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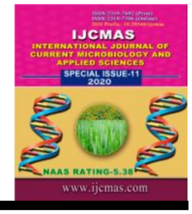

Original Research Article

Yield and Economics of Intercropping Turmeric and Ginger in Elephant Foot Yam

R. Naga Lakshmi[1*], E. Padma[2], B.V.K. Bhagavan[3], K. Mamatha[1] and M.M. Naidu[4]

[1]Horticultural Research Station, Kovvur, Dr YSRHU, Andhra Pradesh
[2]College of Horticulture, Venkataramannagudem, Dr YSRHU, Andhra Pradesh
[3]Horticultural Research Station, Ambajipeta, Dr YSRHU, Andhra Pradesh
[4]Horticultural Research Station, Darsi, Dr YSRHU, Andhra Pradesh, India

**Corresponding author*

A B S T R A C T

In Andhra Pradesh, elephant foot yam cultivation is concentrated in the rich alluvial soils of Krishna and Godavari delta. Productivity of these lands could be fully exploited by growing intercrops as intercropping system utilizes resources efficiently. An investigation was carried out at Horticultural Research Station, Kovvur, Andhra Pradesh to know the suitability of turmeric and ginger as inter crops in elephant foot yam for three years. The experiment conducted with seven treatments replicated four times in randomized block design. The treatments include T_1: Elephant foot yam sole, T_2: Elephant foot yam intercropped with turmeric in single row, T_3: Elephant foot yam intercropped with turmeric in double row, T_4: Elephant foot yam intercropped with ginger in single row, T_5: Elephant foot yam intercropped with ginger in double row, T_6: Turmeric sole and T_7: Ginger sole. The pooled data revealed that intercropping elephant foot yam with turmeric and ginger in different row arrangements did not affect the elephant foot yam yield significantly. Moreover, in all the inter cropping treatments, land equivalent ratio was consistently greater than unity. Highest elephant foot yam equivalent yield (67.23 t ha^{-1}) was recorded in elephant foot yam intercropped with turmeric in 1:2 row arrangement. However, maximum income per rupee investment (1.90) was obtained when elephant foot yam intercropped with turmeric in 1:1 row arrangement.

Keywords

Elephant foot yam, Inter crops, Turmeric, Equivalent yield, Land equivalent ratio, Benefit cost ratio

Introduction

In order to fulfill the food requirement of ever-growing population in the country like India, there is every need to increase the productivity and land utilization per unit area. The best approach to intensify land use is by adopting intercropping which is the most popular cropping system in subsistence tropical agriculture (Obadoni, 2010). It increases total productivity through efficient utilization of inter-row space and different growth resources (Willey, 1979). Intercropping is defined as growing of two or more crops on the same piece of land in the same growing season (Andrews and Kassam, 1976). The growth of two crops together in the same field during a growing season may result in inter specific competition or facilitation between the plants (Zhang and Li, 2003). Selection of companion crops (Begum *et al.*, 2010), relative sowing time (Islam *et al.*, 2004), spatial arrangement of component crops (Islam *et al.,* 2006) and fertilizer management (Akhteruzzaman *et al.,* 2008) are the important factors of intercropping systems for getting higher productivity.

Elephant foot yam (*Amorphophallus paeoniifolius*) (Dennst.) Nicolson, is a tropical tuber crop used as a vegetable. It is highly remunerative crop which is being grown on large extent traditionally in Andhra Pradesh especially under Godavari and Krishna alluvial soils which are highly fertile. Vegetable crops like vegetable cowpea, coriander and palak can be profitably grown as inter crops in elephant foot yam (Kannan *et al.,* 2001; Jha *et al.,* 2008). There is no information available with regards to the effect of intercropping of turmeric and ginger grown in association with elephant foot yam under different row arrangements. Row arrangement in contrast to arrangement of component crops within rows, may also influence the productivity of an intercropping system (Oseni and Aliyu, 2010). Rhizomatous crops like turmeric (*Curcuma longa* L.) and ginger (*Zingiber officinale* Rosc.) which comes up well under shaded condition can be accommodated in the interspaces in elephant foot yam for efficient utilization of land. Hence, the present investigation was under taken to know the suitability and profitability of turmeric and ginger as intercrops in the elephant foot yam cropping system under Godavari alluviums to utilize the rich land resources most efficiently to the maximum extent possible.

Materials and Methods

A field experiment was conducted at Horticultural Research Station, Kovvur, Andhra Pradesh, India, located at $17^0 00'$ N latitude, $81^0 43'$ E longitude and 15.66 m above mean sea level. The experimental site receives an annual rainfall of 110 cm from South - West monsoon (June to September), North - East monsoon (October to November) and also through summer showers. The weather prevailed during the experimental period (Mean of three years) is presented in Fig. 1. The black alluvial soil at the experimental site is endowed with good drainage with pH of 7.9 and EC 0.52 dSm^{-1}. The experiment was laid out in Randomized Block Design with seven treatments replicated four times. The treatments comprise of T_1: Elephant foot yam Sole; T_2: Elephant foot yam + Turmeric (1:1); T_3: Elephant foot yam + Turmeric (1:2); T_4: Elephant foot yam + Ginger (1:1); T_5: Elephant foot yam + Ginger (1:2); T_6: Turmeric Sole and T_7: Ginger Sole.

The experimental field was thoroughly ploughed to fine tilth. The seed corms (300g size) of elephant foot yam (main crop) were planted at 90 x 60 cm spacing in plots of size 5.4 x 5.4 m under irrigated conditions. In 1:2 row arrangement i.e., between two rows of elephant foot yam (EFY) inter crops were planted at 25 x 25 cm spacing whereas in case of 1:1 row arrangement, intercrops were planted in single row by following intra row spacing of 25 cm. Corms of elephant foot yam cv. Gajendra, rhizomes of turmeric cv. Kovvur Turmeric Selection - 8 and local cultivar of ginger were used as planting material. All the plots were fertilized with 10 t of farmyard manure along with 250 kg N, 60 kg P_2O_5 and 250 kg K_2O per hectare. The entire recommended quantity of phosphorus and farmyard manure was incorporated in the last ploughing. Nitrogen and potassium were applied in three equal splits at 40, 80 and 120 days after sprouting of corm through pocketing method. In addition to main crop, recommended dose of fertilizers was given to all intercrops separately as per schedule. Irrigation was given at 7 to 10 days intervals by flooding method. All other cultural practices as scheduled for the cultivation of elephant foot yam as well as intercrops were followed. Harvesting of elephant foot yam and intercrops were done at 180 days after planting. Observations were recorded from main crop on corm yield. The yields of intercrops were recorded separately and elephant foot yam equivalent yield was calculated. The economics of intercropping system was computed on the basis of farm gate prices. Land equivalent ratio (LER) is defined as the relative land area under sole crop that is required to produce yields achieved in intercropping. The LER was worked out by using the following formula given by Willey (1979).

LER = La + Lb = (Ya/Sa + Yb/Sb)

Where,
La and Lb = LER's for the crops a and b
Ya and Yb = Individual crop yield under intercropping
Sa and Sb = Individual crop yield under sole cropping

Economic efficiency was calculated in terms of benefit cost ratio. Data was statistically analyzed for variance by the procedure given by Panse and Sukhatme (1989).

Results and Discussions

Yield of elephant foot yam

The data (Table 1) depicted that intercropping turmeric and ginger at different row arrangements in elephant foot yam did not influence the corm yield of elephant foot yam considerably. There was no significant difference between sole crop yield of elephant foot yam (38.57 t ha^{-1}) and that under intercropping with turmeric and ginger. This might be due to the fact that, when the base crop and intercrops were adequately fertilsed then there is no yield reduction in the main crop (Nayar and Suja, 2004). Similar results were observed by Kannan *et al.,* (2001), Chattopadhyay *et al.,* (2008) in elephant foot yam intercropped with vegetables. It was interpreted by Singh *et al.,* (2013) that less competition for resources and better scope of intercultural operations at early growth stages were the favourable points, which might have triggered the process of partitioning photosynthates from source to sink resulting in higher yield of main crop. Further, Das and Maharana (1995) explained that elephant foot yam does not compete for light because it is able to tolerant shade.

Yield of inter crops

Among intercrops, turmeric produced higher yield than ginger (Table 1). EFY intercropped with turmeric in 1:1 row arrangement yielded 19.99 t ha^{-1} while in 1:2 row arrangement yielded 25.35 t ha^{-1} compared to sole turmeric crop (38.12 t ha^{-1}). EFY intercropped with ginger in 1:1 row arrangement yielded 1.34 t ha^{-1} whereas in 1:2 row arrangement yielded 1.86 t ha^{-1} compared to sole ginger crop (4.47 t ha^{-1}). Low yield of ginger might be attributed to the fact that slightly alkaline (7.9 p^H) soils are not suitable to grow ginger as ginger crop does not thrive well in alkaline soil.

Elephant foot yam equivalent yield

Among different intercrop combinations under study, significantly highest elephant foot yam equivalent yield was recorded in elephant foot yam intercropped with turmeric in 1:2 row arrangement (67.23 t ha^{-1}) compared to elephant foot yam sole crop (38.57 t ha^{-1}). Lowest elephant foot yam equivalent yield 10.73 t ha^{-1} was recorded in ginger sole crop. Moreover, elephant foot yam intercropped with ginger in 1:1 or 1:2 has recorded significantly higher elephant foot yam equivalent yield of 42.97 and 43.44 t ha^{-1} respectively compared to elephant foot yam sole crop. The higher productivity of the intercrop system compared to the sole crop might have resulted from complementary and efficient use of growth resources by the component crops as explained by Li *et al.*, (2006). Willey (1979) also elucidated that mixed cropping was more efficient and productive than sole cropping because of higher combined yield and better energy use efficiency.

Land Equivalent Ratio (LER)

LER reflects the extra advantage of intercropping system over sole cropping system. According to Edje (1987), if the LER is equal to 1, then there is no difference in yield between growing the crop in pure or mixed stand. If the LER is greater than 1, there is a yield advantage when both crops were grown as mixed compared to pure stands. However, if the LER is less than 1, it will be better in terms of yield to grow both crops separately, as it indicates yield disadvantage. In the present study LER was greater than 1 in all the intercropping treatments and the range of yield advantage over sole cropping of elephant foot yam was between 33 and 64 %. Among the intercropping systems, highest LER (1.64) was computed in EFY intercropped with turmeric in 1:2 row arrangement indicating that 64 % more area was required in a pure cropping system to equal the yield of intercropping. On the other hand, the high value of LER revealed that interspecific interaction or complementarity was greater than the competition so that intercropping resulted in greater land-use efficiency. Further, Nassab *et al.*, (2011) explained that high performance in terms of LER is obtained in plant communities with low competition. Higher LER greater than 1.00 in intercropping compared to monocropping was also reported for cassava-legumes intercropping (Hidoto and Loha, 2013).

Table.1 Performance of turmeric and ginger as inter crops in elephant foot yam based cropping system

Treatment	Yield of main crop (t ha^{-1})	Yield of inter crops (t ha^{-1})	Elephant foot yam equivalent yield (t ha^{-1})	LER
T_1- EFY Sole	38.57	-	38.57	1.00
T_2- EFY + Turmeric 1:1	35.85	19.99	59.27	1.45
T_3- EFY + Turmeric 1:2	37.54	25.35	67.23	1.64
T_4- EFY + Ginger 1:1	39.74	1.34	42.97	1.33
T_5- EFY + Ginger 1:2	38.67	1.86	43.44	1.42
T_6- Turmeric Sole	-	38.12	44.65	1.00
T_7- Ginger Sole	-	4.47	10.73	1.00
SE m$\pm$	0.93	0.66	1.14	-
CD (P=0.05)	NS	2.02	3.40	-

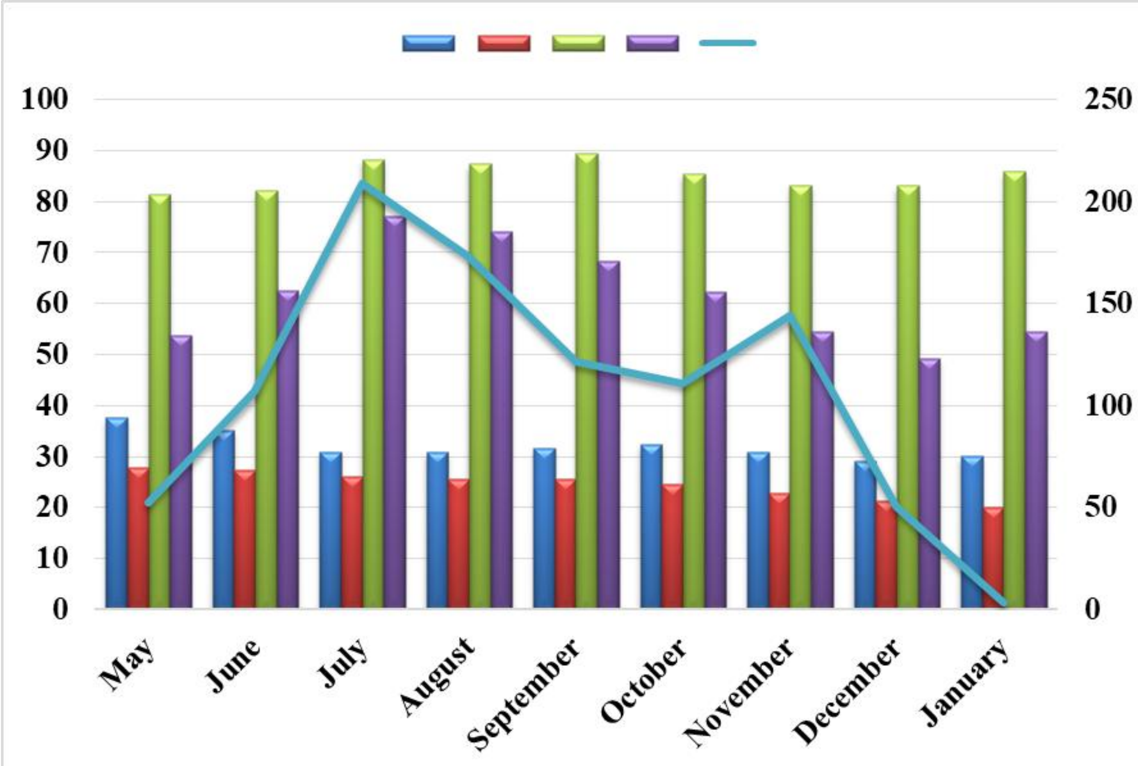

Fig.1 Weather during the experimental period (Mean of three years)

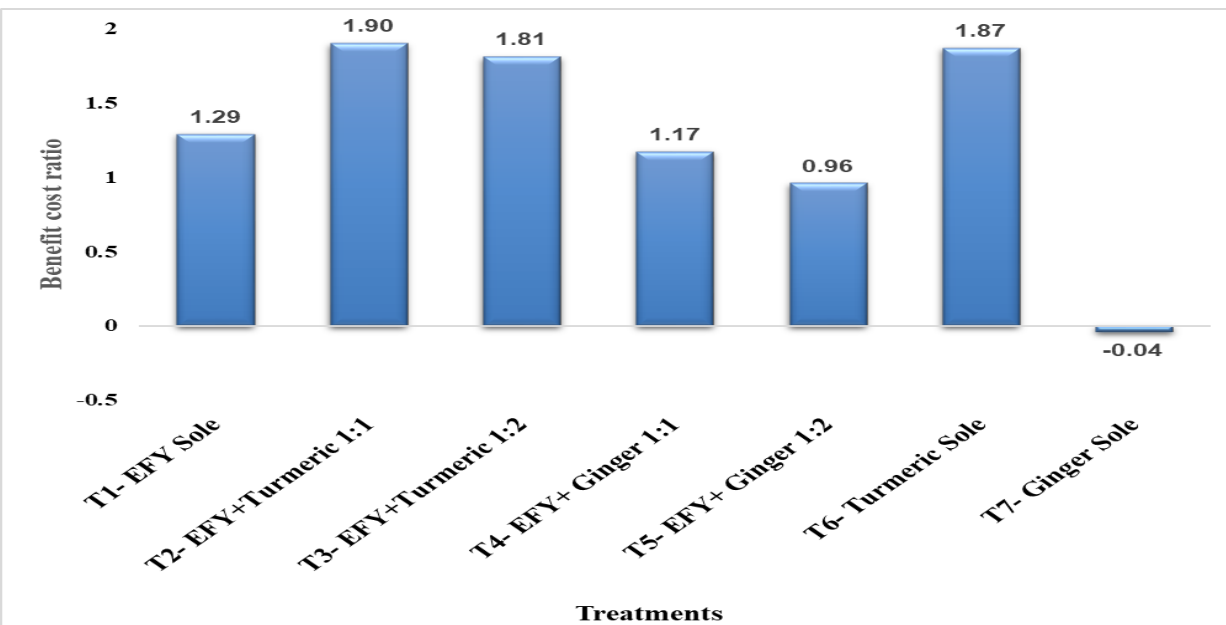

Fig.2 Benefit cost ratio of different inter cropping systems in elephant foot yam

Economic efficiency

Economic analysis is essential to know about risks involved in the adoption of any practice. From the Fig. 2, it was observed that considerable economic benefits were achieved from the elephant foot yam intercropped with turmeric over sole elephant foot yam. Highest benefit cost ratio of 1.90 was obtained in elephant foot yam intercropped with turmeric in 1:1 row arrangement followed by elephant foot yam intercropped with turmeric in 1:2 row arrangement (1.81) compared to sole crop of elephant foot yam (1.29). Ravindran *et al*., (2006) also advocated intercropping of tuber crops for better remuneration. Intercropping ginger at 1:1 or 2:1 row arrangement in elephant foot yam under Godavari alluvial soils is not advantageous as the benefit cost ratio is low compared to sole elephant foot yam.

From the experimental findings, it can be inferred that the productivity of unit land area is increased by intercropping rather than monocultures. It could be concluded that elephant foot yam alternating with double row of turmeric recorded highest elephant foot yam equivalent yield and LER. However, keeping the benefit cost ratio in view, elephant foot yam alternating with single row of turmeric may be recommended for realizing better profits in intercropping system with efficient utilization of land resources.

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