers on yield and yield contributing characters of groundnut

Dry pod and haulm yield

The significantly highest dry pod yield (27.75 q ha⁻¹) and dry haulm (49.86 q ha⁻¹) were obtained in T₂ (GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) over the other treatments. The treatment GRDF was at par with treatment 100% RDN through vermicompost (T₅) for dry pod and haulm yield groundnut (Table 2). The application of GRDF to groundnut increased pod yield by 33.86% and haulm yield 35.23% over absolute control (T₁). The application of GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹ increased higher yield of groundnut which could be attributed to favourable changes in physical and chemical characteristics of the soils that might have enabled better pod formation. Moreover, the positive influence of these treatments through immediate supply of nutrients from inorganic sources especially at the early stage of the crop and slow and steady supply of essential nutrients in proper ratio to plant and soil from FYM throughout the crop growth period improved

adequate biomass production and improvement in pod yield. These results were close in conformity with Rahevar *et al.* (2015) [15] and Sarade *et al.* (2016) [17]. The application of 100% RDN through vermicompost (T₅) was recorded the highest dry pod yield and haulm yield of groundnut as compare to 100% RDN through FYM and 100% RDN through press mud compost. The treatment 100% RDN through vermicompost (T₅) and 100% RDN through FYM (T₃) were at par with each other for dry pod yield of groundnut. The 100% RDN through vermicompost application to groundnut crop increased dry pod yield as might be due to vermicompost containing adequate amounts of macronutrients and trace element and hormones and this has been hypothesized to result in greater root initiation, increased root biomass, enhanced plant growth and development and altered morphology of plants growth and ultimately increased pod yield. Similar results were also found by Mycin *et al.* (2010) [11] and Mathivanan *et al.* (2013).

Table 2: Effect of different levels organic and inorganic fertilizers on yield parameter of groundnut

Tr. No.	Treatments	Number of pods plant ⁻¹	Weight of pods plant ⁻¹ (g)	100 kernel weight (g)	Dry pod yield (q ha ⁻¹)	Dry haulm yield (q ha ⁻¹)	Shelling percentage (%)	Harvesting index (%)
T ₁	Absolute control	29.00	56.45	39.00	20.73	35.11	68.00	28.86
T ₂	GRDF (25:50:00 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹ + 10 t FYM ha ⁻¹)	39.28	72.33	44.75	27.75	49.86	71.88	29.82
T ₃	100% RDN through FYM	36.38	67.33	42.93	25.74	44.79	70.55	29.16
T ₄	100% RDN through PMC	36.04	64.67	42.80	25.49	43.68	70.55	28.8
T ₅	100% RDN through Vermicompost	38.86	71.33	43.83	26.94	47.48	71.06	29.25
T ₆	100% RDN (50% RDN through FYM + 50% RDN through PMC)	35.77	63.33	41.92	25.02	43.54	68.51	28.49
T ₇	100% RDN (50% RDN through FYM + 50% RDN through Vermicompost)	36.53	63.67	42.40	25.06	43.02	69.07	28.87
T ₈	100% RDN (33% RDN through PMC + 33% RDN through Vermicompost + 33% RDN through FYM)	36.07	65.00	42.13	24.75	42.77	67.32	28.47
	S.Em +	0.99	1.58	1.42	0.43	0.76	0.31	0.44
	CD at 5%	3.00	4.82	NS	1.33	2.32	0.95	NS

Shelling percentage and harvesting index

The significantly highest shelling percentage (71.88) was recorded in T₂ (GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) and followed by application of 100% RDN through vermicompost (T₅) over the rest of other treatments and both these treatments were at par with each other (Table 2). The application of GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹ recorded higher shelling percentage due to application of chemical fertilizers and FYM could be owing to improvement in nutritional environment which might have favourably influenced carbohydrate metabolism which in turn increased the uptake of nutrients and ultimately resulted in increased shelling percentage of groundnut. Similar results were also reported by Rahevar *et al.* (2015) [15]. The application of 100% RDN through vermicompost (T₅) noted higher harvesting index of groundnut (29.25) as compare to the 100% RDN through FYM (29.16) and 100% RDN through press mud compost (28.80). This might be due to the reason that application of vermicompost to groundnut helped in maintaining higher amount of nutrient availability, steady

supply of all essential nutrients and better nutrient uptake by plant throughout life cycle of groundnut. Similar result was found by Chakrawarty and Kushwaha (2009) [14].

Number and weight of pods per plant

Result revealed that the number of pods per plant of groundnut was significantly influenced by different treatments organic and inorganic fertilizers (Table 2). The significantly highest number of pods per plant (39.28) and weight of pod per plant (72.33 g) was obtained in T₂ (GRDF 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) over the rest of treatments. The treatment T₂ was at par with treatments T₃ (36.38), T₅ (38.86) and T₇ (36.53) for number of pods per plant groundnut and T₅ for weight of pods per plant of groundnut. The application of 100% RDN through vermicompost (T₅) was recorded highest number of pods per plant and weight of pods per plant as compare to 100% RDN through FYM and 100% RDN through press mud compost. The significantly highest number of pods per plant and weight of pods per plant was obtained in T₂, this might be due to the

application of chemical fertilizers and well decomposed vermicompost and its combination, produces more number of pods per plant could be owing to higher availability of plant nutrients which is conducive for physical environment leading to enhanced moisture holding capacity, better aeration, root activity and nutrient absorption which consequently in complementary effect was increased dry matter accumulation in the reproductive parts and formation of higher sink capacity with the addition of organics and resulted increased in number of pods of groundnut and weight of pods per plant. Similar results were also found by Rahevar *et al.* (2015) [15], Sarade *et al.* (2016) [17] and Kamalakannan (2017) [8].

100 kernel weight

The numerically higher 100 kernel weight of groundnut (44.75 g) was noticed in the treatment T₂ (GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) and followed by the application of 100% RDN through vermicompost (T₅) (43.83 g) as compare to the rest of treatments (Table 2). The application of GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹ increased 100 kernel weight of groundnut due to application of chemical fertilizers and FYM could be owing to higher availability of plant nutrients which is conducive for chemical and physical environment leading to enhanced moisture holding capacity, better aeration, root activity and nutrient absorption and finally would have resulted increases weight of pods of groundnut. Similar results were also reported by Rahevar *et al.* (2015) [15]. The application of 100% RDN through vermicompost (T₅) was recorded higher 100 kernel weight (43.83 g) over the 100% RDN through FYM (42.93 g) and 100% RDN through press mud compost (42.80 g). This might be due to the soil application of vermicompost to groundnut helped in maintaining higher amount of nutrient availability and better absorption of nutrient by plant throughout life cycle of groundnut. Similar results were also found in Thirunavukkarasu and Vinoth (2013) [21].

Effect of organic and inorganic fertilizers on quality parameters of groundnut

Effect of organic and inorganic fertilizers on oil content and oil yield: Treatment T₂ (GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) recorded significantly higher oil content (51.10%) and oil yield (1003.33 kg ha⁻¹) of groundnut over the rest of treatments (Table 3). The application of 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹ to groundnut was at par with treatment of 100% RDN through vermicompost (T₅) for oil content (49.45%) and yield (945.56 kg ha⁻¹) of groundnut. It clearly indicated that GRDF application can be replaced by 100% RDN through vermicompost. The increased oil content and oil yield of groundnut under GRDF treatment could be due to better availability of desired and required nutrients in the crop root zone resulting from their solubilisation by microorganisms caused by the organic acids produced from the decaying organic matter i.e. FYM and also the increased uptake by groundnut. The presence of sulphur in applied SSP was also involved in the synthesis of fatty acids and increased the protein quality through the synthesis of certain amino acids such as cysteine, cystine and methionine. It is evident from the results that sulphur had a remarkable influence on oil content. Similar findings were also observed by Ravi *et al.* (2008) [16] and Devi *et al.* (2013) [5]. The application of 100% RDN through vermicompost (T₅) registered higher oil content (49.45%) and yield (945.56 kg ha⁻¹) of groundnut as compare to the 100% RDN through FYM (49.36% and 910.49 kg ha⁻¹) and 100% RDN through press mud compost (49.57% and 902.11 kg ha⁻¹). However treatments T₃, T₄, T₅ and T₇ were at par with each other for oil content and oil yield of groundnut (Table 3). The increased oil content and oil yield of groundnut might be due to the unique role of organic matter in improving the nutritional environment of *rhizosphere* via improvement in nutrient availability. Thus, the balanced nutrient uptake by plant owing to enhanced level of vermicompost probably favoured enzyme activities responsible for oil synthesis. Similar results were also found by Sharma *et al.* (2017) [19].

Table 3: Effect of different levels organic and inorganic fertilizers on quality parameter of groundnut

Tr. No.	Treatments	Oil content in kernel (%)	Oil yield (kg ha ⁻¹)	Protein content in kernel (%)	Protein yield (kg ha ⁻¹)
T ₁	Absolute control	48.07	722.98	24.47	368.39
T ₂	GRDF (25:50:00 N:P ₂ O ₅ :K ₂ O kg ha ⁻¹ + 10 t FYM ha ⁻¹)	51.10	1003.33	28.31	549.85
T ₃	100% RDN through FYM	49.36	910.49	27.24	502.59
T ₄	100% RDN through PMC	49.57	902.11	27.24	495.51
T ₅	100% RDN through Vermicompost	49.95	945.56	27.97	529.60
T ₆	100% RDN (50% RDN through FYM + 50% RDN through PMC)	48.26	853.84	27.30	482.41
T ₇	100% RDN (50% RDN through FYM + 50% RDN through Vermicompost)	49.26	876.15	27.76	476.20
T ₈	100% RDN (33% RDN through PMC + 33% RDN through Vermicompost + 33% RDN through FYM)	48.68	864.15	26.51	470.47
	S.Em +	0.38	28.56	0.32	11.98
	CD at 5%	1.15	86.63	0.97	36.35

Effect of organic and inorganic fertilizers on protein content and protein yield

The significantly highest protein (28.31%) and protein yield (549.85 kg ha⁻¹) was noticed in treatment T₂ (GRDF- 25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) over rest of treatments (Table 3). However, treatment T₂ was at par with treatment T₅ for protein content (27.97%) and protein yield (529.60 kg ha⁻¹). The increased protein content in groundnut under T₂ might be due to the role of nitrogen and sulphur which are integral part of protein and phosphorus is structural element of certain co-enzymes which are proteinaceous in nature. These findings were in close conformity with those reported by Ola *et al.* (2013). The application of 100% RDN

through vermicompost (T₅) registered higher protein content (27.97%) and protein yield (529.60 kg ha⁻¹) of groundnut as compare to the 100% RDN through FYM (27.24% and 502.59 kg ha⁻¹) and 100% RDN through press mud compost (27.24% and 495.51 kg ha⁻¹) and treatments T₃ and T₅ were at par with each other with respect to protein content and protein yield of groundnut (Table 3). The higher protein content and protein yield of groundnut in T₅ might be due to the unique role of humus or humus-like substances (humates) in vermicompost that are believed to stimulate plant nutrient uptake and metabolism, had influence on protein synthesis. Similar results were reported by Mycin *et al.* (2010) [11].

Conclusions

It can be concluded from the study that the for biofertilier treated groundnut seed, application of GRDF (25:50:00 N:P₂O₅:K₂O kg ha⁻¹ + 10 t FYM ha⁻¹) or 100% RDN through vermicompost along with 50 kg P₂O₅ ha⁻¹ (as SSP) to groundnut recorded higher growth parameters, yield, quality parameters of groundnut.

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