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Effect of Ghana jeevamrutha and liquid jeevamrutha on growth parameters of banana (*Musa paradisiaca* L.) cv. Ney poovan (AB)

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Abstract
A field experiment was conducted to study the effect of Ghana jeevamrutha and liquid jeevamrutha at different levels at Hanagal of Haveri district Karnataka. The experiment contains tens treatments with three replications laid in a randomized complete block design and the cv. Ney poovan is the commercial variety used for the study. T_{10} - POP recorded the maximum plant height (273.17 cm), pseudostem girth (71.06 cm), number of leaves (16.10), leaf area (15.35 m^2) at 8 MAP and minimum number of days for shooting (264.50), number days from shooting to harvest (106.50) and number of days for total crop duration (371.00). Among the different levels of ghana jeevamrutha and liquid jeevamrutha T_9 - ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre recorded the maximum plant height (241.62 cm), pseudostem girth (62.32 cm), number of leaves (15.65), leaf area (12.71 m^2) at 8 MAP and minimum number of days for shooting (279.50), number days from shooting to harvest (119.17) and number of days for total crop duration (398.67). Minimum values for plant height (201.57 cm), pseudostem girth (52.52 cm), number of leaves (13.73), leaf area (8.78 m^2) at 8 MAP and maximum number of days for shooting (306.50), number days from shooting to harvest (133.00) and number of days for total crop duration (439.50) was recorded in T_1 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre.

Keywords: Banana, Ghana jeevamrutha, liquid jeevamrutha, Ney poovan, growth parameters

Introduction
Banana (*Musa paradisiaca* L.) is one of the ancient fruits of the world. The term banana comes from the Arabic word "BANAN," which means "finger" (Boning, 2006) [6]. It is known by several names *viz*., Adam's fig, Apple of paradise and Tree of wisdom. Banana is the world's most commonly cultivated tropical and subtropical fruit crop with over 132 countries producing it. After rice, wheat and milk, banana is the world's fourth most significant food commodity by gross value of production (INIBAP 2000) [8]. Among the fruit crops, banana stands first in production, productivity and second most important fruit crop next to mango in India. It is heavy feeder of nutrients and approximately a quarter of the total input cost goes for fertilizers and manures. Every year, a banana crop of 50 tonnes per hectare removes 320 kg of nitrogen, 32 kg of phosphorus and 325 kg of potassium (Lahav and Turner, 1983) [9]. As a result, maintaining a high level of soil fertility through timely and judicious application of N, P and K is critical for achieving good banana production and quality. However, application of inorganic fertilizers for production of banana increases the yield substantially but could not able to sustain the fertility status of the soil (Bharadwaj and Omanwar, 1994) [5] and causes serious damage to environment and health. Continuous application of inorganic fertilizers leads to accumulation of heavy metals in the tissues, affecting the fruit nutritional value and edibility. To achieve sustainable soil fertility, crop productivity and improve farmer's profitability the role of natural farming component *viz*., Ghana jeevamrutha and liquid jeevamrutha which are safe for human, animal and environment are becoming popular among the farmers. Keeping these points in view, the present investigation was undertaken to study the effect of Ghana jeevamrutha and liquid jeevamrutha on growth parameters of banana cv. Ney poovan (AB).

Material and Methods

The present investigation on the effect of jeevamrutha on growth parameters of banana cv. Ney poovan (AB) was carried out at Hanagal of Haveri district situated at 14.767 ºN 75.126 ºE latitude and at 555 m elevation which comes under zone 09 of Karnataka during 2019-2020 and 2020-2021. The experiment was laid out in Randomized Complete Block Design with three replications. Tissue cultured plants were treated with beejamrutha and planted at the spacing of 2.7×2.7 m. The required intercultural operations were taken regularly.

Table 1: Details of the treatments imposed during the experimentation

Treatment No.	Treatment
T_1	Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre
T_2	Ghana jeevamrutha @ 400 kg/acre + liquid jeevamrutha @ 100 l/acre
T_3	Ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 100 l/acre
T_4	Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 200 l/acre
T_5	Ghana jeevamrutha @ 400 kg/acre + liquid jeevamrutha @ 200 l/acre
T_6	Ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 200 l/acre
T_7	Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 300 l/acre
T_8	Ghana jeevamrutha @ 400 kg/acre + liquid jeevamrutha @ 300 l/acre
T_9	Ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre
T_{10}	Package of practice (200:100:300 g NPK/plant/year)

*Ghana jeevamrutha was applied 30 days before planting and at starting of ratoon crop.
* Liquid jeevamrutha was applied at 15 days interval.
* NPK was applied at monthly intervals after planting to till two months before shooting.

Observations on growth parameters were recorded at 2 months interval till shooting from five tagged plants in each treatment from three replications. The plant height was measured from the ground level from marked point upto the angle between youngest first and second leaf axil in the pseudostem was noted and the mean was expressed in centimetres. The circumference of the pseudostem was measured at 30 cm above the ground level by using the measuring tape and expressed in centimeters. The number of functional fully opened green leaves were counted from each tagged plant and expressed as number of leaves per plant. The leaf area was designed by using the subsequent formula and it was articulated in square meter (Murray, 1960) [10].

$$\text{Leaf area} = \text{Leaf length} \times \text{leaf width} \times 0.8 \times \text{No. of leaves}$$

The number of days required from planting to shooting, shooting to harvest and total crop duration were counted and expressed as number of days. Experimental data collected was subjected to statistical analysis by adopting Fisher's method of Analysis of Variance (ANOVA) as outlined in Gomez and Gomez (1984) [18]. Critical Difference (CD) values were calculated whenever the "F" test was significant at 5 per cent level.

Result and Discussion

In the present study, the pooled data reveled that significant difference was noticed with respect to all the growth parameters expect for number of leaves. The maximum plant height at 2 months after planting [MAP] (47.22 cm), 4 MAP (118.83 cm), 6 MAP (214.98 cm) and 8 MAP (273.17 cm) was recorded in T_{10} - POP which was followed by T_9 - ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre 2 MAP (41.82 cm), 4 MAP (102.32 cm), 6 MAP (183.02 cm) and 8 MAP (241.62 cm) and minimum values were recorded in T_1 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre at 2 MAP (32.17 cm), 4 MAP (64.32 cm), 6 MAP (143.00 cm) and 8 MAP (201.57 cm) which is presented in Table 2. It is evident from the Table 3, that the maximum pseudostem girth was recorded in T_{10} - POP at 2 MAP (16.98 cm), 4 MAP (29.34 cm), 6 MAP (55.13cm) and 8 MAP (71.06 cm) was recorded in T_{10} - POP which was followed by T_9 - ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre 2 MAP (14.87 cm), 4 MAP (25.43 cm), 6 MAP (47.22 cm) and 8 MAP (62.32 cm) and minimum values were recorded in T_1 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre at 2 MAP (11.07 cm), 4 MAP (15.74 cm), 6 MAP (36.46 cm) and 8 MAP (52.52 cm). The treatment T_{10} - POP recorded the significantly maximum values for all the vegetative parameters could be attributed to the higher uptake of nutrients, particularly nitrogen (Nalina *et al*., 2009) [11]. Nitrogen enhances growth and vegetative matter production in plants (Alvarez *et al*., 2001) [1]. This fact is also supported by Pafli (1965) [12] that the uptake of nitrogen which is the chief constituent of chlorophyll, proteins and amino acids is accelerated through its supply at appropriate time to the plants. Nitrogen is responsible for the formation, growth and development of the cells and also it increases the meristematic tissue formation. Next to nitrogen, phosphorous is an essential mineral nutrient for the growth and development of the plants (Attia *et al*., 2009) [3]. Due to application of P along with N might have profoundly enhanced the root development of the plant. Thus, it promoted the plant height and girth.

Table 2: Effect of Ghana jeevamrutha and liquid jeevamrutha on plant height (cm) of banana cv. Ney poovan (AB)

Treatments	2 MAP			4 MAP			6 MAP			8 MAP		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	33.07	31.27	32.17	65.23	63.40	64.32	144.33	141.67	143.00	203.47	199.67	201.57
T_2	35.57	33.67	34.62	67.90	65.93	66.92	150.70	148.67	149.68	209.60	207.07	208.33
T_3	35.56	33.70	34.63	69.83	68.47	69.15	153.80	151.67	152.73	211.90	209.00	210.45
T_4	35.20	34.33	34.77	70.30	69.23	69.77	159.60	157.03	158.32	218.87	216.33	217.60
T_5	36.67	34.80	35.73	77.17	75.67	76.42	163.60	161.33	162.47	219.93	217.67	218.80
T_6	39.07	37.80	38.43	82.37	80.73	81.55	167.97	164.90	166.43	224.40	222.30	223.35
T_7	43.03	39.73	41.38	93.13	92.63	92.88	178.17	175.83	177.00	236.83	234.67	235.75
T_8	42.10	40.50	41.30	97.23	96.07	96.65	180.23	177.80	179.02	239.50	237.33	238.42
T_9	42.80	40.83	41.82	103.90	100.73	102.32	184.70	181.33	183.02	242.90	240.33	241.62
T_{10}	48.57	45.87	47.22	120.00	117.67	118.83	216.20	213.77	214.98	274.67	271.67	273.17
S.Em±	3.07	1.58	2.25	4.72	4.00	4.33	6.78	5.76	6.25	7.84	7.69	7.76
CD @ 5%	9.13	4.70	6.70	14.04	11.87	12.85	20.16	17.11	18.57	23.31	22.84	23.05

Table 3: Effect of Ghana jeevamrutha and liquid jeevamrutha on pseudostem girth (cm) of banana cv. Ney poovan (AB)

Treatments	2 MAP			4 MAP			6 MAP			8 MAP		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	11.98	10.17	11.07	16.60	14.87	15.74	37.52	35.40	36.46	53.63	51.40	52.52
T_2	12.69	10.50	11.60	17.33	15.13	16.23	39.14	36.53	37.84	54.94	52.87	53.90
T_3	12.74	10.73	11.74	17.82	15.43	16.63	39.70	37.53	38.62	55.65	53.40	54.53
T_4	12.60	11.43	12.02	17.88	16.00	16.94	41.43	39.68	40.56	57.40	55.10	56.25
T_5	13.12	11.17	12.15	19.70	17.70	18.70	42.53	40.25	41.39	57.29	56.03	56.66
T_6	14.00	12.98	13.49	21.03	19.00	20.01	43.57	41.09	42.33	58.91	56.33	57.62
T_7	15.37	14.33	14.85	23.73	21.47	22.60	46.31	44.67	45.49	62.18	60.03	61.11
T_8	15.04	14.14	14.59	24.72	22.73	23.73	46.87	44.83	45.85	62.84	60.53	61.69
T_9	15.33	14.40	14.87	26.46	24.40	25.43	48.31	46.13	47.22	63.64	61.00	62.32
T_{10}	17.63	16.33	16.98	30.31	28.38	29.34	56.16	54.10	55.13	72.04	70.07	71.06
S.Em±	1.12	0.79	0.87	1.19	0.61	0.79	1.77	1.43	1.55	2.05	1.78	1.89
CD @ 5%	3.33	2.34	2.59	3.53	1.81	2.35	5.25	4.25	4.60	6.09	5.28	5.61

Leaf area was significantly maximum in T_{10} - POP at 2 MAP (0.48 m^2), 4 MAP (2.40 m^2), 6 MAP (8.64 m^2) and 8 MAP (15.35 m^2) which was followed y T_9 - Ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre 2 MAP (0.41 m^2), 4 MAP (1.82 m^2), 6 MAP (6.99 m^2) and 8 MAP (12.71 m^2) and minimum in T_1 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre at 2 MAP (0.31 m^2), 4 MAP (1.40 m^2), 6 MAP (5.47 m^2) and 8 MAP (8.78 m^2) [Table 4]. There was no significant difference among the treatments for number of leaves during all the stages of growth. However, during all the stages of growth the maximum number of leaves was recorded in T_{10} - POP (16.10) and minimum was recorded in T_1 - Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre (13.73).

The maximum value for leaf area was recorded in the treatment T_{10} - POP is due to the application of inorganic fertilizers which has increased the nutrient supply that enhances the initiation and expansion of leaves leading to the increased leaf area of the plant. Also this might be due to reason that inorganic fertilizers can supply the required quantity of nutrients instantly in a balanced proportion coinciding with the crop requirement these results are in accordance with Sweta (2017) [16] and Anusha *et al*. (2018) [2]. The minimum values were recorded in T_1 - Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre that might be due to the low dose of Ghana jeevamrutha and liquid jeevamrutha which led to non-availability of sufficient quantity of nutrients for crop growth

Table 4: Effect of Ghana jeevamrutha and liquid jeevamrutha on leaf area (m^2) of banana cv. Ney poovan (AB)

Treatments	2 MAP			4 MAP			6 MAP			8 MAP		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	0.31	0.31	0.31	1.37	1.44	1.40	5.36	5.58	5.47	9.19	8.37	8.78
T_2	0.34	0.34	0.34	1.43	1.45	1.44	5.52	5.7	5.65	9.59	10.00	9.79
T_3	0.33	0.33	0.33	1.49	1.53	1.51	5.83	6.03	5.93	10.18	10.59	10.38
T_4	0.34	0.35	0.35	1.50	1.58	1.54	6.11	6.28	6.19	10.50	10.93	10.72
T_5	0.36	0.36	0.36	1.63	1.69	1.6	6.12	6.39	6.25	10.81	11.22	11.02
T_6	0.35	0.36	0.36	1.61	1.72	1.67	6.40	6.87	6.64	11.22	11.42	11.32
T_7	0.37	0.38	0.37	1.71	1.77	1.74	6.60	7.01	6.81	11.49	12.32	11.91
T_8	0.39	0.39	0.39	1.82	1.84	1.83	6.78	7.08	6.93	11.85	12.85	12.35
T_9	0.41	0.42	0.41	1.77	1.86	1.82	6.81	7.18	6.99	11.96	13.45	12.71
T_{10}	0.48	0.48	0.48	2.36	2.44	2.40	8.40	8.88	8.64	14.56	16.13	15.35
S.Em±	0.02	0.02	0.02	0.11	0.12	0.12	0.43	0.51	0.46	0.60	0.78	0.62
CD @ 5%	0.06	0.06	0.06	0.34	0.37	0.35	1.27	1.51	1.38	1.79	2.32	1.84

Table 5: Effect of Ghana jeevamrutha and liquid jeevamrutha on number of leaves of banana cv. Ney poovan (AB)

Treatments	2 MAP			4 MAP			6 MAP			8 MAP		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	6.87	6.67	6.77	8.73	8.87	8.80	11.63	11.73	11.68	13.97	13.50	13.73
T_2	7.07	6.87	6.97	8.97	8.87	8.92	11.87	11.87	11.87	14.10	14.43	14.27
T_3	6.77	6.67	6.72	8.87	8.97	8.92	11.77	11.87	11.82	14.40	14.73	14.57
T_4	6.83	6.73	6.78	8.97	9.10	9.03	12.10	12.10	12.10	14.73	15.07	14.90
T_5	7.00	6.87	6.93	9.10	9.07	9.08	12.07	12.17	12.12	14.87	15.20	15.03
T_6	7.00	7.00	7.00	8.87	9.20	9.03	12.00	12.30	12.15	15.00	15.00	15.00
T_7	7.10	7.00	7.05	9.20	9.30	9.25	12.07	12.40	12.23	15.07	15.63	15.35
T_8	7.20	7.10	7.15	9.30	9.40	9.35	12.20	12.30	12.25	15.17	15.87	15.52
T_9	7.20	7.10	7.15	9.30	9.40	9.35	12.20	12.43	12.32	15.30	16.00	15.65
T_{10}	7.30	7.20	7.25	9.40	9.50	9.45	12.33	12.63	12.48	15.87	16.33	16.10
S.Em±	0.24	0.23	0.22	0.30	0.31	0.30	0.42	0.46	0.44	0.42	0.66	0.45
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Among the different levels of Ghana jeevamrutha and liquid jeevamrutha the plants treated with Ghana jeeavamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre (T_9) recorded the maximum values for all the vegetative parameters which was followed by Ghana jeeavamrutha @ 400 kg/acre + liquid jeevamrutha @ 300 l/acre (T_8). This increase in the growth parameters might be attributed to solubilization of nutrients in soil and absorption of nutrients and moisture which is in the same line as reported by (Boraiah, 2013; Siddappa, 2015; Yogananda *et al*., 2015; Siddappa *et al*., 2016) [7, 14, 17, 15]. Also higher doses of Ghana jeevamrutha and liquid jeevamrutha stimulates the activities of micro-organisms to release the nitrogen in a synchronous manner, which might have stirred the cellular activity. Further the presence of growth promoting hormones *viz*., IAA and GA_3 in jeevamrutha might have favored rapid cell division and multiplication contributing to increased growth parameters among the different levels of ghana jeevamrutha and liquid jeevamrutha which was in accordance with Sweta (2017) [16].

The minimum number of days for shooting was recorded in T_{10} - POP (264.50) where the plants were treated with the recommended dose of fertilizers which was on par with T_9 - ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre (279.50), T_8 - ghana jeevamrutha @ 400 kg/acre + liquid jeevamrutha @ 300 l/acre (281.83), T_7 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 300 l/acre (283.83) and T_6 - ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 200 l/acre (286.83) and maximum was recorded in T_1 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre (306.50). The minimum days from shooting to harvest was recorded in T_{10} - POP (106.50) which was on par with T_9 - Ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre (119.17 days) while the maximum number of days was recorded in T_1 - Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre (133.00). Total duration of the crop was recorded minimum in T_{10} (371.00 days) which was followed by T_9 - ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre (398.67 days) and maximum number of days was recorded in T_1 - ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre (439.50 days). Among the plants treated with different levels Ghana jeevamrutha and liquid jeevamrutha T_9 - Ghana jeevamrutha @ 600 kg/acre + liquid jeevamrutha @ 300 l/acre recorded the minimum number of days for shooting, days from shooting to harvest and total duration of the crop.

Table 6: Effect of Ghana jeevamrutha and liquid jeevamrutha on reproductive parameters of banana cv. Ney poovan (AB)

Treatments	Days taken for shooting			Days from shooting to harvest			Total duration		
	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled	Plant crop	Ratoon crop	Pooled
T_1	307.33	305.67	306.50	132.67	133.33	133.00	440.00	439.00	439.50
T_2	304.67	302.67	303.67	131.00	132.00	131.50	435.67	434.67	435.17
T_3	298.33	297.00	297.67	130.33	131.67	131.00	428.67	428.67	428.67
T_4	293.67	290.33	292.00	130.67	128.67	129.67	424.33	419.00	421.67
T_5	289.33	286.00	287.67	128.00	129.33	128.67	417.33	415.33	416.33
T_6	288.33	285.33	286.83	126.67	127.67	127.17	415.00	413.00	414.00
T_7	285.67	282.00	283.83	125.33	126.67	126.00	411.00	408.67	409.83
T_8	284.00	279.67	281.83	123.67	120.67	122.17	407.67	400.33	404.00
T_9	280.33	278.67	279.50	119.33	119.00	119.17	399.67	397.67	398.67
T_{10}	267.67	261.33	264.50	109.00	104.00	106.50	376.67	365.33	371.00
S.Em±	7.51	8.27	7.75	4.52	5.59	4.89	9.91	7.05	6.58
CD @ 5%	22.32	24.58	23.02	13.43	16.61	14.52	29.45	20.95	19.56

In the present investigation the T_{10} - POP resulted in reduced duration for shooting, shooting to harvest and total duration of the crop. This may be due to the optimum quantity of nutrients available through inorganic fertilizers that have hastened the process of initiation and emergence of inflorescences due to earlier production of leaves with larger leaf area per plant and better net assimilation rates. Parida *et al*. (1994) [13] observed that higher doses of nitrogen hastened the process of initiation and emergence of inflorescence due to more number of leaves with larger leaf area per plant and better disposition of photosynthetic activity resulting in higher assimilation rates. The treatment T_1 - Ghana jeevamrutha @ 200 kg/acre + liquid jeevamrutha @ 100 l/acre recorded the maximum number of days for all the reproductive parameters

and this may be due to low leaf emission rates under organic cultivation which may be due to slow mineralization of the organic manures (Babu *et al.* 2008) [4].

Conclusion

The present study reveals that among the organic treatments combination, application of higher dose of Ghana jeevamrutha along with liquid jeevamrutha gave maximum plant height, pseudostem girth, leaf area and minimum number of days for shooting, shooting to harvest and total crop duration. These fermented organic nutrients can be a better alternative for the use of inorganic inputs to maintain soil health for sustainable development.

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