

Studies on the performance of intercrops on the nutrient uptake and yield attributes of mango cv. AMRAPALI

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■ DEBASIS BEHERA, PARTHA SARATHI MUNSI¹ AND DEBI PRASAD RAY¹

AUTHORS' INFO

Associated Co-author :

¹Department of Crop Improvement, Horticulture and Agricultural Botany (CIHAB), Palli Siksha Bhavana, (Institute of Agriculture), Visva-Bharati, SRINIKETAN (W.B.) INDIA

Author for correspondence: DEBASIS BEHERA

Department of Crop improvement, Horticulture and Agricultural Botany (CIHAB), Palli Siksha Bhavana, (Institute of Agriculture), Visva-Bharati, SRINIKETAN (W.B.) INDIA
Email: drdebasisbehera@gmail.com

ABSTRACT : Development of mango based intercropping is the need of hour to increase production along with increasing income of mango growers. Keeping the above facts in to consideration different intercrops like pineapple, turmeric and ginger were tried in mango orchard of Department of Horticulture, Government of Odisha situated at Bhubaneswar for two years (2007-08 and 2008-09) with and without application of biofertilizers to study the impact of intercrops and biofertilizer on growth and yield characteristics of mango. The experiment was carried out in Randomized Block Design with three replications and seven treatments. From the experiment it was found that intercrops had positive impact on growth and yield attributes of mango. Application of biofertilizers also showed positive result. Growing of intercrops like ginger, turmeric and pineapple with biofertilizers and inorganic fertilizers in mango orchard revealed that maximum mango yield was recorded intercropping with turmeric with application of biofertilizers (36.87 quintal per hectare) T₄ followed by intercropping with ginger with application of biofertilizers (34.47 quintal per hectare) T₇ and minimum was recorded in control (22.07 quintal per hectare) where no intercrop was grown over the two years of investigation. The percentage increase of yield over control is 40 per cent. The application of biofertilizers also increased the yield over control and inorganic fertilizers to the tune of 48 per cent and 20 per cent, respectively.

Key Words : Intercrop, Biofertiliser, Mango

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Mango (*Mangifera indica* L.) is a member of Anacardiaceae family is a unique species with respect to growth, nature and diversity. This fruit crop is grown in 85 countries, among which 63 countries produce more than 1000 metric tonnes in a year. In these countries, mango serves as an integral part in human life since it is not only a rich source of nutrients but also a common good shared in culture, life style and religion. The demand of food can probably be met through more intensive crop production with increase in productivity per unit area and time. Mango trees provide enough space even if they are fully grown as they do not cover much area. It is possible to grow a mixed fruit orchard, such as mango intercropped with other fruit crops, vegetables and spices during initial years of establishment. Intercropping in mango with suitable crops bring good income

and improves the fertility of the soil. During the first few years, intercropping can be practiced with no shortage of irrigation. Intercropping of some vegetables and spices in plantation can be practiced if sufficient irrigation and manuring facilities are available. Among the mango cultivars the cultivation of 'Amrapali' is spread across the districts of Odisha due to its aroma, keeping quality and adaptability to the local climate. The demand for 'Amrapali' mangoes from specific pockets in coastal region of Odisha is high. This cultivar of mango has been planted on large area in the state of Odisha and the production is expected to be increased by many folds in near future in the state of Odisha. However, in spite of all this, mango yield in Odisha is 5 to 6 tonnes per hectare as compared to the world yield of 25 tonnes per hectare. This gap in yield is due to poor management practices and post-harvest losses as the

farmers lack technical know how about the mango production leading towards a great threat to sustainable establishment and income from their existing orchard. Mango fruit crop provides opportunities of utilizing the land spaces to its maximum, particularly during the initial years of establishment. Inter cropping during the first 3 to 4 years of mango plantation is a simple and inexpensive strategy which has been recognized as a potentially benefited technology to increase crop production due to its substantial yield advantage than sole cropping. In this context, biofertilizers have been well accepted as economical, cost effective, renewable and safe organic source of plant nutrients to sustain crop productivity. At this juncture, it is realized that fertilizers coming from fermented and decomposed organic materials are very nutritious safe fertilizer materials for mango based intercropping.

RESEARCH PROCEDURE

The present investigation was carried out for a period of two years from 2007 to 2009 at progeny orchard of the Department of Horticulture, Government of Odisha situated at Bhubaneswar. The soil of the experimental site is sandy loam in texture with acidic in nature. The summer months from March to May are hot and humid. The south west monsoon lashes Odisha in June. The month of July and August receive the maximum rainfall. The experiment was laid out in Randomized Block Design with seven treatments and three replications. The treatments were T₁: Control (without intercrop), T₂: Mango intercropping with pineapple (with biofertilizers), T₃: Mango intercropping with pineapple (with inorganic fertilizers), T₄: Mango intercropping with turmeric (with biofertilizers), T₅: Mango intercropping with turmeric (with inorganic fertilizers), T₆: Mango intercropping with ginger (with biofertilizers), T₇: Mango intercropping with ginger (with inorganic fertilizers). All the intercrops were planted as per the design and treatments in their respective plots. The main crop mango was fertilized each year with N, P and K (1,000 : 500 : 500 g N : P₂O₅ : K₂O/tree/year) in the form of urea (46 % N), single super phosphate (16 % P₂O₅) and muriate of potash (60 % K₂O), respectively. In intercrop pineapple each plant was fertilized with 12 g of N, 4g of P₂O₅ and 12 g of K₂O per year. Half of nitrogen and phosphorus and full dose potassium applied after two months of planting and rest nitrogen and phosphorus applied after six month. This was also followed in ratoon. The main crop was applied with biofertilizers (*Azospirillum* and *Azotobacter*) 6kg per hectare incubated with cow dung and applied with farm yard manure 1:25 ratio each year. In all the three intercrops (pineapple, turmeric and ginger) *Azospirillum* and *Azotobacter* incubated with cow dung were applied in the inter spaces mixed with farm yard manure @ 6 kg per hectare. Timely harvesting of main crop and intercrops at mature stage was done as per the common farmer's practices. Observation on

growth characters, vegetative characters, flowering characters, yield characters were recorded and the data were statistically analysed.

RESEARCH ANALYSIS AND REASONING

The application of biofertilizers produced significantly plant height, girth, number of laterals, number of laterals/sq.mt followed by inorganic fertilizers and least in control. Height of plant was found significant due to the effect of fertilization presented in Table 1. Maximum plant height (3.37 m) was recorded due to application of biofertilizers (*Azospirillum* and *Azotobacter*) followed by inorganic fertilizer (NPK) 3.11m and minimum in control (2.92 m). The interaction effect between intercrops and fertilization on height of plant was found non-significant (Table 2). However, maximum height was recorded in ginger with application of biofertilizers in both the years of study. The effect of fertilization was noticed significant on the plant girth (Table 1). Maximum plant height was recorded due to application of biofertilizers (39.06 cm) followed by application of inorganic fertilizers (36.83 cm) and minimum in control (29.5cm). The interaction effect between intercrops and fertilization on girth of plant was observed significant and presented in Table 2. Maximum girth was recorded in ginger with application of biofertilizers and minimum in pineapple with application of biofertilizers. Significant variations was not evident in due to the effect of fertilization on the number of laterals per sq.m among all the treatments. However, maximum laterals were recorded due to application of biofertilizers (36.6) and minimum in control (35.2). It is evident from the Table 2 that the interaction effect between intercrops and fertilization was found non-significant. However, maximum laterals were recorded in ginger with application of inorganic fertilizers and minimum in pineapple with application of inorganic fertilizers. The effect of fertilization on leaf area was noticed significant on both the years of study. Maximum leaf area was observed due to application of biofertilizers and minimum due to application of inorganic fertilizers. There was no significant difference recorded between inorganic fertilizer and control. Interaction effect between intercrop and fertilization as presented in Table 2 was found non-significant in both the years of study. However, maximum leaf area was recorded in intercrop turmeric with application of biofertilizers 94.83 and minimum in pineapple with application of inorganic fertilizers. The intercrops added organic matter to the soil and increased the nutrient status of soil. The mango plant shades leaves which were added to the soil in the way of inter culture with crops like turmeric and ginger. Ratha and Swain (2008) reported better growth in mango due to intercropping system in Odisha. Pawar *et al.* (2006) conducted trial in Maharashtra on intercropping system of agronomic intercrops in fruit orchards to find out suitable intercropping system. Baghel *et al.* (2004)

Table 1 : Effect on growth and flowering characters of mango cv. AMRAPALI due to fertilization

Fertilizers	Height of plant (m)		Girth of plant (cm)		Lateral / sq.m		Leaf area (cm ²)		Number of panicles /sq.m			Number of flowers /panicle			Sex ratio						
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09					
Control	2.66	3.16	2.92	24.66	34.33	29.50	34.3	36.0	35.2	91.33	91.00	91.17	28.8	27.5	28.2	3775.0	3995.0	3885.0	3.36	3.41	3.38
Biofertilizers	3.07	3.68	3.37	34.44	43.67	39.06	36.1	37.0	36.6	92.89	93.78	93.33	32.6	33.1	32.8	4275.8	4356.7	4316.2	3.46	3.58	3.52
Inorganic fertilizers	2.82	3.41	3.11	31.00	42.67	36.83	36.0	37.0	36.5	90.48	91.22	90.85	32.5	32.2	32.4	4047.8	4054.4	4051.1	3.51	3.48	3.49
C.D. (P=0.05)	0.13	0.14	0.09	1.81	NS	1.17	NS	NS	0.9	1.90	1.05	1.03	NS	NS	NS	58.3	105.3	56.9	NS	0.04	NS

NS = Non-significant

Table 2 : Effect on growth characters of mango cv. AMRAPALI due to interaction between intercrops and fertilization

Intercrops* fertilizers	Height of plant (m)		Girth of plant (cm)		Lateral / sq.m		Leaf area (cm ²)		Number of panicles /sq.m			Number of flowers /panicle			Sex ratio						
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09					
Control	2.66	3.16	2.92	24.66	34.33	29.50	34.3	36.0	35.2	91.33	91.00	91.17	30.7	32.3	31.5	4116.0	4225.0	4170.5	3.40	3.49	3.44
Pineapple and bio-fertilizer	2.73	3.30	3.01	24.67	33.33	29.00	33.7	35.0	34.3	92.00	93.00	92.50	30.3	31.0	30.7	3971.7	3985.0	3978.3	3.46	3.47	3.46
Pineapple and inorganic-fertilizer	2.35	2.87	2.60	24.33	35.33	29.83	33.7	34.3	34.0	88.27	89.00	88.63	32.0	33.7	32.8	4229.0	4278.3	4253.7	3.41	3.53	3.48
Turmeric and bio-fertilizer	3.10	3.63	3.37	38.00	47.00	42.50	36.3	37.3	36.8	94.33	95.33	94.83	33.7	32.0	32.8	4013.3	4048.3	4030.8	3.54	3.49	3.52
Turmeric and inorganic-fertilizer	2.90	3.53	3.21	29.33	46.00	37.67	36.0	37.0	36.5	91.33	92.67	92.00	35.0	33.3	34.2	4482.3	4566.7	4524.5	3.58	3.72	3.65
Ginger and bio-fertilizer	3.37	4.10	3.73	40.67	50.67	45.67	38.3	38.7	38.5	92.33	93.00	92.67	33.5	33.7	33.6	4158.3	4130.0	4144.2	3.53	3.48	3.50
Ginger and inorganic-fertilizer	3.20	3.83	3.51	39.33	46.67	43.00	38.3	39.7	39.0	91.83	92.00	91.97	NS	NS	NS	NS	NS	98.7	NS	0.07	0.06
C.D. (P=0.05)	NS	NS	NS	3.14	2.88	2.02	NS	NS	NS	NS	NS	NS	30.7	32.3	31.5	4116.0	4225.0	4170.5	3.40	3.49	3.44

NS=Non-significant

also stated that intercropping in mango proved beneficial for increasing the yield. Sarakar *et al.* (2004) of view that intercrops significantly influenced the vegetative character. Badshah *et al.* (2000) also reported that intercropping with soybeans in the peach orchard showed highest shoot length, maximum number of flowers as compared to control. The induction of flowering was also significantly higher due to biofertilizers application. The number of panicles per sq.mt. and flowers per panicle were highest due to application of biofertilizers compared to inorganic fertilizers and minimum in control presented in Table 1. The sex ratio was also comparatively more due to application of biofertilizers (Table 1). Due to application of biofertilizers, sex ratio was increased resulting highest number of fruits per panicle at pea and marble stage. The present findings are in conformity with the findings of Satpathy and Banik (2002).

The yield per plant was recorded highest due to application of biofertilizers followed by inorganic fertilizers and control (Table 3). The increase in yield was about 60 per cent. The yield per hectare also increased considerably (Table 3). The application of biofertilizers is responsible for microbial activities in soil which finally induced better plant growth, flowering and mango yield per hectare. The present findings are in conformity with the findings of Manna (2011), Kumar and Singh (2011), Hasan *et al.* (2009), Satpathy and Banik

(2002). The interaction effect of intercrops and biofertilizers also increased the maximum fruits per plant were recorded intercropping with turmeric with application of biofertilizers followed by ginger with application of biofertilizers and minimum yield was recorded in control (Table 4) and the average maximum fruit weight was recorded in control due to sink source relationship of plant. The yield per plant was highest in intercropping with turmeric with application of biofertilizers followed by ginger with application of biofertilizers and minimum in control. The increase in yield was recorded more than 50 per cent. Similar findings were also found Kumar and Singh (2011); Jain *et al.* (2008); Rout (2006) Dutta and Kundu (2012); Pawar *et al.* (2006) and Rath and Swain (2005).

Growing of intercrops like ginger, turmeric and pineapple with biofertilizers and inorganic fertilizers in mango orchard revealed that maximum mango yield was recorded intercropping with turmeric with application of biofertilizers (36.87 quintal per hectare) followed by intercropping with ginger with application of biofertilizers (34.47 quintal per hectare), intercropping with pineapple with application of biofertilizers (33.93 quintal per hectare) and minimum was recorded in control (22.07 quintal per hectare) where no intercrop was grown over the two years of investigation presented in Table 3. The percentage increase of yield over control was 40 per cent. The application of biofertilizers also increased the yield over control

Table 3 : Effect on yield attributing characters of mango cv. AMRAPALI due to fertilization

Fertilizers	Number of fruits /plant			Yield of mango (q/h)			Conversion of yield of intercrops to mango equivalent yield (q/h)			Total yield (q/h)		
	2007-08	2008-09	Pool	2007-08	2008-09	Pool	2007-08	2008-09	Pool	2007-08	2008-09	Mean
Control	13.3	24.0	18.7	16.00	28.13	22.07	0	0	0	16.00	28.13	22.06
Biofertilizers	24.0	43.8	33.9	25.33	44.84	35.09	77.59	155.29	116.44	102.93	200.14	151.53
Inorganic fertilizers	20.3	34.0	27.2	21.69	34.18	27.93	63.85	122.04	92.94	85.54	156.21	120.88
C.D. (P=0.05)	2.7	3.9	2.2	2.73	4.65	2.55	12.37	14.46	9.01	12.77	15.62	9.55

Table 4 : Effect on yield attributing characters of mango cv. AMRAPALI due to interaction between intercrops and fertilization

Intercrops* fertilizers	Number of fruits /plant			Yield of mango (q/h)			Conversion of yield of intercrops to mango equivalent yield (q/h)			Total yield (q/h)		
	2007-08	2008-09	Pool	2007-08	2008-09	Pool	2007-08	2008-09	Pool	2007-08	2008-09	Pool
Control	13.3	24.0	18.7	16.00	28.13	22.07	0	0	0	16.00	28.13	22.06
Pineapple and bio-fertilizer	24.3	42.0	33.2	26.13	41.73	33.93	0	193.89	96.94	26.13	235.62	130.88
Pineapple and inorganic-fertilizer	21.7	37.7	29.7	22.53	37.87	30.20	0	167.89	83.94	22.53	205.75	114.14
Turmeric and bio-fertilizer	19.7	51.7	35.7	20.67	53.07	36.87	135.11	153.33	144.22	155.78	206.39	181.09
Turmeric and inorganic-fertilizer	16.0	31.3	23.7	17.07	31.73	24.40	110.22	128.89	119.55	127.29	106.62	143.95
Ginger and bio-fertilizer	28.0	37.7	32.8	29.20	39.73	34.47	97.67	118.67	108.17	126.87	158.40	142.63
Ginger and inorganic-fertilizer	23.3	33.0	28.2	25.47	32.93	29.20	81.33	69.33	75.33	106.80	102.27	104.53
C.D. (P=0.05)	NS	NS	NS	4.72	8.05	4.42	21.42	25.05	15.6	NS	NS	NS

NS = Non-significant

and inorganic fertilizers to the tune of 48 per cent and 20 per cent, respectively. The yield of intercrops when converted to mango equivalent yield it was found that in turmeric with application of biofertilizers maximum monetary return was recorded followed by turmeric with application of inorganic fertilizers and minimum was recorded in control. From the present investigation it can be concluded that growing of turmeric, ginger and pineapple as intercrops along with biofertilizers recorded maximum benefit in comparison growing Amrapali mango alone.

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