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Short Communication

Biological efficiency of chilli + amaranth intercropping system under fertigation

Anitrosa Innazent, S. Anitha *, C. George Thomas, K.P. Prameela and V. I. Beena

College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur - 680 656, Kerala, India

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Abstract

An experiment was conducted at Water Management Research Unit, Vellanikara during January to July 2017 to study the biological efficiency of chilli+ amaranth intercropping system under different nutrient and water regimes. The treatments consisted of chilli + amaranth intercropping system planted at two different planting geometries *viz*., normal row planting and paired row planting, three nutrient levels *viz*., 100, 75 and 50 per cent NPK recommendation of both crops as fertigation and two irrigation levels *viz*., 100 per cent Epan and 75 per cent Epan along with two controls *viz*., chilli pure crop and amaranth pure crop. Biological efficiency of intercropping system was assessed by calculating LER, LEC, ATER, RCC and CEY. Chilli + amaranth intercropping under normal row planting produced significantly higher LER (2.84) compared to paired row planting. The intercropping system fertilized at 100 per cent of the recommended NPK dose to both crops showed the highest LER (2.81) compared to lower doses. Irrigation at 100 per cent Epan recorded significantly higher values of LEC (1.54) and ATER (2.56). Chilli equivalent yield was higher in chilli+ amaranth intercropping system (16553 kg/ha) compared to pure crop. The higher values of LER (>1.0), LEC (> 0.25), ATER and CEY revealed the biological efficiency of chilli + amaranth intercropping system compared to pure crop system.

Keywords: ATER, CEY, Intercropping, LEC, LER, RCC.

India ranks second in vegetable production, next only to China, and contributes about 12 percent of the world's production. The estimated production of vegetables in Kerala is 8.25 lakh MT as against the requirement of 36.7 lakh MT with practically little scope for horizontal expansion of the area under cultivation. Hence technology needs to be generated to include vegetables in the intercropping systems. Intercropping will help to increase total production per unit land per unit time. Productivity of intercropping systems can be enhanced by curtailing inter and intra species competition for various resources. This is possible by selecting compatible crops, adopting suitable planting geometry and proper water and nutrient practices. Fertigation is widely popularized as an efficient and economically viable method for water and nutrient management, on account of its highly localized application and flexibility in scheduling water and fertilizer applications. Research works on optimal schedules for micro-irrigation, fertigation and planting geometry in intercropping systems are very limited. The present study was done against this back drop and to assess the biological efficiency of chilli + amaranth intercropping system under different nutrient and water regimes.

The experiment was conducted at Water Management Research Unit, Vellanikara from January to July 2017 in randomized block design with three replications. Chilli variety (Ujwala) with longer duration (150 days) and wider spacing was taken as the base crop, and amaranth (Arun) with shorter duration (75 days) and closely spaced was

*Author for correspondence: Phone: 9446433292, Email: anitha.sarala@gmail.com

intercropped in chilli to study the yield advantage of intercropping system under different planting geometry, nutrient and irrigation levels. The treatments consisted of chilli+ amaranth intercropping system planted at two types of planting geometry *viz*., normal row planting (NR) and paired row planting (PR), three nutrient levels, *viz*., 100, 75 and 50 per cent NPK recommendation of both crops as fertigation (NL 100, NL 75 and NL 50), two irrigation levels, *viz*., 100 per cent Epan and 75 per cent Epan (IL 100 and IL 75) and two controls, *viz*., pure crop of chilli and amaranth. Chilli under normal row was planted at a spacing of 45cm x 30 cm. Under paired row planting, the spacing for chilli was 30/60cm x 30 cm. The spacing for pure crop chilli was 45cm x 30cm. Spacing for both pure and intercrop amaranth was 30cm x 20 cm. Daily irrigation was given at 100 per cent Epan and at 75 per cent Epan as per treatments. The drip lines were laid at a spacing of 45 cm. Nutrients @ 100 per cent, 75 per cent and 50 per cent of NPK recommendations for both the crops based on soil test value were applied to intercropping system as fertigation at weekly intervals (Table 1).

Table 1. Fertilizer recommendation for chilli and amaranth

Crop	Recommendation (kg/ ha)		
	N	P_2O_5	K_2O
Chilli	75	40	25
Amaranth	100	50	50

Intercropped plots received nutrients for both the crops as per treatments. NPK (100 per cent) based on soil test value was given as fertigation for pure crop of chilli and amaranth at weekly intervals with irrigation at 100 per cent Epan. Ten fertigations were given for chilli and five fertigations for amaranth at weekly intervals (Table 2). Yields of crops under intercropping system and pure crops were recorded. The biological efficiency of intercropping was evaluated in terms of Land Equivalent Ratio (LER), Land Equivalent Coefficient (LEC), Area-Time Equivalent Ratio (ATER), Crop Equivalent Yield (CEY), and Relative Crowding Coefficient (RCC) using the formulae suggested by Mead and Willey (1980), Adetiloye et al. (1983), Hiebsch and McCollum (1980), Verma and Modgal (1983) and de Wit (1960) respectively. Observations recorded were statistically analyzed and are presented below.

Table 2. Schedule of fertilizer application

Weeks	Schedule of fertigation (% of recommendation)	
	Chilli	Amaranth
Week II	5	10
Week III	5	20
Week IV	10	30
Week V	10	30
Week VI	15	10
Week VII	15	
Week VIII	15	
Week IX	15	
Week X	5	
Week XI	5	
Total	100	100

Perusal of the data revealed that the yield of intercropped chilli was 41 per cent lower than pure crop yield (Fig. 1). The higher yield under sole crop system may be due to lesser competition for growth resource in pure crop system compared to intercropped system. Anitha and Geethakumari (2006) attributed yield reduction in intercropped chilli to aggressive nature of amaranth. However for amaranth, the yield was 17 per cent higher under intercropping compared to pure crop (Fig. 1). The better yield of intercropped amaranth was due to the aggressive growth nature of amaranth and continuous receipt of nutrients through fertigation. Pure crop amaranth received fertigation for five weeks. But under intercropping, even though the amaranth plant population was less compared to pure crop, it benefitted from the fertigation given to chilli crop. This resulted in higher yield from the subsequent harvests of intercropped amaranth compared to pure crop and was reflected in total production.

The biological efficiency of intercropping was determined by LER, LEC, ATER, RCC and CEY by comparing the productivity of a given area of intercropping with that of sole crop (Table 3). An ideal parameter for evaluating the bio suitability of

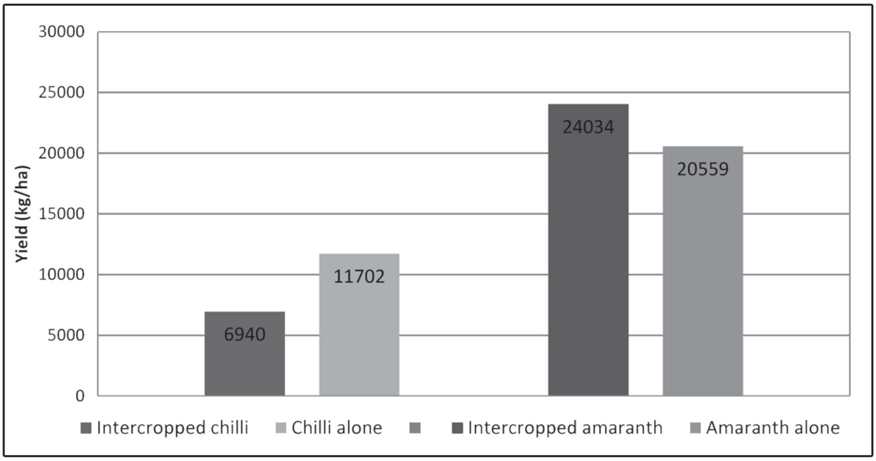

Fig. 1. Performance of pure crop and intercropped chilli and amaranth under different nutrient and water regimes

intercropping system is LER (Mead and Willey, 1980), which represents the relative land area under sole crop to produce the same yield as that of intercropping. LER value higher than one indicates that the intercropping system is more productive. Irrigation levels had no significant effect on LER while planting geometry and nutrient levels had significant influence on LER. Normal row planting recorded significantly superior LER (2.84) compared to paired row planting and NL 100 was observed to have significantly higher LER (2.81) compared to other nutrient levels (Table 3). In the present study, LER of chilli+ amaranth system grown under different planting geometry receiving different nutrient levels and irrigation levels was more than one (Table 3). This indicated the advantage in land use of intercropping chilli and amaranth over sole cropping. Higher LER (2.84) under normal row planting compared to paired row planting indicating that the intercropped system performed better under normal row planting. This may due to the higher combined yield recorded with intercropping system planted in normal row planting. A similar trend was noticed by Anitha and Geethakumari (2001). Intercropping system receiving 100 per cent recommended NPK for both

Table 3. Influence of planting geometry, nutrient and irrigation levels on parameters for evaluating the suitability of chilli+amaranth intercropping system

Treatments	LER	LEC	ATER	RCC	CEY (kg/ha)
Planting geometry					
A1 Normal row planting	2.84	1.35	2.39	-8.59	16565.71
A2 Paired row planting	2.39	1.31	2.42	-58.89	16541.18
CD (0.05)	0.22	NS	NS	NS	NS
Nutrients					
B1 100% NPK as fertigation	2.81	1.48	2.51	-10.41	17437.32
B2 75 % NPK as fertigation	2.46	1.21	2.34	-80.17	15889.72
B3 50% NPK as fertigation	2.58	1.30	2.37	-10.65	16333.30
CD (0.05)	0.27	NS	NS	NS	NS
Irrigation					
C1 100% Ep	2.67	1.54	2.56	-57.13	17463.41
C2 75% Ep	2.56	1.12	2.25	-10.35	15643.48
CD (0.05)	NS	0.40	0.29	NS	NS

crops recorded significantly higher values of LER compared to other levels of nutrients. Awasthi et al. (2011) observed that chickpea+fennel intercropping system performed efficiently with 100 per cent of RDF.

Planting geometry and nutrient levels had no significant effect on LEC (Table 3). Irrigation levels revealed significant influence on LEC and the maximum value was recorded at 100 per cent Epan (1.54). LEC of intercropped treatments receiving 100 per cent Epan was significantly higher compared to 75 per cent Epan (Table 3). This may due to higher yield of chilli and amaranth recorded with intercropping system receiving 100 per cent Epan. Any intercropping system involving two crops become beneficial when it has a LEC of more than 0.25 indicating that each crop in the system should give at least 50 per cent of their sole crop yield. Joseph and Balan (2008) reported higher LEC value for ash gourd + amaranth intercropping system (0.925) due to higher yield and LER of amaranth, thus resulting in higher LEC.

The duration of field dedicated to production is not considered while calculating LER. ATER considers the land occupancy period of the crop i.e., the utilization of area and time by crops in the intercropping system. The land occupancy period of chilli in this experiment was 194 days and that of amaranth was 93 days. Levels of irrigation significantly influenced ATER and maximum value (2.56) was recorded at 100 per cent of Epan (Table 3). Planting geometry and nutrient levels had no significant effect on ATER. The result indicated that the utilization of space and time under different planting patterns and different levels of nutrients were similar, whereas space and time utilization was significantly higher with intercropping system receiving 100 per cent irrigation. Higher value of ATER was due to the better combined yield in intercropping and the temporal difference that existed.

The mean values on RCC are presented in Table 3. In the present study no significant variation in RCC of intercropping system was observed due to planting geometry, nutrient levels, irrigation levels and their interactions. RCC indicates whether a species of crop, when grown in mixed population produced more or lesser yield than expected in pure stand. If the component has a coefficient less than, equal to or greater than one, it means that it has produced less yield, same yield or more yield than expected. Value less than one in this study was due to the lesser yield of intercropped chilli than pure crop chilli.

In intercropping, if more than one species is involved it is difficult to compare the produce due to different nature of the products. Hence the equivalent yield was calculated by converting the intercropped yield into base crop yield by considering the market rate of both the crops. Chilli equivalent yield was higher in chilli+ amaranth intercropping system (16553 kg/ha) compared to sole crop due to maximum utilization of growth resources under intercropping system. Anitha and Geethakumari (2006) reported that significantly higher chilli equivalent yield (10421 kg/ha) was recorded with chilli + amaranthus intercropping than pure crop. Tarafder et al. (2003) revealed that the highest chilli equivalent yield (2732 kg/ha) and land equivalent ratio (1.34) was obtained from onion + chilli intercropping system. CEY was not significantly influenced by planting geometry, nutrient levels and irrigation levels (Table 3). Even though planting geometry, nutrient levels and irrigation levels did not show significant influence on CEY, higher CEY were noticed for normal row planting, NL 100 and IL 100. It was the direct reflection of higher yield of intercrops.

Based on the results obtained it can be recommended that to get maximum biological benefit from chilli+amaranth intercropping system, planting should be done at normal row with 100 per cent recommended dose of nutrients for both the crops and irrigation should be given at 100 Epan under fertigation.

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