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EFFECT OF INTEGRATED APPLICATION OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON YIELD, QUALITY AND ECONOMICS OF MACHINE SOWN GROUNDNUT

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ABSTRACT

A field experiment was conducted in the farmer's field at Arasampalayam village, Rasipuram (Tk.), Namakkal (Dt.), Tamil Nadu during May-Sep, 2021 (Vaigasipattam) to study the effect of integrated nutrient management on yield, quality and economics of machine sown groundnut. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The treatments consisted of T_0 – Absolute control (No organics and inorganics), T_1 – RDF through inorganic fertilizers (25:50:75 Kg N, P_2O_5, K_2O ha^{-1}), T_2 – 75% RDN + 25% N on equivalent basis of EFYM, T_3 – 50% RDN + 50% N on equivalent basis of EFYM, T_4 – 75% RDN + 25% N on equivalent basis of poultry manure compost, T_5 – 50% RDN + 50% N on equivalent basis of poultry manure compost, T_6 – T_2 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS, T_7 – T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS, T_8 – T_4 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS, T_9 – T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS. The results of this experiment showed that combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS recorded highest yield attributes, yield, quality and economics recorded with significantly higher values.

Keywords: Integrated, EFYM, Poultry manure compost, Salicylic acid, TNAU groundnut rich, RDN.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a premier oilseed crop in India which occupies first position in terms of area and second position in terms of production. Groundnut contributed nearly 40 per cent of total oilseed production in India. It is one of the most important leguminous edible oilseed and cash crop and is a valuable source of all the nutrients (48 to 50 per cent of oil, 26 to 28 per cent protein, 20 per cent carbohydrates and 5 per cent fibre). Groundnut is also valued as a rotation crop. Being a legume with a root nodule it can synthesis atmospheric nitrogen and thereby improve soil fertility. It is an important multipurpose crop for resource less poor farmers in the semi - arid tropics (Shwetha *et al*., 2018).

Globally, groundnut is cultivated over an area of 30.00 million hectares with a production of 50.25 million metric tonnes and productivity of 1.67 metric tonnes ha^{-1} annually. India ranks first in the world's groundnut area (6.02 m. ha), production (6.70 million metric tonnes) and with the productivity (1.11 t ha^{-1}) during 2020 - 2021 (USDA, 2022). In India, the groundnut production is mostly concentrated in Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Rajasthan. In Tamil Nādu, groundnut is cultivated with an area of 4.09 lakh ha, production of 10.23 lakh tonnes and productivity of 2502 kg ha^{-1} during 2020 – 2021 (Indiastat, 2022).

Groundnut is highly responsive to fertilizer application, although being a legume is capable of fixing atmospheric nitrogen, it responds to small quantity of nitrogenous fertilizer applied as starter dose (Chaudhary *et al*., 2015). An average crop of groundnut yielding 1900 kg ha^{-1} removes about 170 kg N, 30 kg P and 110 kg K from the soil (Aulakh *et al*.,1985). Therefore, Cultivation of groundnut depletes the soil fertility rapidly unless the crop is adequately fertilized. So, balanced use of macro and micro nutrients is essential for enhancing the groundnut production.

Nowadays, use of chemical fertilizer is increasing to boost up crop production to meet the demand of growing population of the nation. Simultaneously the cost of chemical fertilizer has been increasing constantly and also excess application of these fertilizers has resulted in environmental problem. Use of organics alone does not result in spectacular increase in crop yields, due to their low nutrient status. So, there is an integrated application of alternative source of nutrients for sustaining the desired crop productivity (Tiwari, 2002). The integrated nutrient management practices enhance crop production and sustains soil productivity. Hence, it is necessitated to integrate different sources of nutrients to meet the crop requirement, which would in long way to sustain the groundnut productivity and minimise the cost of cultivation. The combined application of organic manure and N fertilizer maintains a continuous N supply, prevents losses and thus enables more efficient utilization of the applied nitrogen (Dwivedi *et al*., 2016).

Foliar application of nutrients is one of the most common methods to correct plant nutrient deficiencies and bridging the gap of crop nutrient requirement. Foliar application of the correct nutrients in relatively low concentrations at critical stages in crop development contributes significantly to higher yield and quality. Salicylic acid is a common phenolic compound that can act as a plant growth regulator plays an important role in various physiological processes and environmental stress responses and TNAU groundnut rich is a crop booster enriched with micronutrients applied at later stages of plant growth especially at peg formation and pod development stages to boost the crop yield. Foliar application of salicylic acid and TNAU groundnut rich increases flowering, speed up photosynthesis, prevents flower drop and supplement the required micronutrients at a faster rate. Therefore, an attempt has been made to increase the groundnut yield by combining foliar application of nutrients along with recommended dose of fertilizers.

MATERIALS AND METHODS

The field experiment for this study was conducted at the farmer's field at Arasampalayam village in Rasipuram taluk of Namakkal district, Tamil Nadu during vaigasipattam (May – Sep), 2021. Geographically the field is situated at 11.44^{o} N latitude, 78.08^{o} E longitude with an altitude of +132.67 meters above mean sea level. The average annual rainfall of this study area is 640 mm. The entire cropping period received the rainfall of 118 mm distributed over 22 rainy days. The maximum temperature during cropping period ranged from 31^{o} to 37^{o}C, while the minimum temperature ranged from 23^{o} to 28^{o}C with a mean of 25.5^{o}C and the relative humidity ranged from 48 to 70 per cent .

The soil of the experimental field was sandy loam in texture with a pH of 8.4. The soil was low in available nitrogen (198.50), high in available phosphorus (24.75) and high in available potassium (348.20). The predominantly grown groundnut variety TNAU Co 6 of this region was chosen for this study for its suitability and yield potentiality. The seeds were dibbled by using tractor drawn seed drill to maintain optimum plant population. The experiment was laid out in a Randomized Block Design (RBD) with three replications.

The treatments consisted of T_0 – Absolute control (No organics and inorganics), T_1 – RDF through inorganic fertilizers (25:50:75 Kg N, P_2O_5, K_2O ha^{-1}), T_2 – 75% RDN + 25% N on equivalent basis of EFYM, T_3 – 50% RDN + 50% N on equivalent basis of EFYM, T_4 – 75% RDN + 25% N on equivalent basis of poultry manure compost, T_5 – 50% RDN + 50% N on equivalent basis of poultry manure compost, T_6 – T_2 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS, T_7 – T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS, T_8 – T_4 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS, T_9 – T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS.

The recommended dose of 25:50:75 kgs of NPK ha^{-1} in the form of urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) were applied on machine sown groundnut crop. 50% N, 100% P_2O_5 and 50% K_2O were applied as basal dose. The remaining 50% N and 50% K_2O were top dressed in two equal splits on 20 DAS and 45 DAS. The recommended dose of P_2O_5 and K_2O was applied to all the treatments except absolute control. The treatments with different doses of N were applied as per treatment schedule. Besides, the enriched farm yard manure and poultry manure compost was applied well before the sowing of groundnut as per the treatments. Quantity of EFYM, poultry manure compost to be added to each treatment was calculated on the basis of N content in EFYM and poultry manure compost. The remaining recommended dose of N was supplied through inorganic fertilizers. Gypsum @ 80 kg S on 45 DAS, foliar application of salicylic acid @ 100 ppm and TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS were applied as per treatment schedule.

Irrigation was given immediately after sowing with good quality water with due care to avoid excess soaking of seeds. The life irrigation was given on 3 DAS. The subsequent irrigation was given to the crop as and when required. The standard crop management practices were followed during the cropping period. The periodical observations on yield attributes and yield were recorded. The estimated data were analyzed as per the procedure outlined by Gomez and Gomez (1994). The critical difference was worked out at 5 per cent probability level for significant results.

RESULTS AND DISCUSSION

Yield attributes

The data on yield parameters like number of pods $plant^{-1}$, peg to pod percentage, 100 kernel weight, shelling percentage as influenced by integrated application of organic manures and inorganic fertilizers along with foliar application of fertilizers are presented in table 1. The results of the experiment showed that combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_8) recorded highest yield parameters *viz*., number of pods $plant^{-1}$ (32.27), peg to pod percentage (74.54), 100 kernel weight (48.45) and shelling percentage (73.29). It was followed by the treatment T_6 - 75% RDN + 25% N on equivalent basis of EFYM + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS. However, T_9 - T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS and T_7 - T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS were next in order and found to be on par with each other at both the stages of crop growth. This was followed by T_1, T_4, T_2, T_5 and T_3. Whereas, the absolute control (T_0) had the least effect in all other treatments.

The increased yield attributes might be due to combined application of RDN and poultry manure compost along with foliar application of nutrients. It might be due to adequate supply of nutrients through organic and inorganic sources enhanced the biological nitrogen fixation which facilitates better root proliferation and pegging. The highest yield components in the application of NPK and Poultry manure compost might be due to greater availability and uptake of nutrients throughout the growing season. Similar results were reported by Akintoye and Olaniyan (2012); Rehman *et al*. (2008).

The increased yield attributes with the foliar feeding of TNAU rich was due to the fact that, improvement in photosynthesis and carbohydrate metabolism resulting into greater formation of photosynthetic and metabolites in source and later on translocated in the newly formed sinks which ultimately increased the yield parameters. These results are in agreement with the findings of Shivakumar and Kumuthia (2003). The increased number of flowers by foliar application of salicylic acid might be due to salicylic acid can induce transitions from vegetative to reproductive growth and its accumulation is associated with early flowering (Dietrich *et al.*, 2005; Jin *et al.* (2008).

Table 1. Effect of integrated nutrient management on yield attributes of machine sown groundnut

Treatments	Number of pegs plant^{-1}	Number of pods plant^{-1}	Peg to pod percentage	Shelling percentage	100 kernel weight (g)
T_0 – Absolute control (No organics and inorganics)	17.68	10.29	58.21	70.55	48.32
T_1 – RDF through inorganic fertilizers (25:50:75 Kg N, P_2O_5, K_2O ha^{-1})	26.96	18.91	70.15	72.03	48.39
T_2 – 75% RDN + 25% N on equivalent basis of EFYM	24.32	16.54	67.98	71.56	48.37
T_3 – 50% RDN + 50% N on equivalent basis of EFYM	22.05	14.28	64.78	71.08	48.34
T_4 – 75% RDN + 25% N on equivalent basis of poultry manure compost	24.85	17.08	68.73	71.68	48.38
T_5 – 50% RDN + 50% N on equivalent basis of poultry manure compost	22.54	14.72	65.32	71.17	48.35
T_6 – T_2 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	30.58	22.47	73.48	72.91	48.43
T_7 – T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	28.28	20.41	72.18	72.44	48.41
T_8 – T_4 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	32.27	24.05	74.54	73.29	48.45
T_9 – T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	28.94	21.00	72.56	72.56	48.42
SEm±	0.28	0.34	-	0.09	0.03
CD(p=0.05)	0.83	1.00	-	0.28	NS

RDN* - Recommended dose of nitrogen RDF* - Recommended dose of fertilizers

EFYM* - Enriched farmyard manure DAS* - Days after sowing

The lowest value for all yield components was recorded in control plots due to inadequate supply of nutrients. These results are in line with Akintoye and Olaniyan (2012).

Yield

The combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_8) significantly increased the pod yield (3280 kg ha^{-1}), kernel yield (2398 kg ha^{-1}), haulm yield (4977 kg ha^{-1}) and harvest index (39.72). It was followed by the treatment T_6 - 75% RDN + 25% N on equivalent basis of EFYM + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS. This was followed by T_9, T_7, T_1, T_4, T_2, T_5 and T_3. Whereas, the absolute control (T_0) had the least effect in all other treatments.

When poultry manure compost was combined with chemical fertilizer, the pod yield of groundnut was increased significantly as compared to sole application of either Poultry manure compost or superphosphate. This might probably because of the increased release of the macro- and micronutrients in soil resulting in better extraction of nutrients by the crop.

The increase in pod and haulm yield might due to increased growth and yield attributes. This might be due to adequate and steady supply of all nutrients to plants at all stages of crop growth. These results are in similar with the reports of Snehal *et al.* (2014) and Manisha Basu *et al*. (2008).

Foliar application resulted in greater absorption, assimilation and translocation of nutrients for increased photosynthesis. Increased production of dry matter and its efficient translocation to the economic parts ultimately reflected on the final yield.. Therefore, better availability and uptake of nutrients could be assigned as the proper reason for significant increase in dry matter production and its accumulation with foliar spray treatments (Malladada, 2005; Dalei *et al.* 2014). The yield increase of groundnut due to micronutrients application is attributed to that, activation of various enzymes and increased basic metabolic rate in plants, facilitated the synthesis of nucleic acids and harmones, which inturn enhanced the yield due to greater availability of nutrients and photosynthates. These results are in agreement with findings of Helpyati (2001) and Sumangala (2003).

Foliar application of TNAU groundnut rich and salicylic acid at flowering and peg formation stages substantially helped to meet the demand of the crop at the right time when the pollen tubes were to be developed and that reduces the number of unfilled pods and bold healthy seeds in pod increased the pod weight. These results are in similar with the findings of Ansari *et al.* (2014) and karimian *et al*. (2015) in groundnut.

Quality

Even though the integrated application of a 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_8) registered higher oil content of 48.93 % and it was followed by the application of 75% RDN + 25% N on equivalent basis of EFYM + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_6). A significant improvement from that of other treatments was not attributed.

Table 2. Effect of integrated nutrient management on yield and quality of machine sown groundnut.

Treatments	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
T_0 – Absolute control (No organics and inorganics)	1620	1138	2579	46.59	532.52
T_1 – RDF through inorganic fertilizers (25:50:75 Kg N, P_2O_5, K_2O ha^{-1})	2524	1813	3888	47.98	872.27
T_2 – 75% RDN + 25% N on equivalent basis of EFYM	2226	1588	3461	47.63	758.74
T_3 – 50% RDN + 50% N on equivalent basis of EFYM	1905	1349	2989	47.18	638.82
T_4 – 75% RDN + 25% N on equivalent basis of poultry manure compost	2310	1651	3585	47.76	790.91
T_5 – 50% RDN + 50% N on equivalent basis of poultry manure compost	1998	1417	3127	47.39	673.89
T_6 – T_2 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	3064	2229	4665	48.64	1086.61
T_7 – T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	2758	1993	4222	48.26	964.23
T_8 – T_4 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	3280	2398	4977	48.93	1176.28
T_9 – T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	2854	2066	4365	48.35	1001.33
SEm±	70.25	50.05	67.58	0.60	17.94
CD(p=0.05)	208.72	150.17	200.76	NS	53.31

RDN* - Recommended dose of nitrogen RDF* - Recommended dose of fertilizers

EFYM* - Enriched farmyard manure DAS* - Days after sowing

Table 3. Effect of integrated nutrient management on the economics of machine sown groundnut.

Treatments	Gross income (Rs.ha^{-1})	Cost of cultivation (Rs.ha^{-1})	Net income (Rs.ha^{-1})	B:C ratio
T_0 – Absolute control (No organics and inorganics)	93299	61771	31528	1.51
T_1 – RDF through inorganic fertilizers (25:50:75 Kg N, P_2O_5, K_2O ha^{-1})	145232	69634	75597	2.08
T_2 – 75% RDN + 25% N on equivalent basis of EFYM	128117	70661	57455	1.81
T_3 – 50% RDN + 50% N on equivalent basis of EFYM	109669	71690	37979	1.52
T_4 – 75% RDN + 25% N on equivalent basis of poultry manure compost	132945	69879	63065	1.90
T_5 – 50% RDN + 50% N on equivalent basis of poultry manure compost	115015	70123	44891	1.64
T_6 – T_2 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	176249	74835	10141	2.35
T_7 – T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	158670	75863	82807	2.09
T_8 – T_4 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	188657	74052	114605	2.54
T_9 – T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS	164189	74296	89892	2.20

RDN* - Recommended dose of nitrogen RDF* - Recommended dose of fertilizers

EFYM* - Enriched farmyard manure DAS* - Days after sowing

The combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_8) significantly recorded the highest oil yield of 1176.28 kg ha^{-1} and it was followed by the application of 75% RDN + 25% N on equivalent basis of EFYM + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_6). However, T_9 - T_5 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS and T_7 - T_3 + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS were found to be on par with each other. The treatment T_0 – Absolute control recorded the lowest oil yield of 532.52 kg ha^{-1}.

Economics

Regarding the monetary benefit of the varied integrated nutrient approaches revealed that the combined application of 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_8) excelled all other treatments with the monetary advantage of Rs.188657 ha^{-1} of gross income, Rs. 114605 ha^{-1} of net income and the benefit-cost ratio of 2.54. The integrated application of 75% RDN + 25% N on equivalent basis of EFYM + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS (T_6) stand next. The lowest gross income of Rs. 93299 ha^{-1} with Rs. 31528 ha^{-1} of net income and benefit-cost ratio of 1.51 resulted in the treatment T_0 – Absolute control.

The increased yield from the combined application of NPK + Poultry manure compost along with foliar application of nutrients contributed to increasing net benefits and net return. The combined application of organic and inorganic fertilizer increased the synchrony between the nutrients released and plant uptake and hence, enhanced crop yields. This suggests that integration of organic and inorganic fertilizers is a more economically profitable approach among smallholder farmers in tropical developing countries. This results are in agreement with Mutegi *et al*. (2012); Moghadamla and Mirshekari (2014), who found the highest gross and net benefit in the combined application of organic and inorganic fertilizer compared to that of the sole application of either fertilizer.

CONCLUSION

The present investigation concluded that 75% RDN + 25% N on equivalent basis of poultry manure compost + Foliar application of salicylic acid @ 100 ppm + TNAU groundnut rich @ 5.0 kg ha^{-1} on 35 and 45 DAS registered the maximum yield attributes, yield, quality and economics of machine sown groundnut. Integrated use of organic manures and inorganic fertilizers along with foliar application was one of the best nutrient management practices to enhance the groundnut yield.

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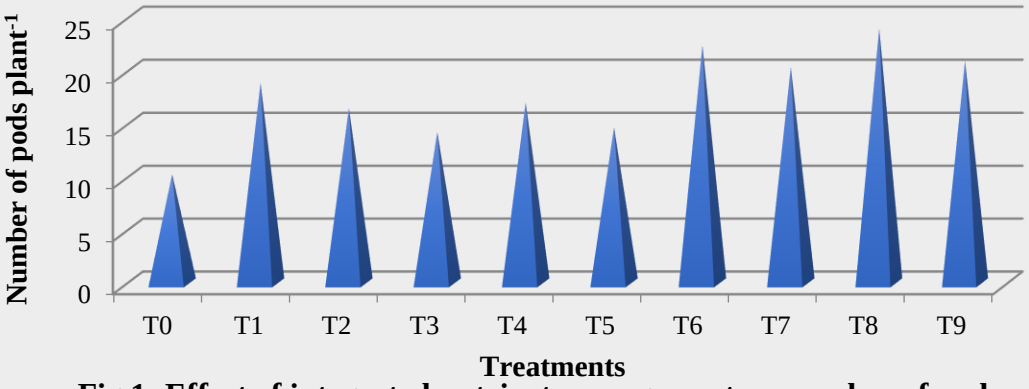

Fig 1: Effect of integrated nutrient management on number of pods plant^{-1} of machine sown groundnut

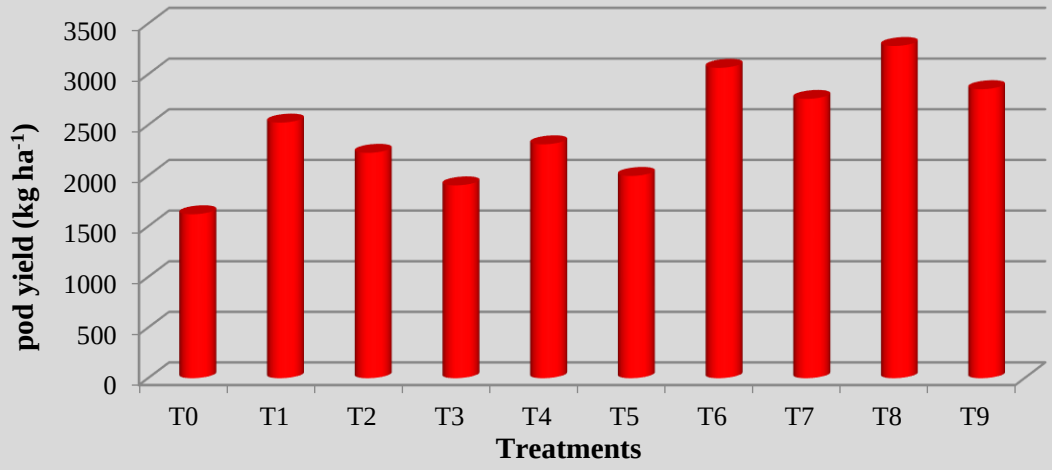

Fig 2: Effect of integrated nutrient management on pod yield (kg ha^{-1}) of machine sown groundnut

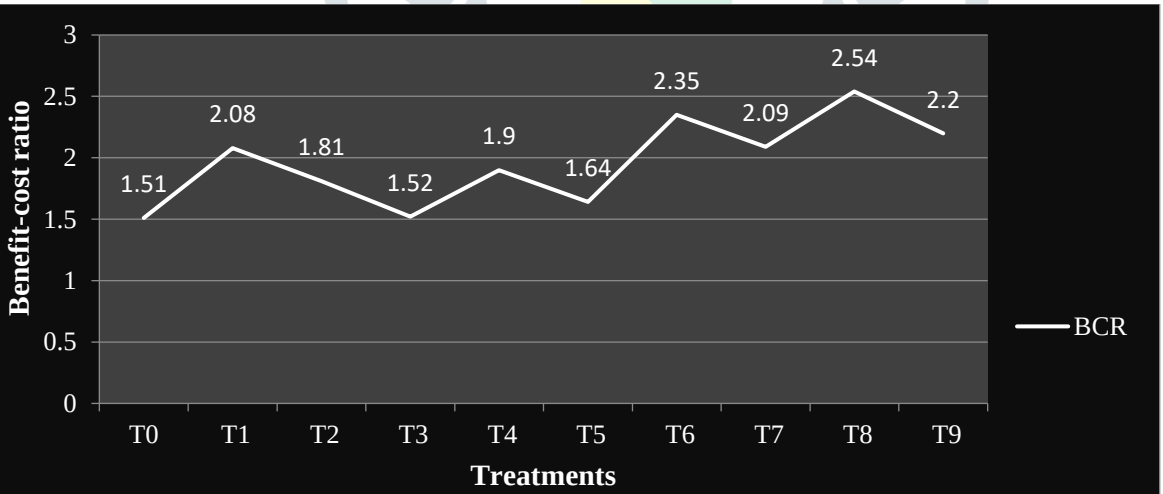

Fig 3: Effect of integrated nutrient management on benefit-cost ratio of Machine sown groundnut