

Suitability of Grain Amaranth in Different Intercropping System

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Abstract: Different intercrops crops were studied keeping grain amaranth as main crop to harness the nutritional benefit of grain amaranth as well as better intercropping system to achieve higher productivity and profitability. Grain amaranth when grown as sole crop, the B:C ratio was higher (3.15) as compared to all other treatments involving sole crops or intercrops. Considering the market nature for grain amaranth, it may not be ideal to grow grain amaranth as a sole crop alone. Hence the main objective was to introduce and popularize grain amaranth cultivation through other crops as intercrop. Among the intercrop treatments, growing of grain amaranth + pigeon pea (2:1) recorded higher B:C ratio of 2.75 with LER of 1.17, which was followed by grain amaranth + finger millet (2:8) with B:C ratio of 2.60 with LER of 1.19 and grain amaranth + groundnut B:C ratio (2.44) with LER of 1.22.

Keywords : Finger millet, grain amaranth, groundnut, intercrop, pigeon pea.

INTRODUCTION

Grain amaranth is a potential underutilized crop known for its nutritive grain. In the recent past, it has emerged as one of the important health care crop because of its high protein and minerals in the grain with high lysine content in the protein. Though, it is considered as crop of food and nutritional security, its cultivation is very limited both at global and national level and its full potential have not been exploited. For any underutilized potential crop species, the first step is to popularize the crop with farmers, creating market potential and to create awareness with the consumers about the nutritional benefits of crop. As there is limited market for grain amaranth, this crop cannot be promoted as pure or sole crop alone in the initial stage. Hence, such underutilized crops like grain amaranth needs to be grown in a popular existing cropping system. Underutilized crops bring diversity into crop rotations and provide new possibilities for soil cultivation. Intercropping i.e. sowing two or more crops together represents a high valued strategy

for long term sustainable plant production management, due to its many beneficial effects like effects on increasing diversity of cultivated crops and nitrogen fixations by legumes (Bergkvist *et al.*, 2011, Hauggaard-Nielsen *et al.*, 2007, Lithourgidis *et al.*, 2011, Sun *et al.*, 2009). Intercropping of Soybean in sunflower crops constitutes a feasible alternative to increase land productivity in conventional cropping systems (Elba *et al.*, 2014). Intercropping of mungbean with pigeon pea recorded higher pigeon pea equivalent yield and also improved soil fertility than sowing of sole crops (Malik *et al.*, 2013). In this context, present study on intercropping grain amaranth with other crops of regional importance was carried out to evaluate the suitability of grain amaranth as intercrop in regular cropping system.

MATERIALS AND METHODS

The experiment was conducted at Main Research Station, University of Agricultural Sciences,

Hebbal, Bengaluru, India for two consecutive kharif seasons during 2017 and 2018. The experimental site is situated at an altitude of 120 58' North, longitude of 770 35' East and altitude of 899 meters above mean sea level. The normal annual rainfall is 862.95mm. The soil type is sandy loam with a pH of 6.55, Electrical conductivity of 0.26 dS m⁻¹, organic carbon 0.62 per cent available N 236, P₂ O₅ 27.2 and K₂O 176.2 kg/ha. The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice. Among the treatments, grain amaranth, pigeon pea, groundnut and finger millet were grown as a sole crop.

The different intercropping combinations tried were grain amaranth + pigeon pea (2:1), grain amaranth + groundnut (2:4), grain amaranth + finger millet (2:4), grain amaranth + pigeon pea (2:2), grain amaranth + groundnut (2:8) and grain amaranth + finger millet (2:8). The varieties used were grain amaranth (Suvarna), pigeon pea, (BRG-2), groundnut (TMV-2) and finger millet (GPU-28). The crop was grown under protective irrigation. The recommended dose of fertilizer was applied to respective crop when they were sown alone. While under the treatment of intercropping recommended dose of fertilizer (60N 40P₂O₅ 20 K₂O kg/ha) was given to grain amaranth crop. At the time of sowing 50 per cent of N was applied with full dose of P₂O₅ and K₂O and remaining N was top dressed at 30 DAS. Necessary plant protection measures were taken to protect the crop from pests and diseases. The land equivalent ratio was calculated by using the formula:

$$\text{Land equivalent ratio (LER)} = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where Y_{ab} and Y_{ba} are individual crop yield in intercropping and Y_{aa} and Y_{bb} are their yields as sole crop.

Economics of various treatments was worked out considering the prevailing market price of concerned crop and the grain equivalent yield of grain amaranth was calculated.

RESULTS AND DISCUSSION

Grain yield

The pooled results of different cropping system

with regard to yield, LER and Economics comprising grain amaranth equivalent yield, gross returns, net returns and B:C ratio are presented in the tables 1-3. Sole crop of grain amaranth significantly recorded maximum grain yield of 1169 kg/ha as compared to other grain amaranth based intercropping systems (Table 1). Among the intercrops studied, the grain yield was higher when they were grown as sole crop than the grain yield obtained in intercropping system. Thus, growing of pigeon pea, groundnut and finger millet as intercrop in grain amaranth caused significant reduction in grain / seed yield at different row proportion as compared to sole crop. Though growing sole crop may be advantage from the yield point, but considering the importance of agrobiodiversity and to harness the nutritional benefits of grain amaranth, through intercropping systems it's always better to practice intercropping especially with underutilized crops like grain amaranth which needs promotion through intercropping system rather as sole crop.

LER differed significantly in intercropping systems. It was higher (1.22) in grain amaranth + groundnut (2:4 row proportion) and was on par with (LER 1.19) grain amaranth + finger millet (2:8), grain amaranth + pigeon pea 2:1 row proportion (LER 1.17).

The intercropping of grain amaranth + groundnut (2:4) significantly recorded higher grain amaranth equivalent yield (1171.83 kg/ha) which was on par with grain amaranth sole crop (1168.83 kg/ha), grain amaranth + pigeon pea 2:1 row proportion (1127.50 kg/ha) and grain amaranth + finger millet (2:8) 1104 kg/ha. (Table 2).

Comparative economic analysis of intercropping system indicated that net returns/ha was higher in grain amaranth grown as a sole crop (INR 27,291) with B:C ratio of 3.15 followed by grain amaranth + pigeon pea 2:1 (INR 25,121 with B:C ratio 2.75) grain amaranth + groundnut 2:4 (INR 24,241 with B:C ratio 2.44) and grain amaranth + finger millet 2:8 (INR 23,791 with B:C ratio 2.60) (Table 3).

Singh *et al.* (2009) realized high yield advantage (LER 1.92) with sugarcane + amaranth 2:2 intercropping system followed by sugarcane

Table 1: Seed yield of grain amaranth and intercrops over the years

Treatments	Seed yield (kg/ha)					
	2017		2018		Pooled mean	
	Grain amaranth	Intercrop	Grain amaranth	Intercrop	Grain amaranth	Intercrop
Amaranth Sole Crop	1076	-	1262	-	1169	-
Pigeon pea Sole Crop	-	228	-	963	-	595.50
Groundnut Sole Crop	-	1104	-	1012	-	1058.33
Ragi Sole Crop	-	2812	-	3070	-	2940.33
Amaranth + Pigeon pea (2:1)	844	082	995	346	921.00	214.00
Amaranth + Groundnut (2:4)	381	892	515	887	447.83	889.67
Amaranth + Ragi (2:4)	247	2423	305	2536	276.17	2479.50
Amaranth + Pigeon pea (2:2)	628	096	723	405	675.33	250.67
Amaranth + Groundnut (2:8)	310	905	356	829	332.83	866.83
Amaranth + Ragi (2:8)	326	2496	390	2725	357.83	2610.67
SEm(±)	63.33	96.20	42.48	100.62	62.66	67.76
LSD (0.05)	195.19	288.42	130.89	301.69	182.16	194.69

Table 2: Land equivalent ratio (LER) and grain amaranth equivalent yield over the years

Treatments	Land equivalent ratio			Grain amaranth equivalent yield (kg/ha)		
	2017	2018	Pooled mean	2017	2018	Pooled mean
Amaranth Sole Crop	1.0	1.0	1.0	1076.0	1262.0	1169.0
Pigeon pea Sole Crop	1.0	1.0	1.0	196.0	963.0	579.0
Groundnut Sole Crop	1.0	1.0	1.0	694.0	1012.0	853.0
Ragi Sole Crop	1.0	1.0	1.0	803.0	877.0	841.0
Amaranth + Pigeon pea (2:1)	1.18	1.16	1.17	914.0	1341.0	1128.0
Amaranth + Groundnut (2:4)	1.15	1.28	1.22	942.0	1402.0	1172.0
Amaranth + Ragi (2:4)	1.10	1.06	1.08	940.0	1030.0	985.0
Amaranth + Pigeon pea (2:2)	1.04	0.99	1.02	710.0	1128.0	919.0
Amaranth + Groundnut (2:8)	1.11	1.09	1.10	878.0	1180.0	1032.0
Amaranth + Ragi (2:8)	1.18	1.19	1.19	1039.0	1169.0	1104.0
SEm(±)	0.93	0.041	0.051	79.1	50.8	61.8
LSD (0.05)	0.275	0.121	0.147	235.1	151.0	177.1

Table 3: Grain amaranth equivalent yield, gross returns, net returns and B:C ratio

Treatments	Grain equivalent yield (kg/ha) Pooled mean	Gross returns (INR)	Net returns (INR)	B:C ratio
Amaranth Sole Crop	1168.83	40,915	27,291	3.15
Pigeon pea Sole Crop	579.33	20,265	4,115	1.34
Groundnut Sole Crop	853.17	29,855	11,405	1.62
Ragi Sole Crop	841.00	29,400	14,150	1.93
Amaranth + Pigeon pea (2:1)	1127.50	39,463	25,121	2.75
Amaranth + Groundnut (2:4)	1171.83	41,020	24,241	2.44
Amaranth + Ragi (2:4)	984.67	34,458	19,812	2.35
Amaranth + Pigeon pea (2:2)	919.17	32,165	13,371	2.17
Amaranth + Groundnut (2:8)	1031.67	29,462	12,013	1.69
Amaranth + Ragi (2:8)	1104.00	38,640	23,791	2.60
SEm(±)	61.88	-	-	-
LSD (0.05)	177.11	-	-	-

+ amaranth (1:1). Sugarcane + amaranth fertilized at 150% RDF fetched the highest net returns (INR 78,135/ha) and B:C ratio of 3.14.

CONCLUSION

In the present study, the grain amaranth as sole crop recorded higher B:C ratio (3.15) with net returns of INR 27,291, considering the agro-biodiversity in intercropping system and nutritional importance of grain amaranth, growing of Grain amaranth + pigeon pea (2:1), grain amaranth + groundnut (2:4) and grain amaranth + finger millet (2:8) row proportions were found to be economical which may help to introduce and popularize the grain amaranth in different cropping systems than sole crop.

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