Original Research Article

IMPACT OF FERTIGATION REGIMES ON QUALITY OF GINGER (Rio-De-Jenereo and Himachal)

Comment [e1]: Change the title of the manuscript to be more appropriate

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 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).

Key points: Ginger, FYM, PSB, AMF and Gingerol

INTRODUCTION

Comment [e2]: Add references and previous research in this field to the 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 (Jabborova and Egamberdieva, 2019). 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. 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.

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 (Hebbar *et al*., 2004). 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.

Material 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.

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) + Ginger Special 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

RESULTS AND DISCUSSION

Comment [e3]: What is the effect of organic fertilizers?

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 %).

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 (Dinesh *et al*., 2012). However, the injudicious and indiscriminate use of chemical fertilizers deteriorate the soil's physical, chemical and biological environment, and reduce yield considerably.

Comment [e4]: Comparison of chemical fertilizers with organic fertilizers and their effects on the growth of ginger, its oils and fibres

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 (Shaikh *et al*., 2010; Yamgar *et al*., 2001; Tiwari *et al*., 2014: Ajithkumar *et al*., 2002; Singh *et al*., 2015)

CONCLUSION

The significant variations were observed among the all treatments for quality parameters in ginger. Among the all treatments, T2 [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 superior for essential oil (%), oleoresin content (%), gingerol (%) and crude fibre (%). The experiment on impact of fertigation regimes

Comment [e5]: reason why it is the best combination

on quality of ginger (Rio-De-Jenereo and Himachal) helps for identifying the best nutrient combinations for improving quality parameters in ginger under Bangalore condition.

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**

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Comment [e6]: The references are few... Add more recently references

Comment [e7]: Standardization of naming references .. Using one of the scientific reference writing systems