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Weed smothering efficiency and cotton equivalent productivity of Bt cotton based intercropping systems

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ABSTRACT

A field experiment was conducted at Cotton Research Station, (TNAU), Srivilliputtur under winter irrigated condition from September 2020 to February 2021. The objective of the study was to identify a suitable intercropping system with higher weed smothering efficiency and cotton productivity. The experiment was carried out in a randomized block design with ten treatments replicated thrice. The weed density and biomass were reduced by all the intercropping systems when compared to sole cropping. Among the intercrops, cluster bean, blackgram and greengram were more efficient in reducing the weed density than onion and coriander. The seed cotton equivalent yield was highest with intercropping of paired row planted Bt cotton with one row each of onion and cluster bean (3.75 t/ha) followed by two rows of cluster bean (3.70 t/ha) and two rows of onion intercropping (3.69 t/ha) as compared sole cotton (2.39 t/ha), cotton + blackgram (2.55 t/ha) and cotton + greengram intercropping system (2.56 t/ha).

Cotton also known as “white gold” and “king of fibre crops” is an important fibre cum cash crop of India and Tamil Nadu as well. India has the largest area (41.3%) of cotton in the world, but, due to its lower productivity, it’s share to the total world cotton production is only 25.4%. In Tamil Nadu, cotton is cultivated in an area of 1.55 lakh ha during 2020-21 with a production of 5.0 lakh bales and productivity of 548 kg/ha, which is below the world average yield of 768 kg/ha (Anonymous 2021). Intercropping has been recognized as potentially beneficial and economic system of crop production to increase the cropping intensity and resource utilization for efficient management of inputs (Singh and Singh 2016). As cotton is a relatively longer duration and its slow growth during earlier stage offer vast scope for intercropping. Weeds, when uncontrolled, removed 32.6:3.33:18.46 kg NPK/ha by reducing the cotton nutrient uptake by 94 to 96% (Ayyadurai and Poonguzhalan 2010). Cotton is very sensitive to crop-weed competition due to slow growth during early stage and wider spacing (Kalaichelvi 2008). Intercropping and crop rotations will help in the ecological intensification of cotton-based cropping systems (Matloob *et al*. 2020). Intercropping of short duration field crops (Rajput *et al*. 2016) and vegetable crops (Rajput *et al*. 2018) has the potential to smother the weeds in the cotton based intercropping system. Selection of suitable intercropping system is paramount importance to realize higher productivity and also effective reduction of weed growth (Giri *et al*. 2006). Thus, an experiment was conducted to identify weed smothering intercrops for managing weeds and obtain higher productivity of irrigated Bt cotton.

A field experiment was conducted at Cotton Research Station, (TNAU), Srivilliputtur under winter irrigated condition from September 2020 to February 2021. The objective of the study was to identify a suitable intercropping system with higher weed smothering efficiency and cotton productivity. The experiment was carried out in a randomized block design with three replications. The treatments consisted of: sole Bt cotton; paired row planting of Bt cotton with two rows of onion; paired row planting of Bt cotton with two rows of cluster bean; paired row planting of Bt cotton with two rows of coriander; paired row planting of Bt cotton with one of row onion + one row cluster bean; paired row planting of Bt cotton with one row of cluster bean + one row coriander; paired row planting of Bt cotton with one row of coriander + one row onion; paired row planting of Bt cotton with one row each of onion

+ cluster bean + coriander; Bt cotton at normal spacing with 2 rows of blackgram and Bt cotton at normal spacing of with 2 rows of greengram. The sowing of experimental crop was taken up on 02.09.2020. The soil of the experimental field was clay loam with a pH of 8.26 dSm/m. The available soil nutrient status was low in N (196 kg/ha), high in P (40 kg/ha) and also high in K (496 kg/ha). The varieties used for the intercrops were *CO5* (small onion), *CO1* (cluster bean), *CO4* (coriander), *VBN8* (blackgram) and *CO8* (greengram). Normal spacing of 120 x 60 cm was followed in sole Bt cotton and blackgram and greengram intercropping. For other treatments, paired row planting of 80 x 60 cm for cotton and 50 x 10 cm for 2 rows intercropping and 40 x 10 cm for three rows of intercropping were followed. A fertilizer recommendation of 120: 60: 60 kg NPK/ha was applied for all the treatments and no additional fertilizers or pesticides were applied to intercrops. Hand hoeing twice on 25 days after seeding (DAS) and 45 DAS were undertaken for all the treatments. The data on weed density and biomass were recorded at 20 and 40 DAS. The weed smothering efficiency (WSE) was calculated and the seed cotton yield and yield of intercrops were also recorded. The seed cotton equivalent yield (SCEY) was calculated by multiplying the yield of intercrop with the market price of cotton and dividing with the market price of intercrop.

Effect on weeds

The weed density was lower during the early stage (20 DAS) than the later stage (40 DAS) of crop growth (**Table 1**). All the intercropping systems reduced the weed density compared to sole crop and among the intercrops cluster bean, blackgram and greengram were more efficient in reducing the weed density than onion and coriander during both the stages of observation. At 20 DAS, significant reduction in weed density was observed under the intercropping of cotton with two rows of cluster bean, blackgram, greengram, one row each of onion and cluster bean, cluster bean + coriander and one row each of cluster bean, coriander and onion intercropping with cotton than sole of cotton. At 40 DAS also, all the intercropping systems reduced the weed density significantly than pure cotton except two rows of onion intercropping with cotton. The lower weed density recorded under cotton with pulses and cluster bean intercropping systems was due to production of high foliage of pulses in the system; which suppressed weeds growth efficiently than intercropping of onion and coriander with cotton. Reduced weed density under Bt cotton inter cropped with pulses, cluster bean and coriander are in conformity with the findings of Sankaranarayanan *et al* (2012) and Harisudan (2019), Sivakumar and Subbain (2010)

The weed biomass followed a similar trend as that of weed density. All the intercropping systems significantly reduced the weed biomass than pure crop of cotton alone except cotton intercropping with two rows of onion, two rows of coriander and one row each of cotton + coriander at 20 DAS. At 40 DAS also, all the intercropping systems except cotton

Table1. Weed density, weed biomass and weed smothering efficiency as influenced by inter cropping in Bt cotton

Treatment	Weed density (no./m^2)		Weed biomass (kg/ha)		Weed smothering efficiency (%)	
	20 DAS	40 DAS	20 DAS	40 DAS	20 DAS	40 DAS
Sole Bt cotton	153(12.4)	231(15.2)	402(20.1)	890(29.8)	--	--
Paired row planting of Bt cotton with two rows of onion	151(12.3)	212(14.6)	397(19.9)	842(29.0)	1.31	5.39
Paired row planting of Bt cotton with two rows of cluster bean	142(11.9)	176(13.3)	304(17.4)	726(26.9)	6.54	18.41
Paired row planting of Bt cotton with two rows of coriander	149(12.2)	205(14.3)	393(19.8)	830(28.8)	2.61	6.74
Paired row planting of Bt cotton with one row onion + one row of cluster bean	140(11.8)	164(12.8)	293(17.1)	711(26.7)	8.50	20.15
Paired row planting of Bt cotton with one row of cluster bean +one row of coriander	137(11.7)	161(12.7)	284(16.9)	702(26.5)	10.46	21.13
Paired row planting of Bt cotton with one row of coriander + one row of onion	146(12.1)	204(14.3)	387(19.7)	817(28.6)	4.58	8.20
Paired row planting of Bt cotton with one row each of onion + cluster bean + coriander	124(11.2)	146(12.1)	276(16.6)	685(26.2)	18.95	23.08
Normal spacing of Bt cotton with 2 rows of black gram	129(11.4)	151(12.3)	295(17.2)	713(26.7)	15.68	19.94
Normal spacing of Bt cotton with 2 rows of greengram	132(11.5)	153(12.4)	308(17.6)	727(27.0)	13.73	18.33
LSD (p=0.05)	8.65	23.7	39.0	63.5	-	-

Figures in parentheses indicate transformed $\sqrt{x+0.5}$ values

+ 2 rows of onion registered significantly lesser weed biomass than sole cropping. The lesser weed biomass recorded in cotton intercropped with cluster bean and pluses was due to the corresponding lower weed growth and also higher foliage production as compared to onion and coriander. A similar reduction in weed biomass was reported earlier with the intercropping of cotton with cluster bean and coriander (Sankaranarayanan *et al.* 2012) and pulses (Sivakumar and Subbaian 2010).

Effect on weed smothering efficiency

Weed smothering efficiency (WSE) indicates the percentage of weed biomass suppression by the treatment than control. In the present study, all the intercropping systems smothered the weeds, compared to sole crop during both the stages of observation (**Table 1**). Moreover the WSE was higher at 40 DAS than at early stage of 20 DAS. Among the intercropping systems, cotton intercropped with three crops of onion, cluster bean, and coriander smothered the weeds more efficiently with the higher WCE of 18.95 and 23.08%, respectively during 20 and 40 DAS. The next efficient treatments were cotton intercropped with two rows of blackgram (15.68%) at 20 DAS. At 40 DAS, intercropping of one row each of cluster bean and coriander (21.13%), two rows of cluster bean (20.15%) followed by two rows of blackgram (19.94%) with greater WSE. The higher weed smothering efficiency with above intercropping systems might be due to better utilization of light, water and nutrients by the intercrops through greater competition with weeds and also by suppressing the germination of weeds (Altieri and Liebman 1986). In addition, more foliage producing capacity of intercrops resulted in high light interception and suppressed underground weed growth. The higher WSE was reported earlier too in cotton intercropped with cluster bean and coriander (Sankaranarayanan *et al*. 2012, Harisudan 2019), short duration vegetables (Gadade *et al*. 2006) and pulses (Giri *et al*. 2006, Sivakumar and Subbaian 2010).

Effect on seed cotton yield and seed cotton equivalent yield (SCEY)

The seed cotton yield was not influenced by different treatments **(Table 2**). However, all the intercrops studied had equally increased the seed cotton yield indicating the complementary effect without competition during the growth and development of main cotton crop. Among them, intercropping of Bt cotton with one row each of onion, cluster bean, coriander recorded highest seed cotton yield (2.46 t/ha) followed by that of one row each of onion and cluster bean (2.45 t/ha) and intercropping of two rows of cluster bean (2.44 t/ha). Similar result of non- significant response between sole crop and intercropping of cotton was reported by Sankaranarayanan *et al.* (2012) and Maitra *et al.* (2001). The intercropped legumes (cluster bean, greengram, blackgram) might have improved the soil health and soil fertility as reported by Sankaranarayanan *et al.* (2010) and Rao *et al.* (2009).

Table 2. Seed cotton yield and seed cotton equivalent yield as influenced by inter cropping in Bt cotton

Treatment	Seed cotton yield (t/ha)	Intercrop yield (t/ha)	Seed cotton equivalent yield* (t/ha)
Sole Bt cotton	2.39	--	2.39
Paired row planting of Bt cotton with two rows of onion	2.42	Onion 1.81	3.69
Paired row planting of Bt cotton with two rows of cluster bean	2.44	Cluster bean 3.14	3.70
Paired row planting of Bt cotton with two rows of coriander	2.43	Coriander 1.13	2.84
Paired row planting of Bt cotton with one row of onion + one row of cluster bean	2.45	Onion 1.01 Cluster bean 1.49	3.75
Paired row planting of Bt cotton with one row of cluster bean +one row of coriander	2.44	Cluster bean 1.38 Coriander 0.61	3.21
Paired row planting of Bt cotton with one row of coriander + one row of onion	2.43	Onion 0.85 Coriander 0.56	3.23
Paired row planting of Bt cotton with one row each of onion + cluster bean + coriander	2.46	Onion 0.74 Cluster bean 1.14 Coriander 0.46	3.60
Normal spacing of Bt cotton with 2 rows of black gram	2.41	Black gram 0.13	2.55
Normal spacing of Bt cotton with 2 rows of greengram	2.42	Greengram 0.13	2.56
LSD (p=0.05)	NS	-	-

*****Price of produces (₹/kg): cotton = 51, onion=35, cluster bean=20, vegetable coriander= 18, greengram and blackgram= 55

The clusterbean (1:1) intercropping system recorded higher seed cotton yield than cotton + blackgram (1:1) and cotton + greengram (1:1) intercropping system as reported by Ravindra Kumar *et al.* (2017).

The total productivity in terms of seed cotton equivalent yield (SCEY) increased with all the intercrops studied (**Table 2**). Among them, the highest total SCEY was with intercropping of one row each of onion and cluster bean with cotton (3.75 t/ha) followed by two rows of cluster bean (3.70 t/ ha) and two rows of onion (3.69 t/ha). The next higher total SCEY was observed with intercropping of Bt cotton with three crops (onion, cluster bean and coriander) (3.60 t/ha). The higher SCEY with these intercropped treatments were due to additional yield of intercrops obtained and also prevailing remunerative market price. The higher SCEY was also reported earlier in cotton intercropped with cluster bean (Ravindra Kumar *et al.* 2017, Sankaranarayanan *et al.* 2012), onion (Maitra *et al* 2001), coriandar (Sankaranarayanan *et al.* 2012) and pulses (Pandagale *et al.* 2019, Khagkharate *et al.* 2014). The lesser total SCEY under pulses intercropping was a result of lower grain yield of pulses than vegetables.

It may be inferred from this study that cotton based intercropping system including cotton intercropped with one row each of cluster bean and onion and with two rows of cluster bean may be recommended for reducing weeds growth with enhanced weed smothering efficiency and attain higher seed cotton equivalent yield.

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