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Efficient use of drumstick in multitier cropping system under semi-arid ecosystem

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Abstract

To achieve the projected target of 220 MT of vegetable production by 2020, augmentation in vegetable production needs to be formulated for different cropping system to fully exploit the natural resources. Number of cropping systems have been developed for different ecosystems, however, a suitable vegetable based cropping system is lacking for semi-arid and arid ecosystem. Considering the nature of growth pattern of the component crops and their yield potential, drumstick (base crop) and cucurbits (climbers) have been chosen in the cropping system. An experiment comprising eleven treatments with three replications in randomized block design was conducted at Central Horticultural Experiment station, Vejalpur from 2004-05 and 2005-06. The results revealed that the interaction of component crops did not significantly reduce the growth parameters of base crop (drumstick) over sole crop. Higher the cropping index (200%), drumstick equivalent yield (28.65 kg/ha) and land equivalent ratio (2.39) has been observed in the treatment combining drumstick and ridge gourd. This multitier system reduced the cost of input by 70.1 and 64.0 per cent comparing bower system and local system respectively.

Key words: Drumstick, cropping system, cucurbits

Introduction

In India, the current status on vegetable production (94.0 MT) is capable to supply only 175 g vegetables per capita per day against the recommendation by dietician (300 g). To fulfill the recommended consumption level, 220 MT of vegetables required to be produced by 2020 to the projected population of 1.5 billion. The threat on shrinking of agricultural land, ignited an opportunity for diversification towards plant architectural management and utilization to fit them into the cropping system approach. The present concept of cropping system defines the yearly sequences and spatial arrangements of crops (horizontal approach) and its interaction with farm resources. The plant architectural arrangement and utilization (vertical approach) in the cropping system has been completely neglected so far.

Suitability of component crops depends primarily on soil and climatic conditions, however, compatibility aspects deserve prime consideration. Competition of crops for external factors (light, space, nutrients) and internal factors (flowering and fruiting period) leads to reduce yield and poor suitability in the cropping system. Hence, selection of compatible crops and their planting geometry could increase the productivity and net income (Shivaramu and Shivshankar, 1992). Considering the nature of growth pattern of the component crops and their yield potential, drumstick (base crop) and cucurbits (climbers or supportive crops) are the vegetables which are highly grown by the poor farm holdings as pure crops. Presently, drumstick is the most widely known vegetables for its drought tolerant (Palada, 1996) highly nutritious vegetable (Ramachandran, 1980) grown at about 380.5 km² producing 1.1 to 1.3 million tonnes of tender fruits (Rajangam *et al.*, 2001). Presently, drumstick is getting momentum in northern parts of India too. Cucurbitaceous crops like bitter gourd, bottle gourd, ridge gourd, sponge gourd and snake gourd are cultivated at an area of 2.42 lakh ha, with production of 25.0 lakh t and productivity of 10.024 t/ha in our country (Siddhu, 2002). However, requirement of pandal for its cultivation is a greater hurdle for enhancing the area under cucurbits to the farmers, as it requires high investment.

Presently, the interspaces between the base crop has been given priority , but the plant architecture can also be utilized in the cropping system. Though, number of cropping systems has been developed for different ecosystems but they showed poor success in arid and semi-arid ecosystem due to the harse climate and poor economic status of farming community. Hence, modified cropping system using through plant architectural management and utilization for developing a suitable vegetable based cropping system for semi-arid and arid ecosystem is a prime requisite. Hence, the present experiment was attempted to assess the suitability of drumstick under multitier cropping system, to analyze the impact of drumstick based cropping system on monetary returns, and to assess the different existing cropping systems with drumstick based system for economy and profitability.

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Materials and methods

A field experiment was conducted at Central Horticultural Experiment Station (CIAH) Vejalpur during 2004-05 and 2005-06. The experimental site is located at 22 ° 41· 33 - and 73 °33 ·22 - and lies between 110-115m above mean sea level. The annual rainfall mainly is confined to three months (July to September) with an average of 35 rainy days a year. The annual maximum and minimum temperature ranged from 42-43°C in May and 6-7°C in January, respectively. The annual potential evapo-transpiration ranged from 1500-1600 mm against the annual precipitation of 750 mm. The soil having pH of (6.9-7.22) EC-0.1-0.2DSM, and available N-112.5-207kg/ha, P-6.75-22.05kg/ha, K-139.5-253.125 Kg./ha. The treatment details are viz. T1=drumstick (pure crop), T2=bottle gourd, T3=bitter gourd, T4=ridge gourd, T5= sponge gourd, T6= snake gourd, T7= drumstick + bottle gourd, T8= drumstick + bitter gourd, T9=drumstick + ridge gourd, T10=drumstick + sponge gourd, T11= drumstick + snake gourd. Each treatment was maintained at 5.0 x 3.0 m plot. The treatments were laid out in randomized block design and the treatments were replicated thrice. Cucurbits were sown in the second week of June and nine and four hills (around three year old drumstick) were maintained in pure and intercropping plots respectively. After establishment of vines, were directed towards drumstick trunk so as to climb on and they were strictly maintained at harvestable height. Except irrigation, all other recommended package of practices was followed to assess the potential yield of crops under sole crop and half the dose of recommended fertilizers was applied to the intercrop treatments. The observations on vegetative, floral, fruiting and yield parameters were recorded and the average was used for the statistical analysis. The drumstick equivalent yield was calculated by multiplying the yield of a particular intercrop to the market rate of that crop and divided by the drumstick market rate and finally add the drumstick yield with that figure.

The productivity of the intercropping was evaluated by the land equivalent ratio (LER) and economic net return. LER is often been considered to be an index of intercropping advantages, The LER defined as LA+LB=A/A + B/B, where as LA, LB are the individual LER of A and B , LA is obtained by dividing the yield of crop A in inter cropping (A) by the yield of the same crop in sole cropping (AS). LB was calculated in the same (Vandermeer, 1989). Economic net income analysis was undertaken to assess economic feasibility of different intercrops.

Results and discussion

Growth attributes

Plant vigour and earliness are the prime parameters to be considered for gourds cultivation under semi-arid and arid ecosystem. Plant length, days to female flowering and fruiting in different gourd were observed and analyzed. The data presented in Table-1 clearly indicated that there was no significant different in these parameters of supportive crops on COD method than pure crop (G). Ridge gourd and sponge gourd recorded the highest plant length (more than 4.0 m) followed by bottle gourd and snake gourd (more than 3.0 m). The lowest plant length was recorded in bitter gourd (less than 2.5 m). Earliness flowering is an economically important parameters for gourds. Among the gourds tested, bitter gourd proved to record the earliest female flowering, followed by ridge gourd and sponge gourd. Snake gourd took more periods for female flowering. Further, it is understood from the non significant difference between the G and COD methods indicating suitability of drumstick as support. This might be due to the compatibility of drumstick in terms of light provided to the supportive crops growth and development. The differential behavior of components crops in intercropping system is concordance with finding of Kulbir singh *et al*, (2001)

Yield attributes

It was observed that among the supportive crops tested for yield, the highest yield was obtained in ridge gourd (48.83 kg) followed by bottle gourd (43.96 kg) under the COD method than 40.62 and 32.29 kg respectively in G method. The lowest yield was recorded in bitter gourd in both the methods. Assessing the feasibility of yield among G and COD, showed that the higher values over G method proved an increment of 44.96, 36.15 and 38.70 per cent in ridge gourd, bottle gourd, and snake gourd indicating the need of support for harvesting higher marketable produce over G method. This result is in concordance with the finding of Abuselaha and Dutta (1995) who reported that significant difference in the yield of gourds grown on 3 m height trellis (33.41%) and bower system (36%) over ground trailing method. This finding is in contrary with findings of Palada (1996) who observed that drumstick trees are highly competitive with eggplant and sweet corn and reduced yield up to 50 per cent. However, the significant improvement in the yield of gourds strongly justified from the fact that until July end, there was no dense vegetative shoot found on drumstick trees. The open centered barren branches might have facilitated sufficient sunlight to under storied crops. The non-coincidence of flowering of drumstick indicating its fitness to multitier cropping system. Fukai and Trenbath (1993) also reported that intercropping is most productive when inter crops differ greatly in growth duration so that their minimum requirements for growth resources occur at different times. Further, it was observed that when the fruit development started in drumstick trees (November), the gourds finished their life cycle under semi-arid ecosystem. However, a meager yield reduction in drumstick at 11.71, 9.74, and 8.29 per cent observed with combination of snake gourd followed bitter gourd and ridge gourd indicating the thorough study on cropping system based nutritional supplementation to avert this reduction. These

Table 1. Effect of drumstick in multitier cropping system on vegetative and flowering parameters of different cucurbitaceous crops

Cropping system	Plant length (cm)			Days to female flowering			Yield per plot (Kg)		
	2004-05	2005-06	Mean	2004-05	2005-06	Mean	2004-05	2005-06	Mean
1.Bottle gourd	246.5	238.4	242.45	56.2	57.2	56.73	30.21	34.33	32.29
2.Bitter gourd	290.1	288.3	289.23	49.2	51.3	50.25	16.39	20.15	18.20
3.Ridge gourd	473.1	459.3	466.21	56.8	58.1	57.45	38.26	43.12	40.62
4.Sponge gourd	483.5	479.1	481.32	54.2	51.5	52.85	26.10	34.51	30.28
5.Snake gourd	342.8	253.2	298.05	65.3	64.2	64.75	19.32	23.53	21.41
6.Drumstick +bottle gourd	241.5	221.4	231.45	54.1	55.6	54.85	41.23	46.68	43.96
7.Drumstick +bitter gourd	282.9	274.6	278.75	50.7	51.4	51.05	19.31	23.14	21.24
8.Drumstick + ridge gourd	488.0	461.3	474.65	57.2	55.3	56.25	45.60	52.22	48.84
9.Drumstick +sponge gourd	475.1	470.8	472.95	53.6	49.3	51.45	36.12	40.15	38.12
10.Drumstick +snake gourd	353.4	329.3	341.35	61.8	66.3	64.05	26.88	32.60	29.68
CD at 5%	ns	ns		ns	ns		0.56	0.71	

G=ground spreading method, COD= climbed over drumstick

Table 2. Yield and economics of drumstick based multitier cropping system (pooled data)

Cropping system	Yield per plot (kg)	Total yield per ha (t)	Income of drumstick (Rs.)	Income of annual crops (Rs.)	Total income (Rs.)	Total expenditure (Rs)
1.Drumstick	40.33	26.88	71725	-	71725	26585
2.Bottle gourd (G)	-	21.52	-	48829	48829	15882
3.Bitter gourd (G)	-	12.13	-	36400	36400	12364
4.Ridge gourd (G)	-	22.46	-	49412	49412	14229
5.Sponge gourd (G)	-	20.18	-	36336	36336	13247
6.Snake gourd (G)	-	14.26	-	39946	39946	13288
7.Drumstick + bottle gourd (COD)	38.23	54.77	63666	67405	131072	33586
8.Drumstick + bitter gourd (COD)	36.39	38.42	60650	42480	103130	33454
9.Drumstick + ridge gourd (COD)	36.98	57.21	61633	71632	133265	29781
10.Drumstick + sponge gourd (COD)	37.23	50.21	62000	45744	107744	31815
11.Drumstick + snake gourd (COD)	35.63	43.52	59333	43530	102864	30251
CD at 5%	ns	4.33				

G=ground spreading method, COD= climbed over drumstick

S. Raja, V. V. Apparao, B. G. Bagle, and T. A. More, Indian Journal of Arid Horticulture, 2009 4(1): 1-5

findings are supported by the results of Singh *et al.*, (2001) in sweet pepper indicating the yield reduction in the main crop when intercropped with non leguminous crops. Reddy *et al.*, (1993) also reported that the reduction in the yield of arecanut.

Economic feasibility

When the values of land equivalent ratio appears to be greater than one under intercropping system, this usually indicates the efficiency of this system over the sole cropping system (Vandermeer, 1989). In this study, the land equivalent ratio as an indicator of biological efficiency intercropping system was always greater than one (Table 3). Highest land equivalent ratio was obtained in the treatment combining drumstick with ridge gourd (2.39) i.e. 2.39 times area is required to get the same produce in their monoculture treatment. This multitier system approach not only reduced the space by 2.39 times but also neglected the use of trellis system of cultivation. The same treatment recorded the highest drumstick equivalent ration (28.65 t/ha). Willey (1979) reported that the practical significance of LER can only be fully assessed when related to the actual economic yield. However, Muoenke and Asiegbu (1997) concluded that the highest LER values did not always reflect highest monetary return to the farmer.

The sustainability of any intercropping system is influenced by the economic returns, which determine the commercial feasibility of different intercropping. The economics of various combination are given in Table 3. The maximum net profit of Rs 103484/- followed by Rs. 97486/- in drumstick + ridge gourd and drumstick + bottle gourd combination respectively. The most economically satisfactory intercropping system was obtained with drumstick + ridge gourd (3.47%), followed by drumstick + bottle gourd (2.98%). It is a compulsion of farmers of semi-arid region to grow crops in rainy season alone, for which investing in preparing trellis cant be an economical. In the present study, the drumstick based multitier system reduced the cost input required for preparing trellis by 71 and 64 per cent comparing the bower and traditional system respectively as these two systems incurred Rs. 83000/- and Rs.67100/- respectively for preparing trellis (Table 4). Hence, it is concluded that the drumstick multitier cropping system, not only brings the drumstick grown areas under gourds and vice versa, but also facilitates to introduce more annual vegetables, favourable price during glut period, easy accessible for intercultivation enhance the input use efficiency. Similar observation are also noted by Patil *et al.*, (1992), Hegde *et al* (1993) and Nagwedar *et al.*, (1997) drumstick in coconut based vegetable cropping system. Hence, this system can be commercially exploited to the poor farming community.

Table 3. Profitability and compatibility of drumstick based multiter cropping system for semiarid ecosystem (pooled data)

Cropping system	Net income (Rs)	C/B ratio	Drumstick reduction over pure crop	Yield (%)	Supportive crop % Yield increase over pure crop	Drumstick equivalent yield (t/ha)	Land equivalent ratio
1. Drumstick	45140	1.69		-	-	-	1.00
2. Bottle gourd (G)	32947	2.07		-	-	19.80	1.00
3. Bitter gourd (G)	24036	1.94		-	-	14.56	1.00
4. Ridge gourd (G)	35183	2.47		-	-	19.76	1.00
5. Sponge gourd (G)	23089	1.74		-	-	14.53	1.00
6. Snake gourd (G)	26658	2.00		-	-	15.97	1.00
7. Drumstick + bottle gourd (COD)	97486	2.90		5.28	36.15	26.96	2.26
8. Drumstick + bitter gourd (COD)	69676	2.08		9.74	16.73	16.99	2.01
9. Drumstick + ridge gourd (COD)	103484	3.47		8.29	44.96	28.65	2.39
10. Drumstick + sponge gourd (COD)	75929	2.38		7.73	25.91	18.29	2.12
11. Drumstick + snake gourd (COD)	72613	2.40		11.71	38.70	22.16	2.21

G=ground spreading method, COD= climbed over drumstick

Table 4: Comparative performance of drumstick based multiter system over bower and traditional system

S. No.	Factors	System of cultivation		
		Bowar system	Traditional system	Drumstick based multitier system
1	Spacing for each poles	3.0 x 3.0 m	3.0 x 2.0 m	5.0 x 3.0 m
2	Cost for trellis formation	83600	67100	-
3	Cost of cultivation	16100	15800	29780
4	Yield (kg/ha)	30000	23700	57160
5	Total expenditure	99700	82900	29780
6	Total income	66000	52140	133265
7	Net Income	-33700	-30760	103485
8	Input reduction percent	71.0 64.0 -		

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