



Effect of *Vrkshayurvedic* Farming on Physiological Parameters, Nutrient Uptake, Pest and Disease Incidence in Bhendi

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An investigation was carried out to study the effect of *Vrkshayurvedic* farming on bhendi (*Abelmoschus esculentus*) cv. Arka Anamika at Agricultural College and Research Institute, Madurai during 2007. This experiment was carried out to study the effect of green leaf manures and soaking of seeds along with foliar sprays of green leaf extracts on physiological parameters, uptake of nutrients and incidence of pest and diseases. The experiment was laid out in split plot design with twenty treatments (four green leaf manures i.e., *Albizia lebbbeck*, *Delonix regia*, *Gliricidia sepium* and *Leucaena leucocephala*) incorporation @ 10t ha⁻¹ in main plots and five different green leaf extracts i.e. *Alangium salvifolium*, *Annona squamosa*, *Aegle marmelos*, *Morinda tinctoria* and *Ocimum sanctum*) @ 5 per cent in the form of seed soaking and two foliar sprays at 25 and 45 days after sowing in sub plots) and two controls in three replications. Among the treatment combinations, *Albizia lebbbeck* + *Annona squamosa* recorded the best performance for physiological parameters viz., dry matter production, crop growth rate and relative growth rate and highest uptake of N, P and K. The least incidence of pest and diseases also recorded in *Albizia lebbbeck* with *Annona squamosa*.

Key words: *Vrkshayurvedic* farming, Green leaf manure, Physiological parameters, Nutrients, Pest and Disease.

Bhendi (*Abelmoschus esculentus* L. Moench) is an important vegetable crop grown widely in various parts of India throughout the year. India is the largest producer of bhendi covering an area of 3.98 lakh ha with an annual production of 40.99 lakh tonnes (Anon., 2007). Bhendi requires heavy dosage of nutrients. *Vrkshayurvedic* farming (application of green manures and green leaf manures) opens new vistas to reduce the inorganic fertilizer requirements. The physiological attributes viz., dry matter production, crop growth rate and relative growth rate play major role in yield enhancement. Similarly nutrient uptake and incidence of pest and disease determines the yield and quality of fruits. High nutrient uptake was stimulated by microbial growth and root growth due to improvement in soil physical conditions created by addition of organics. Tiwari and Srivastava (2004) reported the presence of antifungal, antibacterial and bio-pesticide properties in the leaf extracts of custard apple in the form of phenolic and non-volatile substances. Spraying with the leaf extracts that has higher peroxidase (PO), polyphenol oxidase (PPO) and phenyl alanine ammonia lyase (PAL) activity considerably reduced the pest and disease menace. PAL is very essential for the synthesis of phenolics, phyto-alexins and lignin which induce disease resistance (Riker and Riker 1936). In

Bhendi, yellow vein mosaic disease is the most important and destructive viral disease. The disease is caused by begomoviruses and beta satellite molecules, that are transmitted by whiteflies (Bag *et al.*, 2012). With this background, the field experiment was carried out to study the effect of *Vrkshayurvedic* farming techniques on physiological attributes, nutrient uptake and pest and disease incidence of bhendi.

Materials and Methods

A field experiment was conducted at college orchard, Agricultural College and Research Institute, Madurai during 2007. The experiment was laid out in split plot design with four green leaf manures (*Albizia lebbbeck*, *Delonix regia*, *Gliricidia sepium* and *Leucaena leucocephala*) in main plots and five different green leaf extracts (*Alangium salvifolium*, *Annona squamosa*, *Aegle marmelos*, *Morinda tinctoria* and *Ocimum sanctum*) in sub plots with three replications. The meteorological data of cropping season are furnished in Table 3.

Main plot (Basal application of green leaf manure)

The leaves of *Albizia lebbbeck*, *Delonix regia*, *Gliricidia sepium*, *Leucaena leucocephala* were used as green leaf manures. Green leaves from the above tree species were collected and

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incorporated in to the field @ 10 t ha⁻¹ during field preparation and was allowed for 45 days into the soil for decomposition process. The nutrient content of the green leaf manures are given in Table 1.

M₁ : *Albizia lebbbeck*

M₂ : *Delonix regia*

M₃ : *Gliricidia sepium*

M₄ : *Leucaena leucocephala*

Sub plot (Seed treatment and foliar spray of fresh leaves extract)

S₁ : *Alangium salvifolium*

S₂ : *Annona squamosa*

S₃ : *Aegle marmelos*

S₄ : *Morinda tinctoria*

S₅ : *Ocimum sanctum*

The leaf extracts of the above species were prepared separately by grinding fresh leaves with distilled water at 1:1, kept for 6 hours and the extract was filtered to serve as stock. Bhendi seeds were soaked in 5 per cent solution for 30 minutes. The soaked seeds were dried under shade before

Table 1. Nutrient content of the green leaf manures

Trees	Common name	N (%)	P (%)	K (%)
<i>Albizia lebbbeck</i>	Woman's tongue	3.26	0.34	1.53
<i>Delonix regia</i>	Gulmohar	3.10	0.30	2.00
<i>Gliricidia sepium</i>	Mother of cocoa	3.10	0.50	3.00
<i>Leucaena leucocephala</i>	Subabul	3.01	0.12	2.50

sowing. Five per cent of leaf extract prepared from stock solution was sprayed twice viz., 25 and 45 days after sowing. Two control plots viz., absolute control (C₁) and recommended dose of inorganic

Table 2. Soil nutrient status after decomposition of tree leaves and postharvest

Treatment	Post harvest stage (kg ha ⁻¹)			After decomposition of tree leaves (kg ha ⁻¹)		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
M ₁ S ₁	260	13.50	259	289	16.50	270
M ₁ S ₂	270	15.50	321	300	18.50	333
M ₁ S ₃	265	15.99	275	281	16.99	289
M ₁ S ₄	253	13.50	285	279	16.75	290
M ₁ S ₅	245	12.50	287	269	15.90	299
M ₂ S ₁	261	13.50	221	280	16.25	231
M ₂ S ₂	270	14.00	300	391	16.27	312
M ₂ S ₃	259	13.00	291	289	15.50	300
M ₂ S ₄	261	13.50	287	279	16.00	298
M ₂ S ₅	262	14.50	275	276	16.27	290
M ₃ S ₁	261	13.00	281	285	15.50	293
M ₃ S ₂	261	14.00	275	289	15.99	281
M ₃ S ₃	269	14.50	301	292	17.00	314
M ₃ S ₄	262	14.25	277	279	17.25	289
M ₃ S ₅	231	13.75	287	290	16.25	291
M ₄ S ₁	271	13.00	298	291	15.90	302
M ₄ S ₂	253	14.75	297	279	17.00	305
M ₄ S ₃	231	13.00	285	289	16.35	297
M ₄ S ₄	265	13.00	250	289	16.00	260
M ₄ S ₅	261	14.00	257	281	17.75	278
C ₁	175	13.50	210	-	-	-
C ₂	280	25.00	347	-	-	-

NPK (40:50:30) alone (C₂) were also maintained. The soil nutrient status after decomposition of tree leaves (kg ha⁻¹) and post harvest (kg ha⁻¹) are furnished in the Table 2.

Results and Discussion

Physiological parameters

The incorporation of green leaf manures had significant effect on dry matter content, crop growth rate (CGR) and relative growth rate (RGR) of bhendi at the final harvest stage. The highest dry matter content (2403.00 kg ha⁻¹), CGR (18.81 g cm⁻² day⁻¹) and RGR (0.0127 mg g⁻¹ day⁻¹) were recorded by application of *Albizia lebbbeck* (M₁). The highest dry matter content (1662.08 kg ha⁻¹) and CGR (18.51g cm⁻² day⁻¹) were recorded by *Annona squamosa* leaf extract sprays (S₂). The highest RGR (0.0126 mg g⁻¹ day⁻¹) was recorded in *Ocimum sanctum* leaf extract sprays (S₅). The interaction effect was also significant. The highest dry matter content (1803.33 kg ha⁻¹), CGR (22.46 g cm⁻² day⁻¹) and RGR (0.0136 mg g⁻¹ day⁻¹) were recorded in the interaction of M₁S₂ (Table 4).

This study clearly revealed that the dry matter production and CGR were high in the treatment with *Albizia lebbbeck* as green leaf manure and seed soaking and foliar sprays of *Annona squamosa*. This might be due to the gradual release of nutrients from the decomposing green leaf manures and subsequent availability of nutrients that lead to better uptake of nutrients, ultimately resulting in increased dry matter production (Bheemaiah and Subramaniyan, 2003). These results were in confirmation with the findings of Bohra *et al.* (2006). In addition, the presence of secondary metabolites in the leaf extracts might have enhanced the vegetative growth which would have increased the dry matter production. In the present study the RGR showed a higher trend during the early phase and lower during the later phase. This might be due to the utilization of the photosynthates for the fruit development. The absolute control recorded lowest level of physiological parameters which might be due to the non-availability of additional nutrients from the soil to the plant.

Nutrient uptake

The incorporation of green leaf manures had significant effect on nutrient uptake in bhendi at final harvest. The highest uptake of nitrogen (65.17 kg ha⁻¹), phosphorus (5.88 kg ha⁻¹) and potassium (111.03 kg ha⁻¹) were recorded in M₁ (*Albizia lebbbeck*). The application of leaf extract through seed treatment and foliar sprays had a significant effect on nutrient uptake in bhendi. Among the sub plot treatments, S₂ (*Annona squamosa*) registered the highest uptake of nitrogen (65.79 kg ha⁻¹), phosphorus (5.95 kg ha⁻¹) and potassium (109.18 kg ha⁻¹). The interaction effect was also significant. Among the treatment combinations, M₁S₂ recorded

Table 3. Meteorological data during the crop growth period (August to November 2007)

Standard Month		Rainfall		Temperature °C		RH (%)		PE	SS	WV
week	&date	RF (mm)	RD	max	mini	0.72	14.14	(mm)	(hrs day ⁻¹)	(km hrs ⁻¹)
31	Aug 3-5	-	-	36.6	25.6	64	39	5.99	6.1	1.9
32	6-12	2.2	-	35.9	24.8	69	36	5.79	7.5	2.6
33	13-19	-	-	35.7	26.2	64	38	5.80	7.0	3.5
34	20-26	49.4	3	35.7	24.2	76	43	4.69	7.1	1.5
35	27-2	1.2	-	36.3	24.7	72	38	5.36	8.5	1.7
36	Sep 3-9	19.4	2	33.4	24.2	79	54	3.88	4.7	1.7
37	10-16	8.0	1	33.8	24.2	70	41	4.40	6.2	2.0
38	17-23	-	-	35.2	24.7	70	38	5.07	6.3	1.5
39	24-30	3.0	1	35.0	25.2	70	41	4.75	6.8	1.1
40	Oct 1-7	16.6	1	36.7	24.7	65	37	5.31	8.7	1.7
41	8-14	48.8	2	34.2	23.7	76	48	3.56	5.6	2.4
42	15-21	60.8	5	32.2	23.3	84	48	3.10	5.0	1.8
43	22-28	38.6	4	29.9	22.7	80	62	2.96	3.4	4.5
44	29 Nov 4	56.4	2	29.9	23.4	83	68	2.97	4.6	1.1
45	5-11	122.8	6	29.6	22.6	86	63	2.29	6.3	3.4
46	12-18	19.8	2	29.8	23.3	80	64	3.00	5.9	6.8
47	19-25	12.2	3	29.2	22.8	82	61	2.76	5.8	2.5
48	26 Dec 2	4.0	1	30.1	22.9	80	58	3.54	6.7	4.9

RH-Relative Humidity SS-Sunshine WV-Wind Velocity RD-Rainfall Distribution PE-Potential Evapotransferation

the highest uptake of nitrogen (77.77 kg ha⁻¹), phosphorus (6.78 kg ha⁻¹) and potassium (124.78 kg ha⁻¹) (Table 5). It may be due to the release of different organic acids during decomposition of green and green leaf manures and their chelation

with Fe and Al, which helps in solubilization of unavailable forms of phosphorus and release the mono calcium phosphate into the labile pool of soil, thus making it available to the growing crops. Apart from this, the release of nutrients at a slower rate

Table 4. Effect of Vrکشayurvedic farming on dry matter content, CGR and RGR in bhendi cv. Arka Anamika at harvest stage

Green leaf incorporation	Dry matter content (kg ha ⁻¹)					Crop growth rate (g cm ⁻² day ⁻¹)					Relative growth rate (mg g ⁻¹ day ⁻¹)							
	S ₁	S ₂	S ₃	S ₄	S ₅	Mean	S ₁	S ₂	S ₃	S ₄	S ₅	Mean	S ₁	S ₂	S ₃	S ₄	S ₅	Mean
M ₁	2323.33	2713.00	2411.67	2320.00	2247.00	2403.00	17.28	22.46	19.67	17.82	16.79	18.81	0.0119	0.0136	0.0134	0.0124	0.0120	0.0127
M ₂	2405.33	2326.33	2305.67	2360.00	2325.00	2344.47	18.73	17.32	16.79	19.00	18.14	17.99	0.0126	0.0120	0.0116	0.0132	0.0127	0.0124
M ₃	2225.00	2303.33	2621.67	2313.00	2414.67	2375.53	16.44	17.20	20.69	17.19	19.95	18.29	0.0118	0.0120	0.0128	0.0119	0.0136	0.0124
M ₄	2293.33	2305.00	2280.00	2238.33	2275.33	2278.40	16.63	17.08	16.46	16.34	17.23	16.75	0.0116	0.0119	0.0115	0.0117	0.0122	0.0118
Mean	2311.75	2411.92	2404.75	2307.83	2315.50	2350.35	17.27	18.51	18.41	17.59	18.03	17.96	0.0120	0.0124	0.0124	0.0123	0.0126	0.0123
Control plots																		
C ₁					1162							8.39						0.0116
C ₂					2950							24.07						0.0138
		M	S		M x S		M		S		M x S		M	S			M x S	
SEd		12.336	11.915		24.627		0.373		0.196		0.444		0.0002	0.0001			0.0003	
CD(0.05)		30.186	24.272		52.699		0.668		0.398		0.973		0.0002	0.0001			0.0003	

during the decomposition favours the availability of nutrients for the entire crop growth period (Trivedi *et al.*, 1995). Similar observations were recorded by Patel *et al.* (2003) in cluster bean. The absolute control registered the lowest uptake of nutrients due to low availability of nutrients in the soil.

Pest and disease incidence

The incorporation of green leaf manures had significant effect on shoot and fruit borer infestation and yellow vein mosaic virus incidence in bhendi. The lowest incidence of shoot and fruit borer (30.16 per cent) and yellow vein mosaic virus (22.75 per cent) was recorded in M₁ (*Albizia lebbbeck*). The application of leaf extract through seed treatment and foliar sprays had a significant effect on percentage of shoot and fruit borer incidence and yellow vein mosaic virus infection in Bhendi. Among the treatments, S₅ (*Ocimum sanctum*) recorded the

lowest shoot and fruit borer incidence (29.36 per cent). The lowest yellow vein mosaic virus infection per cent (22.94) was recorded in S₂ (*Annona squamosa*). Among the treatment combinations, the lowest per cent of shoot and fruit borer incidence (23.99 per cent) and yellow vein mosaic virus (19.21 per cent) was recorded in M₁S₂ (*Albizia lebbbeck* + *Annona squamosa*). The present study revealed that the percentage of yellow vein mosaic virus, shoot and fruit borer was lowest in the treatment with *Albizia lebbbeck* as green leaf manures and seed soaking along in combination foliar sprays of *Annona squamosa*. This might be due to the release of polyphenols during the decomposition of green leaf manures which acts as the suppressors of disease causing organisms (King and Healt, 1967). They added that the application of plant extracts resulted in significant induction of resistance inducing enzymes or mechanisms in the

Table 5. Effect of Vrکشayurvedic farming on uptake of N, P and K in bhendi cv. Arka Anamika at harvest stage

Green leaf incorporation	Nitrogen (kg ha ⁻¹)					Phosphorus (kg ha ⁻¹)					Potassium (kg ha ⁻¹)							
	S ₁	S ₂	S ₃	S ₄	S ₅	Mean	S ₁	S ₂	S ₃	S ₄	S ₅	Mean	S ₁	S ₂	S ₃	S ₄	S ₅	Mean
M ₁	61.66	77.77	63.24	62.02	61.16	65.17	5.63	6.78	5.94	5.67	5.38	5.88	108.65	124.78	111.56	108.66	101.49	111.03
M ₂	62.35	62.29	61.86	62.62	61.61	62.15	5.86	5.74	5.44	5.79	5.62	5.69	107.41	106.31	105.93	100.92	102.10	104.53
M ₃	60.89	61.17	71.18	62.12	60.95	63.26	5.54	5.63	5.96	5.64	5.76	5.70	104.09	102.95	114.73	107.67	104.34	106.76
M ₄	62.50	61.91	61.51	60.04	60.16	61.23	5.63	5.64	5.47	5.64	5.57	5.59	104.55	102.69	103.08	102.30	102.52	103.03
Mean	61.85	65.79	64.45	61.70	60.97	62.95	5.66	5.95	5.70	5.68	5.58	5.72	106.18	109.18	108.83	104.89	102.61	106.34
Control plots																		
C ₁						35.27						4.65						53.23
C ₂						79.67						7.95						125.27
	M		S		M x S		M		S		M x S		M		S		M x S	
SEd	0.712		0.517		1.167		0.071		0.069		0.142		1.061		0.888		1.911	
CD(0.05)	1.742		1.053		2.556		0.174		0.139		0.304		2.596		1.809		4.134	

host and thereby reducing the severity of diseases. The superiority of *Annona squamosa* over other sprays may be due to the fact that plants can absorb the active principles more rapidly or in other words there may be better compatibility between the host components when compared to other sprays. Similar observations were recorded by Verma *et al.* (1994) in mungbean yellow vein mosaic virus and Srinivasan and Sunder Babu (2001) in brinjal fruit borer. The recommended dose of inorganic fertilizers recorded the highest pest and disease incidence. This might be due to the higher level of nitrogen application, which would have caused excessive vegetative growth, succulence growth coupled with absence of repellent action favouring the incidence of pest and diseases (Shridhar *et al.*, 2000). The absolute control also recorded higher incidence of pest and diseases due to the absence of resistance mechanism to manage the pest and diseases.

The present investigation revealed that, *Albizia lebbbeck* + *Annona squamosa* recorded the best performance for physiological parameters and highest amount of nutrients uptake. The least incidence of pest and diseases was also recorded in *Albizia lebbbeck* with *Annona squamosa*.

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