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RESEARCH NOTE

Studies on weed management practices in irrigated Bt-cotton (*Gossypium hirsutum* L.)

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A field experiment was conducted during *kharif*, 2015 at Agricultural Research Station. Malnoor, University of Agricultural Sciences, Raichur, Karnataka, to study the weed management practices in irrigated Bt-cotton. The results revealed that pendimethalin 38.7 CS(PRE)-pyrithiobac sodium 10 EC as POE at 30 DAS recorded 2253kg ha^{-1}, ₹ 70745 ha^{-1} and 3.31 higher seed cotton yield, net return and B:C respectively. This may be attributed to superior yield and growth parameters like bolls per plant (39.57) and plant height (133.5 cm). This may be due to the efficient weed control, higher weed control eficiency (85.16%) and lower weed index (9.03) in this weed management practice. Though weed free check recorded higher seed cotton yield, net returns and B:C were low due to high cost of cultivation.

Key words: Herbicides, Weed density, Weed index

Cotton is known as 'white gold' and an important natural commercial fiber crop grown extensively in the world particularly in India and more so in Karnataka. *Bt*-cotton is intensively cultivated in black soils of north eastern dry zone of the Karnataka (Zone 2) covering part of the Tungabhadra project (TBP) and Upper Krishna project (UKP). Area under this crop in these commands has been increasing drastically over the past half decade. The average seed cotton yield is around 2.0 t ha^{-1} which is far less than actual potential yield. This may be attributed to weed menace. In Karnataka yield loss in Bt. Cotton due to weeds ranges from 50 to 85 per cent (Patil, 2010).

Presently, pendimethalin and alachlor are used as pre-emergence herbicides to control weeds in cotton for 30-35 days after sowing depending on the dose, soil type and environmental conditions, and thus can prevent early weed competition. But due to heavy and continuous rainfall during August, it becomes very difficult to go for inter cultivation in time. The only option and commonly followed method is hand weeding but incessant rains and high cost and not availability of labours at peak periods is the main constrains in controlling weeds in time that reduces yield. Hence, it is necessary to tackle the situation with the appropriate post emergent application of herbicides. Therefore, the present investigation was under taken to study the efficiency of suitable pre and post emergence herbicides in sequence for controlling weeds in Bt. cotton.

A field experiment was conducted during *kharif* 2015-16 at Agriculture Research Station, Malnoor, coming under University of Agricultural Sciences, Raichur. The soil of the experimental field was medium deep black, with pH 8.10, EC 0.30 dSm^{-1}, OC 0.33%. high available P_20_5 (34 kg/ha) but medium in available K_20 (294 kg/ha). The experiment comprising 9 weed management practices *i.e.* T_1 : pendimethalin 38.7 CS @ 0.68 kg a.i.ha^{-1} (PRE) - HW 30 DAS - IC at 60 DAS, T_2 : pyrithiobac sodium 10 EC @ 125 g a.i.ha^{-1} (PRE) -HW 30 DAS - IC at 60 DAS, T_3 : pendimethalin 38.7 CS @ 0.68 kg a.i.ha^{-1} (PRE) -pyrithiobac sodium 10 EC @ 125 g a.i.ha"[1] (POE) at 30 DAS, T_4: pendimethalin 38.7 CS @ 0.68 kg a.i.ha^{-1} (PRE) - pyrithiobac sodium 10 EC @ 125 g a.i.ha^{-1} + propaquizafop 10 EC @ 0.1 kg a.i.ha^{-1} (POE) at 30DAS, T_5: pendimethalin 38.7 CS @ 0.68 kg a.i.ha^{-1} (PRE) -imazethapyr 10 SL @ 0.75 kg a.i.ha^{-1} (POE) at 30 DAS, T_6 : Pendimethalin 38.7 CS @ 0.68 kg a.i.ha"[1] (PRE)- imazethapyr 10 SL_@ 0.75 kg a.i.ha^{-1} (30 DAS) + propaquizafop 10 EC @ 0.1 kg a.i.ha^{-1} (POE) at 30 DAS, T_7 : Hand weeding thrice (30, 60, 90 DAS), T_8: Weed free check, T_9 :Weedy check was conducted in randomized block design with three replications.

Hybrid *Bt* cotton "Bindass" was sown on 23-7-2016 by giving a spacing of 90 cm x 60 cm. The gross and net plot size was 7.2 x 4.8m and 3.6 x3.6 m, respectively. The recommended fertilizer dose (150 kg N, 75 kg P_2O_5 and 75 kg K_2O per ha) was applied as per package of practices. Pre-emergence herbicide, pendimethalin 38.7 CS and pyrithiobac sodium 10 EC was sprayed just after sowing. The post emergence herbicides (pyrithiobac sodium 10 EC, imazethapyr 10 SL and propaquizafop 10 EC) were sprayed 30 days after transplanting. The spray was done using hand operated knapsack sprayer fitted with flat fan nozzle. The spray solution used was 750 $litha^{-1}$. Weed density was recorded by putting a quadrate of 0.25 m at random in each plot and converted to square meter. The data was subjected to $(X+1)^{1/2}$ transformation as suggested by Bartlett (1947). All the other agronomic practices were followed as per the recommended package of practices.

The data revealed that different weed control treatments influenced the total weed density at harvest significantly (Table 1). Weed free check recorded significantly lowest weed density (0.71 m^{-2}) while the highest weed density of 7.24 m^{-2} was recoded in weedy check. With respect to the herbicide treatments, T_4 (pendimethalin 38.7 CS (PRE) -pyrithiobac sodium 10 EC + propaquizafop 10 EC (3.58 m^{-2}), T_3 (pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC as POE (3.58 m^{-2}) ; T_2 (pyrithiobac sodium 10 EC (PRE) - HW 30 DAS - IC at 60 DAS (3.85 m^{-2}), T_4 (pendimethalin 38.7 CS (PRE) - HW 30 DAS - IC at 60 DAS (3.89 m^{-2}) were significantly superior but on par with hand weeding thrice (3.34 m^{-2}) indicating the efficiency of these treatments in controlling weeds.

The dry weight of weeds as influenced by different treatments followed similar trend to that of weed density. Weed free check recorded significantly lowest weed weight (0.71 m^{-2}). This was followed by hand weeding thrice (T_3) (3.27 g in^{-2}). T_3 (pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC as POE (-3.55 g m^{-2}); T_4 (pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC + propaquizafop 10 EC (3.67 g m^{-2}). These treatments were on par with each other but superior over rest of the treatments. Significantly higest dry weight was recorded in weedy check (9.11 g m^{-2}).

Table 1. Weed density, weed dry weight, seed cotton yield and economics as influenced by weed management practices

Treatments	Weed density (m^2) ($g\ m^{-2}$)	Weed dry weight ($kg\ ha^{-1}$)	Seed cotton yield (₹ ha^1)	Net returns (₹ ha^1)	B:C
T_1 Pendimethalin 38.7 CS @ 0.68 kg $a.i.ha^{-1}$ (PRE) -HW 30 DAS- IC at 60 DAS	3.9(14.7)	4.0(15.5)	2045	60715	2.94
T_2 Pyrithiobac sodium 10 EC @ 125 g $a.i.\ ha^{-1}$ (PRE) - HW 30 DAS - IC at 60 DAS	3.8(14.3)	4.3(17.9)	1956	63582	2.91
T_3 Pendimethalin 38.7 CS @ 0.68 kg $a.i.ha^{-1}$ (PRE) - pyrithiobac sodium 10EC @ 125 g $a.i.\ ha^{-1}$ (POE) (30 DAS)	3.6(12.4)	3.5(12.1)	2253	70745	3.31
T_4 Pendimethalin 38.7 CS @ 0.68 kg $a.i.ha^{-1}$ (PRE) - pyrithiobac sodium 10EC @ 125 g $a.i.ha^{-1}$ + propaquizafop 10 EC @ 0.1 kg a.i.ha"[1] (POE) (30DAS)	3.4(11.3)	3.7(12.9)	2203	62679	2.72
T_5 Pendimethalin 38.7 CS @ 0.68 kg $a.i.ha^{-1}$ (PRE) - imazethapyr 10 SL @0.75 kg $a.i.ha^{-1}$ (POE) (30 DAS)	4.6(20.7)	5.1(25:2)	1929	55495	2.77
T_6 Pendimethalin 38.7 CS @ 0.68 kg $a.i.ha^{-1}$ (PRE) - imazethapyr 10 SL@0.75kg $a.i.ha^{-1}$ (30-35 DAS) + propaquizafop 10 EC @ 0.1 kg $a.i.ha^{-1}$ (POE) (30 DAS)	4.8(22.3)	5.6(31.2)	1775	45715	2.34
T_7 Hand weeding thrice (30, 60, 90 DAS)	3.3(10.7)	3.3(10.2)	2338	68786	2.89
T_8 Weed free check	0.7(0.0)	0.7(0.0)	2400	69226	2.78
T_9 Weedy check	7.2(52.0)	9.1(82.6)	1466	39035	2.45
S.Em±	0.2	0.7	93	4460	0.15
C.D. at 5%	0.6	0.5	277	13370	0.46

*Figures in paraentheses indicate $\sqrt{x-1}$ transfarmed values

The seed cotton yield is the economic part in interest based on which superiority of the treatment is decided. In present investigation, seed cotton yield was significantly higher in weed free check (2400 kg ha^{-1}) as weeds were continuously removed as and when the weeds are noticed. However this is not possible as scarcity of labours and not economical. Hence, this is not recommended. The next best'and feasible system that recorded the highest seed cotton yield was hand weeding thrice (T_3) (2338 kg ha^{-1}). This was followed by T_3 (pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC as POE (2253 kg ha^{-1}) and T_4 (pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC + propaquizafop 10 EC (2203 kg ha^{-1}). These treatments were on par with each other but significantly superior over rest of the treatments. The increase in yield was to the tune of 59.5, 53.7 and 50.3 per cent, respectively over weedy check (1466 kg ha^{-1}). Final assessment and recommendation of any technology depends on the economics *i.e.,* particularly on net returns and benefit coat ratio. Pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC as POE (T_3) recorded significantly highest net returns of ₹ 70,745 ha^{-1}, followed by T_4 (pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC + propaquizafop 10 EC (₹ 62,679 ha^{-1}) and T (pendimethalin 38.7 CS (PRE) - HW 30 DAS - IC at 60 DAS (₹ 60,715 ha^{-1}). Sreenivas (2000) reported minimum weed count, weed dry weight and higher with farmer's practice of three inter cultivation and hand weeding at 35. 55 and 75 DAS recorded significantly higher seed cotton yields. On the other hand weedy check recorded significantly lowest net returns (₹ 39,035) even through the cost of cultivation was low. This was due to low gross returns resulted from reduced yield attributes and yield due to sever weed competition throughout the cop growth period. Similar results wee reported by Srinivasan and Venkatesan (2002).

The BC ratio was significantly influenced by different weed control treatments and it was followed similar trend to that of net returns. Pendimethalin 38.7 CS (PRE) - pyrithiobac sodium 10 EC as POE (T_3) recorded the highest BC ratio (3.31). This may be due to higher gross returns as result of higher seed cotton yield and comparatively lower cost of cultivation. This was followed by pendimethalin 38.7 CS (PRE) - HW 30 DAS - IC at 60 DAS (T_1) (2.94). These were comparable with hand weeding thrice and significantly higher over weedy check (2.45) . The less BC ratio in weedy check was mainly due to low gross returns as a result of reduced seed cotton yield. Similar results were reported by Sreenivas (2000) an Satao and Laharia (2000).

On the basis of the present investigation, it was concluded that the treatment T_3 *i.e.*, application of pendimethalin 38.7 CS @ 0.68 kg $a.i.ha^{-1}$ (PRE) followed by pyrithiobac sodium 10 EC @ 125 g $a.i.ha^{-1}$ (POE) at 30 DAS was the best treatment that controlled weeds very efficiently and resulted in higher seed cotton yield and net returns.

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