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Effect of different intercropping systems on yield attributes and economics of cotton

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Abstract
A Field experiment was conducted at Kallampuli village, Kadayanallur block, Tenkasi District during *Kharif* season (May to October) 2020 to evaluate the effect of different intercropping systems on yield attributes of cotton. The intercrops included in the investigation were T_1-Cotton alone, T_2-Cotton+Blackgram, T_3-Cotton+Greengram, T_4-Cotton+Cowpea, T_5-Cotton+Tomato, T_6-Cotton+Brinjal, T_7-Cotton+Coriander, T_8-Cotton+Sunflower, T_9-Cotton+Sesame. Among the various intercrops evaluated, the higher yield components of cotton *viz*., number of monopodial branches plant^{-1}, number of sympodial branches plant^{-1}, number of squares plant^{-1}, number of bolls plant^{-1}, boll weight of cotton were noticed in Cotton+Blackgram, and these parameters significantly increase the seed cotton yield of cotton. This was followed by Cotton+Greengram. This was statistically on par with Cotton+Cowpea intercropping system. The least values for all the yield parameters were registered with cotton+sunflower intercropping system.

Keywords: Cotton, intercropping system, number of monopodial branches plant^{-1}, number of sympodial branches plant^{-1}, number of squares plant^{-1}, number of bolls plant^{-1}, boll weight of cotton, seed cotton yield, economics

Introduction
Cotton (*Gossypium* sp.) is the most important fibre crop known as King of Fibre and accounts for around 25% of the total global fibre production. Cotton is also one of the most important commercial and cash crops cultivated in India so that called as White Gold. In the raw material consumption basket of the Indian textile industry the contribution of Cotton is around 59% besides earning valuable foreign exchange by exporting of raw materials and goods. It plays a major role in sustaining the livelihood of an estimated 5.8 million cotton farmers and 40-50 million people engaged in related activities such as cultivation, processing and trading. India got the first place in the world in Cotton acreage with around 126.07 lakh hectares under cotton cultivation which is around 37% of the world area of 363.3 lakh hectares. Approximately 62% of cotton in India is cultivated as rainfed cotton and 38% as irrigated cotton. In terms of productivity India ranks poorly compared China (1764 Kg/ha) and USA (955 Kg/ha) during 2018-19 India's productivity is estimated at 453.43 Kg/ha. In Tamil Nadu cotton is cultivated in 0.70 lakh hectares with the production of 5 lakh bales and productivity of 1214 kg/ha.

Intercropping in cotton is one of the ways to improve the food security and soil fertility whilst generating cash income of the rural poor. Introducing additional population of intercrops without reducing the base crop population gives rise to severe competition between crop plants for soil moisture and nutrients. Replacing certain rows of base crop population with intercrops is ideal for reducing the competition for resources and to achieve higher production by better utilization of moisture and nutrients from the soil and with above soil by harvesting the maximum possible solar radiation which in turn better photosynthate formation (Thavaprakash *et al*., 2005) [15]. Now a days intercropping is common in intensive agriculture to maximize the land use and also significant in reducing the weeds infestation. Less weed infestation was recorded in the intercropping system than the monoculture system.

The common practise of cotton cultivation is intercrop or mixed cropping with pulses or vegetables. Also, when parts of the legume is senesces and decomposes soil N supply to the associated crop is improved. However, the monetary advantages of pulses intercropping are meager. In addition to that existing low-price situation for cotton produce is discouraging the cotton cultivation. To overcome these situations intercropping of high value vegetable crops is

one of the viable options. While considering the inconsistency in performance and price fluctuation of vegetable crops, intercropping of multi vegetables with different growth habits are aimed. Intercropping is one of the ways to increase the cropping intensity and resource utilization (Harisudan *et al*., 2008) [5]. Intercropping in Cotton has been recently recognized as potentially beneficial and economic system of crop production. Intercropping in cotton could exploit the environment in better way besides providing insurance against the inclement weather situation and consequent crops.

Crop diversification through intercropping has been recognised as kind of biological insurance against risk and aberrant rainfall behaviour in dry environment (Dutta and Bandyopadhyay, 2006) [4]. Growing of legumes like Black gram, Green gram, Cowpea were constituted as potential intercrops under rainfed condition (Lawrence and Gohain, 2011) [8]. Intercropping is one of the potential cropping systems to exploit the natural and artificial resources more efficiently than a single crop. Cropping system involving legumes, oilseeds and cereals together in the same field offers the possibility of yield advantage for both component crops and one of them as monocropping (Ogutu *et al*., 2012) [11]. An intercrop having different growth habit and canopy can easily be accommodated with least competition. Intercropping in cotton with oilseed and pulse crops will increase the net returns of the cropping system.

Materials and Methods

A Field experiment was conducted at Kallampuli village, Kadayanallur block, Tenkasi District during *Kharif* season (May to October) 2020. The field is situated at $9^0$2' N latitude, $77^0$22' longitude and at an altitude of 143 meters above Mean sea level (MSL). The weather of Kadayanallur block is moderately warm with hot summer months. The *kharif* season received a total rainfall of 690.4 mm within 91 rainy days. The maximum temperature ranged from 31.2 ^{0}C to 27.6 ^{0}C and the minimum temperature ranged from 28.0 ^{0}C to 26.5 ^{0}C. The highest mean relative humidity is 90.2 percent during September and the lowest relative humidity is 74.2 percent during May. The soil of the experimental field was Clay loam soil with pH of 7.3 and EC of 0.3 d Sm^{-1}. Regarding fertility status of the soil were classified as low in available nitrogen (137 kg ha^{-1}), medium in available phosphorous (19 kg ha^{-1}) and high in available potassium content (180 kg ha^{-1}). The experiment was laid out in Randomized Block Design with nine treatments and replicated thrice. The cotton hybrid RCH-659 was grown during the investigation. The intercrops Black gram (ADT 5), Greengram (CO 6), Cowpea (CO 2), Tomato (CO 3), Brinjal (PKM 1), Coriander (CO 1), Sunflower (CO 2), Sesame (CO 1) were chosen for the study.

The following observation were taken to study the effect of different intercropping systems on yield attributes of cotton.

Results and discussion

Effect on yield parameters of cotton

Number of monopodial branches plant^{-1}, number of sympodial branches plant^{-1}, number of squares plant^{-1}, number of bolls plant^{-1}, boll weight of cotton were higher in Cotton+Blackgram, and these parameters effectively increase the seed cotton yield. Cotton + blackgram recorded the highest yield of 2974.22 kg ha^{-1}. And it was followed by 2773.63 kg ha^{-1} which is in cotton + greengram intercropping system. It was on par with cotton + cowpea (2658.18 kg ha^{-1}) intercropping system. The lowest yield (1875.26 kg ha^{-1}) obtained in cotton + sunflower intercropping system (T_8). This is in accordance with the findings of Chellamuthu and Ramaswami (2000) [3].

Increased yield of cotton would also have been resulted due to the nitrogen fixing ability of blackgram. Nitrogen fixed by blackgram would have contributed for the increased yield of intercropped cotton over sole cotton cropping system. The above findings is with (Jayakumar *et al*., 2008) [7] in agreement where cotton yield increased when intercropped with legume. Legume intercropping increased the yield of cotton by increasing the NO_3 and NH_4 concentrations and populations of beneficial active bacteria in the cotton rhizosphere. These may be the reasons for the increased yield of cotton in intercropped treatments.

Main advantage of intercropping is more efficient utilization of available resources and the increased productivity compared with each sole crop of mixture. So that the yield of intercropped cotton is increased compared with sole cropping (Mucheru Muna *et al.*, 2010) [10].

Cotton + sesame intercropping recorded higher seed cotton yield comparable with the sole cotton. This is in conformity with the findings of Aladakatti *et al.* (2011) [1]. Cotton + cowpea intercropping system significantly increase the yield of cotton and production efficiency also increased. These results are in corroborate with the findings of Rajpoot *el al.* (2014) [12].

Table 1: Effect of different intercropping systems on yield attributes on cotton

Treatments	Monopodial branches plant^{-1}	Sympodial branches plant^{-1}	Squares plant^{-1}	Bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
T_1-Sole cotton	1.20	12.09	34.20	39.21	4.53	2312.51
T_2-Cotton+Black gram	2.20	22.00	48.81	43.32	5.31	2974.22
T_3-Cotton+Green gram	1.92	20.39	46.19	42.19	5.14	2773.63
T_4-Cotton+Cowpea	1.90	20.19	46.09	41.10	4.93	2658.18
T_5-Cotton+Tomato	1.62	15.29	38.09	36.41	4.25	2058.43
T_6-Cotton+Brinjal	1.59	15.09	38.00	35.22	4.16	1949.86
T_7-Cotton+Coriander	1.79	16.89	41.89	37.53	4.47	2134.62
T_8-Cotton+Sunflower	1.41	13.49	36.10	34.17	4.11	1875.26
T_9-Cotton+Sesame	1.70	18.59	44.19	36.52	4.32	2104.53
S.Em	0.02	0.25	1.76	0.43	0.02	65.60
CD (P=0.05)	0.07	0.74	5.23	1.51	0.05	187.66

Table 2: Effect of different intercropping systems on Economics on cotton

Treatments	Economics			
	Total cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	Return rupee^{-1} Invested
T_1-Sole cotton	73254	105485	32231	1.44
T_2-Cotton+Black gram	75466	168289	92823	2.23
T_3-Cotton+Green gram	75454	159962	84508	2.12
T_4-Cotton+Cowpea	75433	159163	83730	2.11
T_5-Cotton+Tomato	75796	147802	72006	1.95
T_6-Cotton+Brinjal	75844	146378	70534	1.93
T_7-Cotton+Coriander	75323	147633	72310	1.96
T_8-Cotton+Sunflower	75634	123283	47649	1.63
T_9-Cotton+Sesame	75367	152995	77628	2.03

Effect on economics

The highest net return and return rupee^{-1} invested (Rs 92823 and 2.23) was recorded in cotton + blackgram followed by cotton + greengram. The least net return and return rupee^{-1} invested (Rs 32231 and 1.44) was recorded in sole cotton.

Intercropping blackgram with cotton recorded highest gross return over cotton sole cropping. Similarly, maximum net returns per ha and BCR were observed from intercropping of cotton + blackgram system was higher over cotton alone. This is due to the fact that blackgram enjoys premium price in the market owing to its inherent traits.

Cropping system does not influence the seed cotton yield that much but the additional yield of intercrops makes a system more remunerative over the sole cotton. It also minimizes the weeds and insect infestation also brings about a more distribution of farm labor than sole cropping. (Seema sepat *et al*., 2010) [13]. Intercropping system stabilizes the productivity and enhance the total returns which is more benefitable to the farmers also act as a insurance against the crop failure. (Singh *et al*., 2011) [14].

Intercropping can increase total crop production and the ratio of production to investment by optimizing population structure and interspecific relationships between intercrops (Huang *et al*., 2016) [6]. The cotton-based intercropping aims to maximize the yield of both companion crops and monetary returns (Ali *et al*., 2020 and Matloob *et al.*, 2020) [2, 9].

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