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Impact of Fertigation Regimes on Quality of Ginger (Rio-de-Janeiro and Himachal)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Ginger is used as one of the important ingredients in traditional as well as modern medicine besides as a spice. It boosts immunity and is a rich source of many biologically active substances and minerals. Although it is a medicinally important crop, its productivity is, however, affected due to poor nutrient management and therefore it requires an adequate supply of nutrients in the form of inorganic fertilizers or organic manuring, or a mixture of both. In this context, the present study was aimed to investigate the effect of fertigation regimes on quality of ginger (Rio-De-Jenereo and Himachal) at vegetable division in department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore. The experiment comprised of eleven treatments, Sources of nutrients used were FYM (Farm Yard Manure), Azotobacter, PSB (Phosphate Solubilising Bacteria), AMF (Arbuscular Mycorrhizal Fungi), KMB (Potassium Mobilizing Bio fertilizer), Inorganic sources (Urea, DAP, MOP, SSP, Ginger special, Neem cake). The results

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showed that the application of 200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) fertigation + FYM 30 t/ha, Neem cake 2 t/ha] was found effective for increment in essential oil (%), oleoresin content (%), gingerol (%) and crude fibre (%) in both varieties of ginger among the all treatments evaluated in this zone (Bangalore).

Keywords: Ginger; FYM; PSB; AMF; gingerol.

1. INTRODUCTION

"Ginger (*Zingiber officinale* Rosc.) is a spice and medicinal plant belonging to the *Zingiberaceae* family. Ginger has long been used in folk medicine in India and China. Especially, the wet and dry root of ginger is widely used in the medicine and food industry" [1]. "It has been used in folk medicine for colds, sore throats, asthma, and joint pain and stimulates appetite. Ginger is also rich in beneficial nutrients for example phosphorus, potassium, and calcium, which play important roles in human physiological processes. These substances play an important role in boosting human immunity and maintaining health" [1]. The dry rhizome of ginger is medicinal contains biologically active compounds. The rhizome contains carbohydrates, fats, proteins, vitamins, minerals, amino acids, monoterpenoids (camphene, sineiol, borneol, citral curcumin, and linalool), gingerol, and sesquiterpenoids.

Growing of spices for various purposes has been famous in India since ancient times. "The cultivated area under spices and herbs in India is about two million hectares and production accounting for 2.2 million tonnes and about 47% of the world business. There exists a huge diversity in India of some of its native spices viz., tamarind, curry leaf, black pepper, cardamom and to certain extent ginger, turmeric, Garcinia and cinnamon. In fact, there is no state in India that does not grow spices, which plays a significant role in lives of people and for their economic stability" [2].

Ginger is grown in many countries of tropics and subtropics. Currently ginger is commercially cultivated in India, China, Taiwan, Philippines, Ceylon, Jamaica, Fiji and Nigeria on a commercial scale. Nigeria accounts for about half of the total world area under Ginger, while India's contribution to global production is 50%. Australia stands first in production of ginger confectionary products in the world. India is the largest producer of ginger in the world. Ginger is cultivated in India in an area of 105.9 (000 ha) with annual production of 370.3 (000 tonnes). In India the important ginger growing states are Kerala, Meghalaya, Orissa, West Bengal, Mizoram, Andhra Pradesh, Himachal Pradesh, Arunachal Pradesh and Karnataka. In Karnataka, the crop is grown in an area about 20,489 hectares with a production of 1,98,181 tonnes per annum [3]. It is mainly grown in the districts of Hassan, Shimoga, Chikkamagalore, Dakshina Kannada, Kodagu, Mysore and Bangalore.

Being an exhaustive crop ginger removes large amount of nutrients from soil. Enough nutrients have to be applied in order to meet its nutritional requirement and to obtain higher yields. The continuous and indiscriminate use of conventional fertilizers results in several problems such as acidity, alkalinity, micro nutrient deficiencies, soil and ground water pollution. There is a need to maintain proper co-ordination among resources like soil, water, organic matter, biotic life and plant nutrient supply to maintain crop production at higher level.

Nitrogen can be applied easily with drip irrigation because the main sources of nitrogen are completely water soluble. Further, the fertigation is more efficient means of applying nutrients that are liable to leaching such as NO_3 and K_2O than conventional broadcasting. However, other nutrients like phosphorous can also be applied through drip irrigation system if available in soluble form [4]. Fertigation with nitrogen and potash is more common. With phosphorous fertigation is not widely practiced, mainly due to emitters getting clogged by the formation of insoluble phosphorous precipitates. In fertigation, use of 100 per cent water soluble fertilizers (WSF) is normally recommended to safeguard the drip system in the long run. The information on fertigation in ginger is very meagre. In this view, there is need to standardize fertigation schedule for ginger.

2. MATERIALS AND METHODS

The experiment was conducted in the field of vegetable division in department of Horticulture, Gandhi Krishi Vignana Kendra, University of Agricultural Sciences, Bangalore. The

experimental site is located at an altitude of 930 meters above MSL and 12°-58' North latitude and 77°-35' East longitude lying in the eastern dry zone 5 of Karnataka. The experiment was carried out in randomized block design with three replications. The rhizomes of two varieties *viz* Rio-de-Janeiro and Himachal having 3 to 4 buds (15 to 20 g) were treated with Mancozeb (3 g/l of water) solution for about half an hour prior to planting. The treated rhizomes were planted in beds at 3.5 to 4.0 cm depth at 45 × 30 cm spacing. The observations on essential oil (%), oleoresin content (%), gingerol (%) and crude fibre (%) were statistically analysed. The treatment details included.

3. RESULTS AND DISCUSSION

Essential oil content for both the varieties was recorded highest in T_2 [200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha]. It was 3 % for Rio-de-Janeiro and 2.94 % for Himachal. In case of Rio-de-Janeiro, the value was on par with T_3 (2.86 %). For Himachal, the highest value was on par with T_3 (2.86 %), T_4 (2.73 %) and T_{11} (2.76 %).

Oleoresin content for both the varieties was recorded highest in T_2 [200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha]. It was 9.47 % for Rio-de-Janeiro and 9.26 % for Himachal. For Himachal, the highest value was on par with T_3 (9.05 %) and T_{11} (8.97 %).

Gingerol content for both the varieties was recorded highest in T_2 [200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha]. It was 11.75 % for Rio-de-Janeiro and 12 % for Himachal. In case of Rio-de-Janeiro the value was on par with T_3 (11.12 %), T_4 (10.27 %), T_7 (10.45 %), T_8 (5.15 %) and T_{11} (10.16 %). For Himachal, the highest value was on par with T_3 (11.90 %), T_4 (11.14 %), T_5 (10.18 %), T_7 (10.75 %), T_{10} (10.84 %) and T_{11} (11.25 %).

Crude fibre content for both the varieties was recorded highest in T_2 [200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha]. It was 6.10 % for Rio-de-Janeiro and 6.18 % for Himachal. In case of Rio-de-Janeiro, the value was on par with T_3 (5.93 %), T_4 (5.90 %), T_7 (5.36 %), T_8 (5.15 %) and T_{11} (5.80 %). For Himachal the highest value was on par with T_3 (6.01 %), T_4 (5.90 %), T_7 (5.57 %), T_8 (5.33 %) and T_{11} (5.71 %).

Table 1. List of treatments use for the study

Treatment	Details
T_1	RDF (100:50:50 N: P_2O_5: K_2O kg /ha normal fertilizers) + FYM 30 t/ha, Neem cake 2t/ha
T_2	200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha
T_3	150 % RDF (150:75:75 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha
T_4	100 % RDF (100:50:50 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha
T_5	75 % RDF (75:37.5:37.5 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30t/ha, Neem cake 2t/ha
T_6	50 % RDF (50:25:25 N: P_2O_5: K_2O kg/ha) NF soil application + 50% Fertigation (50:25:25 NPK kg/ha) WSP + FYM 30 t/ha, Neem cake 2t/ha
T_7	100 % RDF (100:50:50 N: P_2O_5: K_2O kg/ha NF) + Azotobacter + PSB + AMF + KMB + FYM 30t/ha, Neem cake 2t/ha
T_8	75 % RDF (75:37.5:37.5 N: P_2O_5: K_2O kg/ha WSF) + Azotobacter + PSB + AMF + KMB + FYM 30t/ha, Neem cake 2t/ha
T_9	50 % RDF (50:25:25 N: P_2O_5: K_2O kg/ha WSF) + Azotobacter + PSB +AMF + KMB + FYM 30 t/ha, Neem cake 2t/ha
T_{10}	50 % RDF (50:25:25 N: P_2O_5: K_2O kg/ha WSF) + N P_2O_5 K_2O 25 % Foliar spray at 60, 90, 120 DAP + Azotobacter + PSB + AMF + KMB + FYM 30 t/ha, Neem cake 2t/ha
T_{11}	100 % RDF (100:50:50 N: P_2O_5: K_2O kg/ha WSF) + Azotobacter + PSB + AMF + KMB + FYM + Neem cake

Table 2. Effect of fertigation treatments on essential oil content in ginger

Sl. No.	Treatments	Rio-de-Janeiro	Himachal
		Essential oil (%)	Essential oil (%)
1	T_1	1.60	1.46
2	T_2	3.00	2.94
3	T_3	2.86	2.86
4	T_4	2.70	2.73
5	T_5	1.96	2.10
6	T_6	1.74	1.97
7	T_7	2.56	2.64
8	T_8	2.20	2.26
9	T_9	2.06	2.08
10	T_{10}	2.04	1.98
11	T_{11}	2.67	2.76
F test		*	*
SEm ±		0.07	0.08
CD @ 5%		0.19	0.24

Table 3. Effect of fertigation treatments on oleoresin content (%) in ginger

Sl. No.	Treatments	Rio-de-Janeiro	Himachal
		Oleoresin content (%)	Oleoresin content (%)
1	T_1	5.73	5.63
2	T_2	9.47	9.26
3	T_3	8.99	9.05
4	T_4	8.76	8.37
5	T_5	6.92	7.14
6	T_6	6.69	6.84
7	T_7	7.44	7.23
8	T_8	7.20	7.16
9	T_9	6.82	6.97
10	T_{10}	6.76	6.93
11	T_{11}	8.30	8.97
F test		*	*
SEm ±		0.15	0.20
CD @ 5%		0.43	0.57

Table 4. Effect of fertigation treatments on gingerol content (%) in ginger

Sl. No	Treatments	Rio-de-Janeiro	Himachal
		Gingerol (%)	Gingerol (%)
1	T_1	05.60	06.10
2	T_2	11.75	12.00
3	T_3	11.12	11.90
4	T_4	10.27	11.14
5	T_5	08.34	10.18
6	T_6	06.95	08.56
7	T_7	10.45	10.75
8	T_8	09.29	09.86
9	T_9	07.13	09.16
10	T_{10}	07.46	10.84
11	T_{11}	10.16	11.25
F test		*	*
SEm ±		0.75	0.64
CD @ 5%		2.14	1.82

Table 5. Effect of fertigation treatments on crude fibre (%) in ginger

Sl. No	Treatments	Rio-de-Janeiro	Himachal
		Crude fibre (%)	Crude fibre (%)
1	T_1	3.86	4.20
2	T_2	6.10	6.18
3	T_3	5.93	6.01
4	T_4	5.90	5.90
5	T_5	4.75	4.62
6	T_6	3.93	4.71
7	T_7	5.36	5.57
8	T_8	5.15	5.33
9	T_9	4.40	4.56
10	T_{10}	4.28	4.64
11	T_{11}	5.80	5.71
F test		*	*
SEm ±		0.38	0.40
CD @ 5%		1.08	1.13

Quality parameters in the study were gingerol content, essential oil, crude fibre and oleoresin content. All the parameters were highest in T_2 [200 % RDF (200:100:100 N: P2O5: K2O kg/ha) Fertigation + FYM 30 t/ha, Neem cake 2 t/ha].

"Ginger is a shallow-rooted plant and a gross feeder of nutrients and hence requires a plentiful supply of nutrients at critical growth stages. Imbalance, low or no fertilizer application is a constraint which adversely affects growth and yield of rhizomes" [5]. However, the injudicious and indiscriminate use of chemical fertilizers deteriorate the soil's physical, chemical and biological environment, and reduce yield considerably.

"Providing adequate and balance nutrients by combining organic manures and inorganic chemical fertilizers in suitable proportions remains a viable choice for sustainable crop production, maintaining soil health and safeguarding the environment" [6-10].

"Organics is the bio-degradable product of organic matter by mutual interactions of earthworms and microorganisms. It is an excellent nutrient-rich natural biofertilizer, plant growth promoter, and soil conditioner that supplies primary, secondary, and micronutrients to plants and improves soil properties and yield. Turmeric responds to applications of organic matter and experimental evidences are available on the beneficial effects of organic matter either alone or in combination with inorganic fertilizers on growth, productivity and quality of turmeric. Its nutrient requirement is quite high due to shallow rooting and capacity to produce large amount of dry matter per unit area. Therefore, the need-based application of plant nutrients through organic and inorganic manures is essential to optimum growth. Integrated use of inorganic with organic manures are necessary for sustaining soil fertility and productivity. Hence, keeping the above aspects and importance in view the present study was taken up to evaluate the effect of different forms of organic and inorganic fertilizer combination on growth, yield and quality of turmeric" [11].

4. CONCLUSION

Considering the overall results after studying the impact of different treatments in the study it can be known that T_2 [200 % RDF (200:100:100 N: P_2O_5: K_2O kg/ha) Fertigation + FYM 30 t/ha, Neem cake 2 t/ha] has outperformed all other treatments in the study. Use of higher dose of fertilizers (200 %) specifically through fertigation can result in better quality parameters in ginger. Increased observations recorded in yield parameters like rhizome length, breadth, fingers, nodes, fresh and dry rhizome yield and quality parameters like gingerol, oleoresin, crude fibre and essential oil content have revealed the effectiveness of different treatments under study. The experiment on impact of fertigation regimes on quality of ginger (Rio-De-Jeneiro and Himachal) helps for identifying the best nutrient combinations for improving quality parameters in ginger under Bangalore condition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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