Eco-friendly Weed Management Strategies for High Density Planting System Cotton in Vertisol of Northern Karnataka

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Introduction

Cotton (Gossypium sp.) is popularly known as “the white gold or the king of fibre crops” ranks fifth in area and third in production of cotton after USA and China. The productivity of cotton is 505.46 kg/ha much lower than the world average (621 kg/ha). Among the cotton growing states, Karnataka ranks eighth with an area (5.46 lakh ha) and seventh in production with 18.0 lakh bales of lint with an average productivity of 560.44 kg of lint per ha (Anon., 2018). The high density planting system (HDPS) is now being conceived as an alternate production system having a potential for improving productivity and profitability, increasing efficiency, reducing input costs and minimizing risks associated with India's cotton production system. Of many problems faced by the cotton growers, the most troublesome one is the control of weeds particularly during early stages of crop growth. Weed infestation in cotton has been reported to offer severe competition and causing yield reduction to an extent 50 to 85 per cent (Venugopalan et al., 2009). Thus, if proper weed control measures are followed, there would be greater availability of nutrients and moisture for the benefit of crop (Jalis and Shah, 1982). Cotton with minimal weed competition during the initial phase i.e., three to five weeks would yield better (Mohamed...
Ali and Bhanumurthy, 1985). Thus, there is need for selection of new molecules of pre-emergence to control weeds during initial crop period. Thus, there is need for selection of new molecules of pre-emergence to control weeds during initial crop period.

**Materials and Methods**

Experiment was conducted in 2017 and 2018 at Department of Agronomy, College of Agriculture, UAS, Raichur. The soil of the experimental site is medium black with clay loam texture. During the crop growth period in 2017 the amount of rainfall received during cropping season was 874.2 mm in 47 rainy days. In 2018 total rainfall received during the cropping period was 216.1 mm in 20 rainy days. Experiment was laid out in Randomized Completely Block Design with three replications. Cotton variety Suraj was selected for the study in both the years. Seeds were hand dibbled at a spacing of 60 cm x 20 cm. Crops were planted in July and August months in 2017 and 2018 respectively. Treatments consist of Pendimethalin 38.7 CS @ 680 g a.i. ha\(^{-1}\) as PE followed by (fb) HW at 25 DAS and IC at 50 and 75 DAS, Clomazone 50 EC @ 250, 500 and 750 g a.i. ha\(^{-1}\) as PE fb HW at 25 DAS and IC at 50 and 75 DAS, Clomazone 50 EC @ 250, 500 and 750 g a.i. ha\(^{-1}\) as PE fb pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) at 25 DAS as POE, Clomazone 50 EC @ 250, 500 and 750 g a.i. ha\(^{-1}\) as PE fb pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) + quizolofop ethyl 5 EC @ 37.5 g a.i. ha\(^{-1}\) at 25 DAS as POE, Pendimethalin 38.7 CS @ 680 g a.i. ha\(^{-1}\) as PE fb Pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) + Quizolofop ethyl 5 EC @ 37.5 g a.i. ha\(^{-1}\) at 25 DAS as POE, One HW at 25 DAS and IC at 50 and 75 DAS, weed free check and unweeded control.

Observations on weed density, weed dry weight, growth and yield attributes weed control efficiency (WCE), weed Index (WI) and economics were analysed following the procedure given by Gomez and Gomez (1984) for RCBD. The data pertaining to weeds were transformed to square root scale of √(X+1) and analysed as suggested by Snedecor and Cochran (1967). Whenever significant difference existed, critical difference was constructed at 5 per cent probability level. That treatment, where the difference was not significant was denoted as NS.

**Results and Discussion**

**Weed density**

Pre emergence application of clomazone 50 EC @ 250 g a.i. ha\(^{-1}\) (4.4) were on par with each other and recorded significantly lower total weed population. Further, increase in clomazone 50 EC from 250 to 750 g a.i. ha\(^{-1}\) did not show any significant differences. It was on par with application of pre emergence application of pendimethalin 38.7 CS @ 680 g a.i. ha\(^{-1}\) (4.7). This was due to better control of all weed species by causing discolouring or whitening on target weed plants which enters through roots and emerging shoots and was transported with the transpiration stream in the xylem and inhibits the carotenoid synthesis. This results impaired chloroplast development and pigment loss in susceptible plants and showed necrosis after coming into contact with sunlight (Veeramani et al., 2008). The left over weeds were controlled by hand weeding at 25 DAS and inter cultivation at 50 and 75 DAS.
Weed dry weight depicted a similar response as the total weed population in various treatments. The reduced weed density under clomazone 50 EC at 250 to 750 g a.i. ha\(^{-1}\) had resulted in reduced weed biomass at all the stages of crop growth. This might be attributed to rapid depletion of carbohydrate reserve of the weeds through rapid respiration (Prakash et al., 1999) (Table 1).

The biomass of grasses, sedges and broad-leaved weeds were reduced due to different weed management treatments. Madavi et al., (2017) also reported reduction in weed dry weight by sequential application of pendimethalin as PE fb PoE pyrithiobac sodium + quizalofop ethyl was might be due to better weed control by tank mix combination of these PoE weedicides.

**Yield attributes**

Pendimethalin 38.7 CS @ 680 g a.i. ha\(^{-1}\) as PE (14.4 cm) and clomazone 50 EC @ 250 a.i. ha\(^{-1}\) as PE (14.5 cm) were on par with weed free check. Increase in clomazone 50 EC @ 250 or 500 g a.i. ha\(^{-1}\) did not show any significant differences. This might be due to better weed control in the above treatments which resulted in efficient utilization of light, water and nutrients than other treatments. Unchecked weed growth in unweeded control reduced the plant height.

This was attributed to suppressing effect of weeds on crop plants (Chander et al., 1997). Heavy weed competition reduced the nutrient uptake by crop and reduced the growth of crop as evidenced from the lowest plant height in unweeded control (Balasubramanian, 1985).

The increased number of sympodials plant\(^{-1}\) with the application of pre emergence herbicide, clomazone 50 EC @ 250 or 500 g a.i. ha\(^{-1}\) as PE with HW at 25 DAS and IC at 50 and 75 DAS and combined application of pre and post emergence herbicides was due to improvement in growth attributes such as monopodials per plant, leaf area index and total dry matter production (Table 3 and 4).

Significantly more number of bolls plant\(^{-1}\) was recorded in weed free check (T\(_{13}\): 1.8 plant\(^{-1}\)) and was on par with the pre emergence application of pendimethalin 38.7 CS @ 680 g a.i. ha\(^{-1}\) (1.5) and clomazone 50 EC @ 250 g a.i. ha\(^{-1}\) or 500 g a.i. ha\(^{-1}\) with or without pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) + Quizalofop ethyl 5 EC @ 37.5 g a.i. ha\(^{-1}\) were significantly superior over unweeded control. This was in accordance with the findings of Nehra et al., (1988). Unweeded control treatment recorded lesser boll weight due to season long infestation of weeds.
**Table 1** Total weed density and dry weight at different growth stages in eco-friendly weed management through chemical approaches in HDPS cotton

| Treatments | Total weed density (no. m⁻²) | Weed dry weight (g m⁻²) |
|------------|-------------------------------|------------------------|
|            | 25 DAS | 50 DAS | 75 DAS | 100 DAS | 25 DAS | 50 DAS | 75 DAS | 100 DAS |
| Pendimethalin 38.7 CS @ 680 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 4.7 (20.7) | 5.5 (29.7) | 5.5 (29.3) | 5.7 (31.7) | 2.43 (4.93) | 7.41 (54.1) | 8.45 (70.4) | 9.3 (85.9) |
| Clomazone* 50 EC @ 250 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 4.4 (18.7) | 5.3 (28.0) | 6.1 (37.0) | 5.2 (26.0) | 2.39 (4.71) | 6.29 (39.0) | 7.30 (53.0) | 9.4 (87.1) |
| Clomazone EC @ 500 g a.i. ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 4.3 (18.0) | 4.8 (22.7) | 5.5 (29.7) | 5.2 (27.0) | 2.41 (4.83) | 5.67 (31.2) | 7.46 (54.7) | 8.9 (78.2) |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 4.4 (18.3) | 5.6 (30.7) | 6.1 (36.7) | 5.6 (30.0) | 2.38 (4.93) | 6.45 (40.6) | 8.40 (69.6) | 9.4 (86.9) |
| Clomazone 50 EC @ 250 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 4.7 (20.7) | 5.7 (23.2) | 6.0 (35.3) | 5.3 (27.3) | 2.33 (4.48) | 5.82 (33.0) | 7.35 (54.7) | 8.9 (78.5) |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 4.3 (17.7) | 4.8 (23.3) | 5.6 (31.0) | 5.4 (28.3) | 2.32 (4.56) | 5.44 (29.4) | 7.29 (52.4) | 9.0 (79.8) |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 4.9 (23.3) | 5.6 (30.3) | 5.5 (29.3) | 5.7 (32.3) | 2.35 (4.55) | 6.78 (45.2) | 7.20 (52.4) | 8.9 (79.0) |
| Clomazone 50 EC @ 250 g a.i./ha fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 5.0 (24.7) | 5.1 (25.3) | 5.9 (34.9) | 6.0 (35.3) | 2.47 (5.12) | 6.60 (42.7) | 7.06 (49.4) | 8.5 (71.2) |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 4.0 (15.0) | 5.1 (25.0) | 5.0 (23.7) | 5.7 (31.3) | 2.45 (5.04) | 5.81 (32.8) | 7.18 (50.7) | 8.0 (62.5) |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 4.4 (18.7) | 5.4 (29.0) | 4.8 (22.7) | 5.4 (29.0) | 2.49 (5.19) | 6.65 (43.4) | 7.31 (52.6) | 9.1 (82.4) |
| Clomazone 50 EC @ 250 g a.i./ha fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 4.3 (17.3) | 4.2 (17.3) | 5.2 (25.7) | 5.5 (29.0) | 2.53 (5.42) | 6.95 (48.0) | 7.62 (57.1) | 9.0 (79.3) |
| Pendimethalin 38.7 CS @ 680 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 6.9 (47.3) | 4.5 (19.7) | 5.7 (31.3) | 5.3 (27.7) | 3.12 (8.75) | 7.00 (49.5) | 7.78 (59.7) | 9.2 (84.1) |
| HW at 25 DAS and IC at 50 and 75 DAS | 1.0 (0.0) | 1.0 (0.0) | 1.0 (0.0) | 1.0 (0.0) | 1.00 (0.00) | 1.00 (0.00) | 1.00 (0.00) | 1.0 (0.0) |
| Weed free check | 8.9 (78.7) | 9.3 (86.7) | 10.7 (113.0) | 10.8 (114.7) | 3.51 (11.3) | 12.54 (156.2) | 13.66 (186.0) | 16.2 (262.1) |
| Unweeded control | 0.7 (0.7) | 0.5 (0.5) | 0.6 (0.6) | 0.14 (0.14) | 0.41 (0.41) | 0.42 (0.42) | 0.26 (0.26) | 0.26 (0.26) |

*S.Em.*

* Figures in parenthesis indicate original values

**Values are square root transformed \(1\)
Table 2: Weed control efficiency (%) at different growth stages in eco-friendly weed management through chemical approaches in HDPS cotton

| Treatments                                                                 | 25 DAS | 50 DAS | 75 DAS | 100 DAS | 125 DAS | At harvest |
|----------------------------------------------------------------------------|--------|--------|--------|---------|---------|------------|
| Pendimethalin 38.7 CS @ 680 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 56.1   | 65.2   | 61.7   | 66.4    | 70.8    | 75.3       |
| Clomazone* 50 EC @ 250 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS   | 58.1   | 74.9   | 71.1   | 66.9    | 72.8    | 76.6       |
| Clomazone 50 EC @ 500 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS    | 56.8   | 79.9   | 70.3   | 69.7    | 73.3    | 77.9       |
| Clomazone 50 EC @ 750 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS    | 54.9   | 74.0   | 62.2   | 66.3    | 72.4    | 74.7       |
| Clomazone 50 EC @ 250 g a.i ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 60.6   | 78.7   | 69.5   | 69.8    | 74.7    | 74.5       |
| Clomazone 50 EC @ 500 g a.i ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 60.5   | 80.9   | 71.5   | 69.2    | 75.9    | 79.0       |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 59.1   | 71.1   | 71.1   | 69.9    | 75.3    | 76.7       |
| Clomazone 50 EC @ 250 g a.i./ha fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 54.1   | 72.6   | 73.1   | 72.5    | 76.6    | 73.4       |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 54.5   | 78.8   | 72.4   | 75.5    | 78.0    | 70.2       |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 53.5   | 72.3   | 71.3   | 68.3    | 73.8    | 74.5       |
| Pendimethalin 38.7 CS @ 680 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS. | 52.2   | 69.4   | 69.5   | 69.4    | 72.2    | 71.8       |
| HW at 25 DAS and IC at 50 and 75 DAS                                       | 22.7   | 67.9   | 67.4   | 67.6    | 68.2    | 74.4       |
| Weed free check                                                           | 100.0  | 100.0  | 100.0  | 100.0   | 100.0   | 100.0      |
| Unweeded control                                                          | 0.0    | 0.0    | 0.0    | 0.0     | 0.0     | 0.0        |
| S.Em.±                                                                   | 5.8    | 3.5    | 3.2    | 1.7     | 1.5     | 2.6        |
| CD at 5%                                                                  | 16.8   | 10.1   | 9.3    | 4.9     | 4.3     | 7.5        |
Table 3: Sympodial branches, bolls per plant and boll weight at harvest in eco-friendly weed management through chemical approaches in HDPS cotton

| Treatment                                                                 | Sympodial branches/plant | Bolls per plant | Boll weight (g) |
|---------------------------------------------------------------------------|--------------------------|-----------------|-----------------|
| Pendimethalin 38.7 CS @ 680 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 18.8                     | 18.7            | 2.74            |
| Clomazone* 50 EC @ 250 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS  | 18.0                     | 18.9            | 2.76            |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS  | 18.3                     | 19.4            | 2.85            |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS  | 18.0                     | 17.7            | 2.75            |
| Clomazone 50 EC @ 250 g a.i. ha⁻¹ fb pyrithiobac sodium¥ 10EC 75 g a.i. ha⁻¹ at 25 DAS as | 18.2                     | 18.7            | 2.76            |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 18.4                     | 19.1            | 2.85            |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 18.0                     | 17.7            | 2.76            |
| Clomazone 50 EC @ 250 g a.i./ha fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS¥ | 17.9                     | 18.6            | 2.77            |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 18.6                     | 19.2            | 2.93            |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @75 g a.i. ha⁻¹ + quizolofop ethyl 5EC @ 37.5 g a.i. ha⁻¹ at 25 DAS. | 18.0                     | 17.8            | 2.69            |
| Pendimethalin 38.7 CS @ 680 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS. | 18.2                     | 18.6            | 2.72            |
| HW at 25 DAS and IC at 50 and 75 DAS                                      | 15.8                     | 15.8            | 2.50            |
| Weed free check                                                          | 19.2                     | 20.8            | 3.12            |
| Unweeded control                                                         | 13.6                     | 12.5            | 2.08            |
| S.Em.±                                                                   | 0.5                      | 0.8             | 0.14            |
| CD at 5%                                                                 | 1.3                      | 2.3             | 0.39            |
Table 4 Yield attributes in eco-friendly weed management through chemical approaches in HDPS cotton

| Treatments                                                                 | Weed index | Seed cotton yield (kg/ha) |
|---------------------------------------------------------------------------|------------|---------------------------|
|                                                                           | 2017       | 2018                      | Pooled       | 2017  | 2018  | Pooled |
| Pendimethalin 38.7 CS @ 680 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 11.1       | 7.5                       | 9.3          | 1367  | 1326  | 1346   |
| Clomazone* 50 EC @ 250 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS | 12.0       | 8.5                       | 10.3         | 1387  | 1304  | 1345   |
| Clomazone 50 EC @ 500 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS  | 6.8        | 10.8                      | 8.8          | 1477  | 1410  | 1444   |
| Clomazone 50 EC @ 750 g a.i ha⁻¹ fb HW at 25 DAS and IC at 50 and 75 DAS  | 12.5       | 17.2                      | 14.9         | 1370  | 1183  | 1277   |
| Clomazone 50 EC @ 250 g a.i ha⁻¹ fb pyrithiobac sodium¥ 10EC 75 g a.i. ha⁻¹ at 25 DAS as | 9.0        | 12.9                      | 11.0         | 1407  | 1246  | 1326   |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 4.7        | 11.1                      | 7.9          | 1417  | 1267  | 1342   |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10EC 75 g a.i. ha⁻¹ at 25 DAS | 13.2       | 13.0                      | 13.1         | 1361  | 1243  | 1302   |
| Clomazone 50 EC @ 250 g a.i./ha fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS ¥ | 15.6       | 19.9                      | 17.7         | 1296  | 1219  | 1258   |
| Clomazone 50 EC @ 500 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS | 12.1       | 11.6                      | 11.9         | 1407  | 1267  | 1337   |
| Clomazone 50 EC @ 750 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @75 g a.i. ha⁻¹ + quizolofop ethyl 5EC @ 37.5 g a.i. ha⁻¹ at 25 DAS. | 19.5       | 17.9                      | 18.7         | 1283  | 1173  | 1228   |
| Pendimethalin 38.7 CS @ 680 g a.i. ha⁻¹ fb pyrithiobac sodium 10 EC @ 75 g a.i. ha⁻¹ + quizolofop ethyl 5 EC @ 37.5 g a.i. ha⁻¹ at 25 DAS. HW at 25 DAS and IC at 50 and 75 DAS | 17.0       | 14.0                      | 15.5         | 1300  | 1230  | 1265   |
| Weed free check                                                           | 0.0        | 0.0                       | 0.0          | 1603  | 1431  | 1517   |
| Unweeded control                                                          | 38.5       | 39.5                      | 39.0         | 859   | 865   | 862    |
| S.Em.±                                                                    | 8.00       | 6.40                      | 6.20         | 124   | 84    | 85     |
| CD at 5%                                                                  | 23.4       | 18.7                      | 17.9         | 360   | 243   | 246    |

*as pre-emergence; ¥ as post emergent
The increase in boll numbers was due to timely and effective control of weeds, which resulted in better availability of natural resources, which increased plant height, number of sympodials branches and other growth parameters and corresponding increase in the sympodials plant\(^1\). Application of pre and post emergence herbicides also increase the number of bolls due to better control of weeds at critical stage and also later germinated weeds. The lower number of bolls per plant in unweeded control treatment might be due to reduced crop dry matter and increased weed competition as the weeds were allowed freely to compete with cotton plants Madavi (2016).

Application of clomazone 50 EC @ 250, 500 or 750 g a.i. ha\(^{-1}\) as PE followed by one HW at 25 DAS and IC at 50 and 75 DAS, application of pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) and application of clomazone 50 EC @ 250 or 500 g a.i. ha\(^{-1}\) as PE followed by combined application of pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) + quizolofop ethyl 5 EC @ 37.5 g a.i. ha\(^{-1}\) at 25 DAS as POE. The increased boll weight in these management practices was attributed to the reduction in crop weed competition through effective control of weeds, which was favourable for better growth and enhanced leaf area contributing for the activated photosynthesis and translocation of more photosynthates to sink which increased the boll weight (Nalini, 2010).

**Seed cotton yield**

Increased concentration of clomazone from 250 g a.i. ha\(^{-1}\) to 500 g a.i. ha\(^{-1}\) or 750 g a.i. ha\(^{-1}\) did not increase the seed cotton yield, indicating clomazone @ 250 g a.i. ha\(^{-1}\) was optimum. These treatments were on par with weed free check but significantly superior over unweeded control and HW at 25 DAS and IC at 50 and 75 DAS. These treatments were increased yield with the tune of 43.2%, 35.9% and 35.8 over unweeded control. The variation in seed cotton yield may be attributed to be positive association between yield and yield contributing characters like sympodial branches, number of bolls plant\(^{-1}\), mean boll weight and dry matter production. The improvement in growth and yield component in these treatments was due to reduced weed growth and weed dry weight. Better growth of cotton plants in these treatments might be due least competition with weeds for moisture, nutrients, space etc. Shahzad *et al.*, (2012) reported that, hand weeding and herbicidal treatments reduced the weed infestation, resulted in higher seed cotton yield over weedy plots. This was due to heavy infestation of weeds and poor yield components such as lower number of bolls plant\(^{-1}\), less number of sympodial branches, lower seed index under unweeded control.

In conclusion the application of clomazone 50 EC @ 250 g a.i. ha\(^{-1}\) PE fb HW at 25 DAS and IC at 50 and 75 DAS is ideal for better weed control efficiency is good integrated weed control practice. Under scarcity of labours or unfavourable condition like continuous rainfall to employ labour to weeding at later stages, sequential application of clomazone 50 EC @ 250 g a.i. ha\(^{-1}\) fb post emergence application pyrithiobac sodium 10 EC @ 75 g a.i. ha\(^{-1}\) at 25 DAS controlled the weeds effectively and increased seed cotton yields of high density planting system.

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**How to cite this article:**

Kamble Anand Shankar, A. S. Channabasavanna, M. Y. Ajayakumar, Koppalkar, B. G. Mahadevswamy and Amaregouda, A. 2020. Eco-friendly Weed Management Strategies for High Density Planting System Cotton in Vertisol of Northern Karnataka. *Int.J.Curr.Microbiol.App.Sci.* 9(11): 1021-1029. doi: [https://doi.org/10.20546/ijcmas.2020.911.120](https://doi.org/10.20546/ijcmas.2020.911.120)