Biological Forum – An International Journal **15(9): 370-373(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Influence of Intercropping Minor Millets on Growth and Yield of Summer Irrigated Cotton

Prasannasreenithi[1], S.R. Veeraputhiran[2*], A. Gurusamy[3], G. Anand[4] and P. Kannan[5]

[1]PG Scholar, Department of Agronomy, AC & RI, Madurai (Tamil Nadu), India.
[2]Professor (Agronomy) and Head, CRS, Srivilliputhur (Tamil Nadu), India.
[3]Professor, Department of Agronomy, AC & RI, Madurai (Tamil Nadu), India.
[4]Associate Professor, Department of PB&G, AC & RI, Madurai (Tamil Nadu), India.
[5]Associate Professor, Department of Soils and Environment, AC & RI, Madurai (Tamil Nadu), India.

(Corresponding author: S.R. Veeraputhiran)*
(Received: 26 June 2023; Revised: 27 July 2023; Accepted: 26 August 2023; Published: 15 September 2023)
(Published by Research Trend)

ABSTRACT: The wider interspace available with cotton husbandry can be effectively used by intercropping with short duration millets to enhance the input use efficiency and sustainability. Due to slow growth of cotton and weeds challenges the cotton growth and reduced the yield. In addition, higher input with labour cost lead to reduce economic benefits of cotton cultivation. To overcome the challenges intercropping is having enormous potential. Field experiment was conducted at Central farm, Department of Agronomy, Agriculture College and Research Institute, Madurai, Tamil Nadu, India during summer, March–August 2023 to study the feasibility of minor millet intercropping in cotton. The experiment was laid out in randomized block design with ten treatments and were replicated thrice. The treatments consisted of intercropping of barnyard millet, foxtail millet and finger millet at 1:1 ratio under normal geometry (T_1, T_3, T_3), 2:2 ratio under paired row system (T_4, T_5, T_6) and at 1:3 ratio under replacement series (T_7, T_8, T_9) along with cotton sole cropping as control (T_{10}). The results revealed that, among the intercropping system, plant height was higher in (T_4) cotton + barnyard millet at 2:2 ratio and LAI was recorded higher in cotton + foxtail millet at 1:3 ratio (T_8). Cotton + foxtail millet at 2:2 (T_5) obtained higher dry matter production and also seed cotton yield. The maximum cotton equivalent yield (3061 kg ha^{-1}) was recorded in cotton intercropped with barnyard millet at 2:2 ratio under paired row system (90/60 × 30 cm).

Keywords: Cotton, minor millets, plant height, LAI, DMP, seed cotton yield and cotton equivalent yield.

INTRODUCTION

Cotton stands as a major cash crop, often referred to as "white gold" or the "king of fibres." It plays a critical role in both national and global economies, primarily recognized for its significance in the textile industry, accounting for approximately 35 percent of the world's annual demand for natural fibres (Reddy *et al*., 2023). Notably, India occupies a substantial share, with 41.3 per cent of the world's cotton cultivated area. In the state of Tamil Nadu, cotton is cultivated across 1.55 lakh hectares, yielding 5.0 lakh bales with a productivity of 548 kg per hectare. However, this falls below the global average yield of 768 kg per hectare (Anonymous, 2021). To maximize resource utilization in cotton cultivation, intercropping has been identified as a promising and economically viable approach (Veeraputhiran and Sankaranarayanan *et al*., 2021). Minor millets have gained popularity in recent years due to their significant nutraceutical potential, often referred to as "nutricereals" or "nutraceutical crops" (Zahra *et al*. 2015; Bhandari *et al.*, 2023; Kumar *et al.*, 2023). Intercropping minor millets with compatible crops offers the opportunity to expand the cultivation area of these minor millets and sustain their productivity (Maitra, 2020). The relatively longer duration with slow growing habit of cotton during the initial stages, offers the scope for intercropping in cotton (Panda *et al.*, 2020). The current research was aimed to identify the suitable minor millets which could be effectively used in cotton based intercropping system.

MATERIALS AND METHODS

Field experiment was conducted at Central farm, Agriculture College and Research Institute, Madurai, Tamil Nadu during summer, 2023 (March-August). The farm is geographically located in the Southern zone of Tamil Nadu at 9° 54′N latitude, 78°54′E and at an altitude of 147 m above mean sea level. A total rainfall of 434.4 mm was received in 18 rainy days during the cropping period and the mean evaporation was 5.3 mm day^{-1}. The mean maximum and minimum temperature were 36.3°C and 27.9°C respectively. The mean relative humidity was 84.2 per cent (07.22 hrs) and 57.7 per cent (14.22 hrs). The mean sunshine shine hours were 7.7 hrs day^{-1} with an average wind velocity of 4.7 km hr^{-1}.

The experiment was carried out in a randomized block design with three replications. The soil of the experimental field is sandy clay loam in texture with

low, medium and high in N, P and K status. The treatments consisted of cotton + barnyard millet at 1:1 ratio (T_1), cotton + foxtail millet at 1:1 ratio (T_2), cotton + finger millet at 1:1 ratio (T_3), cotton + barnyard millet at 2:2 ratio (T_4), cotton + foxtail millet at 2:2 ratio (T_5), cotton + finger millet at 2:2 ratio (T_6) under additive series, cotton + barnyard millet at 1:3 ratio (T_7), cotton + foxtail millet at 1:3 ratio(T_8), cotton + finger millet at 1:3 ratio(T_9) under replacement series and cotton sole crop as control (T_{10}). The varieties used in this study were SVPR-6 (cotton), MDU-1 (barnyard millet), CO-7 (foxtail millet) and CO-15 (finger millet). The spacing followed for cotton was 75 × 30 cm under sole crop and replacement series, 90/60 × 30 cm for paired row planting. For all the intercrops, 30 × 10 cm spacing was followed (Fig. 1). The recommended fertilizer of 80: 40: 40 kg NPK ha^{-1} was applied for cotton and no additional fertilizers were applied to intercrops. Periodical biometric observations were taken on 60, 90,120 DAS and at harvest. The plant height of cotton was measured from the base of the plant to the tip of leaf and expressed in cm. The third leaf from the top of main branch was selected as leaf area of the maximum leaf length and breadth were recorded. Additionally, the total number of leaves were counted. The leaf area index was assessed by using the formula given by Ashley *et al.* (1963).

$$LAI = \frac{L \times B \times K \times \text{Number of leaves plant}^{-1}}{\text{Plant spacing in cm}^{-2}}$$

(Where, L – leaf length, B – leaf breath and K – correction factor (7.77))

Five plants were carefully removed from the each treatment which were dried under shade and then oven dried at 80 ± 2°C till a constant weight was recorded and taken as dry weight. Cotton equivalent yield was calculated by using the following formula

$$CEY = \text{Yield of cotton in intercrop} = \left[\frac{\text{Yield of intercrop (kg ha}^{-1}) \times \text{Price of intercrop (₹/kg)}}{\text{Price of cotton (₹/kg)}} \right]$$

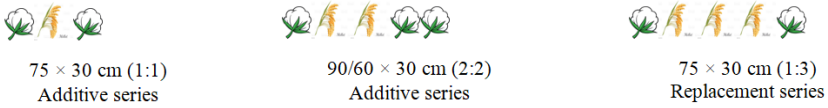

Fig. 1. Spacing adopted for different treatments.

RESULT AND DISCUSSION

Plant height. Plant height is a fundamental parameter used to assess a plant's growth and development, providing insights into its overall health and vigour. In cotton + minor millets intercropping system, no significant difference was observed at 30 DAS. However, significant difference was observed in later stages of crop growth (Table 1). Among the various intercropping system, maximum plant height of cotton (79.66 cm and 123.78 cm at 60 and 120 DAS) was recorded in cotton + barnyard millet at 2:2 ratio (T_4) under paired row system. The increase in plant height was a result of apical dominance of cotton, due to the profuse tillering capacity of barnyard millet in the same treatment (Erasmo *et al.*, 2017). The millets intercropped with cotton at 2:2 ratio and 1:3 ratio recorded maximum plant height when compare with the 1:1 ratio. The reduction in the plant height was mainly due to the competition for resources. The minimum plant height of 53.9 cm (60 DAS) and 85.1 cm (120 DAS) was recorded under (T_1) cotton + barnyard millet (1:1). Aladakatti *et al.* (2011) reported the same results in sorghum and sunflower intercropped with cotton.

Leaf area index: Leaf Area Index (LAI) is a metric that indicate both the density and efficiency of vegetation cover in a specific area. Among the intercropping system, the maximum LAI of 1.88 and 3.62 at 60 sand 120 DAS was observed in cotton + foxtail millet (T_8) (Table 1). The minimum LAI was observed in cotton + barnyard millet intercropping at 1:1 ratio (T_1). The decrease in LAI under intercropping might be attributed due to the competitive and suppressive influence of intercrops, leading to the development of slender and less robust cotton with reduced leaf area and foliage as reported by Sathishkumar *et al.* (2021).

Table 1: Influence of intercropping of minor millets on growth attributes of cotton.

Treatments	Plant height (cm)		Leaf Area Index		DMP (kg ha^{-1})	
	60 DAS	120 DAS	60 DAS	120 DAS	60 DAS	120 DAS
T_1-Cotton+ Barnyard millet (1:1)	53.89	85.13	1.02	3.02	1808	3214
T_2-Cotton + Foxtail millet (1:1)	60.17	92.11	1.30	3.21	2050	3729
T_3-Cotton + Finger millet (1:1)	55.48	92.46	1.17	3.04	1916	3511
T_4-Cotton + Barnyard millet (2:2)	79.66	123.78	1.42	3.23	1842	3466
T_5-Cotton + Foxtail millet (2:2)	67.08	108.54	1.64	3.42	2052	3872
T_6-Cotton + Finger millet (2:2)	66.81	99.46	1.53	3.24	1920	3645
T_7-Cotton + Barnyard millet (1:3)	65.42	109.62	1.74	3.43	690	1550
T_8-Cotton + Foxtail millet (1:3)	73.55	116.02	1.88	3.62	845	1594
T_9-Cotton + Finger millet (1:3)	72.39	113.24	1.84	3.61	806	1552
T_{10}-Sole cotton	78.39	126.89	1.98	3.65	2276	4058
S.Ed	**1.87**	**2.97**	**0.04**	**0.08**	**65.7**	**85.2**
CD (p=0.05)	**4.01**	**6.36**	**0.09**	**0.17**	**140.7**	**182.3**

Dry matter production: Dry matter production refers to the total weight of plant material (biomass) produced through photosynthesis and growth, excluding water content**.** Significant difference in DMP was noticed at all the stages of observation due to intercropping system (Table 1). Among the intercropping system, cotton + foxtail millet at 2:2 ratio recorded the maximum DMP which was comparable with cotton + foxtail millet at (1:1), cotton + finger millet (2:2) at all stages of observations (60 and 120 DAS). Increased competition for nutrient, moisture and environmental factors reduced stem elongation and leaf area. This competition may have contributed to minimum accumulation of dry matter of cotton in intercropping system. Similar results of higher DMP with cotton intercropping was documented by Rathiya *et al.* (2010); Jayakumar and Surendren (2017).

Seed cotton yield: Seed cotton yield is the amount of raw cotton, consisting of both cotton fibre and cotton seed. Seed cotton yield was influenced by different intercrops (Table 2). Cotton + foxtail millet intercropping at 2:2 paired row system (T_5) resulted in maximum seed cotton yield of 2191 kg ha^{-1} and was found superior over other intercropping systems. The minimum seed cotton yield was recorded in cotton + barnyard millet (1:3) under replacement series (T_7). This could be attributed due to the fact that under replacement condition, proportion of plant population was comparatively less which led to yield reduction. This results was in close proximity with the finding of Kumar *et al*. (2017); Panda *et al.* (2020).

Cotton equivalent yield: To access the overall productivity of an intercropping system, the yield of the intercropped plants were converted into a metric known as "cotton equivalent yield". In the present study, all the intercrops under 1:1 and 2:2 ratio produced significantly higher cotton equivalent yield. The maximum cotton equivalent yield of 3061 kg $ha^{-1}$was registered with cotton+ barnyard millet at 2:2 ratio (T_4) under paired row system, which was on par with that of cotton + barnyard millet 1:1 ratio (T_1) and significantly higher than all other intercropping system (Table 2 & Fig. 2). This increase in yield under intercropping system was primarily attributed to the fact that the intercropped plants performed well and also obtain remunerative market price. This is in agreement with the finding of Vekariya *et al.* (2015); Kumar *et al.* (2017); Siddagangamma *et al.* (2021).

Table 2: Influence of intercropping of minor millets on yield of cotton.

Treatments	Seed cotton yield (kg ha^{-1})	Cotton equivalent yield (kg ha^{-1})
T_1-Cotton+ Barnyard millet (1:1)	2158	3003
T_2-Cotton + Foxtail millet (1:1)	2175	2732
T_3-Cotton + Finger millet (1:1)	2167	2788
T_4-Cotton + Barnyard millet (2:2)	2168	3061
T_5-Cotton + Foxtail millet (2:2)	2191	2778
T_6-Cotton + Finger millet (2:2)	2183	2828
T_7-Cotton + Barnyard millet (1:3)	1242	2273
T_8-Cotton + Foxtail millet (1:3)	1274	2026
T_9-Cotton + Finger millet (1:3)	1263	2137
T_{10}-Sole cotton	2240	2240
S.Ed	**48.8**	**71.3**
CD (p=0.05)	**104.5**	**153.2**

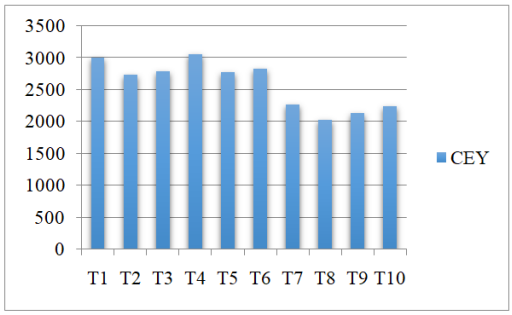

Fig. 2. Cotton equivalent yield.

CONCLUSIONS

It can be concluded from the study that intercropping of barnyard millet at 2:2 ratio under paired row system of cotton can be recommended as viable intercropping system for cotton farmers.

FUTURE SCOPE

The cotton + minor millets intercropping system can be promoted as a way to maintain soil health in cotton fields, which reduces the need for synthetic fertilizers. Cotton is a water- intensive crop, intercropping with drought resistant minor millets can lead to more efficient water use. Cotton + minor millet intercropping system also helps the farmers to mitigate the impact of weather factors and cotton price fluctuations. It also enhance sustainability and diversifying the farm income.

Acknowledgement. The authors greatly acknowledge the DST-FIST, Department of Agronomy, AC & RI, Madurai, for providing instrumentation and lab facilities.
Conflict Of Interest. None.

REFERENCES

Anonymous (2021). Cotton market report newsletter XXXXIII (08):1-2, Indian Cotton Federation, Coimbatore.

Aladakatti, Y. R., Hallikeri, S. S., Nandagavi, R. A., Hugar, A. Y., & Naveen, N. E. (2011). Effect of intercropping of oilseed crops on growth, yield and economics of cotton (*Gossypium hirsutum*) under rainfed conditions. *Karnataka Journal of Agricultural Sciences*, *24*(3), 280-282.

Ashley, D. A., Doss, B. D. and Bennett, O. L. (1963). A Method of Determining Leaf Area in Cotton 1. *Agronomy Journal*, *55*(6), 584-585.

Bhandari, A. S., Jat, K. B., Kanse, A. A., Gorde, P. D., Suri, S. and Patil, A. G. (2023). Millets as Super Foods: A Review. *Acta Scientific nutritional health*, *7*(6), 90-103.

Erasmo, E. A., Gonçalves, R. C., Da Mata, J. F., Oliveira, V. A. and Benício, L. P. (2017). Growth of Brachiariabrizantha planted at different densities and seasons in Santa Fé system with a culture of soybean. *Emirates Journal of Food and Agriculture*, 658-663.

Jayakumar, M. and Surendran, U. (2017). Intercropping and balanced nutrient management for sustainable cotton production. *Journal of Plant Nutrition*, *40*(5), 632-644.

Jayakumar, M. A., K. Sujatha, V. Alex Albert, G. Anand and M. L. Mini (2023). Bioefficacy of Seaweed Coating Formulation on Seed Quality and Biochemical Attributes in Barnyard Millet Var. MDU 1. *Biological Forum – An International Journal, 15*(8), 474-477.

Kumar, R., Turkhede, A. B., Nagar, R. K. & Nath, A. (2017). Effect of different intercrops on growth and yield attributes of American cotton under dry land condition. *International Journal of Current Microbiology and Applied Sciences*, *6*(4), 754-761.

Kumari, C. P., Ramana, M. V., Goverdhan, M., Reddy, G. K., Vinay, G., Kumar, M. S. and Karthik, R. (2022) Cropping System Diversification for various Integrated Farming System Models in Telangana. *Biological Forum– An International Journal*, *14*(1), 1432-1438)

Maitra, S., Pine, S., Shankar, T., Pal, A., & Pramanick, B. (2020). Agronomic management of foxtail millet (*Setaria italica* L.) in India for production sustainability: A review. *International Journal of Bioresource Science*, *7*(1), 11-16.

Panda, S. K., Panda, P., Pramanick, B., Shankar, T., Praharaj, S., Saren, B. K. & Maitra, S. (2020). Advantages of cotton based intercropping system: A review. *International Journal of Bioresource Science*, *7*(2), 51-57.

Rathiya, P. S., Lakpale, R., Shrivastava, G. K., & Bargali, S. S. (2010). Effect of nutrient blending with FYM on biomass production and economics under hybrid cotton soybean intercropping system. *Journal of Plant Development Sciences*, *2*(1&2), 9-18.

Reddy, G. R., Pravallika, K. V. S. D., Gita, B. M. and Reddy, M. C. (2023). An Economic Analysis of Cotton Price Forecasting Using ANN in Andhra Pradesh, India. *International Journal of Economic Plants*, *10*, 041-048.

Sathishkumar, A., Srinivasan, G., & Subramanian, E. Season, intercropping system and weed management practices. *Journals of Soils and Crops*, *31*(2) 270-276.

Siddagangamma, K. R., Channabasavanna, A. S., Mahadevaswamy, K., Ajayakumar, M. Y. & Yadahalli, G. S. (2021). Effect of Herbicides on Soil Microflora and Dehydrogenase Activity in Transplanted Bt Cotton Based Intercropping System. *Int. J. Curr. Microbiol. App. Sci*, *10*(01), 902-909.

Veeraputhiran, R., & Sankaranarayanan, K. (2021). Weed smothering efficiency and cotton equivalent productivity of Bt cotton based intercropping systems. *Indian Journal of Weed Science*, *53*(4), 436-439.

Vekariya, P. D., Khokhani, M. G., Gajera, M. S. & Akbari, K. N. (2015). Productivity and economics of cotton (*Gossypium hirsutum* L.) based intercropping system under rainfed conditions of North Saurashtra agro climatic zone of Gujarat. *J. Cotton Res. Dev*, *29*(2), 264-267.

Zahra, K., Mehdi, D. & Issa, K. (2015). Effect of millet and peanut intercropping on efficiency of use the environmental resource and soil fertility. *Biological Forum – An International Journal*, *7*(1), 800-806.

How to cite this article: Prasannasreenithi, S.R. Veeraputhiran, A. Gurusamy, G. Anand and P. Kannan (2023). Influence of Intercropping Minor Millets on Growth and Yield of Summer Irrigated Cotton. *Biological Forum – An International Journal, 15*(9): 370-373.