https://doi.org/10.46344/JBINO.2022.v11i03.12

INFLUENCE OF ORGANIC INPUTS ON YIELD AND QUALITY OF GINGER CV. NAGALAND LOCAL RED

***Animesh Sarkar, Meyarenla Ozukum, S.P. Kanaujia and Khamrang Mathukmi**

Department of Horticulture, School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University, Nagaland – 797106

Email: asarkar1919@rediffmail.com

ABSTRACT

A field experiment was conducted to study the influence of organic inputs on yield and quality in ginger cv. Nagaland Local Red at School of Agricultural Sciences and Rural Development, Department of Horticulture, Nagaland University, Medziphema during 2017-18. The experiment comprised of eleven treatments with three replications and laid in randomized block design. The treatment comprised of T_0 (control), T_1 (RDF: 80:50:50 Kg NPK ha^{-1}), T_2 (FYM @ 25t ha^{-1}), T_3 (poultry manure @ 3 t ha^{-1}), T_4 (pig manure @ 10 t ha^{-1}), T_5 (vermicompost @ 3t ha^{-1}), T_6 (FYM @ 12.5t ha^{-1} + *Azospirillum*), T_7 (poultry manure @ 1.5t ha^{-1} + *Azospirillum*), T_8 (pig manure @ 5t ha^{-1} + *Azospirillum*), T_9 (vermicompost @ 1.5t ha^{-1} + *Azospirillum*) and T_{10} (*Azospirillum* @ 30g kg^{-1} of seed rhizome). The exponential and significant growth, variation in number of tillers (10.60 to 22.13 at 180 days after planting) and leaf area index (0.58 to 1.08) at 120 DAP were influenced with different organic inputs. Application of poultry manure @ 3 t ha^{-1} and FYM @ 12.5 t ha^{-1} + *Azospirillum* increased the number of fingers (7.67) in each rhizome over control plants (5.79). Vermicompost @ 1.5 t ha^{-1} + *Azospirillum* exerted the maximum fresh weight of rhizomes plant^{-1} (348.12) as well as yield ha^{-1} (290.33q). In proximate analysis, dry recovery percentage (20.66% 100g^{-1}) was increased by pig manure @ 5t ha^{-1} + *Azospirillum* over control (15.94%). The average oil content of fresh rhizome (0.47%) by poultry manure @ 3 t ha^{-1} and oleoresin content (8.77%) by FYM @ 12.5 t ha^{-1} + *Azospirillum* were found to be supremacy.

Keywords: Ginger, Organic inputs, *Azospirillum*. Yield, Quality

Introduction

Spices are high value and export oriented commodity crops, which play an important role in agricultural economy of the country. The term "spices" referred to aromatic or pungent vegetable substances which are used for flavouring foods and have several commercial uses. According to the Bureau of Indian standards (BIS) about 63 spices are grown in India and almost all spices can be grown in India under different agro-climatic region. Most of the spices are native of our country and hence India is aptly known as the "Land of spices".

Ginger (*Zingiber officinale* Rosc.), belongs to family zingiberaceae and is a perennial herbaceous plant which is known for centuries as a spice and medicinal crop. It is native to Tropical South or South East Asia. It is one of the principal spice crops not only in India but also in global trade of spices. In India, it is grown in an area of 164.00 thousands ha with an annual production 1788.0 thousand MT (Anon, 2020). The underground rhizome, economic part of ginger is pungent, aromatic and used for culinary purposes. The rhizomes of ginger are consumed in different forms such as raw finger, dry ginger, bleached dry ginger, ginger powder, sliced ginger, ginger oil, oleoresin, candy, ginger beer, brined ginger, ginger wine etc. It has basic antiseptic properties and is used as a carminative and stimulant in ayurvedic system of medicine.

North East India is considered as the best organic farming hot spot of India and the immense possibility of enhancing the farming techniques of the rural people through organic means. Appraising the increasing demand for organic products all over the world, the ginger farmers can receive higher returns from their produce if grown organically. Microbes enriched biofertilizers have now emerged as a promising component of nutrient supply (Singh, 2002; Nath and Korla, 2000). However, ginger being a heavy feeder and exhaustive crop requires large quantities of manures and fertilizers. Though the applications of chemicals controlled the disease and increased the ginger productivity (Poudyal, 2011) but use of chemicals to enhance the productivity as well as control the disease is criticized throughout the world due to their detrimental effects on the environment (Suthamathy and Seran, 2013). So, constructing the best dosage and mixtures for organic cultivation of ginger can be more profitable and economically viable for the farmers of north east region. Apart from improved varieties like Nadia, China, Rio-De-Janeiro, Varada, etc., a number of local cultivar and treasure house of ginger germplasms exist in north eastern region and pertaining a peculiar flavour and aroma of these local genotypes (Hazarika *et al*., 2013). The cultivar Nagaland Local Red is highly demanded and preferred by local tribal people of Nagaland because of its high pungent and unique aroma. But there is no any scientific intervention and comprehensive research work carried out on this particular genotype.

Materials and methods

The experiment was carried out at instructional cum research farm, SASRD, Nagaland University, Department of Horticulture, Medziphema campus during 2017-18. The experimental plot was located at foot hill of Nagaland with an altitude of 305 m MSL with geographical location of 25°45'43" N latitude and 93°53'04" E and also represents sub-humid sub-tropical climate with moderate temperature prevailing 20°C to 35°C during summer and rarely below 8° C in winter, moderate to high rainfall (2000-2500 mm per annum). The soil pH was 5.5 with organic carbon (15g kg^{-1}) and atmospheric humidity (75 to 85%). The experiment was laid out in randomized block design with eleven treatments and three replications. The field was equally divided into 3 equal blocks; each block was divided into 11 equal size-plots. Spacing of 50 cm was maintained from block to block and 50 cm between the plots. Altogether there were 33 number of plots with each plot size in raised bed at 1.8 m × 1 m following a plant spacing of 30 cm x 20 cm with about 18-20 g rhizome bits. The treatment comprised of T_0 (control), T_1 (RDF: 80:50:50 Kg NPK ha^{-1}), T_2 (FYM @ 25t ha^{-1}), T_3 (poultry manure @ 3 t ha^{-1}), T_4 (pig manure @ 10 t ha^{-1}), T_5 (vermicompost @ 3t ha^{-1}), T_6 (FYM @ 12.5t ha^{-1} + *Azospirillum*), T_7 (poultry manure @ 1.5t ha^{-1} + *Azospirillum*), T_8 (pig manure @ 5t ha^{-1} + *Azospirillum*), T_9 (vermicompost @ 1.5t ha^{-1} + *Azospirillum*) and T_{10} (*Azospirillum* @ 30g kg^{-1} of seed rhizome). The organic inputs were applied to plots according to recommended doses of each treatment before planting of seed rhizome bits The vegetative growth like number of tillers clump^{-1}, leaf area index (LAI) using the formula of Sestak *et al.* (1971), length of primary and secondary fingers, girth size, yield and yield attributing characters were investigated. The biochemical analysis was done by as follows:

Oil content (%)

For estimating oil content in ginger, freshly harvested ginger rhizomes were washed to make free from inert material and cut into small pieces and then crushed with the help of pistil and mortar. Volatile oil was obtained by steam distillation using Clevenger's method. The distillation was done at a constant temperature of 45-50^0 C for 2 hours for each treatment. Percentage of extracted oil was measured in the form of volatile oil (ml) per weight of sample (g).

$$X = \frac{A}{B} \times 100$$

Where, X denotes volatile oil percentage; A denotes volume of volatile oil extracted (ml); B denotes weight of sample used (g)

Dry recovery (%)

For estimating dry matter content in the ginger 100g of freshly harvested ginger were weighed and cleaned and then they were dried in oven and weighed in weighing machine and the result were recorded in terms of percent.

Oleoresin content (%)

In order to estimate oleoresin content in ginger, harvested rhizomes were made free from soil through their proper washing and cut into small pieces. The processed samples were kept in the oven for drying for 6 hours at a temperature of 60°C.Oleoresin was extracted from dry ginger powder with the help of solvent (acetone). The extract was drained after keeping it for overnight incubation and kept in oven for acetone evaporation. Percentage of non-volatile ether extract was calculated as oleoresin percentage by the following formula

$$\text{Oleoresin }\%(\text{w/w}) = \frac{\text{wt.of oleoresin (g)}}{\text{wt.of the sample (g)}} \times 100$$

Crude Fiber (%)

The moisture and fat free sample is successively refluxed with weak sulphuric acid and alkali (NaOH), each followed by filtration and repeated hot water washings. The remaining residue is oven dried and ashed. The loss in weight is expressed as crude fiber.

$$\text{Crude fiber }\% = \frac{w3-(w1\times c)-(w5-w4-D)}{w2}\times 100$$

Where, W_1: Initial capsule wt (g), W_2: Mass (in g) of the sample taken, W_3: Capsule weight along with the residue, W_4: Mass of empty ashing crucible (in g), W_5: Total ash in g (including ashing crucible), C: Blank correction for capsule solubility, D: Mass of capsule ash (in g)

Result and discussion

Vegetative growth

The exponential and significant growth by application of organic inputs was exhibited from 60 DAP and it was continued till 180 DAP in Table 1. The variation in production of tillers at different stages of growth at 60 DAP (1.13 to 1.93), 90 DAP (2.67 to 4.67), 120 DAP (5.53 to 9.33), 150 DAP (9.13 to 18.47) and 180 DAP (10.60 to 22.13) were well marked under different treatments at most of the growth stages. More numbers of tillers (22.13) were observed with the plants applied with FYM @ 12.5t ha^{-1} + *Azospirillum* and the lowest in control (10.60) at 180 days after planting (DAP). The enhancement of tillers is a factor closely related to its productivity since the total tiller affects the amount of photosynthates resulting in higher growth and yield. Kumar *et al*. (2016) also observed that the turmeric plants applied with FYM, vermicompost and neem cake significantly enhanced the plant height, number of tillers, leaf area and stem girth. The influence of leaf area index was significantly noticed in different treatments. The leaf area index was found to vary from 0.38 to 1.25 after 120 days of planting at active shooting stage. The maximum leaf area index (1.25) was recorded by recommended dose of fertilizers (80:50:50 kg NPK ha^{-1}) followed by pig manure @ 10 t ha^{-1} (1.17) and both were statistically at par and the minimum leaf area index (0.38) was recorded by application of poultry manure @ 3 t ha^{-1}.

Yield and yield attributing characters

The yield of ginger depends on rhizome growth and rhizome bulking rate. Development of rhizome begins after initial period of establishment and early shoot stage. The data on yield and yield attributing characters are presented in Table 2. Recommended dose of fertilizers @ 80:50:50 kg NPK ha^{-1} recorded maximum length of primary fingers (6.91 cm), whereas length of secondary fingers (5.20 cm) was increased by application of pig manure @ 10 t ha^{-1}. The overall girth size of fingers varied from 6.12 cm to 8.10 cm. Maximum girth of finger (8.10 cm) was observed from treatment with FYM @ 12.5 t ha^{-1} + *Azospirillum* while the lowest was recorded in control (6.12 cm). The number of fingers in rhizome significantly influenced and varied from 5.79 to 7.76. Significantly more number of fingers per rhizome was recorded by poultry manure @ 3 t ha^{-1} as well as by FYM @ 12.5t ha^{-1} + *Azospirillum* ((7.67). Other organic inputs also improved rhizome yield over control (5.79). Similarly, Shadap *et al.* (2018) assessed maximum number of rhizomes per clump (16.64), girth of fingers (2.34 cm), length of fingers (10.20 cm), clump length (21.25 cm) and rhizome yield per clump (162.23 g) from the plants applied with vermicompost, *Azospirillum*, VAM, PSB and inorganic inputs.

The fresh weight of rhizomes among different treatments significantly varied from 199.61g to 348.12g. The highest mean fresh weight of rhizomes (348.12g) per plant was noticed in vermicompost @ 1.5 t ha^{-1} + *Azospirillum* which was found to be at par with FYM @ 12.5 t ha^{-1} + *Azospirillum* (345.03g) and the lowest was recorded in control (199.61g) followed by recommended dose of fertilizers @ 80:50:50 kg NPK ha^{-1} (222.12g). The average length of fingers, number of fingers and girth size of finger was influenced by application of vermicompost with *Azospirillum* and FYM with *Azospirillum* and ultimately resulted in higher yield. These results were also corroborated with the findings obtained by Velmurugan *et al*. (2007) who reported that application of FYM along with Azospirillum + Phosphobacteria + VAM recorded the maximum yield attributes such as a greater number of mother rhizome per plant (3.98), number of primary rhizomes per plant (13.19) and secondary rhizomes per plant (19.8) in turmeric. Sarma *et al.* (2015) also noted a significant increase in plant height, number of fingers, girth of rhizome, weight of rhizome and rhizome yield (20.48 t ha^{-1}) in Megha Turmeric-1 by application of different combination of organic manure, vermicompost and neemcake.

Different treatments significantly influence the rhizome yield per plot mentioned in Table 2. In general, mean yield variation per plot ranged from 2.99 kg to 5.23 kg. The highest yield per plot was obtained from the plants treated with vermicompost @ 1.5 t ha^{-1} + *Azospirillum* (5.23 kg $plot^{-1}$) which was closely followed by FYM 12.5 t ha^{-1} + *Azospirillum* (5.18 kg per plot) and minimum yield per plot was obtained from control (2.99 kg $plot^{-1}$). Similarly, Jyotsna *et al.* (2013) mentioned that growing of organic ginger treated with *Azotobacter* @ 5 kg ha^{-1} along with phosphotica @ 3.75 kg ha^{-1} resulted in better growth and high productivity of improved quality rhizome with maximum profit in north eastern region of India. The application of organic manures improved the soil aggregates resulting in favorable pore geometry, which in turn increased the soil porosity thereby paving the way for good development of rhizome under the soil along with inoculation of microorganisms.

The plot treated with vermicompost @ 1.5t ha^{-1} + *Azospirillum* showed the most effective in rhizome yield (290.33q ha^{-1}) that was at par with FYM @ 12.5 t ha^{-1} + *Azospirillum* (287.67 q ha^{-1}) and the minimum yield was obtained from untreated control plant (166 q ha^{-1}). In perusal of data, it was noticed that the treatments with vermicompost, FYM and *Azospirillum* inoculum showed in improving the yield attributing characters. The impacts of bio-organic inputs in rhizome yield might be due to high canopy spread and leaf area index that enables production of relatively large amount of assimilates for supremacy. This is in conformity with the findings of Pal *et al.* (2014) who reported that application of FYM @ 25 t ha^{-1} was beneficial as compared to poultry manure, sheep manure, press mud and neem cake to get higher yield in cv. Humanabad local ginger.

Biofertilizer like *Azospirillum* cultures helps in fixing atmospheric nitrogen has been well established by several workers. The rhizome growth and yield enhanced by the application of biofertilizer might be owing to higher availability and efficient use of nutrients and secretion of growth promoting substances and vitamins throughout the growing period as a result of greater microbial activities along with vermicompost and FYM. This treatment combination was found to be optimum in exerting maximum additive and synergistic microbial effects on enhancing growth, yield and productivity of organic ginger. It also produces growth regulating substances like phytohormones, vitamins etc. that helps in improving the quality of the produce by balancing the nutrition of the crop (Arun, 2007).

Physico-chemical attributes

Dry recovery (%)

The data presented in Table 3 shows that application of different treatments significantly affects the dry recovery percent in ginger. The dry recovery percent was found to vary from 15.94% to 20.66%. Maximum dry recovery percentage was observed in pig manure @ 5.0 t ha^{-1} + *Azospirillum* (20.66%) and vermicompost @ 1.5 t ha^{-1} + *Azospirillum* (20.23%) which were statistically at par with each other. The minimum was observed in control (15.94%) followed by poultry manure @ 3 t ha^{-1} (16.18%). Datta *et al.* (2017) found maximum dry recovery (27.22%) and curcumin content (5.24%) using FYM @ 15 t ha^{-1} followed by vermicompost @ 5 t ha^{-1} + *Azospirillum* @ 5 kg ha^{-1} + PSB @ 5 kg ha^{-1} in turmeric. The biofertilizer *Azospirillum* may stimulate nitrate reductase activity in plants. This enzyme regulates nitrogen availability to plants. Improved nitrogen metabolism particularly through nitrate reductase activity might have exerted higher dry matter, essential oil and oleoresin content in rhizomes (Rana & Korla, 2005).

Crude fiber (%)

The crude fiber content was found to vary from 6.47 to 8.98%. Maximum crude fiber (8.98%) content was observed by pig manure @ 10 t ha^{-1} followed by control with 8.55%. The minimum crude fiber content was observed in poultry manure @ 3 t ha^{-1} alone (6.47%) and poultry manure @ 1.5 t ha^{-1} with *Azospirillum* (6.49%) which was at par with each other. Higher fiber content is an undesirable character in ginger; however, the variation was found to be significant in different treatments.

Poultry manure, pig manure, vermicompost and FYM along with *Azospirillum* was also responsible for increasing dry matter content and all the organic inputs inoculated with microbes exhibited statistically at par but poultry manure with *Azospirillum* showed the supremacy affecting the crude fiber content in rhizome that is undesirable characters of rhizome. *Azospirillum*, apart from its ability to fix nitrogen, produce anti-fungal antibiotics that inhibit the growth of several pathogenic fungi in the root region and hence improving root growth and crop nutrition that ultimately improves the quality of the product (Subba Rao, 2001).

Oil content (%)

The data presented in Table 3 revealed that the oil content showed less variation among the different treatments on fresh weight basis. The oil content was found to vary from 0.23 to 0.47% among the different treatments. The highest oil content (0.47%) was observed in poultry manure 3t ha^{-1} followed by FYM 12.5 t ha^{-1} + *Azospirillum* (0.43%). Singh *et al.* (2014) also noticed that vermicompost @ 5 t ha^{-1} alone or in combination of *Azospirillum* @ 5 kg ha^{-1} recorded maximum (4.94%) essential oil content in turmeric. Organic inputs like FYM, Poultry manure, vermicompost, pig manure and *Azospirillum* were found to be exerted a favourable and great role to increase the oil content in rhizome over control.

Oleoresin content (%)

From the perusal of the data in Table 3 it was evident that oleoresin production of ginger was significantly influenced by different treatments. The oleoresin content was found to be vary from 7.03% to 8.77%. The plants treated with FYM @ 12.5 t ha^{-1} + *Azospirillum* yielded the highest oleoresin content (8.77%) in rhizome and the minimum oleoresin content (7.03%) was found in control. The biofertilizer treatments along with vermicompost and FYM improved the rhizome quality by increasing dry matter content, volatile oil and oleoresin content in rhizome and decreasing the crude fiber content that might be due to high assimilation and metabolism efficiency developed by the plants.

It is interesting to note that these quality parameters of rhizome were strongly related to each other either positively or negatively. The dry matter content was positively correlated with fresh weight of rhizome (r=0.541) indicating their compatibility in improving rhizome yield. Oil content in rhizome showed the positive correlation with oleoresin (r=0.763) and fresh weight of rhizome (r=0.412) It was also noticed that crude fibre content in rhizome was strongly but negatively correlated with dry matter (r=-0.122), oil content (r=-0.694) and oleoresin (r=-0.401) This has a good impact on quality control. Increase in dry matter, oil and oleoresin contents in rhizome decreases the crude fibre content and thus improves the rhizome quality. The improvement in quality attributes by all organic treatments is obvious as these sources contain all the micro and macro nutrients and also improve the physic-chemical and biological property of soil which enables roots to proliferate resulting in better utilization of nutrients required for enhancing the quality of crop (Sidhu & Sekhon, 2000).

Conclusion

From the result of the investigation, it was, therefore concluded that combined application of FYM @ 12.5 t ha^{-1} with *Azospirillum* @ 30g kg^{-1} seed rhizome was the best organic inputs for enhancing yield, whereas poultry manure @ 3 t ha^{-1} beneficial effect on properties of ginger cv. Nagaland Local Red under foot hill of Nagaland.

References

Anonymous (2013). National Horticulture Database. Ministry of Agriculture, Govt. of India. http://www.nhb.gov.in.

Arun, K.S. (2007). Biofertilizers for sustainable agriculture. Mechanism of P solubilization. Sixth Edition, Agribios publishers, Jodhpur, India. 196-197.

Datta, S., Jana, J. C., Bhaisare, P. T. and Nimbalkar, K. H. (2017). Effect of organic source of nutrients and biofertilizers on growth, yield and quality of turmeric (Curcuma longa L.). Journal of Applied and Natural science. 9 (4): 1981-1986.

Hazarika, D. and Kakoti, M. (2013). Study on the indigenous varieties of ginger of Golaghat district (Assam), and its Economic viability as aroma ingredients. Journal of Natural products and Resources. 3 (1): 24-29.

Jyotsna, N., Ghosh, M., Ghosh, D. C., Meitei, W. I. and Timsina, J. (2013). Effect of biofertilizers on growth, productivity, quality and economics of rainfed organic ginger (Zingiber officinale Rosc.) Bhaisey cv. In North eastern Region of India. Journal of Agricultural Science and Technology. A 3: 83-98.

Kumar, K. R., Rao, S. N. and Kumar, N. R. (2016). Effect of organic and inorganic nutrient sources on growth, quality and yield of turmeric (Curcuma longa L.). Green Farming. 7 (4): 889-892.

Nath, B. and Korla, B. N. (2000). Studies on effect of biofertilizers in ginger. Indian Journal of Horticulture. 57: 168-171.

Pal, M. V. S., Hedge, N. K., Hanamashetti, S. I. and Kulkarni, M. S. (2014). Effect of organic manures on the performance of ginger under northern dry zone of Karnataka. Journal of agricultural spices and aromatic crops. 23(1)

Poudyal, B. K. (2012) Jeevatu: one of the best bio-agents for the control of soft rot of ginger. 2nd International conference on environment science and biotechnology, IPCBEE. 4: 13

Rana, N. and Korla, B. N. (2005). Integrated farming with organic and inorganic fertilizers on yield and quality of ginger (Zingiber officinale Rosce.). Nigerian journal of soil science. 15:136-138

Sarma, I., Phukon, M. and Borgohain, R. (2015). Effect of organic manure, vermicompost and neemcake on growth, yield and profitability of turmeric (Curcuma longa L.) variety Megha Turmeric – 1. Asian journal of bioscience. 10 (2): 13-137

Sestak A, Catsky J & Jarvis P G 1971 Plant photosynthetic production manual methods. N V Publishers, The Hague, pp. 343-381

Shadap, A., Pariari, A and Lyngdoh, T. A. (2018). Integrated effect of organic and inorganic sources of nutrients on the yield and quality of ginger (Zingiber officinale Rosce.). international journal of current microbiology and applied sciences. 7(4): 754-60

Sidhu, A. S. and Sekhon, N. K. (2000). Effect of phosphorus and FYM application in potato sunflower sequence on an alkaline soil of Punjab. In: Proceedings of National Seminar, Division of Soil Science held at NBSSLUP Nagpur, pp 203.

Singh, K. (2002). Role of biofertilizers in increasing the efficiency of nitrogen to potato crop under North Eastern Hill conditions. Indian Potato Association. 2: 904-907.

Singh, R. P., Agrawal, V. and Verma, A. K. (2014). Effect of biofertilizers and organic manures on essential oil content of turmeric. International journal of chemical studies. 5(3):38-40

Subba Rao, N. S. (2001). An appraisal of biofertilizers in India. In: Biotechnology of biofertilizers (eds. S kanaiyan) Narosapub.house, New Delhi. pp. 45-105.

Suthamathy, N. and Seran, T. H. (2013). Residual effect of organic manure EM Bokashi applied to proceeding crop of vegetable cowpea (Vigna unguiculata) on succeeding crop of radish (Raphanus sativus). Research Journal of Agriculture and Forestry Sciences. 1(1): 2-5

Velmurugan, M., Chezhiyan, N. and Jawaharlal, M. (2007). Studies on the effect of organic manures and biofertilizers of rhizome yield and its attributes of turmeric cv. BSR-2. Asian journal of Horticulture. 2(2): 23-29.

Table 1. Influence of different sources of organic inputs on growth of tillers in days after planting (DAP) and leaf area index (LAI)

Treatments	Number of tillers clump^{-1}					LAI at 120 DAP
	60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	
T_0	1.53	4.40	5.93	9.13	10.60	0.58
T_1	1.93	3.40	6.27	11.00	11.33	1.25
T_2	1.33	2.67	6.60	8.67	12.80	0.96
T_3	1.53	3.20	6.73	11.33	13.13	0.68
T_4	1.27	3.53	6.80	12.07	13.87	1.17
T_5	1.43	3.20	5.53	14.53	16.73	0.97
T_6	1.40	4.67	9.33	18.47	22.13	1.08
T_7	1.87	3.00	6.47	13.40	15.80	0.80
T_8	1.47	3.47	6.47	12.20	14.40	0.82
T_9	1.47	4.47	6.47	16.20	18.80	0.84
T_{10}	1.13	3.33	6.00	11.73	14.00	1.16
SEm (±)	0.08	0.33	0.33	0.95	0.83	0.13
CD at 5%	0.25	0.98	0.97	2.80	2.46	0.38

T_0 (control), T_1 (RDF: 80:50:50 Kg ha^{-1}), T_2 (FYM @ 25t ha^{-1}), T_3 (poultry manure @ 3 t ha^{-1}), T_4 (pig manure @ 10t ha^{-1}), T_5 (vermicompost @ 3t ha^{-1}), T_6 (FYM @ 12.5t ha^{-1} + *Azospirillum*), T_7 (poultry manure @ 1.5t ha^{-1} + *Azospirillum*), T_8 (pig manure @ 5t ha^{-1} + *Azospirillum*), T_9 (vermicompost @ 1.5t ha^{-1} + *Azospirillum*) and T_{10} (*Azospirillum* @ 30g kg^{-1} of seed rhizome).

Table 2. Influence of different sources of organic inputs on yield and yield attributing characters of ginger

Treatments	Length of fingers (cm)		Girth of fingers (cm)	No of fingers	Fresh weight of rhizomes plant^{-1} (g)	Yield plot^{-1} (kg)	Yield (Q ha^{-1})
	Primary fingers	Secondary fingers					
T_0	5.07	4.01	6.12	5.79	199.61	2.99	166.00
T_1	6.91	4.74	7.17	6.72	222.12	3.33	185.33
T_2	6.15	4.41	6.52	7.40	239.40	3.64	202.00
T_3	5.24	4.66	6.45	7.67	245.67	3.68	204.33
T_4	6.43	5.20	6.62	6.33	246.30	3.70	205.33
T_5	5.79	4.54	6.42	6.57	324.10	4.86	270.00
T_6	6.46	5.04	8.10	7.66	345.03	5.18	287.67
T_7	6.71	4.89	7.22	6.92	293.33	4.40	244.33
T_8	5.71	4.87	7.00	6.81	275.43	4.15	230.67
T_9	5.53	4.38	6.47	6.95	348.12	5.23	290.33
T_{10}	5.54	4.66	6.47	6.44	259.12	3.89	216.00
SEm (±)	0.40	0.12	0.22	0.73	9.30	0.25	5.57
CD at 5%	1.17	0.36	0.68	2.17	27.44	0.74	16.43

Table 3. Influence of organic inputs on physico-chemical properties of ginger

Treatments	Dry recovery (%)	Crude fiber (%)	Oil content (%)	Oleoresin (%)
T_0	15.94	8.55	0.23	7.03
T_1	17.26	6.69	0.37	7.33
T_2	17.88	6.88	0.40	8.33
T_3	16.18	6.47	0.47	8.30

T_4	17.82	8.98	0.33	7.10
T_5	16.71	7.39	0.37	8.26
T_6	19.29	7.15	0.43	8.77
T_7	16.67	6.49	0.37	7.33
T_8	20.66	6.54	0.37	7.40
T_9	20.23	7.56	0.37	7.73
T_{10}	17.59	7.46	0.33	7.10
Sem (±)	1.03	0.34	0.04	0.29
CD at 5%	3.02	1.00	0.10	0.84

Table 4. Correlation matrix between physico-chemical properties and yield of ginger cv. Nagaland Local Red

Characters	Dry recovery (%)	Crude fibre (%)	Oil content (%)	Oleoresin (%)	Fresh wt. of rhizome plant^{-1}	Yield (q ha^{-1})
Dry recovery (%)	1					
Crude fibre (%)	-0.122	1				
Oil content (%)	0.206	-0.694	1			
Oleoresin (%)	0.129	-0.401	0.763*	1		
Fresh wt. of rhizome plant^{-1}	0.541*	-0.183	0.412*	0.508*	1	
Yield (q ha^{-1})	0.551*	-0.189	0.416*	0.514*	0.999*	1

*Significant at 1% level