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Influence of Inter and Sequential Cropping of Pulses in Little Millet (*Panicum sumatranse* L.) Based Rainfed Agroecosystem

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ABSTRACT

Little millet (*Panicum sumatranse* L.) is grown in rainfed as well as dry region of India, growing of only cereals is not so much remunerative in present scenario of dry areas of agriculture to fulfil the diverse demand of consumers and rapid growing population. The intercropping system involves two or more crops coexist for some period of their cycles and ensure multifaceted benefits. A Field experiment was conducted to investigate the relative performance and the effects of legume intercropping system on productivity of little millet with two different row ratios (4:1 and 6:1) during *kharif* seasons 2017, at the Center of Excellence in Millets, Athiyandal, Tiruvannamalai District. Among the intercropping system, little millet +pigeonpea- horsegram (6:1) or little millet+pigeonpea-mothbean (6:1) sequence produced plant height, DMP, productive tillers / plant, thousand grain weight, grain yield, stover yield and little millet grain equivalent yield (LMGEY). Further, other intercropping indices, gross returns, net returns and B:C ratio were also found to be higher in little millet intercropped with little millet in 6:1 ratio.

Keywords Little millet, Intercropping, LMGEY, Indices, Yield, Economics.

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INTRODUCTION

Agriculture plays a significant role in most of the developing countries. But due to the increased population and development of urban clusters along with industrial growth in the developing world, there is shrinkage in the availability of land for farming because of its non-agricultural uses. Under these circumstances, the adoption of high-intensity cropping systems may be the viable option to increase agricultural productivity and production as a whole (Gitari *et al.* 2019).Growing of single crop in a year or cereals as sole crop is not beneficial to fulfil the diverse demands of farmers as well as consumers. In monocropping, the land and other resources are underutilized and the land use efficiency could be increased by adopting suitable cropping pattern. Intercropping of legumes with cereals is a recognized practice for economizing the use of nitrogenous fertilizers and increasing the productivity and profitability per unit area.

Little millet (*Panicum sumatranse* L.) is one of the important rainfed as well as dry land crop and is widely cultivated throughout country in dry tracks with fewer natural resources. In the present scenario of agriculture to fulfil the diverse demand of consumers, rapid growing population and depleting soil resources, there is an urgent demand of incorporation the pulses in cereals production system. Intercropping of little millet with different pulses and oilseeds have grater scope to utilize the land and other resources to maximum extent. Furthermore, intercropping cereals with legume provides numerous advantages in terms of total productivity of crops (Jan *et al.* 2016), efficient use of available resources, soil fertility improvement, less use of chemical fertilizers (Jensen *et al*. 2020).

MATERIALS AND METHODS

A field experiment was conducted at Center of Excellence in Millets, Athiyandal, Tiruvannamalai district to evaluate the suitability of inter and sequential crops in little millet under rainfed condition during the *kharif* seasons (2016-17) and with a sequential cropping during *rabi* season. The soil of the experimental field was sandy clay loam in texture, medium in organic carbon (0.50 %) and low in available nitrogen (285 kg / ha) low in available phosphorus (11.0 kg / ha) and available potassium (89.0 kg / ha) with alkaline reaction (pH 8.3

The intercropping system treatmentsare, T_1-Little millet sole crop -Horsegram, T_2 - Little millet sole crop - Mothbean, T_3 - Little millet + Pigeonpea (4:1) -Horsegram, T_4 - Little millet + Pigeonpea (4:1) - Mothbean, T_5 - Little millet + Pigeonpea (6:1) -Horsegram, T_6 - Little millet + Pigeonpea (6:1) - Mothbean, T_7 - Little millet + Lablab (4:1) -Horsegram, T_8 - Little millet + Lablab (4:1) - Mothbean, T_9 - Little millet + Lablab (6:1) -Horsegram and T_{10} - Little millet + Lablab (6:1) - Mothbean. The experimental was laid out in Randomized Block Design with three replications, the little millet variety Co (*Samai*) 4, was sown with Pigeonpea (Co (Rg) 7), lablab (Co 13) followed by sequential crops of horse gram (Paiyur 2) and moth bean (TMV (Mb) 1) pulses crops.

Basal application of 44:22:0 kg NPK / ha was given for base crop of little millet uniformly to all the plots at the time of sowing and no additional dose of fertilizers was used for intercrops. Cultural and plant protection measures were taken up as and when required. Observations were taken on five randomly selected plants in each plot in respect height, number of tillers/hill, number of fingers/hill, length of finger and 1000 grain weight. For economic analysis gross income, total operational cost net returns and B:C ratio was calculated.

Lal and Ray (1976),Verma and Modgal (1983) proposed economics of crop by converting grain/seed/fodder in terms of gross return for valid comparison as Grain Equivalent Yield (GEY). Little millet equivalent yield (LMGEY) of intercropping system was calculated by the formula

$$\text{LMGEY (kg/ha)} = \frac{\textit{Yield of intercrop (Yi)} \times \textit{Price of intercrop (Pi)}}{\textit{Price of base crop (Pp)}}$$

LER (Land Equivalent Ratio) was worked out by using the formula of Willey (1979).

$$\text{LER} = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where,Yaa and Ybb - Yield of ‘a’ and ‘b’ in sole crop situation; Yab and Yba- Yield of ‘a’ and ‘b’ in intercropping situation

Relative crowding coefficient (RCC) indicates whether a crop, when grown in mixed population, has produced more or less yield than expected in pure stand (RCC>1 = Intercropping system is advantageous).

$$\text{RCC} = \frac{Yab \times Zba}{(Yaa\text{-}Yab) \times Zab}$$

Where, Zab - Sown proportion of ‘a’ in combination with ‘b’; Zba - Sown proportion of ‘b’ in combination with ‘a’.

Aggressivity was proposed by McGillchrist and Trenbath (1971), who extended the work of William (1962),McGillchrist (1965). Aggressivity gives a simple measure of how much relative yield increase in

Table 1. Economics of little millet as influenced by intercropping (2017-18). *Significant at p 0.05; NS- Non-Significant at p> 0.05.

Treatments	Plant height (cm) (At harvest)	Dry matter production (kg / ha)	Little millet yield (kg/ha) Grain	Straw	Yield of intercrops (kg / ha)	Little millet Grain equivalent yield (LMGEY)	Yield of sequential crops (kg / ha)	Net income (Rs/ha)	B:C ratio
T_1 Little millet sole crop - Horsegram	103.0	5826	1397	4333	-	1553.7	823	30,175	1.79
T_2 Little millet sole crop - Mothbean	100.7	5721	1463	4267	-	1626.6	873	28,180	1.72
T_3 Little millet + Pigeonpea (4:1) - Horsegram	112.6	4491	975	3492	316	2121.9	632	31, 631	1.90
T_4 Little millet + Pigeonpea (4:1) - Mothbean	114.5	4442	1007	3478	338	2099.0	654	31, 061	1.87
T_5 Little millet + Pigeonpea (6:1) - Horsegram	130.0	6447	1684	4819	239	1209.3	790	51, 985	2.36
T_6 Little millet + Pigeonpea (6:1) - Mothbean	129.8	6331	1633	4689	254	1237.0	699	44, 647	2.15
T_7 Little millet + Lablab (4:1) - Horsegram	110.4	4351	908	381	1494	1425.9	594	13, 432	1.31
T_8 Little millet + Lablab (4:1) - Mothbean	108.3	4214	861	3215	1412	1407.1	641	8, 882	1.20
T_9 Little millet + Lablab (6:1) - Horsegram	117.8	5549	1245	4159	774	102.3	562	19, 696	1.46
T_{10} Little millet + Lablab (6:1) - Mothbean	119.0	5251	1232	3867	752	219.4	624	19, 232	1.47
	5.88	261							
	12.30	545							

component 'a' is greater than that for component 'b'.

$$\text{Aggressivity} = \frac{Yab}{Yaa \times Zab} \times \frac{Yba}{Ybb \times Zba}$$

If the aggressivity value of a component crop with other component crop is zero (0), then the two component crops are said to be equally competitive. Aggressivity value when greater than zero (>0) indicates that one crop is dominating over the other. As it is based on a sample difference, the interpretation of intercropping treatment may become difficult if the values are identical in different treatments.

RESULTS AND DISCUSSION

Growth and yield attributes

Growth attributes like plant height and dry matter production was significantly affected by intercropping. Plant height of little millet was found to be higher at all the stages under the treatment, little millet + pigeonpea - horsegram at 6:1 ratio (T_5) (129.5 cm at harvest) followed by little millet + pigeonpea - mothbean at 6:1 ratio (T_6) (130.0 cm at harvest) (Table 1). Among the various intercrops, little millet + pigeonpea- horsegram at 6:1 ratio (T_5) intercropping system produced higher dry matter production (6447 kg / ha) followed by little millet + pigeonpea - mothbean at 6:1 ratio (T_6) (6331 kg / ha). Similar results were also obtained by Kaushik and Sharma (2017) in wheat based intercropping system.

The yield attributes of little millet like number of productive tillers per hill and test weight is found to be increased when intercropped with pigeonpea at 6:1 ratio (Table 1). This might be due to development of better complementary relationship and non-renewable resources like water, nutrients and incoming sunlight. Tripathi and Kushwaha (2013) also reported that plant height and number of leaves per plant of pearl millet under intercropping system were either higher or statistically at par with sole pearl millet, which might be due to better utilization of space and light interception coupled with nutrient contribution of leguminous crop to cereal crop.

Yield and system productivity

The grain yield of little millet was significantly influenced by various intercrops at harvest and the grain yield ranged from 861 to 1684 kg / ha (Table 1). The highest grain (1684 kg/ha) and straw yields (4819 kg / ha) were recorded little millet + pigeonpea - horsegram at 6:1 ratio (T_6) and it was on par with little millet + pigeonpea - mothbean at 6:1 ratio (T_6) (1633 kg / ha grain yield and 4689 kg / ha straw yield, respectively). Higher grain yield of pigeonpea in 6:1 row ratio could be attributed to higher yield attributes and least competition due to better planting arrangement. These results are in close conformity with the findings of Rathore and Gautam (2003).

Table 2. Effect of different intercropping treatments LER, RCC and RNRI. Data's not statistically analyzed.

	Treatments	Land equivalent ratio (LER)	Relative crowding coefficient (RCC)	Aggressivity	
				Base crop	Inter crop
T_3	Little millet + Pigeonpea (4:1) - Horsegram	1.03	0.54	-0.92	+0.92
T_4	Little millet + Pigeonpea (4:1) - Mothbean	1.08	0.59	-1.02	+1.02
T_5	Little millet + Pigeonpea (6:1) - Horsegram	1.45	1.62	-0.49	+0.49
T_6	Little millet + Pigeonpea (6:1) - Mothbean	1.41	1.54	-0.68	+0.68
T_7	Little millet + Lablab (4:1) - Horsegram	0.83	0.38	-0.38	+0.38
T_8	Little millet + Lablab (4:1) - Mothbean	0.85	0.43	-0.28	+0.28
T_9	Little millet + Lablab (6:1) - Horsegram	0.99	1.12	+0.15	-0.15
T_{10}	Little millet + Lablab (6:1) - Mothbean	0.98	1.03	+0.19	-0.19

Horsegram and mothbean yield were significantly higher in little millet -horsegram/ mothbean sequence than horsegram/mothbean relayed in little millet + pigeonpea or lablab in 4:1 or 6:1 row ratio, but it was on par with horsegram/mothbean relayed in little millet + pigeonpea in 6:1 row ratio. Similar finding was reported by Kumar *et al.* (2008).

Grain equivalent yield

Little millet equivalent yield (GEY) (Table 2) was calculated for comparing different intercropping combinations. The highest little millet grain equivalent yield (2121.9 kg / ha) was recorded in 6:1 row ratio of little millet + pigeonpea -horsegram sequence which was closely followed by 6:1 row proportion of little millet + pigeonpea -mothbean sequence (2099.0 kg / ha). Similar trend was also observed by Basavarajappa *et al.* (2010) in foxtail millet and pigeonpea intercropping systems Kaushik and Sharma (2017) in wheat based intercropping systems.

Other intercropping indices

The intercropping system of little millet + pigeonpea - horsegram at 6:1 ratio recorded significantly higher LER values of during the year of study.This was resulted due to higher yield of little millet in intercropping systems due to a better land utilization as compared to the sole crop. Beyond this; the complementary benefits from other components in the cropping system was also found to play a major role in higher LER (Choudhary 2009). Pigeonpea intercropped with little millet in 6:1 followed by horsegram sequence ratio had higher RCC value of 1.62 compared to other intercropping systems. Similar yield advantage with high, RCC was also observed in pigeonpea in an intercropping system with finger millet (Maitra *et al.* 2000).

Aggressivity of intercrops irrespective of subsequent crops was higher than little millet in little millet intercropped with pigeonpea and lablab in two different ratios except in little millet + lablab (6:1) - horsegram / mothbean as in the year of 2016-17. The aggressivity of base crop of little millet was higher when it was intercropped with lablab in 6:1 ratio either followed by horsegram / mothbean. Similar trend was also observed by Ram and Meena (2015). According to them aggressivity of the intercropping treatments have positive sign value which indicated in pearl millet in different row ratios studied.

Economics of intercropping

The net return (Rs 51,985 / ha) and benefit cost ratio (2.36) were recorded by little millet intercropped with pigeonpea at 6:1 ratio with horsegram as sequence crop during the crop year (Table 1). Little millet intercropped with pigeonpea at 6:1 ratio with mothbean as sequence crop was found to be the second best. According to Seran and Brintha (2009) the intercropping system provides higher cash return to smallholder farmers than growing the monocrops.

CONCLUSION

Based on these results, it may be summarized that to

increase the productivity per unit area in little millet intercropping system under rainfed conditions of Tiruvannamalai District, growing of little millet and pigeonpea in 6:1 row ratio with horsegram or mothbean in sequence have been found superior over other intercropping systems and also growing sole crop of little millet alone.

REFERENCES

Basavarajappa R, Prabhakar A, Halikatti S (2010) Foxtail millet (*Setaria italica* L.) based inter cropping systems under shallow alfisols. *Karnataka J Agric Sci* 16(4): In press.

Choudhary RA (2009) Intercropping in pearl millet (*Pennisetum glaucum* (L.) R. Br. Emend. Stuntz) with pluse crops in rainfed conditions. MSc (Agric) thesis. Submitted to Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

Gitari HI, Nyawade SO, Kamau S, Gachene CKK, Karanja NN, Schulte-Geldermann E (2019) Increasing potato equivalent yield increases returns to investment under potato-legume intercropping systems. *Open Agric* 4: 623–629.

Jan R, Saxena A, Jan R, Khanday M, Jan R (2016) Intercropping indices and yield attributes of maize and black cowpea under various planting pattern. *The Bioscan* 11: 1-5.

Jensen ES, Carlsson G, Hauggaard-Nilesen H (2020) Intercropping grain legumes and cereals improves use of soil N resources and reduces the requirement of synthetic fertilizer: A global scale analysis. *Agron Sustain Dev* 40.

Kalu Ram, Meena RS (2015) Evaluation of pearl millet and mungbean intercropping systems in arid region of Rajasthan. *Bangladesh J Biol* 43 (3): 367-370.

Kaushik SS, Sharma TD (2017) Wheat and component intercrop yield, land equivalent ratio and monetary indices influenced by intercropping and row proportions. *Int J Curr Microbiol Appl Sci* 6: 2626-2631.

Kumar KBH, Halikatti SI, Hiremath SM, Chittapur BM (2008) Effect of intercropping system and row proportions on the growth and yield of little millet and Pigeonpea. *Karnataka J Agric Sci* 21: 479-481.

Lal RB, Ray S (1976) Economics of crop production of different intensities. *Ind J Agric Sci* 46: 93-96.

Maitra S, Ghosh D, Sounda G, Jana P, Roy D (2000) Productivity, competition and economics of intercropping legumes in finger millet at different fertility levels. *Ind J Agric Sci* 70(12): 824-828.

McGillchrist CA, Trenbatn BR (1971) A revised analysis of plant competition experiment. *Biometrics* 27: 659-671.

Rathore SS,Gautam RC (2003) Agro techniques to improve the productivity of pearl millet + cowpea intercropping system under dry land conditions. *Ann Agric Res* 24: 971-975.

Seran TH, Brintha I (2009) Study on biological and economic efficiency of radish (*Raphanus sativus* L.) intercropped with vegetable Amaranthus (*Amaranthus tricolor* L.). *Open Hort J* 2: 17-21.

Tripathi AK, Kushwaha HS (2013) Performance of pearl millet (*Pennisetum glaucum*) intercropped with pigeonpea (*Cajanus-cajan*) under varying fertility levels in the rainfed environment of Bundelkhand region. *Ann Agric Res New Series* 34: 36-43.

Willey RW (1979) Intercropping its importance and research needs, part-I, competition and yield advantages. *Field Crop Abstracts* 32: 1-10.