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Studies on the impact of planting density and nutrient management on growth and yield of banana cv. Ney Poovan under coconut plantation

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Abstract
A field experiment was conducted during the year 2017 - 2018 to evaluate the impact of planting density and nutrient management on growth and yield of banana cv. Ney Poovan under coconut with nine treatments replicated thrice by using factorial randomized block design. Coconut being widely spaced owing to its morphological features provides ample opportunities for cropping in the interspaces. Active root zone of coconut is confined to 25 per cent of the available land area and the remaining area could be profitably exploited for raising subsidiary crops. A high efficiency in the use of available soil moisture and nutrients can be achieved by growing intercrops outside 2 m radius around the base of the palms (Maheswarappa *et al.,* 2000). The present results revealed that among the different treatments, F_6 P_1 (100 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g plant^{-1} in single row planting) recorded best values in term of morphological characters and yield attributes. Hence, the application of 100 per cent RDF along with biofertilizers @ 100 g plant^{-1} in single row planting of banana cv. ney poovan under coconut is best when compared to other treatment and control.

Keywords: impact, planting density, banana, Poovan under

Introduction
Banana is a highly exhaustive crop, readily responds to applied nutrients (Mustaffa and Kumar, 2012) [16] therefore requires large quantities of mineral nutrients for rapid growth and development. Banana cv. Ney Poovan (AB) is the choicest diploid cultivar which is under commercial cultivation on a large scale especially in Karnataka and Tamil Nadu. Major nutrients like nitrogen, phosphorus and potassium play an important role in the vegetative and reproductive phases of crop growth, depending on the cultivar. The basic principle of integrated nutrient management is the maintenance of soil fertility and sustainable agricultural productivity and improving farmer's profitability through judicious and efficient use of inorganic fertilizer along with biofertilizers. It also ensures to sustain the economic status of the farmers and social aspects of agricultural production, local as well as global. Application of bioinoculants containing beneficial microorganisms instead of chemicals are known to improve plant growth through the supply of plant nutrients and may help to sustain environmental health and soil productivity. Coconut being widely spaced owing to its morphological features provides ample opportunities for cropping in the interspaces. Active root zone of coconut is confined to 25 per cent of the available land area and the remaining area could be profitably exploited for raising subsidiary crops. A high efficiency in the use of available soil moisture and nutrients can be achieved by growing intercrops outside 2 m radius around the base of the palms. It was further confirmed that more than 80 per cent of the root activity was confined to a lateral distance of 2 m from the trunk. This shows that on an area basis of total available land in a pure palm stand is not effectively utilised by coconut roots and can support many more crops. Thus, the active root zone of coconut is confined to 25 per cent of the available land area and the remaining area could be profitably exploited for raising subsidiary crops. Therefore, the present investigation to study the impact of planting density and nutrient management on growth, yield and quality of banana cv. Ney Poovan under coconut.

Materials and Methods
The present investigation carried out at farmer field, Rayappanpatty, Department of fruit crops

Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during the period 2017 - 2018 with banana cv. Ney Poovan under coconut. The experiment was laid out in a Factorial Randomized Block Design with nine treatments and three replications. Each treatment had a net area of 200 M^2 having 45 plants. Guard rows were provided on all sides of the plots. Observations were taken up from centrally located ten plants. The recommended spacing of 1.8 m x 1.8 m was adopted for planting. Suckers of banana *cv.* Ney Poovan obtained from disease free field were planted in all the treatments. Recommended cultural practices were carried out regularly. Suckers of uniform size weighing around 1.5 kg $\pm$ 0.5 kg of banana cv. Ney Poovan were selected for planting. The present experiment of various treatments as follows F_1 P_1 (75 per cent RDF in single row planting), F_2 P_1(100 per cent RDF in single row planting), F_3 P_1 (125 per cent RDF in single row planting), F_4 P_1 (150 per cent RDF in single row planting), F_5 P_1 (75 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in single row planting), F_6 P_1 (100 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in single row planting), F_7 P_1 (125 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in single row planting), F_8 P_1 (150 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in single row planting), F_9 P_1 (control) and F_1P_2 (75 per cent RDF in double row planting), F_2 P_2(100 per cent RDF in double row planting), F_3 P_2 (125 per cent RDF in single row planting), F_4 P_2 (150 per cent RDF in double row planting), F_5 P_2 (75 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in double row planting), F_6 P_2 (100 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in double row planting), F_7 P_2 (125 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in double row planting), F_8 P_2 (150 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g $plant^{-1}$ in double row planting), F_9 P_2 (control). The recommended dose of fertilizer (RDF) for banana cv. Ney Poovan: 110 g: 35 g: 330 g NPK $plant^{-1}$ $year^{-1}$ applied as per the treatment schedule. Ten uniform plants were selected randomly in each treatment for recording the following observations on vegetative characters at 3rd, 5th, 7th month and shooting stage after planting. The yield and quality attributes were taken after harvesting of bunches.

Table 1: Effect of planting density and nutrient management on growth characters in cv. Ney Poovan

Treatments	Pseudostem height (cm)			Pseudostem girth (cm)			Number of leaves per plant		
	P_1	**P_2**	**F Mean**	**P_1**	**P_2**	**F Mean**	**P_1**	**P_2**	**F Mean**
F_1	252.40	250.60	251.50	59.53	58.03	58.78	16.06	15.53	15.80
F_2	257.97	256.23	257.10	60.36	59.86	60.11	16.20	15.93	16.06
F_3	255.53	255.50	255.51	65.16	63.00	64.08	16.46	15.96	16.21
F_4	257.00	256.97	256.98	63.90	61.10	62.50	16.36	15.80	16.08
F_5	256.97	257.2	257.08	64.43	62.36	63.40	16.20	16.10	16.15
F_6	255.93	257.90	256.31	71.03	68.60	69.81	16.46	17.00	16.73
F_7	255.07	261.57	258.31	63.53	60.63	62.08	16.50	16.36	16.43
F_8	254.47	257.63	256.05	64.16	62.53	63.35	16.13	16.13	16.13
F_9	226.93	250.60	225.78	46.06	42.90	44.48	11.76	11.30	11.53
P Mean	252.47	253.13	252.80	62.02	59.89	60.95	15.79	15.57	15.68
	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)
P	1.32		2.54	0.86		1.76	0.13		0.26
F	2.32		3.95	1.83		3.73.	0.27		0.56
P x F	4.62		7.84	2.59		5.27	0.39		0.79

Table 2: Effect of planting density and nutrient management on growth characters in cv. Ney Poovan

Treatments	Leaf area index per plant			Phyllochron (days)			Crop duration (days)		
	P_1	**P_2**	**F Mean**	**P_1**	**P_2**	**F Mean**	**P_1**	**P_2**	**F Mean**
F_1	1.72	1.68	1.70	14.23	14.76	14.50	365.26	366.50	365.88
F_2	1.69	1.62	1.65	13.90	14.56	14.23	367.46	369.96	368.71
F_3	1.74	1.72	1.73	13.93	14.66	14.30	367.60	368.20	367.90
F_4	1.63	1.64	1.64	14.20	14.53	14.36	369.06	368.33	368.70
F_5	1.81	1.84	1.83	14.10	14.50	14.30	370.10	370.10	370.10
F_6	1.72	1.65	1.68	13.73	14.16	13.95	354.23	357.36	355.80
F_7	1.55	1.46	1.51	13.60	14.36	13.98	368.96	368.40	368.68
F_8	1.62	1.52	1.57	13.73	14.50	14.11	372.76	370.83	371.80
F_9	1.37	1.34	1.35	15.33	15.70	15.51	384.33	379.06	381.70
P Mean	1.65	1.61	1.63	14.08	14.64	14.36	368.86	368.75	368.80
	SEd		CD (P=0.05)			CD (P=0.05)	SEd		CD (P=0.05)
P	0.020		0.041			0.18	0.63		1.28
F	0.043		0.087			0.38	1.33		2.71
P x F	0.061		0.124			0.54	1.89		3.83

Table 3: Effect of planting density and nutrient management on yield and yield attributes in cv. Ney Poovan

Treatments	Bunch weight (kg plant^{-1})			Number of hands (numbers)			Number of fingers (numbers)			Finger weight (g)		
	P_1	P_2	F Mean	P_1	P_2	F Mean	P_1	P_2	F Mean	P_1	P_2	F Mean
F_1	9.21	9.21	9.21	6.90	6.92	6.91	87.75	87.75	87.74	54.78	51.75	53.26
F_2	8.90	8.90	8.90	6.94	6.96	6.95	87.31	87.32	87.30	62.95	60.43	61.69
F_3	9.32	9.42	9.37	7.27	7.25	7.26	88.15	88.14	88.14	66.49	62.11	64.30
F_4	8.49	8.59	8.54	7.12	7.11	7.11	90.54	90.52	90.53	60.52	58.65	59.58
F_5	8.32	8.42	8.38	6.88	6.86	6.87	87.03	87.04	87.03	64.31	57.26	60.78
F_6	9.50	9.60	9.50	7.45	7.46	7.45	93.38	93.36	93.37	70.99	69.38	70.19
F_7	8.67	8.67	8.67	6.91	6.92	6.91	83.55	83.56	83.55	65.65	61.34	63.49
F_8	8.51	8.51	8.51	6.46	6.46	6.46	86.07	86.08	86.07	62.04	59.55	60.80
F_9	8.07	8.10	8.08	5.55	5.49	5.52	74.04	73.91	73.97	48.54	46.02	47.28
P Mean	8.89	8.79	8.84	6.83	6.82	6.82	86.42	86.40	86.41	61.81	58.50	60.15
	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)
P	0.02		0.04	0.035		0.072	0.422		0.858	0.36		0.73
F	0.04		0.08	0.076		0.154	0.895		1.82	0.76		1.55
P x F	0.06		0.12	0.107		0.218	1.26		2.57	1.08		2.20

Results and Discussion

Effect of planting density and nutrient management on growth characters in banana cv. Ney Poovan

Among the different nutrient treatments, the plants treated with F_6 (100 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g plant^{-1}) registered the highest pseudostem height, pseudostem girth, highest number of leaves per plant highest leaf area index lowest phyllochron and early crop duration *viz.*, (258.31 cm), (69.81 cm), (16.73 leaves), (1.83), (13.95 days) and (355.80 days) respectively compared to other treatments. Among the planting density, the highest pseudostem height (253.13 cm), pseudostem girth (69.81 cm), more number of leaves per plant (15.79 leaves), the highest leaf area index (1.65), and early crop duration (355.80 days) registered in P_1 (single row planting) compared to other level. The interaction effect between F and P were significantly differ in respect to pseudostem height, maximum pseudostem height (261.57 cm), pseudostem girth (71.03 cm) recorded in F_6 P_1, more number of leaves per plant recorded in F_6 P_2 (17.00 leaves) and the highest leaf area index recorded in F_5 P_2 (1.84) and the lowest phyllochron recorded in F_7 P_1 (13.60 days) which is on par with by F_6 P_1 (13.73 days) compared to other treatment combinations (Table 1 & 2). In banana, an uninterrupted growth in terms of height and girth of pseudostem is an important parameter which helps to judge the plant vigour (Simmonds, 1966). Plants with more girth are desirable as they reflect on bunch size and other related characters. Besides, they give better anchorage for the plant (Krishnan and Shanmugavelu, 1979) [5]. The importance of LAI on crop growth is well recognized. An increase in LAI results in better utilization of solar energy. The critical LAI necessary for maximum utilization of photosynthetically active radiation in banana ranges from 4 to 4.5 (Stover, 1984) [3]. This indicates a better utilization of every unit area of land in an efficient way (Apshara, 1997; Nalina, 1999) [1, 11]. A banana crop should produce sufficient number of leaves to harness light energy and synthesise adequate photosynthates for biomass production. Increased production of leaves might help to produce more photosynthates and to induce flower stimulus and early flowering (Venkatesam *et al.*, 1965; Tumer, 1970) [2]. This present findings are in line with the findings of Mahalakshmi *et al.* (2001) [7], Selvaraj *et al.* (2014) and vanilarasu *et al.* (2018) [14] in banana.

Effect of planting density and nutrient management on yield and yield attributes in cv. Ney Poovan

Among the different nutrient treatments, the treatment F_6 (100 per cent of the RDF + Azospirillum @ 100 g + Phosphobacteria @ 100 g + AM fungi @ 100 g plant^{-1}) registered the highest bunch weight (9.55 kg), more number of hands per bunch (7.45 hands), more number of fingers per bunch (93.37 fingers) and highest finger weight (70.19 g) compared to other treatments. Among the planting density, the highest bunch weight (8.89 kg), the more number of hands per bunch (6.83 hands), the more number of fingers per bunch (86.42 fingers) and highest finger weight (61.81 g) recorded in P_1 (single row planting) compared to other level. The interaction effect between F and P were significantly differ in respect to bunch weight, the highest bunch weight (9.50 kg), the more number of hands per bunch, (7.45 hands), the more number of fingers per bunch (93.38 fingers) and the highest finger weight (70.99 g) recorded in the treatment F_6 P_1 compared to other treatments combinations (Table 3). It is well known that efficiency of bio-agents can be exploited with the use of recommended dose of fertilizer which might have improved the yield parameters through better availability and uptake of nutrients from plant roots and enhancing the source sink relationship and thereby increasing the movement of carbohydrates from the leaves to the fruits. High levels of N and K nutrition, very particularly K is indispensable for yield improvement as reflected in this investigation. The time of application of K is critical in increasing the yield (Simmonds, 1987; Langenegger and Smith, 1986) [4]. This present findings are in line with the findings of Murugan (2003) [15], Kavino *et al.* (2010) [6] and vanilarasu *et al.* (2018) [14] in banana.

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