The Pharma Innovation Journal 2022; SP-11(8): 906-909

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 906-909

www.thepharmajournal.com
Received: 08-06-2022
Accepted: 12-07-2022

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Performance and profitability study of leafy vegetables as intercrops in high density mango orchards

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Abstract
The present investigation was carried out to evaluate the performance and profitability study of leafy vegetables as intercrops in high density mango orchard. The experiment was conducted at Mango Research Station, Nuzvid during summer season of 2021-22 with three replications in Randomized Block Design. Leafy vegetables were evaluated for performance and profitability. Based on finding, it was found that Land Equivalent Ratio, Area Time Equivalent Ratio and Monetary Advantage index were highest for mango + Palak (Rs. 2.43, 1.21/- and Rs. 4,30,121.28/-respectively) followed by mango + fenugreek (2.06, 1.03 and Rs. 3,13,939.55/- respectively). Maximum profitability (Rs. 4,31,661/-) and B : C Ratio (2.45) were obtained from mango + palak based intercropping system followed by mango + mint (Rs. 3,74,457.93/-/per ha and 2.29 respectively).

Keywords: Intercropping, profitability, B:C ratio, land equivalent ratio, area time equivalent ratio, monetary advantage index

Introduction
The leafy vegetables have a very high protective food value among all the vegetables. Leafy vegetables are called as mines of minerals and are rich in vitamin A, vitamin C and minerals. Leafy vegetables are good source of iron, calcium, phosphorus, folic acid, riboflavin, ascorbic acid and carotene (Munteanu *et al*. 2011) [4]. Besides this, they contain soft fibrous matter, provide necessary roughage to the diet. The leafy vegetables deserve a better recognition because of its extra nutritive value. The cultivation of leafy vegetables is difficult during summer season. Intercropping allows more efficient usage of natural resources, provides year-round ground cover or at least for a longer period than monocropping and it is advantageous for marginal and small farmers.

Mango is one of the most important and widely cultivated tropical fruit in India. Even in high density plantation also, it is spaced at 5 x 5 meter and intercropping can be taken up till the mango trees attain suitable height and canopy development. The wider spacing and growth pattern of developing roots, nearly 60-70% of unutilized interspace can be exploited by growing inter and mixed crops successfully in the mango orchard.

The inter row space in mango can be used to grow early growing short duration, location specific and market driven crops as inter and filler crops. Thus, allowing more than one crop and utilize the space and other natural resources efficiently. The intercrops not only generate an extra income but also helps to check the soil erosion through proper ground coverage and improves the soil physico-chemical properties. Intercropping is one of the techniques of land utilization for optimum production.

Furthermore, intercropping create additional job opportunity needed in intensive crop production. Even though intercrops and cover crops are important operations in the management of a good orchard, many growers in and around Nuzvid Mandal of Krishna district, Andhra Pradesh do not pay much attention on it and getting low returns in mango cultivation. So the present study was taken up to evaluate the performance of various mango based intercropping system, to record the additional benefits of intercropping in mango orchard along with the selection of best suitable intercrop in high density mango planting at Nuzvid region to increase the income from mango orchards. Hence, the present work is proposed to know the performance and profitability of leafy vegetables *viz.*, palak, coriander, amaranthus, roselle, basella, fenugreek, mint and sorrel grown as intercrops in high density planting mango orchard at Mango Research Station, Nuzvid with the following objectives.

Material and Methods

The experiment was conducted at Mango Research Station (MRS), Nuzvid, Krishna District, Andhra Pradesh. It was conducted during *summer* season 2021-22 and laid out in Randomized Block design replicated thrice. Total eight leafy vegetables including palak, coriander, amaranthus, roselle, basella, fenugreek, mint and sorrel grown as intercrops in high density planting mango orchard at Mango Research Station, Nuzvid. The varieties of palak and amaranthus were collected from IIHR Bangalore, the varieties of fenugreek and coriander were collected from Horticulture research station, LAM, Guntur, Dr. Y.S.R. Horticultural University. Recommended package of practices were followed during the cropping period. The experimental site was well prepared, cultural practices include thinning, weeding, irrigation, fertilizer application and plant protection measures were followed for the healthy growth of crops. Observations on growth parameters were recorded up to 2 months of planting. Data on competitive functions and economics were noted.

Land Equivalent Ratio (LER)

The total area required by sole crop to produce as much as yield was also obtained from same piece of land through an intercropping system. LER value is more than one (1.0) indicates a yield advantage of intercropping.

$$LER = \{L_a + L_b\}\ L_a = \frac{Y_{ab}}{Y_{aa}}\ L_b = \frac{Y_{ba}}{Y_{bb}}$$

Where La and Lb are the LERs for the individual crops, Y_{ab} and Y_{ba} are the individual crop yields in intercropping and Y_{aa} and Y_{bb} are the individual crop yield in sole cropping.

Area Time Equivalent Ratio (ATER)

Area Time Equivalent Ratio provide more realistic comparison of the yield advantage of intercropping over monocropping in terms of time taken by component crops in intercropping system.

$$\text{Area Time Equivalent Ratio (ATER)} = LER \times \frac{D_c}{D_t}$$

Where the LER is Land Equivalent Ratio of the crop, D_c is time taken by crop, D_t is time taken by whole system.

Monetary Advantage Index (MAI): To analyze the economic yield advantage of intercropping system, Monetary Advantage Index (MAI) was calculated.

$$MAI = \text{Value of combined intercrops} \times \frac{(LER-1)}{LER}$$

Higher the MAI value, the more profitable is the cropping system

Economics

Economics of different mango based intercropping system was worked out taking into account the prevailing cost of inputs like labourer, seeds, manures and fertilizers, pesticides and sale price of produce during 2021-22. The cost of various inputs and sale price of produce remained same during both the years of study. The gross return was calculated by multiplying the average yield (q ha-1) of different crops with prevailing market price per quintal and net return was worked out by deducting the cost of cultivation from gross return. The benefit-cost ratio (B: C) of intercropping systems were worked out to know the most remunerative and profitable intercropping system as below:

$$\text{B: C of intercropping system} = \frac{\text{Gross Returns}}{\text{Cost of Cultivation}}$$

Results and Discussion

Effect of intercropping on competitive functions

LER values of mango when grown with all leafy vegetables like Palak, fenugreek, sorrel, Amaranthus, coriander, roselle, basella and mint recorded >1 (2.43, 2.06, 1.99, 1.94, 1.92, 1.91, 1.83 and 1.81 respectively) suggesting better biological efficiency of the system. Higher values of LER with palak, fenugreek and coriander as intercrops in mango might be due to efficient utilization of natural resources *viz.*, space, light *etc.*, for the plant growth. On the other hand, total LER below 1.00 not found in leafy vegetables grown as intercrop with mango. In most cases, the LER values were generally lower for intercropping systems. This could be due to the competitive ability of intercrop which was higher than main crop. LER doesn't consider the duration of crops in the field and it is based on the final harvested products and not on desired yield proportion of the component crops. Moreover, the choice of sole cropped yield for standardizing mixture yield in the estimation of LER is not clear. Therefore, area time equivalent ratio (ATER) provides more realistic comparison of the yield advantage of intercropping over sole cropping in terms of variation in time taken by the component crops of different intercropping systems. The interpretation of ATER involves that ATER> 1 implies the yield advantage; ATER = 1 implies no effect of intercropping; ATER <1 shows yield disadvantages (Bantie *et al*., 2014) [2]. The data regarding ATER as influenced by intercrops are presented in Table 1.

In all the treatments, the ATER values were lesser than LER values (Table 1) indicating the over estimation of resource utilization perhaps due to wide variations in the maturity periods of the crops, of which mango stayed longer on the land and had enough time to compensate for the intercrop competition. ATER is free from problems of over estimation of resource utilization contrary to LER. ATER values of all the intercrops except Palak, fenugreek was less than 1 indicating the advantage of the intercropping systems. ATER values showed the advantage (21%, 3%) of intercrops over sole crop with Palak and fenugreek respectively. This could be due to the reason that intercropping systems can give more efficient total resource exploitation and greater overall production than sole crops (compatible intercrops), whereas, intercropping with other leafy vegetables like sorrel, amaranthus, roselle, mint, basella, and coriander showed ATER value less than 1 indicating the disadvantage (1,3,5,9,10 and 16%) of this crop as intercrop in mango. These results are in conformity with Bantie *et al.* 2014 [2].

Monetary Advantage Index (MAI) was calculated by multiplying the respective yields of the component crops by their market prices during the period of experimentation and divided by respective LER. On the other hand, if Monetary Advantage Index values are positive which show a definite yield advantage to intercropping compared to sole cropping. It is an indicator of the economic feasibility of intercropping systems as compared to sole cropping. (Usha *et al.* 2018) [6].

The data pertaining to MAI as influenced by intercrops are presented in Table 1. MAI values of mango when grown with intercrops had not shown negative values. All the intercropping systems showed a positive MAI value, the present experiment

showed a definite yield advantage compared to mango sole cropping. Maximum MAI value was recorded in mango + palak (Rs. 4,30,121.28) and mango + fenugreek (Rs 3,13,939.55/-) implying the general suitability and economic advantage of these crops as intercrops in mango. A plausible explanation for the high MAI might be the better utilization of resources between mango with palak, fenugreek combination and higher LER value. These results are in conformity with Bantie *et al*. (2014) [2] reported that Values of MAI (Monetary Advantage Index) showed better MAI in lupine-wheat and lupine-finger millet combinations.

Effect of intercropping on economics of mango

Economics for sole mango and mango with different intercrops and the values are presented in table 2.

After perusal of the data presented in Table 2, among the treatments, the highest cost of cultivation (2,98,389) was reported in mango + palak (T_2) followed by mango + roselle (T_3) (2,89,736). The lowest was observed in sole mango treatment (T_9) (1,61,760). This was due to the increased use of resources and resource services in intercropping system compared to sole crop Similar results were reported by Aparna (2017) [1] in mango and Singh *et al*. (2011) [5] in mango.

The highest Gross returns (Rs. 7,30,050.88/-) was reported in mango + palak (T_2) compared to sole mango and other intercrops. Highest gross returns with palak might due to highest yield and market price when compared to other intercrops. The lowest gross returns were recorded in treatment mango + sorrel (T_4) (Rs. 5,30,873.08/-) when compared to sole mango and other inter crops. The reason might be higher cost of cultivation, low yield and price obtained in this treatments. Similar results were reported by Begum *et al.* (2015) [3] in chilli.

As per the data presented in Table 2, the highest net returns were recorded in treatment mango + palak (T_2) with 431661.88 followed by mango + fenugreek (T_6) with 346749.00. The lowest net returns were recorded in treatment mango + roselle (T_3) with 176638.00. The highest B:C ratio was obtained in mango + palak (T_2) with 2.45 and the lowest B:C ratio was recorded in treatment mango + roselle (T_3) with 1.80. It was observed from the data that the maximum net returns and B:C ratio were obtained in mango + palak (T_2) intercropping system, it might be due to high yield of palak compared to other intercrops and the lowest net returns were obtained in mango + roselle (T_3) intercropping system, it might be due to low yield of both roselle and mango. Hence the low net returns and B:C ratio were obtained. Aparna (2017) [1] in mango intercropping system.

Table 1: Economics in intercropping of leafy vegetables as inter crops in HDP mango orchard and in mango sole crop.

Treatments	Cost of cultivation	Gross income	Net income	B:C ratio
T_1	289251	634354.84	345103.84	2.19
T_2	298389	730050.88	431661.88	2.45
T_3	297162	535920.28	238758.28	1.80
T_4	289736	530873.08	241137.08	1.83
T_5	291438	613934.69	322496.69	2.11
T_6	294717	610380.90	315663.90	2.07
T_7	288923	581141.57	292218.57	2.01
T_8	290951	665408.93	374457.93	2.29
T_9	289251	634354.84	345103.84	2.19

HDP – High Density Planting

T_1- Mango + Amaranthus T_2- Mango + Palak T_3- Mango + Roselle

T_4- Mango + Sorrel T_5- Mango + Basella T_6 – Mango + Fenugreek

T_7 – Mango + Coriander T_8 - Mango + mint T_9 – Mango sole

Table 2: Effect of intercrops on competitive function in mango based cropping system.

S. No	Treatment	LER1 (Mango)	LER2 (Intercrops)	LER(1+2) (Cropping system)	ATER1 (Mango)	ATER2 (Intercrops)	ATER (1+2) (Cropping system)	MAI
1	T_1	0.98	0.96	1.94	0.49	0.48	0.97	306836.58
2	T_2	0.99	1.44	2.43	0.50	0.72	1.21	430121.28
3	T_3	0.97	0.94	1.91	0.49	0.47	0.95	255400.03
4	T_4	0.99	0.99	1.99	0.50	0.50	0.99	263781.73
5	T_5	0.98	0.85	1.83	0.49	0.42	0.91	278897.80
6	T_6	1.00	1.06	2.06	0.50	0.53	1.03	313939.55
7	T_7	1.00	0.92	1.92	0.50	0.34	0.84	278130.93
8	T_8	1.00	0.81	1.81	0.50	0.40	0.90	296839.93
9	T_9	-	-	-	-	-	-	-

LER: Land Equivalent Ratio ATER: Area Time Equivalent Ratio MAI: Monetary Advantage Index

T_1- Mango + Amaranthus T_2- Mango + Palak T_3- Mango + Roselle

T_4- Mango + Sorrel T_5- Mango + Basella T_6 – Mango + Fenugreek

T_7 – Mango + Coriander T_8 - Mango + mint T_9 – Mango sole

Conclusion

Based on finding it was found that LER, ATER and MAI were high for mango + palak followed by mango + fenugreek. Palak intercrop with mango recorded good results in economics parameters followed by mint, amaranthus and fenugreek.

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