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Yield and Quality of Ginger as Influenced by Biofertilizers, Organic and Inorganic Manures

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A B S T R A C T

The investigation on organic ginger (var. gorubathan) was carried out to study the effect of organic, inorganic manure and biofertilizers on ginger with reference to rhizome yield and its attributes. The study revealed that, ginger showed better response to the application of organic, inorganic and bio-fertilizer. An experiment was carried out at Horticultural Research Station, Mondouri, BCKV, West Bengal to identify the suitable bio-organic combination for production of with three types of biofertilizers namely nitrogenous biofertilizer (*Azotobacter chroococcum*), phosphate solubilizing Bacteria (*Bacillus polymixa*) and potassic mobilizer (*Fraturia aurantea*) with combination of inorganic fertilizer doses (B1= NPK (100%) + Azotobacter + PSB + K Mobilize B2= NPK (75%) + Azotobacter + PSB + K Mobilizer B3= NPK (50%) + Azotobacter + PSB + K Mobilizer and B4= Recommended NPK (100%) and two levels of FYM *i.e.* 15 t and 30 t. Among different treatments, the sole effect farmyard manure, the maximum number of primary fingers (3.69), weight of primary finger (46.11 g), length of primary finger (3.88 cm), breadth of primary fingers (2.73 cm), number of secondary fingers (4.57), weight of secondary finger (167.0 g), length of secondary finger (9.32 cm), breadth of primary fingers (6.80 cm), yield (24.80 t ha^{-1}) and the higher oleoresin (6.97%) content was recorded with 30 t ha^{-1}, in case of inorganic and biofertilizer, maximum number of primary fingers (3.84), weight of primary fingers (45.67g), length of primary fingers (4.36 cm), length of secondary finger (9.09 cm), breadth of secondary finger (6.61 cm), yield (26.43t ha^{-1}) and oleoresin (6.86) content was observed with combination of B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer).

Introduction

Ginger (*Zingiber officinale* Rosc.) belongs to the family Zingiberaceae, has been prized for its aroma flavour, pungency and medicinal properties since ancient times. Among the major spices grown in the country, ginger occupied an important place, as it is a valuable source of foreign exchange. Oleoresin and essential oil of ginger are its important value added products and export of these products is increasing year after year. The refreshing aroma and the pungent taste make ginger an essential ingredient of food

and also in food processing industries worldwide. Ginger is a long growing crop and needs a balanced supply of nutrients for higher fresh rhizome yield with a better quality, which can be supplied by organic sources. Inadequate or imbalanced nutrient supply is one of the major constraints in harvesting higher fresh rhizome yields. Large scale use of chemical fertilizers has resulted in deterioration of soil health in terms of physical, chemical and biological parameters and is also associated with other problems like nutrient loss through leaching, volatilization and dentrification of nitrogen and fixation of phosphorus. Thus, there is an emergent need to utilize other source of plant nutrients like-organic manures and vermicompost, as they constitute dependable sources of plant nutrients. The judicious use of chemical, organic and biological sources of plant nutrients and their efficient management have shown promising results not only in sustaining productivity and soil health but also in meeting a part of the chemical fertilizer requirement of crop. Biofertilizers have now emerged as a promising component of nutrient supply (Ghosh *et al.,* 2001; Singh 2002). The role of different biofertilizers like *Azospirillum* and *Azotobacter* cultures in fixing atmospheric nitrogen has been well established by several workers (Chandrashekhar, 2003; Indiresh *et al.,* 2003). Integrated plant nutrient system involving a combination of fertilizers, organic manures and biofertilizers are essential to sustain crop production, preserve soil health and biodiversity.

Materials and Methods

The experiment was carried out at Horticultural Research Station, Mandouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during 2016 and 2017 with the variety Gorubathan and spacing is 25×20 cm.The treatment details were followed as main plot applied two different doses of FYM(F1=15 t ha^{-1} and F2=30 t ha^{-1}) and in sub-plot different Bio fertilizers along with inorganic fertilizers with different doses (B1= NPK (100%) + Azotobacter + PSB + K Mobilize B2= NPK (75%) + Azotobacter + PSB + K Mobilizer B3= NPK (50%) + Azotobacter + PSB + K Mobilizer and B4= Recommended NPK (100%). Biofertilizers were collected from Nodule Research Laboratory, BCKV, Mohanpur.In the experiment ginger was fertilised @ 200:75:100 kg NPK ha^{-1}(Dey, 2011) and as per the treatment combination two levels of farmyard manure *i.e.*15 t $ha^{-1}$and 30 t ha^{-1} were applied during land preparation. Three biofertilizers namely (*Azotobacter chroococcum*, phosphate solubilizing bacteria (*Bacillus polymixa)* and Potassic mobilizer (*Fraturia aurantia*) each @ 20 kg $ha^{-1}$was applied. the fertilizers were also applied in three split but started 15 days after the application of biofertilizer and interval between the splits was same. Urea, single super phosphate and muriate of potash were used as inorganic source of N, P and K respectively. Observations on different growth (at 180 days after planting) and yield attributing parameters per replication.

Results and Discussion

The experimental results (pooled data) presented in Table 1 revealed that the details of primary finger number, weight, length, breadth, secondary finger number, weight, length, breadth, project yield and oleoresin contents were recorded with various treatment combination.Among the sole effect of farmyard manure, the maximum number of primary fingers (3.69) was recorded in F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) recorded minimum number of primary finger (3.18). In case of inorganic and biofertilizer, maximum number (3.84) and minimum number (3.16) were associated with B_1 (NPK 100% + *Azotobacter*

+ PSB + K mobilizer) and B_4 (NPK 100%), the maximum weight of primary finger 46.11 g was recorded under F_2 (30t ha^{-1}) and minimum (37.71 g) in F_1 (15t ha^{-1}). In case of inorganic and biofertilizer, B_1 (NPK 100% + *Azotobacter* + PSB+ K mobilizer) recorded maximum weight (45.67g), B_4 (NPK 100%) recorded minimum weight (37.21g), in the sole effect of farmyard manure, the maximum (3.88 cm) and minimum (3.58) length of primary finger were noticed in plants treated with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) respectively.

In case of inorganic and biofertilizer, maximum length of 4.36 cm recorded under B_1 (NPK 100% + *Azotobacter*+ PSB+ K mobilizer) and minimum (3.14 cm) recorded under B_3 (NPK 50%+ *Azotobacter*+ PSB+ K mobilizer), the sole effect of farmyard manure, the maximum (2.73 cm) and minimum (2.44 cm) breadth of primary fingers were observed with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) respectively. In respect of inorganic and biofertilizer the maximum breadth of primary finger (2.76 cm) was associated with B_2 (NPK 75%+ *Azotobacter*+ PSB+ K mobilizer) and minimum breadth of 2.41cm under B_3 (NPK 50%+ *Azotobacter*+ PSB+ K mobilizer), the sole effect farmyard manure, the maximum number of secondary fingers (4.57) was recorded with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) recorded minimum number of 3.68.

In case of inorganic and biofertilizer, maximum number of secondary finger (4.54) and minimum number (3.77) were associated with B_2 (NPK 75% + *Azotobacter* + PSB + K mobilizer) and B_3 (NPK 50% + *Azotobacter* + PSB + K mobilizer), the maximum weight of secondary finger (167.0) g was recorded under F_2 (30 t ha^{-1}) and minimum (138.39 g) was observed in F_1 (15 t ha^{-1}). In case of inorganic and biofertilizer, B_2 (NPK 75% + *Azotobacter* + PSB+ K mobilizer) recorded maximum weight (179.55 g) but B_3 (NPK 50% + *Azotobacter* + PSB+ K mobilizer) recorded minimum weight (115.62 g), the sole effect of FYM, the maximum (9.32 cm) and minimum (7.54 cm) length of secondary finger were noticed in plants treated with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) respectively. In case of inorganic and biofertilizer, maximum length of 9.09 cm was recorded under B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) and minimum of 7.81cm was recorded under B_3 (NPK 50% + *Azotobacter* + PSB + K mobilizer), the sole effect of farmyard manure, the maximum (6.80 cm) and minimum (5.89 cm) breadth of primary fingers were observed with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) respectively.

In respect of inorganic and biofertilizer the maximum breadth of primary finger (6.61 cm) was associated with B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) and minimum breadth of 6.18 cm under B_4 (NPK 100%). In case of sole effect of farmyard manure the maximum (24.80 t ha^{-1}) and minimum (21.62 t ha^{-1}) were associated with F_2 (30t $ha^{-1)}$ and F_1 (15t ha^{-1}) respectively. The plants raised under inorganic and biofertilizer treatment, the maximum yield of 26.43t ha^{-1} was observed under B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) and B_3 (NPK 50% + *Azotobacter* + PSB + K mobilizer) recorded minimum yield (20.21 t ha^{-1}). These findings are in good conformity with the findings of Poinkare *et al.*, (2006) who also observed the better vegetative growth and yield with FYM + 100% RDF + *Azotobacter* + PSB in turmeric. Dash*et al.*, (2008) also recorded highest ginger yield with 100 % NPK (inorganic) along with *Azospirillum* and FYM with highest quality and least rhizome rot incidence. In respect of level of FYM, the yield and quality of ginger increased with the increase of dose from 15 t ha^{-1} to 30 t ha^{-1}. The similar results also obtained by Jana *et al.*, (2017).

Table.1 Effect of biofertilizers, organic and inorganic manures on yield and quality of ginger

Treatment	Primary finger				Secondary finger				Projected yield (t ha^{-1})	Oleoresin percentage
	Number	Weight (g)	Length (cm)	Breadth (cm)	Number	Weight (g)	Length (cm)	Breadth (cm)		
Farm yard manure										
F_1(15t/ha)	3.18	37.71	3.58	2.44	3.68	138.39	7.54	5.89	21.62	6.16
F_2(30t/ha)	3.69	46.11	3.88	2.73	4.57	167.00	9.32	6.80	24.80	6.97
S.Em. (±)	**0.004**	**0.043**	**0.003**	**0.002**	**0.005**	**0.253**	**0.009**	**0.005**	**0.020**	**0.024**
C.D.(P=0.05)	**0.016**	**0.168**	**0.011**	**0.008**	**0.018**	**0.993**	**0.036**	**0.018**	**0.079**	**0.071**
Inorganic fertilizer and biofertilizer										
B_1	3.84	45.67	4.36	2.69	4.31	171.41	9.09	6.61	26.43	6.86
B_2	3.29	42.81	4.00	2.76	4.54	179.55	8.69	6.29	24.04	6.60
B_3	3.46	37.21	3.14	2.41	3.77	115.62	7.81	6.32	20.21	6.59
B_4	3.16	41.94	3.43	2.49	3.90	144.19	8.14	6.18	22.18	6.21
S.Em. (±)	**0.026**	**0.328**	**0.031**	**0.020**	**0.031**	**1.176**	**0.065**	**0.048**	**0.176**	**0.059**
C.D.(P=0.05)	**0.075**	**0.958**	**0.091**	**0.058**	**0.090**	**3.433**	**0.190**	**0.139**	**0.513**	**0.212**

Main Plot - F1 (15t/ha), F2 (30t/ha) Sub-plot - B1= NPK (100%) + Azotobacter + PSB + K Mobilizer, B2= NPK (75%) + Azotobacter + PSB + K Mobilizer, B3= NPK (50%) + Azotobacter+ PSB + K Mobilizer and B4= Recommended NPK (100%)

They observed that increased dose of FYM has increased the rhizome yield, dry recovery and curcumin content in rhizome. As per sole effect of FYM, the higher oleoresin (6.97%) content was recorded with 30 t ha^{-1} as compared to FYM @ 15 t ha^{-1} (6.16%) as per sole effect of inorganic fertilizer and biofertilizer, the oleoresin content decreased from 6.86 to 6.21 with B_1 to B_4. The results indicated that oleoresin content increased due to combined application bio inoculants along with 100 % NPK (inorganic). It also exhibited that oleoresin content decreased with the decreasing level of inorganic NPK *i.e.* 6.86 % to 6.59% with reduction of NPK from 100 % to 50 %.The biofertilizer treatments improved the rhizome quality by increasing the oleoresin content in rhizome. *Azotobacter*, apart from their ability to fix N, produce anti-fungal antibodies 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).

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