Bioefficacy of sequential application of herbicides in cotton

Rajendra A Nandagavi and SI Halikatti

DOI: https://doi.org/10.22271/phyto.2021.v10.i1ac.13656

Abstract

A field experiment was conducted for two years during kharif 2011-12 and 2012-13 to study the bioefficacy of sequential application of herbicides in Bt cotton. Ten weed control treatments were tested in randomised block design and they were replicated thrice. The mean of two years data indicated that, all the herbicide treatments significantly reduced dry weight of weeds over unweeded control. Among the herbicide treatments sequential application of Pyrithiobac sodium at 0.125 kg/ha as pre emergence followed by (fb) Pyrithiobac sodium at 0.125 kg/ha as post emergence, Butachlor at 1.5 kg/ha fb Butachlor at 1.5 kg/ha and Pendimethalin 38.7% CS 0.68 kg/ha fb Pendimethalin 38.7% CS 0.68 kg/ha were quite effective in controlling weeds which reflected in significantly decreased weed dry weight and increased weed control efficiency. These three herbicide treatments also recorded significantly higher yield (2863, 2830 and 2725 kg/ha, respectively). The growth and yield parameters followed similar trend as that of yield. The weed index was also lower in the above three treatments (11.43, 12.45 and 15.45 %, respectively) compared to un weeded control (76.56 %).

Keywords: Bt cotton, kapas yield, sequential application of herbicides, weed index, weed dry weight, WCE

Introduction

Cotton (Gossypium spp.) is an important commercial fibre crop grown under diverse agroclimatic conditions around the world. It is called as a “white gold” and “king of fibre crops”. It is cultivated in tropical and sub tropical regions of more than 111 countries. It provides the main raw material for textile industry. Cotton is the most important global cash crop and controls economy of many nations. It provides gainful employment to several million people during its cultivation, trade, processing, manufacturing and marketing. Cotton and cotton textile industries are engines of economic growth in both developed and developing countries.

India is the largest producer of cotton occupies 37.56 % of world cotton area and produces 24.26% of world cotton production. In India, it is grown in an area of 13.0 m ha with a production of 295 lakh bales and productivity of 494 kg/ha. In Karnataka it is grown in an area of 5.50 lakh ha with production of 18.00 lakh bales and productivity of 556 kg/ha (Anon., 2019) [1].

The productivity of cotton in the country is far below the world average (764 kg/ha). Major hurdle for the productivity of the crop being cultivated in rained areas with predominantly in small holdings. Yield level in small holdings are often reduced because of competition among crops for land and labour, leading to lack of timeliness in field operations and to difficulties in weed control, insect control and picking (Hamdy et al., 1994 [11]). Ramasundaram and Hemchandra (2001) [26] reported that plant density followed by pest control and weed control are the biggest contributors to yield gap, represented by the difference between the recommended method using suitable stand density, weed management and pest control with a highest yield of 1910 kg/ha and the actual farmers production practices (802 kg/ha).

Cotton crop is unable to express its full potential because of biotic and abiotic stresses encountered during its life cycle. Among various factors like poor plant population, damage due to insect pests, imbalanced use of fertilisers and weeds, weeds alone reduce the seed cotton yield to the extent of 30 per cent. The yield losses due to weed competition in cotton crop are estimated to vary from 40 to 85% (Jain et al., 1981 [12]). Brar and Gill, 1985 [5] Deshmukh and Mudholkar, 1988 [7] and Shelke and Bhosle, 1990 [31]). Therefore, control of weeds is essential to reduce the yield gap between actual and potential yield. Among the different agronomic constraints that would influence the productivity of cotton crop, weed infestations have historically been a major issue.

Corresponding Author:
Rajendra A Nandagavi
Assistant Professor (Agronomy),
Department of Agronomy,
Vijayapura, UAS, Dharwad,
Karnataka, India
Management of weeds is considered to be an important step for achieving higher productivity. Despite many advances in weed management technology, cotton growers still face significant challenges from weeds. The initial slow growth of cotton accompanied by wider spacing provide a greater window for weed competition, where plants cannot compete with the fast growing weeds particularly during initial 50 to 60 days. Cotton seedlings have relatively poor vigour and competitor against weeds. Even moderate weed infestations can reduce cotton yields. Weed control needs to be maintained for at least 10 to 14 weeks after cotton emergence to achieve maximum cotton yields (Graham Charles, 2002 [10]).

In cotton, weeds cause several direct and/or indirect negative impacts, such as reducing crop yield, reducing fiber quality, reducing irrigation efficiency, increasing production costs and serving as hosts and habitats for insect pests, disease-causing pathogens, nematodes and rodents. Weeds can directly hinder cotton growth by competing for available resources such as light, moisture, nutrients, space and in some cases, by releasing allelopathic or growth-suppressing chemicals. However, the degree of damage from weed competition depends on the weed species composition, weed densities and duration of weed-crop competition.

Timely and effective weed management practices also play an important role in boosting the productivity of cotton. To sustain crop productivity, the elimination of crop weed competition is of prime importance. Under Indian conditions, normally weeding is done 3 to 4 times manually for the above reasons. For this, the number of labourers required for weeding is high and in the present context the labour is not available, whose cost is ever increasing, resulting in increased cost of cultivation. Further, in many instances it is difficult to control weeds through cultural operations due to unfavorable weather conditions viz., incessant rains, wetness, dry condition, etc. Thus the progressive modernization of agriculture involving intensive use of herbicide is gaining popularity in recent years due to lower cost, easy and timely application and effectiveness in controlling weeds.

A number of broad spectrum herbicides (Pendimethalin, Butachlor, Alachlor, Diuron Pyrithiobac and Oxyfluorfen) are available for use in cotton. These herbicides are quite effective in controlling annual weeds during critical period of crop weed competition.

In long duration, initial slow growth crop like cotton weeds flourish even after critical period of crop weed competition and it is difficult to achieve effective weed control with single application of herbicides (pre emergence or post emergence). Hence, in order to control weeds for a longer period of crop growth there is needs to apply herbicides on sequential basis. Studies conducted by various authors clearly indicated that sequential application of herbicides will provide consistent weed control than single application (Singh, et al., 2004 [132]). Nadanassabady, et al., 2000 [19]). A well planned pre emergence followed by post emergence will provide more consistent weed control. The most complete sequential application of herbicide includes use of pre emergence herbicides with on key broadleaf weeds that also provides at least some early season control of grasses, followed by post emergence herbicides with activity on grasses and broadleaf weeds.

Further, a well-planned sequential application of herbicide is the need of the hour to provide more consistent weed control for longer period especially conventional method of weed control are difficult to practice due to unfavorable weather conditions. Therefore the present investigation was undertaken to study the Bio efficacy of sequential application of herbicides on weed control and growth and yield of Bt cotton.

Material and Methods
Field experiment was conducted for two years in Agricultural Research Station Dharwad in Bt cotton during kharif seasons of 2011-12 and 2012-13. The soil of the experimental site was medium deep black (clayey) with low available nitrogen, medium P₂O₅ and high available K₂O. The experiment was laid out in randomised complete block design with 10 treatments and replicated thrice. The Bt cotton hybrid Mallika was sown on 23rd June 2011 and 6th July 2012 at a spacing of 90 cm X 45 cm. The recommended dose of 100:50:50 kg N, P₂O₅ and K₂O per ha was applied in the form of urea, diammonium phosphate and muriate of potash to all plots uniformly. Herbicides were sprayed as per treatments with knapsack sprayer @750 lit/ha. Visual observations were recorded after pre emergence application and post emergence spray to know the extent of toxicity caused by different herbicides on crop and the extent of weed control by different weed control treatments as given by Rao (1986) [27]. Observation on weed dry weight was recorded from one square meter quadrat at 20, 40 and 60 days after sowing (DAS). Weed control index (WCI) denotes the magnitude of reduction in weed dry weight due to weed control treatments. It was calculated by using the formula given by Mishra and Tosh (1979) [17].

\[
\text{WCI} = \frac{\text{Weed dry weight in unweeded control} - \text{Weed dry weight in treatment}}{\text{Weed dry weight in unweeded control}} \times 100
\]

Weed index is the reduction in crop yield due to presence of weeds in comparison with weed free check plot. It expresses the competition offered by the weeds as measured by reduction in yield owing to their presence. It was worked out by using the formula as given by Gill and Vijay Kumar (1969) [8].

\[
\text{Weed Index } = \frac{X - Y}{X} \times 100
\]

Where,

\[ X = \text{Total seed cotton yield from weed free plot} \]
\[ Y = \text{Yield from the treatment plot for which weed index is to be worked out.} \]

Leaf area index (LAI) was worked out by dividing the leaf area per plant by the land area occupied by the plant. This formula suggested by Sestak et al. (1974) [29].

\[
\text{LAI} = \frac{\text{Leaf area plant}^{-1} \text{ (dm}^2\text{)}}{\text{Land area occupied by the plant (dm}^2\text{)}}
\]

Observations on crop were recorded as per the standard procedure. This weed dry weight data were subjected to square root transformation of \( \sqrt{X + 1.0} \) before analysis. Fischer’s method of analysis of variance was used for analysis and interpretation of the data as outlined by Gomez and Gomez (1984) [9]. The level of significance used in “F” and ‘T’ tests was p=0.05. Critical differences were calculated
Results and Discussions

The dominant weeds observed in the experimental area were, Brachiaria eruciformis, Cydonod dactylon, Dinbra retrifexa and Digitaria marginata among the grassy weeds, Cyperus rotundus among the sedges and among the broad leaved weeds Acalypha indica, Ageratum conyzoide, Alternanthera sessilis, Amaranthus viridis, Commelina benghalensis, Convolulus arvensis, Corchorus trilocularis, Crotophora rotterli, Digera arvensis, Euphorbia hirta, Mollugo disticha, Parthenium hystrophorus, Phyllanthus medraspatensis, Phyllanthus niruri and Trichodesma zeylanicum. Similar flux of weed flora associated with cotton crop was also observed by Arun (1990) [2], Patil (1999) [22], Bharathi et al. (2011) [3] and Prabh et al. (2011) [24].

Effect of sequential application of herbicides on weeds

Weed dry weight differed significantly due to weed control treatments (Table 1). At all the crop growth stages, the lowest weed dry weight was noticed in weed free check. This could be attributed to control of weeds by hand weeding at regular intervals, which resulted in reduced dry matter production of weeds. On the other hand, weedy check recorded the highest weed dry weight. This was mainly due to higher and uninterrupted growth of weeds resulting in greater crop weed competition due to better use of growth resources. These results are in conformity with the findings of Patil (2010) [23] and Rajkumara (2009) [25].

All the herbicide treatments recorded significantly lower weed dry weight at all the stages compared to weedy check. The decreased dry weight of weeds in all the herbicide treatments could be attributed to decreased weed population with better control and increased weed control index. At 20 DAS, all the herbicide treatments recorded significantly lower weed dry weight compared to sequential application of pendimethalin 30% EC @ 1.5 kg/ha fb pendimethalin 30% EC @ 1.5 kg/ha(T1), alachlor 50% EC @ 2.0 kg/ha fb alachlor 50% EC @ 2.0 kg/ha(T1) and recommended practice (T0). At later stages sequential application of pyrithiobac sodium 10% EC @ 0.125 kg/ha fb pyrithiobac sodium 10% EC @ 0.125 kg/ha(T1) recorded significantly lower weed dry weight (1.04, 1.26 and 1.62, at 20, 40 and 60 DAS, respectively) and this was on par with the sequential application of butachlor 50% EC @ 1.5 kg/ha fb butachlor 50% EC @ 1.5 kg/ha, pendimethalin 38.7% CS @ 0.68 kg/ha fb pendimethalin 38.7% CS @ 0.68 kg/ha and weed free check. The lower weed dry weight in the above treatments was mainly due to lower population of grasses, sedges and broad leaved weeds. Reasons could be attributed to direct phytotoxic effect of sequential application of herbicides as well as cumulative effect of herbicides sprayed as pre emergence. Pyrithiobac is readily absorbed by plant roots following pre emergence application and by plant foliage following post emergence application and inhibit acetolactate synthase in susceptible plants. The results are in conformity with the findings of Muthusankaranarayanan et al. (1988) [18] and Panwar et al. (1999) [21]. Pre emergence and post emergence use of pyrithiobac sodium in cotton provides excellent selective control of many troublesome weeds (Snipes and Seifert, 2003) [34].

Performance of crops is directly related to the weed control index and inversely related to the weed index. In the present study among the weed control treatments, sequential application of pyrithiobac sodium 10% EC @ 0.125 kg/ha fb pyrithiobac sodium 10% EC @ 0.125 kg/ha, butachlor 50% EC @ 1.5 kg/ha fb butachlor 50% EC @ 1.5 kg/ha, pendimethalin 38.7% CS @ 0.68 kg/ha fb pendimethalin 38.7% CS @ 0.68 kg/ha and oxyfluorfen 23.5% EC @ 0.2 kg/ha fb oxyfluorfen 23.5% EC @ 0.2 kg/ha recorded the maximum weed control index at all the stages (Table 1). The higher weed control index with these treatments could be attributed to lower weed dry weight and weed number in these treatments. These results corroborate with the findings of Muthusankaranarayanan et al. (1988) [18], Panwar et al. (1999) [21] and Nalini et al. (2011) [20].

Weed index, which is a measure of yield reduction due to weed competition, was the highest in weedy check (76.56%) (Table 2). This was due to lower seed cotton yield in weedy check as a consequence of severe competition offered by unchecked weed growth for nutrients, moisture and light as indicated by poor growth and yield components. The lowest weed index was recorded with sequential application of pyrithiobac sodium 10% EC @ 0.125 kg/ha fb pyrithiobac sodium 10% EC @ 0.125 kg/ha (11.43%) and it was followed by butachlor 50% EC @ 1.5 kg ha−1 fb butachlor 50% EC @ 1.5 kg/ha, pendimethalin 38.7% CS @ 0.68 kg/ha fb pendimethalin 38.7% CS @ 0.68 kg/ha, oxyfluorfen 23.5% EC @ 0.2 kg/ha fb oxyfluorfen 23.5% EC @ 0.2 kg/ha and recommended practice and these were on par with each other. This was mainly due to the higher seed cotton yield realized in these treatments due to improved growth as a consequence of effective control of weeds and reduction in the crop weed competition. This might have enabled the crop to take up more nutrients. Brar and Gill (1993) [5] also found poor yield of cotton due to severe competition for growth resources offered by rapid growth of weeds. Such yield reduction due to weed competition was also observed by Shelke and Bhsle (1990) [31], Thind et al. (1995) [36] and Bharathi et al. (2011) [3].

Effect of sequential application of herbicides on cotton

Herbicides are often selective and crop specific. Understanding the suitable time of herbicide application is more important to avoid crop damage since their specific nature of mode of action. If we use pre emergence herbicides as post emergence there may be chances of crop injuries though selective to specific crop. Therefore, the rating of toxicity was carried in the investigation after each time spray. At pre emergence spray, among the different herbicides, pre emergence toxicity was carried in the investigation after each time spray. Though selective to specific crop. Therefore, the rating of toxicity was carried in the investigation after each time spray. This was mainly due to the higher seed cotton yield realized in these treatments due to improved growth as a consequence of effective control of weeds and reduction in the crop weed competition. This might have enabled the crop to take up more nutrients. Brar and Gill (1993) [5] also found poor yield of cotton due to severe competition for growth resources offered by rapid growth of weeds. Such yield reduction due to weed competition was also observed by Shelke and Bhsle (1990) [31], Thind et al. (1995) [36] and Bharathi et al. (2011) [3].

Yield is the net result of various interactions viz., climate, soil moisture, growth components, crop-weed competition, etc.
nutrient uptake by crop and weeds and various physiological processes occurring within plant during the growing period. Weeds offer serious competition to cotton and cause drastic reduction of yield. Timely control of weeds helps to reduce the crop weed competition and ultimately better utilization of resources to produce higher yield.

Seed cotton yield varied significantly due to different weed management practices (Table 2). Significantly the highest seed cotton yield was obtained with weed free check (3219 kg/ha) compared to any other treatments and weedy check (763 kg/ha). The weed free check recorded 322 per cent higher yield than weedy check. Among the herbicide treatments, sequential application of pyriphlbac sodium 10% EC @ 0.125 kg/ha fb pyriphlbac sodium 10% EC @ 0.125 kg/ha recorded significantly higher seed cotton yield (2863 kg/ha) followed by butachlor 50% EC @ 1.5 kg/ha fb butachlor 50% EC @ 1.5 kg/ha (2830 kg ha⁻¹), pendimethalin 38.7% CS @ 0.68 kg/ha fb pendimethalin 38.7% CS @ 0.68 kg/ha (2725 kg/ha), oxyfluorfen 23.5% EC @ 0.2 kg/ha fb oxyfluorfen 23.5% EC @ 0.2 kg/ha (2738 kg/ha) and recommended practice (2675 kg/ha) which were on par. The increase in yield in these treatments was to the tune of 275, 271, 257, 259 and 251 per cent over unweeded check, respectively. The higher seed cotton yield in these treatments could be attributed to improved yield components viz., number of bolls/plant, boll weight and seed cotton yield/plant. This improvement in turn was due to improved growth attributes such as higher total dry matter production and distribution in different parts, higher leaf area, leaf area index and sympodial branches/plant.

Thus, the improvement in crop growth and yield components was the consequence of lower crop weed competition occurred due to weed free environment with sequential application of herbicides, which shifted the balance in favour of crop in the utilization of nutrients, moisture, light and space. Such improvement in growth and yield parameters and yield due to reduced weed competition was also reported by Sadangi and Barik (2007) [28], Prabhu et al. (2011) [24] and Bharathi et al. (2011) [3].

Differences in seed cotton yield among different weed management practices observed were largely because of differences in yield as well as growth components. Significant differences in the seed cotton yield per hectare could be attributed to the significant differences in the yield components (Table 2) such as, number of bolls per plant and boll weight. Weed free check recorded significantly higher number of bolls per plant (22.23), which is the most important factor deciding the seed cotton yield per plant. Among the herbicide treatments, sequential application of pyriphlbac sodium 10% EC @ 0.125 kg/ha fb pyriphlbac sodium 10% EC @ 0.125 kg/ha, butachlor 50% EC @ 1.5 kg/ha fb butachlor 50% EC @ 1.5 kg/ha and pendimethalin 38.7% CS @ 0.68 kg/ha fb pendimethalin 38.7% CS @ 0.68 kg/ha recorded significantly higher boll weight (5.92, 5.88, 5.83 and 5.79 g, respectively). It can be attributed to higher leaf area, leaf area index and thus greater photosynthesis and dry matter production and also better translocation of metabolites for boll development. It was due to reduced weed competition in these treatments. On the other hand, significantly smaller sized bolls (5.15 g) were noticed in the plots where the weeds left undisturbed throughout the season. These results are in conformity with the findings of Prabhu et al. (2011) [24] and Kelaginamani (1997) [16].

The differences in various yield components of Bt cotton, which led to the significant yield differences among weed management practices could be traced back to differences in growth components. Total dry matter production (Table 3) differed significantly. Weed free check recorded significantly higher total dry matter production. Among the herbicide treatments, sequential application of pyriphlbac sodium 10% EC @ 0.125 kg/ha fb pyriphlbac sodium 10% EC @ 0.125 kg/ha recorded significantly higher total dry matter production (269.8 g/plant) which was on par with sequential application of butachlor 50% EC @ 1.5 kg/ha fb butachlor 50% EC @ 1.5 kg/ha (264.4 g/plant). This was the result of luxuriant crop growth as indicated by higher plant height (118.5 cm), higher number of monopodial (3.10) and sympodial (18.6) branches and higher leaf area index (2.08) which ensured higher dry matter production and its distribution in different parts like stem, leaves and reproductive parts.

On the other hand, total dry matter production was significantly lower in weedy check (107.6 g/plant). Sequential application of pendimethalin 30% EC fb pendimethalin 30% EC, alachlor fb alachlor and diuron fb diuron recorded significantly lower dry matter among the herbicide treatments but they remained significantly high compared to weedy check. The decrease in the total dry matter production of cotton in weedy check may be well associated with severe competition from profusely grown weeds with crop for moisture, nutrients, light and space. Since weeds being wild forms have greater competitive ability than domestic crops. Kelaginamani (1997) [16] and Bouchagier et al. (2008) [4] also noticed reduction in dry matter due to uncontrolled weeds.

| No. | Treatments                                      | Total dry weight of weeds (g/m²) | Weed control Index (%) |
|-----|------------------------------------------------|----------------------------------|------------------------|
|     |                                                | 20 DAS  | 40 DAS  | 60 DAS  | 20 DAS  | 40 DAS  | 60 DAS  |
| T₁  | Pendimethalin 30% EC @ 1.5 kg/ha fb Pendimethalin 30% EC @ 1.5 kg/ha | 1.49 * (1.28) | 2.72 (6.50) | 3.17 (9.17) | 89.04 | 83.77 | 90.80 |
| T₂  | Pendimethalin 38.7% CS @ 0.68 kg/ha fb Pendimethalin 38.7% CS @ 0.68 kg/ha | 1.03 (0.07) | 1.49 (1.25) | 2.21 (4.00) | 99.30 | 96.88 | 95.93 |
| T₃  | Alachlor 50% EC @ 2.0 kg/ha fb Alachlor 50% EC @ 2.0 kg/ha | 1.31 (0.73) | 2.39 (4.83) | 2.89 (7.50) | 93.58 | 87.93 | 92.52 |
| T₄  | Butachlor 50% EC @ 1.5 kg/ha fb Butachlor 50% EC @ 1.5 kg/ha | 1.00 (0.00) | 1.46 (1.17) | 1.97 (2.92) | 100.00 | 97.10 | 97.10 |
| T₅  | Diuron 80% WP @ 1.0 kg/ha fb Diuron 80% WP @ 1.25 kg/ha | 1.04 (0.08) | 2.02 (3.25) | 3.01 (8.08) | 98.89 | 91.73 | 91.88 |
| T₆  | Oxyfluorfen 23.5% EC @ 0.2 kg/ha fb Oxyfluorfen 23.5% EC @ 0.00 (0.00) | 1.52 (1.33) | 2.31 (4.42) | 3.31 (6.42) | 100.00 | 96.79 | 95.56 |
N. Studies on integrated weed management in
yields of Bt cotton can be obtained
with sequential application of pyrithiobac sodium fb
weeds, higher growth a
From this study it can be concluded that effective control of
fb: followed by, IC: Intercultivation, HW: hand weeding, DAS: Days after sowing, Values in parenthesis indicate original values,
*√X +1.0 transformed values T1 to T7 – Intercultivation at 30 and 60 DAS RPP: Recommended package of practice

| Table 2: Yield and yield components of Bt cotton as influenced by sequential application of herbicides. (Pooled mean of 2011-12 and 2012-13) |
|---|---|---|---|---|
| Tr. No. | Treatments | Total number of bolls/plant | Boll weight (g) | Seed cotton yield kg/ha | Weed Index (%) |
| T1 | Pendimethalin 30% EC @ 1.5 kg/ha fb Pendimethalin 30% EC @ 1.5 kg/ha | 17.17 | 5.62 | 2416 | 25.46 |
| T2 | Pendimethalin 38.7% CS @ 0.68 kg/ha fb Pendimethalin 38.7% CS @ 0.68 kg/ha | 19.23 | 5.83 | 2725 | 15.94 |
| T3 | Alachlor 50% EC @ 2.0 kg/ha fb Alachlor 50% EC @ 2.0 kg/ha | 17.93 | 5.62 | 2468 | 23.93 |
| T4 | Butachlor 50% EC @ 1.5 kg/ha fb Butachlor 50% EC @ 1.5 kg/ha | 20.27 | 5.88 | 2830 | 12.45 |
| T5 | Diuron 80% WP @ 1.0 kg/ha fb Diuron 80% WP @ 1.25 kg/ha | 17.87 | 5.69 | 2548 | 21.13 |
| T6 | Oxyfluorfen 23.5% EC @ 0.2 kg/ha fb Oxyfluorfen 23.5% EC @ 0.2 kg/ha | 19.07 | 5.79 | 2738 | 15.07 |
| T7 | Pendimethalin 30% EC @ 1.5 kg/ha fb Pendimethalin 30% EC @ 1.5 kg/ha | 20.60 | 5.92 | 2863 | 11.43 |
| T8 | RPP: Pendimethalin 30% EC @ 1.5 kg/ha + HW at 40 DAS + IC at 60 DAS | 18.83 | 5.72 | 2675 | 17.26 |
| T9 | Weed free check | 22.23 | 6.13 | 3219 | - |
| T10 | Unweeded check | 7.40 | 5.15 | 763 | 76.56 |
| | SEM± | 0.48 | 0.06 | 93 | 2.01 |
| | C D @ 5% | 1.45 | 0.19 | 278 | 6.48 |

| Table 3: Growth Parameters (at harvest) of Bt cotton as influenced by sequential application of herbicides. (Pooled mean of 2011-12 and 2012-13) |
|---|---|---|---|---|
| Tr. No. | Treatments | Plant height (cm) | Leaf area index | Monopodial branches/ plant | Sympodial Branches / plant | Total dry matter production (g/plant) |
| T1 | Pendimethalin 30% EC @ 1.5 kg/ha fb Pendimethalin 30% EC @ 1.5 kg/ha | 103.5 | 1.64 | 2.43 | 16.1 | 208.3 |
| T2 | Pendimethalin 38.7% CS @ 0.68 kg/ha fb Pendimethalin 38.7% CS @ 0.68 kg/ha | 112.8 | 1.92 | 2.83 | 17.9 | 239.3 |
| T3 | Alachlor 50% EC @ 2.0 kg/ha fb Alachlor 50% EC @ 2.0 kg/ha | 106.9 | 1.74 | 2.50 | 17.0 | 213.8 |
| T4 | Butachlor 50% EC @ 1.5 kg/ha fb Butachlor 50% EC @ 1.5 kg/ha | 115.3 | 2.07 | 2.97 | 18.6 | 264.4 |
| T5 | Diuron 80% WP @ 1.0 kg/ha fb Diuron 80% WP @ 1.25 kg/ha | 104.9 | 1.74 | 2.47 | 16.8 | 217.3 |
| T6 | Oxyfluorfen 23.5% EC @ 0.2 kg/ha fb Oxyfluorfen 23.5% EC @ 0.2 kg/ha | 112.3 | 1.84 | 2.77 | 17.9 | 232.7 |
| T7 | Pyrithiobac-sodium 10% EC @ 0.125 kg/ha fb Pyrithiobac-sodium 10% EC @ 0.125 kg/ha | 118.5 | 2.08 | 3.10 | 18.6 | 269.8 |
| T8 | RPP: Pendimethalin 30% EC @ 1.5 kg/ha + HW at 40 DAS + IC at 60 DAS | 110.0 | 1.84 | 2.57 | 17.8 | 235.0 |
| T9 | Weed free check | 126.8 | 2.21 | 3.20 | 19.9 | 295.6 |
| T10 | Unweeded check | 62.8 | 0.67 | 1.77 | 9.1 | 107.6 |
| | SEM± | 2.8 | 0.06 | 0.07 | 0.4 | 6.1 |
| | C D @ 5% | 8.4 | 0.17 | 0.22 | 1.1 | 18.2 |

References
1. Anonymous. All India coordinated cotton improvement project, ICAR, Tamil Nadu. Annual Progress Report, 2019-20.
2. Arun MN. Studies on integrated weed management in rainfed cotton (Gossypium hirsutum L.). M. Sc. (Agri.)
Thesis, University of Agricultural Sciences, Dharwad, 1990.

3. Bharathi S, Pavani M, Narayana E. Response of Bt cotton to post emergence herbicides in Vertisols of Krishna zone. International Journal of Applied Biology and Pharmaceutical Technology 2011;2(1):504-510.

4. Bouchagier P, Efthimiadou A, Katsileros A, Bilalis D, Efthimiadis P. Adverse effect of Bermuda grass on physiologically and Growth components of cotton. Journal of Agronomy 2008;7(1):49-55.

5. Brar HS, Gill HS. Chemical weed control in cotton. Journal of Research, PAU 1985;22:437-443.

6. Brar HS, Gill HS. Studies on the critical period of crop weed competition in cotton. Indian Journal of Ecology 1993;10:148-153.

7. Deshmukh RK, Mudholkar NT. Control of weeds in cotton. Indian Farming 1988, 17-20.

8. Gill GS, Vijay Kumar. Weed index-a new method for reporting control trials. Indian Journal of Agronomy 1969;14:96-98.

9. Gomez KA, Gomez A. Statistical Procedures for Agricultural Research, Second edition, John Wiley and Sons, New York 1984.

10. Graham Charles. Managing Weeds in Cotton, Weedpak – a guide for integrated management of weeds in cotton 2002, P-B 3, 1-B 3, 22.

11. Hamdy M, Shawki Barghouti, Fred Gillham, Tawhid AI-Saffy M. Cotton Production Prospects for the Decade to 2005: A Global Overview. World Bank Technical Paper 1994, 231.

12. Jain SC, Iyer BG, Jain HC, Jain NK. Nutrient competition studies in cotton under different weed control system in Madhya Pradesh. Indian Journal of Weed Science 1981;13(1).

13. Jordan DL, Frans RE, Mc Clellan MR. Cotton (Gossypium hirsutum) response to DPX-PE350 applied postemergence. Weed Technology 1993a;7:159-162.

14. Jordan DL, Frans RE, Mc Clellan MR. Total postemergence herbicide programme in cotton (Gossypium hirsutum) with sethoxdim and DPX-PE350. Weed Technology 1993b;7:196-201.

15. Keeling JW, Henniger CG, Aberthly JR. Effects of DPX-PE350 on cotton (Gossypium hirsutum) growth, yield and fibre quality. Weed Technology 1993;7:930-933.

16. Kelaginamani SV. Weed control in cotton (Gossypium hirsutum L.) in black soils of northern transitional tract of Karnataka. M. Sc. (Agr.) Thesis, University of Agricultural Sciences, Dharwad, 1997.

17. Mishra A, Tosh GC. Chemical weed control studies on dwarf wheat. Journal of Research, OUAT 1979;10:1-6.

18. Muthusankaranarayanan A, Chellamuthu V, Rajamannar A, Rajapandian SSJ. Effect of herbicides on the weed control in rainfed cotton/blackgram intercropping system. Indian Journal of Weed Science 1988;20(3):91-93.

19. Nandanassabady T, Kandasamy OS, Ramesh G. Integration of pre and non selective post emergence herbicides and cultural method for weed control in cotton and its effect on succeeding crops. Tropical Agricultural Research 2000;12:217-225.

20. Nalini K, Muthukrishna P, Chinnusamy C. Evaluation of pendimethalin 38. 7% EC on weed management in winter irrigated cotton. Madras Agricultural Journal 2011;98(4-6):165-168.

21. Panwar RS, Malik RK, Kumar S. Evaluation of pyrithiobac for weed control in cotton. Indian Journal of Weed Science 1999;31(3-4):175-178.

22. Patil MB. Studies on weed management in rainfed chilli + cotton intercropping system. Ph. D. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India) 1999.

23. Patil PR. Efficacy of glyphosate and propaquizafop for control of Cynodon dactylon in cotton. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India) 2010.

24. Prabhu G, Halepityati AS, Pujari BT, Desai BK. Integrated weed management in Bt cotton (Gossypium hirsutum L.) under irrigated conditions. Karnataka Journal of Agricultural Science 2011;24(4):529-530.

25. Rajkumar S. Weed management in onion – chilli – cotton relay intercropping in rainfed Vertisols. Ph. D. Thesis, University of Agricultural Sciences, Dharwad, Karnataka (India) 2009.

26. Ramasundaram P, Hemchandra G. Constraints to cotton production in India. CICR Technical Bulletin 2001;19:1-19.

27. Rao VS. Principles of Weed Science, Oxford and IBH Publishing Co., Pvt. Ltd., New Delhi 1986, 450.

28. Sadangi PK, Barik KC. Effect of weed-management practices on nutrient depletion by weeds, yield and economics of winter-irrigated cotton (Gossypium hirsutum L.). Indian Journal of Agronomy 2007;52(2):172-175.

29. Sestak Z, Catsky J, Jarris PG. Plant Synthesis - Production Manual of Methods, N. V. Publications, The Hague, 1974, 343-381.

30. Shankale MW, Hayes RM, Reich VH, Mueller et al., MSMA and pyrithiobac on cotton (Gossypium hirsutum L.) development, quality and yield. Weed Science 1996;44:137-142.

31. Shelke DK, Bhosle RH. Determination of critical period of crop-weed competition in rainfed cotton. Journal of Maharashtra Agricultural Universities 1990;15(2):257-258.

32. Singh T, Bhatia RK, Singh S, Mehra SP. Bio-efficacy of glufosinate ammonium for weed control in American cotton. Indian Journal of Weed Science 2004;36(3&4):306-307.

33. Snipes CE, Allen RL. Interaction of graminicides applied in combination with pyrithiobac. Weed Technology 1996;10:889-892.

34. Snipes CE, Seifert S. Influence of malathion timing on cotton (Gossypium hirsutum) response to pyrithiobac. Weed Technology 2003;17:866-868.

35. Sreenivas G. Effect of application of glyphosate with or without other pre-emergence herbicides in rainfed American cotton. Indian Journal of Weed Science 2000;32(1/2):98-100.

36. Third RJS, Brar AS, Brar LS. Weed interference in American cotton. Indian Journal Weed Science 1995;27:71-79.