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Economics of rainfed *Bt* cotton as influenced by sequential application of herbicides

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ABSTRACT : A field experiment was conducted during *kharif,* 2011 at the Agricultural College Farm, Bapatla to study the economics of rainfed *Bt* cotton as influenced by sequential application of herbicides. Results indicated that higher weed control efficiency, bolls/plant, seed cotton yield, net returns and benefit cost ratio were found with the farmer's practice. Among the herbicidal combinations, pre emergence application of pendimethalin @ 1.5 kg a.i./ha followed by post emergence application of pyrithiobac @ 63 g a.i./ha resulted in higher weed control efficiency, bolls/plant, seed cotton yield, net returns and benefit cost ratio.

Key words : Benefit cost ratio, fenoxaprop ethyl, pyrithiobac, quizalofop ethyl, sequential application, weed index and weed control efficiency

Cotton (*Gossypium hirsutum* L.) is an important commercial crop of India grown for its lint used as a major textile fibre, which is aptly called as "White Gold". It is contributing upto 85 per cent of raw material to the textile industry. Cotton being a wide spaced and long duration crop suffers from heavy weed competition during the early stages of crop growth. Critical period of crop weed competition is 60 to 70 days from sowing. The weed problem gets more severe due to certain unforeseen factors such as inefficient weeding or interculture coupled with continuous rains during early crop growth period.

Most of the weeds, particularly those growing in intra rows or nearer to the base of plant escape from inter cultivation. Weeds not only compete with the crop for nutrients, moisture, light, heat energy and space but also harbor insects, diseases, reducing the growth and yield of cotton due to weed competition (Pampamichail *et al.*, 2002). So, use of herbicides is one of the best option to avoid the competition from weeds during the critical period of crop growth. Pre emergence herbicides at recommended doses are generally capable of controlling annual weeds upto a period of 30 days (Pawar *et al.*, 2000). Concentration of these herbicides in soil decreases due to the short half life of herbicide molecules leading to emergence of susceptible weed species beyond 30 days after application of herbicides. In the absence of interculture and with regular monsoon rains, weeds germinate in different spells and compete with crop plants and finally reduce the seed cotton yield. Hence, there is a need to go for sequential application of PRE followed by POE herbicides to manage the late emerging weeds to eliminate weed competition throughout the critical period (Pawar *et al.*, 2000). Hence, present investigation was conducted to study the economics of rainfed *Bt* cotton as influenced by sequential application of herbicides.

A field experiment was conducted at Agricultural College Farm, Bapatla during *kharif,* 2011. The experiment was laid out in a randomized block design with 3 replications and 11 treatments *viz.*, T_1- weedy check; T_2- hand weeding twice at 30 and 60 DAS; T_3- pendimethalin @ 1.5 kg a.i./ha as PRE; T_4- pendimethalin @ 1.5 kg a.i./ha as PRE followed by interculture at 40 DAS; T_5- pendimethalin @ 1.5 kg a.i./ha as PRE followed by fenoxaprop-ethyl @ 56 g a.i./ha as POE at 40 DAS; T_6- pendimethalin @ 1.5 kg a.i./ha as PRE followed by quizalofop-ethyl @ 50 g a.i./ha as POE at 40 DAS; T_7- pendimethalin @ 1.5 kg a.i./ha as PRE followed by pyrithiobac @ 63 a.i./ha as POE at 40 DAS and T_8- interculture at 20 DAS followed by fenoxaprop-ethyl @ 56 g a.i./ha at 40 DAS; T_9- interculture at 20 DAS followed by quizalofop-ethyl @ 50 a.i./ha at 40 DAS; T_{10}- interculture at 20 DAS followed by pyrithiobac @ 63 g a.i./ha at 40 DAS; T_{11}-farmer's practice (four times inter cultivation at 15 days interval). The soil of the experimental field was clay loam in texture with a pH 7.8 and was medium in organic carbon (0.52 %), low in available nitrogen (178 kg/ha), medium in available phosphorus (29 kg/ha) and

high in available potassium (384 kg/ha). Cotton hybrid Bunny *Bt 2* was dibbled at 90 x 60 cm spacing on 1st August, 2011. Crop was fertilized with a recommended dose of 120:60:60 kg N, P_2O_5 and K_2O /ha. Pendimethalin was applied on the same day of sowing and other POE herbicides were applied at 40 DAS by using knapsack sprayer with a spray volume of 500 l/ha. Data on weed dry weight was recorded by using quadrate of 0.25 m^2 from four locations of plot at random. The weed control efficiency (WCE) and weed index (WI) were calculated as follows.

$$WCE\ (\%) = \frac{\text{Dry weight of weeds in unweeded control plot - Dry weight of weeds in treated plot}}{\text{Dry weight of weeds in unweeded control plot}} \times 100$$

$$WI\ (\%) = \frac{\text{Seed cotton yield from weed free plot - Seed cotton yield from the treated plot}}{\text{Seed cotton yield from weed free plot}} \times 100$$

The yield attributing characters were recorded from randomly selected 5 plants in each plot. Seed cotton was harvested by three pickings on 13.12.2011, 30.12.2011 and 21.01.2012, respectively. The net returns and benefit cost ratio (BCR) were calculated by using following formulae.

Net returns = Gross returns – Cost of cultivation

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

Weed flora: The weed species which infested the experimental plot were *Cynodon dactylon, Dactyloctenium aegyptium, Digitaria* sanguinalis, *Echinochloa colona, Panicum repens*, (grasses) *Cyperus rotundus* (sedge) and broad leaved weeds *viz.*, *Acalypha indica*, *Acalypha ciliata, Achyranthes aspera, Aristolochia bracteata*, *Cleome viscosa*, *Commelina benghalensis*, *Corchorus trilocularis*, *Cynotis cucullata*, *Digera arvensis, Euphorbia hirta, Euphorbia geneculata, Merrimia emerginata*, *Physalis minima, Phyllanthus maderaspatensis, Trianthema portulacastrum*, and *Tridax procumbens.*

Yield attributes and seed cotton yield: Highest bolls/plant was recorded with farmer's practice (41.7) which was *on a par* with hand weeding twice at 30 and 60 DAS. Bolls/plant was lowest with the weedy check (18.3). This might be due to severe weed competition as the weeds are allowed freely to compete with cotton plants. Among the weed management practices, bolls/ plant observed with T_4, T_7 and T_{10} treatments were comparable with hand weeding twice at 30 and 60 DAS (T_2) but markedly higher than the weedy check. Boll weight was found to be non significant across the weed management practices studied. These results were in agreement with the findings of Srinivasulu *et al.*, (2004). The highest seed cotton yield of 3252 kg/ha was recorded with farmer's practice (Table 1). This was due to occurrence of less competition between cotton plants and weeds leading to more number of bolls and resulted in higher seed cotton yield. Among the weed management practices, seed cotton yield recorded with T_4 (2437 kg/ha), T_7 (2380 kg/ha) and T_{10} (2468 kg/ha) treatments were comparable with hand weeding twice at 30 and 60 DAS (2652 kg/ha).

Weed control efficiency and weed index: Higher weed control efficiency of 86.7 per cent was recorded with farmer's practice (T_{11}) which was *on par* with hand weeding twice at 30 and 60 DAS (75.1 %). Among the weed management practices, WCE recorded with T_4 (62.3 %), T_7 (56.6 %) and T_{10} (52.4 %) were *on par* with each other. This might be due to effective control of broad leaved weeds with integration of interculture either with pendimethalin or pyrithiobac and sequential application of pendimethalin @ 1.5 kg a.i./ha as PRE followed by pyrithiobac @ 63 g a.i./ha as POE at 40 DAS These results were in conformity with the findings of Panwar *et al.*, (2001) and Toler *et al.,* (2002). Among the weed management practices, lowest weed index was recorded with hand weeding twice at 30 and 60 DAS (T_2) which was *on par* with T_4. T_7 and T_{10} treatments. The highest weed index of 56.8 per cent was recorded with weedy check which might be due to higher dry matter accumulation of weeds, consequently, reduced the seed cotton yield.

Economics: The maximum net returns and benefit cost ratio were recorded with farmer's practice (Rs. 84,630/ha and 1.63) and minimum with the weedy check (Rs. 28,410/ha and 0.91)

Table 1. Yield attributes and seed cotton yield as influenced by sequential application of herbicides in cotton

Treat-ments	WCE (%)	Bolls/ plant	Boll weight (g)	Seed cotton (kg/ha)	WI (%)
T_1	-	18.3	4.5	1422	56.8
T_2	75.1	35.3	4.9	2652	17.9
T_3	23.5	28.0	4.7	2136	34.0
T_4	62.3	31.3	4.7	2437	24.5
T_5	34.3	27.3	4.5	2140	33.8
T_6	41.6	27.3	4.4	2034	36.2
T_7	56.6	28.3	4.6	2380	26.4
T_8	36.9	27.3	4.7	2124	34.3
T_9	43.6	26.0	4.4	2150	32.6
T_{10}	52.4	31.0	4.6	2468	23.3
T_{11}	86.7	41.7	5.1	3252	-
P=0.05	11.7	7.0	NS	405.2	12.1

Table 2. Economics of cotton as influenced by sequential application of herbicides

Treat-ments	Gross returns (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Benefit cost ratio (BCR)
T_1	61017	31314	28410	0.91
T_2	113212	55854	55530	0.99
T_3	91352	39076	50636	1.30
T_4	104017	42984	59370	1.38
T_5	91327	40304	49576	1.23
T_6	86875	40310	45118	1.12
T_7	101616	43058	56902	1.32
T_8	90636	39626	49582	1.25
T_9	91747	40688	49612	1.22
T_{10}	105301	43212	60444	1.40
T_{11}	138694	51954	84630	1.63

presented in Table 2. This might be due to effective control of weeds which reflected in less weed population, dry weight of weeds and maximum bolls/plant, higher seed cotton yield and higher gross returns. Among the weed management practices, net returns and benefit cost ratio recorded with T_4, T_7 and T_{10} treatments were higher than the T_2, even though it recorded the higher seed cotton yield and gross returns than the T_4, T_7 and T_{10} treatments. This might be due to higher labour wages involved in performing the hand weeding twice at 30 and 60 DAS.

From this study it is concluded that, in order to reduce the crop weed competition in cotton during critical period, regular intercultural operations (gorru followed by guntaka) is found to be economical. Whenever, wet spells prevails during critical period especially in heavy soils (which does not permit intercultural operations), chemical control of weeds by application of selective POE herbicide like pyrithiobac @ 63 g a.i./ha is recommended to control predominant broad leaved weeds in cotton. For ensured weed free situations during the critical period, sequential application of PRE herbicide pendimethalin @ 1.5 kg a.i./ha followed by POE application of pyrithiobac @ 63 g a.i./ha is found to be more economical.

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