

Effect of integrated nutrient management on growth and yield of banana (*Musa spp.*) variety Grand Naine

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Banana (*Musa spp.*) is one of the important fruit crop of the tropics. The fruits are rich source of carbohydrate and energy. It is grown over 130 countries across the world in an area of 10.1mha and producing 121.85 mt of banana. India is the largest producer of banana contributing 27% of world production (FAO, 2009). In India total area under banana cultivation is 0.796 mha with production of 28.4 mt & productivity is 35.7 mt ha⁻¹. In Orissa total area under banana cultivation is 27486ha with production is around 0.429 mt and productivity is 19.88 mt/ha⁻¹ (Anon, 2012). The consumption pattern of banana is increasing day by day due to its nutritional value and high economic return. Higher productivity in banana is possible through quality planting material, proper nutritional management and other cultural practices.

Integrated nutrient management (INM) is found beneficial for maintenance of soil fertility and plant nutrient supply to an optimum level for sustaining crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner. It was found that early vegetative phase of growth of banana especially upto 3rd / 6th month after transplanting and bunch development stage are the critical stages of banana at which yield is affected. (Prameela, 2010). Grand Naine is a popular variety grown mostly in many place of the country for its high productivity and desired fruit quality (Singh and Chundawat, 2002). Application of *Azospirillum* along with NPK in two split increased the fruit quality in Rasthali banana (Thangaselvabai *et al.*, 2009). Combined application of 100% recommended dose of fertilizer (RDF) along with FYM at 10 kg per plant and phosphate solubilizing bacteria (PSB) and *Azospirillum* each at 25 g per plant increased pseudostem height, girth, required minimum days to flower, crop duration and yield attributes (Bhalerao *et al.* 2009). The present research was carried out to standardize the INM practices for Grand Naine banana.

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Field experiment was conducted at the Horticultural Research Station, Orissa University of Agriculture and Technology, Bhubaneswar, during 2012-13. It lies in between 20°15' N latitude and 85°52'E longitudes and has altitude of 25.5 MSL. The soil of the experimental site is red soil and sandy loam in texture (sand-81.4%, silt-3.4%, clay-15.2%) having pH 5.57, organic carbon 0.56% and the available soil NPK 292,23.4,104 kg.ha⁻¹ respectively were estimated by pH meter method, Walkley and Black's rapid titration method, Kjeldahl method, Olsen's method, respectively (Jackson, 1973). The climate of the research station is warm moist climate with humid summer and mild winter. The experiment was conducted in a randomized block design with 3 replication and 10 treatments. The treatments were - T₁: RDF (100%) (200g N: 50g P₂O₅: 200g K₂O. plant⁻¹. year⁻¹), T₂: RDF (75%) (150g N:37.5g P₂O₅:150g K₂O plant⁻¹year⁻¹), T₃: RDF (75%) + *Trichoderma hazianum* (25g, plant⁻¹), T₄: RDF (75%) + *Azospirillum* (25g, plant⁻¹), T₅: RDF (75%) + PSB (25g.plant⁻¹), T₆: RDF (75%) + PSB + *Azospirillum*, T₇: RDF (100%) + *Trichoderma hazianum*, T₈: RDF (100%) + *Azospirillum*, T₉: RDF (100%) + PSB, T₁₀: RDF (100%) + PSB + *Azospirillum*.

Tissue culture plantlet of variety Grand Naine was planted at a spacing of 1.8 m x 1.8 m. The biofertilizer like *Azospirillum*, PSB and *Trichoderma* were applied @ 25g per plant at the time of planting and after 60 days of planting. The recommended dose of fertilizer for banana at the rate of 200:50:200 g per plants were provided. N, P and K were applied to the respective plants in form of urea, diammonium phosphate (DAP) and muriate of potash (MOP). At the time of planting 100% phosphorus, 25% nitrogen and 50% potassium was applied at time of planting. Lime at 100g was applied at the time of planning due to acidic soil condition. Rest 75% nitrogen applied in three split doses at third, fifth and seventh month after planting. At seventh month rest 50% of potassium was applied along with nitrogen. Planting was done on the 1st April

2012. The plants were irrigated by drip irrigation. Observation on pseudostem height (cm), pseudostem girth(cm), days taken for shooting, average bunch weight (kg), number of hands per bunch , number of fingers per bunch, weight of finger (g), length of finger (cm) and circumference of finger (cm) of fruits were recorded.

The results revealed that there was significant difference in growth and yield of banana under different doses of synthetic fertilizer along with biofertilizers. The height of the plant at the time of shooting was significant (Table 1). The treatment T₁₀ (100% RDF+ *Azospirillum*+ PSB) produced

maximum plant height of 175.07cm followed by T₆ (75% RDF+ *Azospirillum*+ PSB) 171.90cm and minimum height was recorded in T₅(75% RDF+ PSB) 168.27cm. Girth of pseudostem varied between 51.73cm in T₂ and 59.60cm in T₁₀. Treatment T₁₀ was found significantly superior to all other treatments followed by T₇ (57.20cm). Treatment with T₁₀ served maximum height and girth of plant due to application of 100% RDF+ *Azospirillum*+ PSB and the application of biofertilizer increased the availability of nutrient compared to other treatments. Application of 75% RDF with or without biofertilizers caused minimum plant height and girth. *Azospirillum*

Table 1: Effect of INM on vegetative characters of banana cv. Grand Naine

Treatment	Pseudostem height at shooting (cm)	Pseudostem girth at shooting (cm)	Days taken for shooting
T ₁ - RDF 100%	169.07	53.03	225.33
T ₂ - RDF 75%	168.67	51.73	234.33
T ₃ - RDF 75% + <i>T. hazianum</i>	168.87	52.97	211.93
T ₄ - RDF 75% + <i>Azospirillum</i>	169.03	52.33	218.33
T ₅ - RDF 75% + PSB	168.27	54.93	216.33
T ₆ - RDF 75% + PSB+ <i>Azospirillum</i>	171.9	56.6	197.23
T ₇ - RDF 100% + <i>T. hazianum</i>	169.2	57.2	198.6
T ₈ - RDF 100% + <i>Azospirillum</i>	169.47	53.83	213.17
T ₉ -RDF 100% + PSB	170.37	56.57	200.83
T ₁₀ - RDF 100% + PSB+ <i>Azospirillum</i>	175.07	59.6	196.67
F- test	Significant	Significant	Significant
SEm (±)	1.31	1.62	5.82
LSD (0.05)	3.89	4.82	17.29

inoculation along with 100% N increased the vegetative character of banana (Jeeva *et al.*, 1988).

It is interesting to note that application of biofertilizer along with RDF 100% induced early fruiting in T₁₀ (196.67 days) followed by T₆ (197.23days) and maximum days taken for shooting was found in T₂ (234.23 days) treatments. Significant variation was observed on this treatment. As compared to T₁₀ fruiting was delayed by 38 days in T₂ and 30 days in T₁.The early fruiting was attributed due to better activities of *Azospirillum* and PSB in the soil and they attributed for better vegetative growth and early shooting of banana. Application of higher level of nitrogen and *Azospirillum* along with 100g inorganic N produced higher yield (19 kg/plant) of better quality fruits with benefit cost ratio 2.41 and recorded minimum days for shooting (272days) and 4 split

application of inorganic nitrogen (200g/pl) also increased the yield of banana (Thangaselvabai *et al.*, 2009a).The present findings are agreements with the findings of Jeeva *et al.* (1988), Agarwal (1999) and Dinesh *et al.* (2012). Hazarika *et al.* (2011) studied the effect of integrated nutrient management on tissue culture banana variety Grand Naine and reported that the yield attributing characters like number of fingers/bunch, finger volume, circumference of finger, weight of finger were significant by application of biofertilizer, organic manures along with inorganic fertilizers.

Biofertilizer plays a significant role in improving soil fertility by fixing atmospheric nitrogen. It solubilises insoluble P and produces plant growth substances in soil. They help in disease resistant and withstand in stress conditions by different mechanism.

Table 2: Effect of INM on yield attributes of banana cv. Grand Naine

Treatment	No. of hands per bunch	No. of fingers per hand	Weight of bunch (kg)	% increase over control	Yield (t ha ⁻¹)
T ₁ - RDF 100%	7.17	114.95	15.40	14.07	43.12
T ₂ - RDF 75%	6.95	93.67	13.50	-	37.8
T ₃ - RDF 75% + <i>T. hazianum</i>	7.26	104.33	15.73	16.51	44.05
T ₄ - RDF 75% + <i>Azospirillum</i>	7.47	125.73	15.87	17.55	44.43
T ₅ - RDF 75% + PSB	6.97	121.93	15.80	17.03	44.24
T ₆ - RDF 75% + PSB+ <i>Azospirillum</i>	7.61	129.46	15.90	17.77	44.52
T ₇ - RDF 100% + <i>T. hazianum</i>	7.38	118.80	16.07	19.03	44.99
T ₈ - RDF 100% + <i>Azospirillum</i>	7.65	127.00	16.03	18.74	44.89
T ₉ -RDF 100% + PSB	7.24	125.34	16.33	20.96	45.73
T ₁₀ - RDF 100% + PSB + <i>Azospirillum</i>	8.53	135.94	19.17	42	53.67
F-test	Significant	Significant	Significant		Significant
SEm (±)	0.23	2.64	0.58		1.63
LSD (0.05)	0.69	7.84	1.73		4.86

Table 3: Effect of INM on yield attributes of banana cv. Grand Naine

Treatment	Weight of finger(g)	Length of finger(cm)	Circumference of finger(cm)
T ₁ - RDF 100%	105.36	20.98	13.37
T ₂ - RDF 75%	97.24	20.40	12.21
T ₃ - RDF 75% + <i>T. hazianum</i>	113.02	21.76	13.48
T ₄ - RDF 75%+ <i>Azospirillum</i>	106.78	21.59	13.37
T ₅ - RDF 75% + PSB	105.73	21.69	13.73
T ₆ - RDF 75% + PSB + <i>Azospirillum</i>	120.12	22.51	14.49
T ₇ - RDF 100%+ <i>T. hazianum</i>	121.87	22.10	13.52
T ₈ - RDF 100%+ <i>Azospirillum</i>	111.28	22.15	13.81
T ₉ -RDF 100% + PSB	107.07	22.39	13.77
T ₁₀ - RDF 100% + PSB+ <i>Azospirillum</i>	136.71	23.77	15.31
F-test	Significant	Significant	Significant
SEm (±)	4.88	0.26	0.32
LSD (0.05)	14.5	0.79	0.96

Nitrogen fixing bacteria and phosphate solubiliser are the main biofertilizer for increase in yield of banana crop and *Azospirillum* has beneficial effect on yield with varying physiological activities with plant growth substances.

It was revealed from Tables 2 and 3, that the number of hands/bunch, number of fingers/bunch, weight of bunch, yield (t/ha), weight, length and circumference of finger showed significant variations among the treatments. The number of hands per bunch varied between 6.95 in T₂ and 8.53 in T₁₀ treatment. The

number of fingers per bunch was maximum in T₁₀ (135.94) and was found significantly superior to all other treatments followed by T₆ (129.26) and minimum in T₂ (93.67) treatment. Weight of bunch in T₁₀(19.17) was found significantly superior to all other treatments followed by T₉ (16.33) and minimum in T₂ (13.50) treatment. The yield was highest in T₁₀ (53.67t/ha) and lowest in T₂ (37.8 t/ha). All other treatments applied with biofertilizer along with inorganic fertilizers increased the yield over 75% RDF (T₂). Treatment with T₁₀ (100% RDF+*Azospirillum*

+PSB) recorded 42% increase in yield over 75% RDF (T_2). Application of *Azospirillum*, PSB with 100% RDF in T_{10} recorded 21%, 17.77% and 14.07% yield over T_9 (100% RDF+ PSB), T_6 (75% RDF + PSB + *Azospirillum* and T_1 (100%RDF) respectively. The present findings are in agreement with Thangaselvbai (2009), Hazarika *et al* (2011) and Medhi *et al.* (2007).

Thus from the tissue culture plantlets of banana cv. *Grand Naine*, it is revealed that the vegetative characters such as pseudostem height, pseudostem girth at the time of shooting and yield attributing characters like days of shooting, weight of bunch, number of hands per bunch, number of fingers per bunch was varied significantly among the treatments. Early shooting was observed for the treatments T_{10} after 196.67 days and maximum days was taken in T_2 (134.33 days). The yield attributing characters was significantly highest in T_{10} compared to all other treatments and minimum was found in T_2 . Maximum bunch weight was recorded in T_{10} (19.17 kg) treatment and found significantly superior to other treatments followed by T_9 (16.33 kg) and minimum in T_2 (13.50 kg). The highest yield was found in T_{10} (53.67 t ha⁻¹) and lowest was in T_2 (37.80 t ha⁻¹) and treatment with T_{10} recorded 42% of increase in yield over T_1 .

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