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RESEARCH ARTICLE

Stale seed bed technique and leguminous cover crops as components of integrated weed management in irrigated cotton

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ABSTRACT

Integrated weed management approach is preferable to manage weeds effectively and economically. A study was carried out at Central Institute for Cotton Research, Regional station, Coimbatore to study the efficacy of stale seed bed technique (SSBT) in integration with weed smothering legumes as cover crops (CC) in managing weeds of irrigated cotton production system. The experiment was conducted during winter season of 2015-16 and 2016-17 cropping season in a randomized block design with four replications. Six weed control treatments viz., SSBT + CC - *Mimosa invisa*, SSBT + CC - *Crotalaria juncea*, SSBT + CC- *Sesbania aculeata*, SSBT + CC -*Vigna unguiculata* , SSBT + CC - *Desmanthus virgatus* along with one hand weeding (HW) at 30 days after seeding (DAS) was common to all cover crop treatments. They were compared against pre-emergence application (PE) of pendimethalin 1.0 kg/ha at 3 DAS followed by (*fb*) hand weeding twice at 30 and 60 DAS. The weed pressure was reduced significantly with SSBT integrated with leguminous cover crops when compared to currently recommended practice of pendimethalin PE *fb* hand weeding twice. The integration of SSBT to exhaust weed seed bank and growing of leguminous cover crops like *Crotalaria juncea* and *Vigna unguiculata* to smother weeds reduced weed pressure and hence recommended as an effective, sustainable weed management options in irrigated cotton production system

Keywords: Cotton, Stale seed bed technique (SSBT), Cover crops, Legumes, Weed management

INTRODUCTION

Cotton is cultivated at wider row spacing and the crop is slow growing during initial 45 days causing severe weed competition to the crop (Kalaichelvi 2008).Weed management is the most important component of irrigated cotton production system. The farmers are currently using inter-cultivation operations besides manual weeding to control weeds, while the technical recommendation is the pre-emergence (PE) herbicide application followed by (*fb*) two or three inter cultivations (Prabhu *et al.* 2010). However, as the inter-row cultivation operation is weather dependent, its timely adoption may not be possible. The pre-emergence herbicides are effective only for 2 - 4 weeks and hence late emerging weeds escape (Nalayini and Raju 2010). Repeated use of herbicides may be harmful to soil and environment. Hence, adoption of integrated weed management approach with minimum use of herbicides is suggested (Rao and Nagamani 2010). Thus, exploring other options like stale seed bed technique and targeting weeds in advance of cotton sowing to minimise weed pressure during actual cotton growing period and smothering of weeds by compatible leguminous cover crops may help in sustainably managing weeds of irrigated cotton. Cover crops play an important role in smothering the weeds and enclose the open land under vegetative cover until the main crop establishes so as to avoid late emerging weeds competing with main crop. In addition to weed control through physical obstruction and/or biochemical suppression, cover crops provide numerous environmental benefits that can promote long-term sustainability of farm lands. Leguminous covers such as hairy vetch (*Vicia villosa*) increase plant – accessible soil nitrogen leading to increase in growth and yield of cotton (Sainju *et al.* 2005). Cover crops also improve soil composition, conserve soil carbon, nitrogen and moisture content and enhance microbial activity (Hoffman and Regnier 2006). Thus, this study was conducted with the objective of quantifying the effect of integration of the stale seed bed technique with weed smothering leguminous cover crops on weeds and seed cotton yield.

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MATERIALS AND METHODS

Field experiments were conducted consecutively for two years during August – February 2015-16 and

2016-17 cropping season in the new area farm of the Regional station, ICAR - Central Institute for Cotton Research, Coimbatore (11^{0}N, 77^{0}E and 426.6 m MSL), Tamil Nadu. The total rainfall during the study period was (348.4 mm) in 2015-16 and (151 mm) in 2016-17. The experimental soil was low (161.2, 168.5 kg/ha) in soil available N, medium (13.5, 19.5 kg/ha) in phosphorus and high (680.5,720.2 kg/ha) in potash during 2015-16 and 2016-17 cropping season respectively.

The randomized block design with four replications was used. Six weed control treatments viz., stale seed bed technique (SSBT) + cover crop (CC) - *Mimosa invisa*; SSBT + CC-*Crotalaria juncea*; SSBT + CC - *Sesbania aculeata*; SSBT + CC - *Vigna unguiculata*; SSBT + CC - *Desmanthus virgatus*, and pendimethalin 1.0 kg /ha PE on 3 days after seeding (DAS) *fb* hand weeding twice at 30 and 60 DAS. All the treatments of SSBT + CC had received one hand weeding on 30 DAS. For the SSBT based treatments, the field was prepared one month in advance of cotton sowing by giving irrigation on 24 July and 5 August during 2015-16 and 2016-17 respectively. The germinated young weed seedlings were sprayed with mixture of pendimethalin 1.0 kg + glyphosate 1.0 kg two weeks after the irrigation on 7 August during 2015-16 and 19 August during and 2016-17. The germinated weeds were killed by the glyphosate and the weeds germinated after the herbicide spraying were killed by the residual action of pendimethalin. Two weeks after pre-sowing herbicidal spraying, the sowing of cotton crop cultivar RCH 20 Bt was taken up on one side of the ridges at 90 x 60 cm spacing on 21 August 2015-16 and 2 September 2016-17. The respective cover crops were sown on the other side of ridges. The pendimethalin PE was done on 24 August 2015 and 5 September 2016 during 2015-16 and 2016-17, respectively. The recommended dose of 90:45:45 kg/ha NPK were given to cotton crop in four equal splits of N and K at sowing, 30, 60 and 90 DAS while the entire P was applied as basal before cotton sowing. The weed density was recorded on 30 and 60 DAS *i.e.*, on 19 September 2015 and 19 October 2015 during 2015-2016 season and 1 October 2016 and 31 October 2016 during 2016-2017. The cover crops were allowed to smother weeds up to 45 DAS as living mulch and removed on 5 October and 17 October during 2015-16 and 2016-17, respectively and applied in the same sowing line of cover crops which added organics to the soil for sustainability of the system. Cotton was harvested (picked) on 28 December and 16 January during 2015-16 and 12 January and 27 January during 2016-17. The pooled data was subjected to ANOVA (Gomez and Gomez 1984) by using the randomized block design and analysed.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was infested with 15 broad-leaved weeds, six grassy weeds, one sedge weed. The broad-leaved weeds were**:** *Abutilon indicum, Amaranthus viridis, Argemone mexicana, Boerhaavia diffusa, Corchorus trilocularis, Celosia argentea, Datura metal, Digera arvensis, Euphorbia hirta, Gynandropis pentaphylla, Parthenium hysterophorus, Phyllanthus niruri, Portulaca oleracea, Trianthema portulacastrum* and *Tridax procumbens*. The grassy weeds *were: Chloris barbata, Cynodon dactylon, Dinebra arabica, Eleusine aegyptiaca, Panicum repens, Pennisetum cenchroides,* and the sedge *Cyperus rotundus*. Among the weed species, the carpet weed, *Trianthema portulacastrum* was the most dominant weed during initial stage of cotton growth.

The SSBT with cover crops caused significantly greater reduction in weed density and biomass (**Table 1**) on 30 and 60 DAS when compared to pendimethalin PE. The reduction in weed density in SSBT + cover crops might be due to exhausting weed seed bank by SSBT and better weed smothering by cover crops. Smothering effect of intercrop in Bt.

Table 1. Weed density and biomass as influenced by treatments in irrigated cotton

Treatment	Weed density (no./m^2) 30 DAS	Weed biomass (g/m^2) 30 DAS	Weed density (no./m^2) 60 DAS
SSBT + CC - *Mimosa invisa* followed by (*fb*) HW 30 DAS	67 (8.17)	74.5	174 (13.02)
SSBT + CC - *Crotalaria juncea fb* HW 30 DAS	63.0(7.91)	62.5	183.5 (13.54)
SSBT + CC - *Sesbania aculeata fb* HW 30 DAS	46.8 (6.79)	54.0	171.0 (12.69)
SSBT + CC - *Vigna unguiculata fb* HW 30 DAS	49.8 (7.04)	59.5	220.0 (14.7)
SSBT + CC - *Desmanthus virgatus fb* HW 30 DAS	74.0 (8.55)	76.5	158 (12.22)
Pendimethalin 1.0 kg PE *fb* HW twice 30 and 60 DAS	198.5(13.95)	212.5	372 (19.10)
LSD (p=0.05)	2.23	134.2	2.908

Figures in parentheses are square root transformed values for statistical analysis; HW: hand weeding; PE: Pre-emergence application; DAS: days after seeding cotton on weeds was also observed by Veeraputhiran and Sankaranarayanan (2021). Sun hemp grown as intercrop with cotton and later mulched into soil was reported to have lesser weeds (Blaise *et al.* 2020). Suppression of weeds by winter cover crops was attributed to allelopathy (Batish *et al.* 2006) and to physical blockage and shading (Teasdale and Mohler 2000).

Effect on cotton

The highest dry matter production of cotton was recorded with SSBT + *Crotalaria juncea* and it was on par with all other treatments except SSBT + *Sesbania aculeata* which recorded significantly lower cotton dry matter accumulation. The number of bolls/ plant was significantly higher with SSBT + *Vigna unguiculata* and SSBT + *Crotalaria juncea* and were on par and found superior to all other treatments. The differences in boll weight were not statistically significant, but all the SSBT + cover crops produced numerically higher boll weight and the boll weight was highest with SSBT + *Sesbania aculeata.* The seed cotton yield was significantly higher with SSBT with *Vigna unguiculata* + one HW and SSBT + *Crotalaria juncea* + one HW and the lowest (1959 kg/ ha) was recorded with no SSBT –pendimethalin PE + HW twice. The *Sesbania aculeata* which resulted in reduced dry matter accumulation which might be due to its competition with cotton crop for resources. However, all other SSBT + cover crops recorded higher dry matter accumulation by cotton due to lesser weed competition and lesser competition from cover crops for growth factors. Reduction in weed emergence and biomass due to cover crops was attributed earlier to release of allelo chemicals by living roots and residues (Macias et al. 2019) and /or physical interference to weed emergence (Teasdale *et al.* 2000). The fibre quality attributes were not influenced significantly by the weed control treatments.

Effect on sustainability

Inclusion of leguminous cover crops as intercrops with cotton not only for weed smothering but also aids in maintaining sustainability of the system due to legume effect. The fresh biomass added by various cover crops ranged from 1271 to 16238 kg/ha with the dry biomass worked out to about 329 - 3960 kg/ha. The ideal cover crops to be grown with cotton for weed smothering and significant yield improvement are *Vigna unguiculata* and *Crotalaria juncea* as they contributed dry matter of 1591 and 1574 kg/ha with nitrogen contribution of 45.07 and 56.56 kg/ha, respectively. The potential replacement of over 60% of the N fertilizer requirement for optimum cotton production by leguminous cover crop was reported with vetch which produced 225 kg N/ha under Australian condition (Robert *et al.* 2011). The post-harvest N status of the experimental soil revealed that all the cover crops treatments improved the available soil N status over no cover crop treatment. Among the cover crops, *Desmanthus virgatus* and *Crotalaria juncea* recorded significantly higher available soil N over other crops might be due to higher N fixation by

Table 2. Dry matter production of cotton, yield attributes, seed cotton yield and post-harvest soil available nitrogen status as influenced by treatments

Treatment	Dry matter of cotton (t/ha) at harvest	Bolls/ plant	Boll wt. (g/boll)	Seed cotton yield (t/ha) 2015-16	Seed cotton yield (t/ha) 2016-17	Seed cotton yield (t/ha) Pooled	Post-harvest soil available N (kg/ha)
SSBT + CC - *Mimosa invisa fb* HW 30 DAS	4.50	28	6.15	3.24	1.17	2.20	172.9
SSBT + CC - *Crotalaria juncea fb* HW 30 DAS	4.78	33.4	6.08	3.41	1.52	2.46	182.0
SSBT + CC - *Sesbania aculeata fb* HW 30 DAS	3.84	24.8	6.28	3.16	1.13	2.14	172.2
SSBT + CC - *Vigna unguiculata fb* HW 30 DAS	4.23	34	6.03	3.58	1.41	2.49	172.9
SSBT + CC - *Desmanthus virgatus fb* HW 30 DAS	4.28	28.2	5.92	3.33	1.22	2.28	185.2
Pendimethalin 1.0 kg PE *fb* HW twice 30 and 60 DAS	4.15	24.9	5.82	2.86	1.06	1.96	168.0
LSD (p=0.05)	0.89	3.49	NS	0.44	0.17	0.22	7.71

Table 3. Fresh biomass production, dry matter accumulation and nitrogen contribution by leguminous cover crops as affected by different treatments

Treatment	Fresh wt. of cover crops (CC) (kg/ha)	Dry wt. of cover crops (kg/ha)	N contribution by cover crops (kg/ha)
SSBT + CC - Mimosa invisa followed by (*fb*) HW 30 DAS	1271	329	13.61
SSBT + CC - *Crotalaria juncea fb* HW 30 DAS	6664	1591	56.56
SSBT + CC - *Sesbania aculeata fb* HW 30 DAS	16238	3960	163.5
SSBT + CC - *Vigna unguiculata fb* HW 30 DAS	12219	1574	45.07
SSBT + CC - *Desmanthus virgatus fb* HW 30 DAS	3441	956	48.09
LSD (p=0.05)	2103	265.9	20.50

Table 4. Fibre quality attributes of cotton as influenced by stale seed bed technique and leguminous cover crops

Treatment	2.5 % Span length (mm)	Uniformity ratio	Micronaire	Tenacity 3.2 mm (g/tex)	Elongation (%)
SSBT + CC - Mimosa invisa followed by (*fb*) HW 30 DAS	31.0	46	4.3	21.1	6.9
SSBT + CC - *Crotalaria juncea fb* HW 30 DAS	30.5	47	4.3	20.2	6.8
SSBT + CC - *Sesbania aculeata fb* HW 30 DAS	30.2	46	4.1	21.0	6.8
SSBT + CC - *Vigna unguiculata fb* HW 30 DAS	31.1	46	4.1	20.9	6.6
SSBT + CC - *Desmanthus virgatus fb* HW 30 DAS	31.2	46	4.3	20.6	6.8
Pendimethalin 1.0 kg *fb* HW twice 30 and 60 DAS	30.9	46	4.3	20.7	6.8
LSD (p=0.05)	NS	NS	NS	NS	0.265

these crops. Similar finding of higher inorganic N with cover crop Vetch than other crops was reported by Sainju *et al*. (2006). Adusumilli and Fromme (2016) reported that introducing cover crop in an irrigated cotton system has a positive effect on cotton yield and soil organic matter.

It is concluded that integration of stale seed bed technique with leguminous cover crops like *Vigna unguiculata* or *Crotalaria juncea* results in efficient weed smothering and may be recommended as components of integrated weed management method in irrigated cotton production system for improving the sustainability.

REFERENCES

Adusumilli N and Fromme D. 2016. Evaluating benefits and costs of cover crops in cotton production system in Northwest Louisiana. Southern Agricultural Economics Association Annual Meeting, San Antonia, Texas, February 6-9, 2016.

Batish DR, Singh HP, Kohli R K and Dawra GP. 2006. Potential for allelopathy and allelochemicals for weed management. pp. 209–256. In: *Handbook of sustainable weed management*. (Eds. Singh HP, Batish DR and Kohli RK), Food Products Press, New York, NY.

Blaise D, Manikandan, Verma P**,** Nalayini P**,** Chakraborty M and Kranthi KR. 2020. Allelopathic Interactions and its mulch as an integrated weed management strategy for rainfed Bt transgenic cotton hybrids. *Crop Protection* **135**: 105214.

Gomez KA and Gomez AA. 1984. Statistical procedure for agricultural research, 2nd ed., New York (NY): Wiley.

Hoffman M L and Regnier E E. 2006. Contributions to weed suppression from cover crops. pp. 51–75. In: *Handbook of sustainable weed management*. (Eds. Singh HP, Batish DR and Kohli RK), Food Products Press, New York, NY.

Kalaichelvi K. 2008. Effect of planting geometry and fertilizer levels on weed density and biomass in Bt cotton. *Indian Journal of Weed Science* **40**(1&2): 66–68.

Macias FA, Mejias FR and Molinillo JMG. 2019. Recent advances in Allelopathy for weed control: from knowledge to applications.Pest management Science.**75**: 2413–2436.

Nalayini P and Raju R 2010. Recent advances in weed management. *Cotton Research Journal* **1**(1):18– 35.

Prabhu G, Halepyati A S and Pujari BT 2010.Weed Management Studies in Bt Cotton (*Gossypium hirsutum*) under irrigated conditions. pp: 263. In: *Proc. XIX National Symposium on Resource Management Approach Towards Livelihood Security*, 2-4 December, 2010, UAS, Bangalore.

Rao A N and Nagamani A. 2010. Integrated weed management in India- Revisited. *Indian Journal of Weed Science* **42**: 123–135.

Robert MZ, Krishna N R, Krutz, LJ, Gordon ER, Ryan E J and Price LD. 2011. Can leguminous Cover crops Partially replace Nitrogen fertilizer in Mississipi Delta Cotton Production?. *International Journal of Agronomy* **9**(4): 1–9.

Sainju UM, Singh BP and Whitehead WF. 2005. Tillage, cover crops, and nitrogen fertilization effects on cotton and sorghum root biomass, carbon, and nitrogen. *Agronomy J.* **97**: 1279–1290.

Sainju UM, Whitehead WF, Singh BP and Wang S. 2006. Tillage, Cover crops and nitrogen fertilization effects on soil nitrogen and cotton and sorghum yields. *European Journal of Agronomy* **25** :372–382.

Teasdale JR and Mohler CL. 2000. The quantitative relationship between weed emergences and the physical properties of mulches. *Weed Science* **48**: 385–392.

Veeraputhiran R and 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.