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Effect of biofertilizers, organic and inorganic manures on the performance of ginger yield

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Abstract
An experiment was carried out at Horticultural Research Station, Mondouri, BCKV, West Bengal to identify the suitable bio-organic combination for production of organic ginger variety Gorubathan, 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%). Among different treatments, maximum weight, length, breadth and plot yield ($3m^{-2}$) were recorded, in respect of sole effect of farmyard manure, F_2 (30t ha^{-1}) maximum weight of clump (236.27 g), maximum length of clump (15.09 cm), maximum clump breadth (11.71 cm), and maximum plot yield (9.92 kg $3m^{-2}$) were recorded. Under inorganic and biofertilizer treatment, B1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) recorded maximum clump weight (251.74 g), maximum clump length (15.16 cm) under B_2 (NPK 75% + *Azotobacter* + PSB + K mobilizer), maximum clump breadth (12.07 cm) under B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) and maximum yield 10.57 kg $3m^{-2}$ was observed with B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer).

Keywords: Biofertilizers, ginger, inorganic fertilizers, organic fertilizers and yield

Introduction
Ginger (*Zingiber officinale* Rosc.) belongs to the family Zingiberaceae, has been prized for its aroma flavour, pungency and medicinal properties since ancient times. Commonly used as a spice for over 2000 years (Bartley and Jacobs, 2000) [1] and contains characteristic odour and flavour such as the pungent taste (Jolad *et al*., 2005) [3]. 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. 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) [2] 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 Tables-1 revealed details on weight, length, breadth and yield of the clump were recorded with various treatment combination. Among different treatments, in sole effect of farmyard manure, F_2 (30t ha^{-1}) recorded maximum weight of clump (236.27 g) and minimum (205.98 g) was observed in F_1 (15t ha^{-1}). Under inorganic and biofertilizer treatment, B1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) recorded maximum clump weight (251.74 g) and minimum (192.51 g) clump weight was recorded in B_3 (NPK 50% + *Azotobacter* + PSB + K mobilizer). In respect of sole effect of farmyard manure the maximum (15.09 cm) and minimum (13.92 cm) length of clump were noticed with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) respectively. In case of sole effect of inorganic and biofertilizers, B_2 (NPK 75% + *Azotobacter* + PSB + K mobilizer) recorded maximum clump length of 15.16 cm as compared to minimum length of clump (13.74 cm) under B_3 (NPK 50% + *Azotobacter* + PSB + K mobilizer). In sole effect of farmyard manure, the breadth of clump was maximum (11.71 cm) under F_2 (30t ha^{-1}) and minimum breadth (10.82 cm) in F_1 (15t ha^{-1}). In case of inorganic and biofertilizer, maximum (12.07 cm) and minimum (10.79 cm) clump breadth were observed under B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) and B_2 (NPK 75% + *Azotobacter* + PSB + K mobilizer) respectively. In respect of sole effect of farm yard manure, maximum (9.92 kg $3m^{-2}$) and minimum (8.65 kg m^{-2}) plot yield were observed with F_2 (30t ha^{-1}) and F_1 (15t ha^{-1}) respectively. Under inorganic and biofertilizer, maximum yield 10.57 kg $3m^{-2}$ was observed with B_1 (NPK 100% + *Azotobacter* + PSB + K mobilizer) and minimum yield (8.08 kg $3m^{-2}$) under B_3 (NPK 50% + *Azotobacter* + PSB + K mobilizer). These findings are in confirmation with the reports of Singh (2015) [4] who observed maximum growth parameters (height, leaf and tiller number), yield (56.6t ha^{-1}) with B: C ratio (5.27) with combined application of 100 NPK + biofertilizers + FYM. Velmurugom *et al.* (2007) [5] also reported that combined application of FYM + *Azospirillum* + Phosphatic bacteria + VAM exhibited the highest yield of turmeric. This may be due to the action of bioinculents which resulted into more plant height, number leaves $tiller^{-1}$ and number of leaves producing more carbohydrates in the plants. Thus more food was transformed towards rhizomes for accumulation and thereby increased number of primary rhizome and secondary rhizome $plant^{-1}$ and overall yield ha^{-1}.

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

Treatment	Weight of clump (g)	Length of clump(cm)	Breadth of clump (cm)	Yield per plot (Kg $3m^{-2}$)
Farm yard manure				
F_1(15t/ha)	205.98	13.92	10.82	8.65
F_2(30t/ha)	236.27	15.09	11.71	9.92
S.Em. (±)	0.191	0.007	0.008	0.008
C.D. (P=0.05)	0.751	0.027	0.030	0.032
Inorganic fertilizer and biofertilizer				
B_1	251.74	15.15	12.07	10.57
B_2	228.97	15.16	10.79	9.61
B_3	192.51	13.74	10.80	8.08
B_4	211.26	13.97	11.42	8.87
S.Em. (±)	1.676	0.109	0.087	0.070
C.D. (P=0.05)	4.891	0.318	0.254	0.205

Main Plot-F_1 (15t/ha), F_2 (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%).

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