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Yield Potential and Economics of Chilli + Amaranth Intercropping System as Influenced by Plant Geometry and Fertigation

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ABSTRACT

Background: Intercropping is a method of increasing cropping in order to increase productivity by mixing several crops and more effectively utilising the available resources. The productivity of intercropping systems can be increased by using the right planting geometry, together with effective nutrition and water management.

Methods: The experiment was carried out at the Water Management Research Unit in Vellanikkara. The experiment was set up using a randomised block design that was triple duplicated. Two different planting geometries, normal row planting and paired row planting, three nutrient levels, or 100, 75 and 50% of the NPK recommendation for both crops as fertigation and two irrigation levels, or 100% Epan and 75% Epan, made up the treatments.

Result: The yield of intercropped chilli was 41% lower than that of chilli grown as a pure crop, according to crop performance under the intercropping and pure crop systems. However, intercropping increased amaranth production by 17% compared to pure crop. Amaranth receives nutrients from the fertigation supplied to the chilli crop in addition to the fertigation of amaranth. Because of this, intercropped amaranth produced more dry matter; absorbed more nutrients and produced a better yield. Gross return, net return and B:C ratio was used to evaluate the economic advantage of the intercropping system. In comparison to pure crops of chilli (Rs.197716) and amaranth (Rs.24548), the net return of the chilli-amaranth intercropping system (Rs. 428212) was 116 per cent higher and 164 per cent higher, respectively. The study indicated that there is an effective utilization of space, nutrients and water when amaranth was raised as an intercrop with chilli.

Key words: Amaranth, Chilli, Fertigation, Intercropping, Plant geometry.

INTRODUCTION

India ranks second in vegetable production (next only to China), contributing to 12 percent of the world's production. Kerala is expected to produce 8.25 lakh MT of vegetables, compared to a need of 36.7 lakh MT. However, there is no room for the area to be expanded horizontally to increase vegetable production. One strategy to improve agricultural production through better use of available but limited resources is to increase cropping intensity. Adoption of multiple cropping could boost crop intensity. The intercropping system, which involves growing many crops simultaneously on the same plot of land, increases cropping intensity in both the space and time dimensions. Therefore, in addition to supporting widespread vegetable cultivation, technology development is required to include vegetables in intercropping systems.

Chilli is one of the major vegetable crops which is widely spaced and cultivated throughout the tropics and subtropics. Anitha and Geethakumari (2003) studied the production and economics of chilli- amaranth intercropping system and indicated that it is a viable system for summer fallows of Kerala. Chilli (*Capsicum annuum* L.) is selected as base crop of the study, It is one of the important spice crops of India and also of the world used as a condiment both as green and dry. The chilli cv. Ujwala, the most popular variety was ideal for cultivation in Kerala. The wider spacing of chilli can be effectively utilized for growing intercrops. Amaranth, one of the most preferred vegetable crops and short-duration crop used mainly as leafy vegetable was intercropped in between chilli. The duration, critical stages and rooting pattern of amaranth cv. Arun was different from chilli cv. Ujwala. Amma and Ramdas (1991) documented

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performance of amaranthus as an intercrop under different cropping situations. Intercropping with amaranth not only increases the net return but also provides cultural weed control, fertility and moisture conservation and land use maximization (Awe and Abegunrin, 2009).

Anitha and Geethakumari, (2006) reported that to reap maximum economic advantage from chilli-based cropping systems, both crops should be supplied with 100 percent of the recommended dose as per the package of practices. Tarafder *et al.* (2003) found that additional income was fetched from intercropping chilli at different onion populations. Mamun (2002) studied the economics of the chilli–mustard intercropping system and indicated that an additional net income of Rs.1937 per ha was obtained from an intercropping system rather than a sole crop. Suresha *et al.* (2007) noted that the highest gross returns and net returns were realized by intercropping garlic with chilli followed by cluster bean with chilli. The above studies revealed the suitability of chilli under intercropping. The present study is proposed against this backdrop to assess the yield potential and economics of chilli-amaranthus intercropping system under different nutrient and water regimes.

MATERIALS AND METHODS

The experiment was conducted at Water Management Research Unit, Vellanikkara, Thrissur, Kerala. The field is located geographically at 13°32′N latitude and 76°26′E longitude, at an altitude of 40.3 m above mean sea level. The experimental site experiences a typical tropical humid climate. The maximum temperature during cropping period was 38°C and the minimum temperature was 29.4°C. The average RH during the crop growth period was 69.8%. A total rainfall of 1302.6 mm was received over 31 rainy days. The experiment was laid out in randomized block design (RBD) with 3 replications. The treatment consisted of 2 planting geometry (normal row planting and paired row planting), 3 nutrient levels (100%,75% and 50% NPK for both crops as fertigation), 2 irrigation levels (100% and 75% Epan) and 2 controls (chilli alone and amaranth alone under fertigation).

RESULTS AND DISCUSSION

Chilli yield

Planting geometry and nutrient levels, had no significant influence on yield of intercropped chilli (Table 1). Yield of intercropped chilli varied significantly amongst irrigation levels. Maximum yield was recorded at 100 percent of Epan which was superior to irrigation level at 75 per cent. The nutrient levels could not bring significant variation in yield of chilli. Pure crop of chilli recorded the highest yield (11,701.82 kg/ha) compared with other treatments. From the result it was observed that the performance of crop differ when it was grown as intercrop and pure crop. Here the plant population of chilli under pure and intercrop was same. In this experiment the yield performance of chilli under sole crop was significantly higher compared to the performance of chilli under intercropping system (Fig 1). This may be due to the better development of growth and yield parameters and nutrient uptake of sole crop of chilli compared to intercropped chilli. The better development of growth and yield parameters under sole crop system may be due to the lesser competition for growth resource in pure crop system compared to intercropped system.

Table 1: Influence of planting geometry, nutrient levels and irrigation levels on yield and economics of chilli+ amaranth intercropping system.

Treatments	Chilli yield (kg/ha)	Amaranth yield (kg/ha)	Gross returns (Rs.)	Net returns (Rs.)	B:C ratio
Planting geometry					
A1 Normal row planting	6,709.37	24,640.84	828,285.40	430,125.40	2.08
A2 Paired row planting	7,170.29	23,427.23	827,059.30	426,299.20	2.07
SEm±	575.82	648.78	32,133.15	32,132.98	0.08
CD (0.05)	NS	NS	NS	NS	NS
Nutrients					
B1 100% NPK for both crops	6,946.29	26,227.57	871,865.90	463,552.70	2.14
B2 75 % NPK for both crops	7,160.12	21,824.02	794,486.20	395,026.30	1.99
B3 50% NPK for both crops	6,713.09	24,050.52	816,664.90	426,057.90	2.09
SEm±	705.23	794.60	39,354.92	39,354.70	0.10
CD (0.05)	NS	2,331.06	NS	NS	NS
Irrigation					
C1 100% Ep	8,035.24	23,570.43	873,170.70	472,960.70	2.18
C2 75% Ep	5,844.42	24,497.64	782,174.00	383,463.90	1.96
SEm±	575.82	648.78	32,133.15	32,132.98	0.08
CD (0.05)	1,689.25	NS	NS	NS	NS
Chilli pure crop	11,701.82	20,559.35	585,091.09	197,716.60	1.51
Amaranth pure crop			411,187.06	24,548.28	1.06

Levels of irrigation given to intercropped treatments plants revealed that yield of intercropped chilli receiving water at 100 per cent Epan was significantly higher compared to intercropped chilli receiving water at 75 per cent of Epan (Fig 3). The yield reduction was 27.26 per cent by reducing the water to 75 per cent. The development of growth and yield attributes and uptake of nutrients were significantly higher for intercropped chilli receiving water 100 per cent Epan compared to intercropped chilli receiving water at 75 per cent Epan. There by high yield for intercropped chilli receiving irrigation at 100 per cent Epan. Performance of intercropped amaranth was not significantly influenced by the irrigation levels.

Chilli recorded significantly higher yield when chilli was grown under a pure crop system with 100 per cent of Epan followed by an intercropped system with IL 100 (Fig 3). Suresha *et al* (2007) studied on chilli based intercropping system and reported that sole crop chilli yielded higher than intercropping system. Similar observation was recorded by Begum *et al.* (2015) in chilli intercropping system. Sani *et al.* (2015) studied on effect of irrigation levels on corn- soybean intercropping system and concluded that highest yield was obtained with pure crop of soybean. This may due to absence of competition and also due to higher NPK uptake of chilli (64.28, 12.57 and 84.85 kg/ha) under sole cropping system. It was observed that the growth parameters like plant height (190.32 cm), leaf number (195), branches number (21.73) and leaf area (3305.08 cm^2) produced by chilli in pure crop was superior than different irrigation levels under intercropping system. IL 100 shows better performance of chilli under intercropping system. That is, lower irrigation level (IL 75) was not sufficient to meet demand of chilli in intercropping system. These resulted in poor performance of NPK uptake and growth and yield attributes and thereby lower yield with IL 75.

Amaranth yield

Nutrient levels revealed significance on the yield of amaranth (Table 1). Nutrient level of 100 percent of fertilizer dose produced superior yield (26,227.57 kg/ha) and was superior to NL 75 and NL 50. However, planting geometry and irrigation levels had no significance on yield. Total yield produced by amaranth under normal row planting (24,640.84 kg/ha) was on par with paired row planting (23,427.23 kg/ha). And total yield produced by amaranth receiving irrigation at IL 75 (24,497.64 kg/ha) was on par with IL 100 (23,570.43 kg/ha). Pure crop of amaranth produced less yield (20,559.35 kg/ha) than intercropped amaranth.

Among the different treatment combinations between planting geometry and different nutrient levels, normal row planting with 100 percent of nutrient dose recorded higher yield of 28,162.31 kg/ha and was on par with paired row planting receiving NL 50 (26,191.87 kg/ha). In the case of interaction effect between plant geometry with different nutrient and irrigation level, a higher yield (31,104.93 kg/ha) was registered by intercropped amaranth planted at normal row receiving NL 100 and IL 100. In the case of amaranth, the yield performance of amaranth under intercropping situation was significantly higher compared to pure crop amaranth (Fig 1). Even though the plant population of amaranth under intercropping system was less compared to pure crop amaranth, the yield of amaranth under

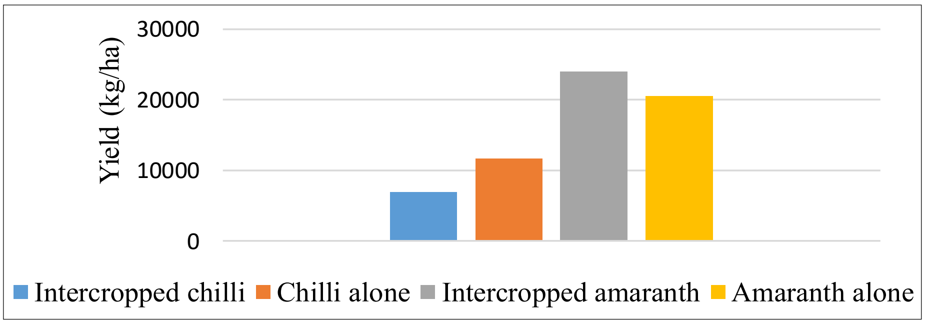

Fig 1: Performance of crops under intercropping system

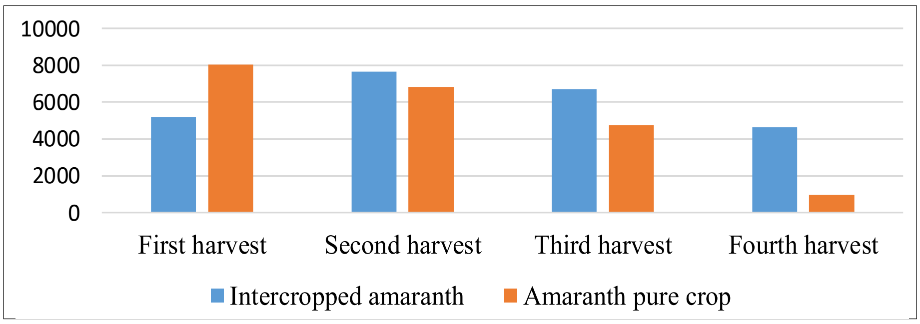

Fig 2: Yield of amaranth in different harvest.

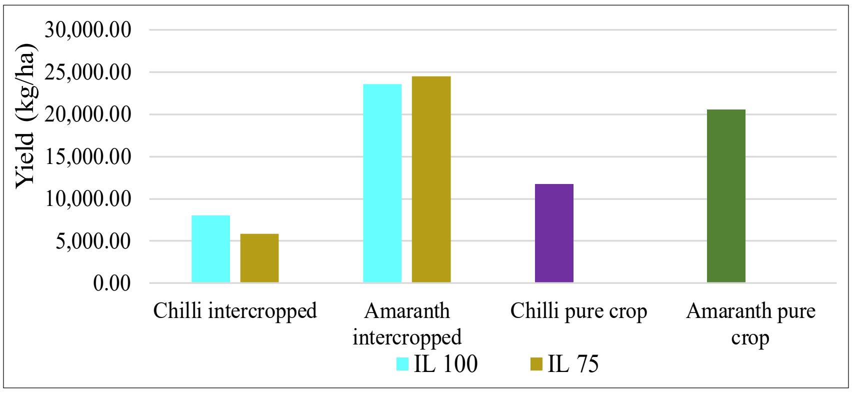

Fig 3: Influence of irrigation levels on yield of cropping system.

intercropping system was higher. This was due to the higher yield obtained from the intercropped amaranth for the second, third and fourth harvests (Fig 2). For pure crop amaranth the yield obtained at first harvest was higher compared to intercropped amaranth. But for intercropped amaranth, the cumulative effect of higher yield obtained from the subsequent harvest leads to higher yield. The yield increase of amaranth under the intercropping system was due to the receipt of continuous nutrients through fertigation. For amaranth, the fertigation schedule was for five weeks. But for intercropped amaranth in addition to the fertigation of amaranth, nutrients were received from the fertigation given to the chilli crop. This resulted in the higher dry matter production and nutrient uptake of intercropped amaranth and finally higher yield for intercropped amaranth compared to pure crop.

Intercrop yield of amaranthus was significantly influenced by different nutrient levels. Higher yield was noticed for NL 100 (26,227.57 kg/ha) followed by NL 50 (24,050.52 kg/ha). The yield increase of intercropped amaranth receiving 100 percent NPK both crops may be due to the higher availability of nutrients. Dry matter production and NPK uptake were higher when received 100 per cent NPK for both crops. This resulted in better nutrient uptake and there by yield. Jensen (1996) opined that due to complementary use of soil and atmospheric nitrogen by component crops in intercropping system, resulted in better yield advantage in pea-barley intercropping system. The better performance of amaranth than chilli in chilli- amaranth intercropping system may be due to better exploitation of nutrients and other resources by amaranthus. Though the higher yield of amaranth was from the intercropped system than pure crop indicates the dominant nature of amaranthus in chilli- amaranthus intercropping system.

Economics of cultivation

The data pertaining to the economics (Rs./ha) of cultivation of chilli-amaranth intercropping system under different planting geometry, nutrient and irrigation levels are presented in Table 1. The data indicated that gross return, net return and B:C ratio were not significantly influenced by planting geometry, nutrient and irrigation levels. Among different treatments, pure crop of chilli and amaranth recorded lower gross returns of Rs.585,091.09 and Rs. 411,187.06 respectively. The interaction effect between planting geometry and nutrient level had observed significance on gross return. Normal row planting with NL 100 recorded a higher gross income of Rs. 960,078.80, which was on par with paired row planting with NL 50 (Rs. 938,171.70). The lowest gross return was observed in normal row planting with NL 50 (Rs. 695,158.20). Among different treatment combinations, normal row planting with 100 per cent of nutrient level was recorded higher net income (Rs. 553,065.70). In the case of different treatment combinations with paired row planting, NL 50 with paired row planting obtained a higher net income (Rs. 546,264.60). Chilli+ amaranth intercropping system recorded significantly high B:C ratio of 2.07 and high net return of Rs. 4,28,212 compared to pure crop of chilli and amaranth (Table 1). The gross return and net return of chilli+amaranth intercropping system was 41.4 and 116 percent higher compared to pure crop chilli and 101 and 164 per cent higher to pure crop of amaranth (Table 1). Mamun (2002) studied the economics of chilli– mustard intercropping system and indicated that an additional net income of Rs.1937 per ha was obtained from an intercropping system than sole crop. Economic analysis done by Suresha *et al.* (2007) for chilli based cropping system revealed that the highest gross returns (Rs. 108766/ha), net returns (Rs. 59261/ha) and B:C ratio (1.75). Chilli and garlic intercropping led to higher yields compared to growing chilli alone due to the increased combined yield. Also, Anitha and Geethakumari (2006) reported that to reap maximum economic advantage from a chilli-based cropping system, the crops should be supplied with 100 percent of the recommended dose as per the package of practices. Planting geometry, nutrient levels and irrigation levels failed to show significance with gross return, net return and B:C ratio in the intercropping system.

CONCLUSION

The results of the study are summarized and listed herewith. Performance of crops under intercropping and pure crop system revealed that the yield of intercropped chilli was 41 per cent lower than chilli pure crop. However, for amaranth the yield was 17 percent higher under intercropping compared to pure crop. A paired row pattern was adopted to accommodate more intercrops. However, planting geometry had no significant influence on the yield performance of intercropped chilli and amaranth. Since normal row planting is sufficient for the chilli-amaranth intercropping system. The nutrient levels showed no significant difference in the yield of intercropped chilli, whereas the yield of intercropped amaranth was significantly influenced. Intercrop yield of amaranth at 100 percent of nutrient dose (26,227 kg/ha) was significantly higher than intercrop yield of amaranth at 75 (21,824 kg/ha) and 50 percent of nutrient dose (24,050 kg/ha) and pure crop yield (20,559 kg/ha). Intercropped chilli receiving irrigation at 100 percent Epan recorded 37 percent higher yield compared to a lower level of irrigation. However, the performance of intercropped amaranth was not significantly influenced by the irrigation levels. The net return of chilli-amaranth intercropping system (Rs.428212) was 116 percent higher compared to pure crop chilli (Rs.197716) and 164 percent higher to a pure crop of amaranth (Rs.24548). Higher gross returns, net returns and B:C ratio revealed the economic benefit of the chilli- amaranth intercropping system compared to pure crop of chilli and amaranth.

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Author contribution

All authors equally contributed.

Author statement

All authors read, reviewed, agreed and approved the final manuscript. Written informed consent was obtained from all participants prior to publication.

Study area/ sample collection

The experiment was conducted at Water Management Research Unit, Vellanikkara, Thrissur, Kerala.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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Conflict of interest

We declare no known conflict of interests that could have appeared to infiuence the work reported in this paper.

REFERENCES

Anitha, S. and Geethakumari, V. L. (2003). Bio economic suitability of chilli (*Capsicum annum*) based cropping system [Abstract]. In: Abstracts, National workshop on Homestead Farming; 6-7 Mar. 2003, Kerala. Farming System Research Station, Sadanathapuram, KAU, Kerala, p. 26.

Anitha, S. and Geethakumari, V. L. (2006). Nutrient management in chilli (*Capsicum annuum* L.) based cropping system. Indian Journal of Crop Science. 1(1-2): 209-210.

Amma, S. P. K. and Ramdas, S. (1991). Studies on raising amaranthus as mixed crop on weed suppression and yield of bhindi [*Abelmoscus esculentus* (L.) Monech]. South Indian Horticulture. 39: 76-80.

Awe, G. O. and Abegunrin, T. P. (2009). Effects of low input tillage and amaranth intercropping system on growth and yield of maize (*Zea mays*). African Journal of Agricultural Research. 4 (7): 578-583.

Begum, S. A., Zaman, M. S., and Khan, A. S. M. M. R. (2015). Intercropping of root crops with chilli in charlands of Mymensingh. Progressive Agriculture. *26*(2), 109-114.

Jensen, E.S. (1996). Grain yield, symbiotic N2 fixation and interspecific competition for inorganic N in pea-barley intercrops. Plant and Soil. 182: 25-38.

Mamun, A.N.M., Choudhury, D.A., Ibrahim, M., Hossain, M.A. and Kabir, A.H.M.F. (2002). Performance of chilli as intercropped with mustard. Pakistan Journal of Biological Science. 5(9): 909-910.

Sani, Y. G., Jamshidi, K., Yousefi, A. and Moghadam, M. R. A. (2015). Control potency of corn and soybean intercropping on weeds at different irrigation condition. Advances Plants Agricultural Research. 2 (4): 54-60.

Suresha, B.A., Allolli, T.B., Patil, M.G., Desai, B.K. and Hussain, S.A. (2007). Yield and economics of chilli based intercropping system. Karnataka Journal of Agricultural Science. 20(4): 807-809.

Tarafder, I.H., Rahman, M.S., Hossain, A.K.M.M., Syeda, J.A., and Rahman, M.M. (2003). Economic returns and yield of chilli as intercropped with varying onion population. Pakistan Journal of Biological Science. 6: 149-152.