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# Bioefficacy of tembotrione against mixed weed complex in maize

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**ABSTRACT**

A field experiment was conducted at the Norman E. Borlaug Crop Research Center, Pantnagar, during the rainy seasons of 2009 and 2010 to evaluate the efficacy of tembotrione (42% SC), a new post-emergence herbicide against mixed flora in maize as well as its residual effect on growth and yield of the succeeding mustard crop. The experimental field was highly infested with *Echinochloa colona*, *Digitaria sanguinalis* and *Cyperus rotundus*. Post emergence application of tembotrione 120 g/ha along with surfactant was found most effective to control the grassy as well as non-grassy weeds as compared to other herbicidal treatments either applied as pre or post emergence. This treatment also recorded highest grain yield during both the years which was at par with a lower dose (110 g/ha + surfactant) or even pre emergence application of the herbicide. Addition of surfactant (1000 ml/ha) increased the kernel yield significantly and reduced the density of weeds effectively as compared to the application of tembotrione without surfactant. No residual effects were observed on the growth and yield of succeeding mustard crop.

**Key words:** Herbicides, Maize, Tembotrione, Weed flora, Yield

Maize (*Zea mays* L.) is the most important cereal crop after wheat and rice, grown in virtually every suitable agricultural region of the globe. In India, it is cultivated as a food as well as feed crop under varying soil, topography, seasons and management practices throughout the country.

A wider row spacing and sowing of the crop with the onset of monsoon provides a favorable environment for weed growth. Apart from offering competition for light, space and moisture, it also helps the weeds to absorb more nutrients than the crop. A higher level of infestation combined with many weed species pose a major problem in *Kharif* maize. Almost all types of weeds *viz.*, grassy, BLWs and sedges infest the maize fields. The extent of nutrient loss varies from 30-40% of the applied nutrients (Mundra *et al.* 2002). Weeds being a serious negative factor in crop production are responsible for marked loss (28-100%) in crop yield (Pandey *et al.* 2001). Atrazine, recommended as a pre-emergence herbicide, is not effective against some of the weeds, both grassy and non grassy as well as the sedge *Cyperus rotundus*. Hence, there is need for some alternate post-emergence herbicide which can provide broad spectrum weed control in *Kharif* maize without affecting the crop growth and yield of crop.

Keeping in view the above facts, the present investigation was carried out for the evaluation of post-emergence herbicide tembotrione 42% SC with or without surfactants against mixed weed complex in maize at the G.B.P.U.A & T, Pantnagar during *Kharif* 2009 and 2010.

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## MATERIALS AND METHODS

A field experiment was conducted at the Norman E. Borlaug, Crop Research Center, Pantnagar, during *Kharif* 2009 and 2010 in a randomized block design with twelve treatments replicated thrice. The treatments consisted of three doses of tembotrione *viz.*, 100, 110 and 120 g/ha with or without surfactant (1000 ml/ha) , 2-4,D Na salt (80 WP, 800 ml/ha), atrazine, diuron and pendimethalin (1000 ml/ha) and twice hand weeding (at 20 and 40 DAS) while an untreated plot served as a control.

Maize crop variety *'4212'* was sown on 24th June, 2009 and 17th June, 2010 during the first and second years, respectively, in plots of size 3.0m x 5.0m. Herbicides were sprayed with Knapsack sprayer fitted with flat fan nozzle. In 2009, pre-emergence herbicides (atrazine, pendimethalin and diuron) were applied on June 24, 2009 and the post-emergence herbicide tembotrione alone or in combination with surfactant was applied on July 10, 2009 while in 2010, pre-emergence were applied on June 19, 2010 and post emergence on July 7, 2010. The different cultural practices recommended for maize crop were adopted during the crop growth period. Crop was harvested on September 23, 2009 and September 24, 2010, respectively.

Weed sampling was done randomly by placing a 0.5 x 0.5 m quadrate at four different locations in the experimental unit to assess the weed flora at 30 and 45 DAS and the number of weed species were counted and expressed

in number/$m^2$. Dry weight of total weed species was recorded after drying and expressed in g/$m^2$. Observations for yield and yield attributing characters were recorded after the harvest of crop.

The succeeding mustard crop was sown in RBD with five treatments, which include four doses of tembotrione *viz.*, 100, 110, 120 and 240 g/ha along with surfactant (1000 ml/ha) and untreated plot as a control. Mustard variety *"Kranti"* was sown on October 14, 2009 and October 12, 2010 during *Rabi* season in the different experimental plot with a row to row spacing of 50 cm. Crop was harvested on March 5, in both the years.

The experimental data obtained during the course of investigation were subjected to statistical analysis by analysis of variance (ANOVA) for the randomized block design to test the significance of the overall differences among the treatments by the "F" test and conclusion was drawn at 5% probability level. Standard error of mean was calculated in each case. When the 'F' value from analysis of variance tables was found to be significant, the critical difference (C.D.) was computed to test the significance of the difference between the two treatments.

## RESULTS AND DISCUSSION

The experimental plot was uniformly infested with the grassy weeds *Echinochloa colona* (41.0 and 49.4%), *Digitaria sanguinalis* (6.6 and 12.0%), *Bracharia ramose*(4.7 and 3.7%) while the BLWs included *Phyllanthus niruri* (4.3 and 5.94%), *Cleome viscosa* (2.7 and 3.5%) and *Trianthema monogyna*. *Cyperus rotundus* was the only sedge during both the seasons (Tables 3 and 4).

### Weed population

All the weed control treatment significantly reduced weed population compared to that in weedy check plots (Tables 1, 2, 3 and 4). Tembotrione (post-emergence) along with surfactant was found to be very effective in reducing the weed density and their growth. Density of both grassy and non-grassy weeds decreased with increase in the doses of the tembotrione from 100 to 120 g/ha at both the stages of observation (30 and 45 days after sowing). Addition of surfactant was found to increase the bio-efficacy of tembotrione in reducing the density of weeds. Among the pre-emergence herbicides, atrazine was found most effective in reducing the weed density over other herbicides.

Among the herbicidal treatments, tembotrione at all the three doses (100, 110 and 120 g/ha) when applied post-emergence with the surfactant at 2-4 leaf stage of weeds registered significantly less population of all the weed species compared to the herbicidal treatments at both the stages of observation. Among the different doses of tembotrione, higher dose (120 g) was found more effective than its lower doses in reducing the weed density at both 30 and 45 DAS. Application of tembotrione along with the surfactant at all the doses was found superior than the application of tembotrione alone or other herbicides applied as pre-emergence or the hand weeding treatment in reducing the weed population during both the years of study.

*Echinochloa colona* among the grassy and *Cyperus rotundus* among the sedges were the most dominating weeds in maize at both the stages during both the years. Among all the weed species, *Bracharia ramose* and *Cleome*

**Table 1. Effect of treatments on grassy weeds ($m^2$) at 30 days after sowing in maize**

| Treatment | Dose | Application stage | Grassy | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *E.colona* | | *D. sanguinalis* | | *B. ramosa* | |
| | | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Tembotrione+S | 100+S | 15-20 DAS | 4.0(56.0) | 3.9(47.3) | 2.0(6.7) | 1.5(5.3) | 0.0(0.0) | 0.0(0.0) |
| Tembotrione+S | 110+S | 15-20 DAS | 3.8(46.0) | 3.6(34.7) | 1.1(2.7) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) |
| Tembotrione+S | 120+S | 15-20 DAS | 3.5(32.0) | 3.2(24.7) | 0.5(1.3) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) |
| Tembotrione | 100 | 15-20 DAS | 4.6(97.3) | 4.7(112.0) | 2.5(12.0) | 2.4(10.7) | 1.7(4.7) | 1.7(4.3) |
| Tembotrione | 110 | 15-20 DAS | 4.3(80.0) | 4.6(98.7) | 2.4(10.7) | 1.5(5.3) | 1.7(4.3) | 1.6(4.0) |
| Tembotrione | 120 | 15-20 DAS | 4.2(63.3) | 4.0(56.0) | 2.3(9.3) | 1.5(5.3) | 1.4(3.0) | 1.4(3.0) |
| Atrazine | 1000 | 0-3 DAS | 3.6(34.7) | 4.7(106.7) | 1.1(2.7) | 0.5(1.3) | 0.0(0.0) | 0.5(1.3) |
| Pendimethalin | 1000 | 0-3 DAS | 4.2(68.0) | 5.0(149.3) | 2.0(6.7) | 1.8(5.3) | 0.0(0.0) | 0.5(1.3) |
| 2,4-D Na salt | 800 | 20-25 DAS | 5.3(203.3) | 4.7(113.3) | 3.3(26.7) | 3.1(21.3) | 2.4(10.7) | 2.0(6.7) |
| Diuron | 1000 | 0-3 DAS | 3.9(51.3) | 4.1(57.3) | 2.4(10.7) | 2.4(10.7) | 1.1(2.7) | 1.1(2.7) |
| Hand weeding | - | 20 & 40 DAS | 4.1(62.7) | 3.7(41.3) | 1.8(5.3) | 2.3(9.3) | 0.0(0.0) | 1.1(2.7) |
| Weedy check | - | - | 5.2(177.3) | 5.5(254.7) | 3.4(29.3) | 3.3(26.7) | 2.6(13.3) | 1.9(6.7) |
| LSD (P=0.05) | - | - | 0.3 | 0.3 | 0.8 | 1.2 | 0.5 | 1.0 |

Original values are given in parentheses; S - Surfactant

**Table 2. Effect of treatments on non-grassy weeds ($m^2$) at 30 days after sowing in maize**

| Treatment | Dose | Application stage | Non-grassy weeds | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *P.niruri* | | *C. viscosa* | | *T. monogyna* | | *C. rotundus* | |
| | | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Tembotrione+S | 100+S | 15-20 DAS | 1.1(2.7) | 0.5(1.3) | 0.0(0.0) | 0.5(1.3) | 1.1(2.7) | 0.5(1.3) | 3.7(41.3) | 3.0(20.0) |
| Tembotrione+S | 110+S | 15-20 DAS | 1.1(2.7) | 0.5(1.3) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 3.5(32.0) | 2.4(10.7) |
| Tembotrione+S | 120+S | 15-20 DAS | 0.0(0.0 | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 3.3(25.3) | 2.0(6.7) |
| Tembotrione | 100 | 15-20 DAS | 1.8(5.3) | 1.3(4.0) | 1.6(4.0) | 1.5(3.7) | 1.6(4.0) | 1.5(3.7) | 4.4(78.7) | 3.7(41.3) |
| Tembotrione | 110 | 15-20 DAS | 1.3(4.0) | 1.3(4.0) | 1.5(3.7) | 1.2(2.3) | 1.4(3.3) | 1.4(3.3) | 4.1(60.0) | 3.2(24.0) |
| Tembotrione | 120 | 15-20 DAS | 1.1(2.7) | 1.1(3.0) | 0.9(2.0) | 1.1(2.0) | 1.4(3.3) | 1.2(2.3) | 4.0(54.7) | 2.9(17.3) |
| Atrazine | 1000 | 0-3 DAS | 1.1(2.7) | 0.5(1.3) | 1.1(2.7) | 0.5(1.3) | 0.0(0.0) | 0.0(0.0) | 4.8(128.0) | 4.3(77.3) |
| Pendimethalin | 1000 | 0-3 DAS | 2.0(6.7) | 1.8(5.3) | 2.0(6.7) | 1.8(5.3) | 1.8(5.3) | 2.0(6.7) | 4.8(130.0) | 4.3(70.7) |
| 2,4-D Na salt | 800 | 20-25 DAS | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.5(1.3) | 0.5(1.3) | 3.4(30.7) | 2.8(16.0) |
| Diuron | 1000 | 0-3 DAS | 1.1(2.7) | 1.1(1.3) | 1.1(2.7) | 1.1(2.7) | 1.8(5.3) | 1.3(4.0) | 4.0(56.0) | 4.0(56.0) |
| Hand weeding | - | 20 & 40 DAS | 0.5(1.3) | 0.5(1.3) | 1.1(2.7) | 0.5(1.3) | 1.1(2.7) | 1.1(2.7) | 3.6(36.0) | 3.6(34.7) |
| Weedy check | - | | 2.3(9.3) | 2.0(6.7) | 2.3(9.3) | 2.0(6.7) | 2.3(9.3) | 2.0(6.7) | 5.0(145.3) | 4.4(85.3) |
| LSD (P=0.05) | - | | 1.2 | NS | 0.9 | 0.9 | 0.8 | 1.0 | 0.3 | 0.4 |

Original values are given in parentheses; S - Surfactant

**Table 3. Effect of treatments on grassy weeds ($m^2$) at 45 days after sowing in maize**

| Treatment | Dose | Application stage | Grassy weeds | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *E.colona* | | *D. sanguinalis* | | *B. ramosa* | |
| | | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Tembotrione+S | 100+S | 15-20 DAS | 3.7(39.3) | 3.5(32.7) | 1.8(5.3) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) |
| Tembotrione+S | 110+S | 15-20 DAS | 3.6(36.0) | 3.3(27.3) | 1.1(2.7) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) |
| Tembotrione+S | 120+S | 15-20 DAS | 3.0(18.7) | 3.0(18.7) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) |
| Tembotrione | 100 | 15-20 DAS | 4.1(61.3) | 4.3(72.7) | 2.4(10.7) | 1.8(5.3) | 1.7(4.3) | 1.7(4.3) |
| Tembotrione | 110 | 15-20 DAS | 3.8(42.7) | 4.0(52.0) | 2.3(9.3) | 1.3(4.0) | 1.6(4.0) | 1.7(4.3) |
| Tembotrione | 120 | 15-20 DAS | 3.7(40.7) | 3.5(34.0) | 2.1(8.0) | 1.1(3.0) | 1.4(3.3) | 1.4(3.3) |
| Atrazine | 1000 | 0-3 DAS | 3.6(36.0) | 3.5(32.7) | 0.0(0.0) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) |
| Pendimethalin | 1000 | 0-3 DAS | 4.2(69.3) | 3.8(45.3) | 2.2(9.3) | 2.0(6.7) | 0.0(0.0) | 1.1(2.7) |
| 2,4-D Na Salt | 800 | 20-25 DAS | 4.9(132.0) | 4.6(101.3) | 3.4(29.3) | 3.2(25.3) | 2.6(13.3) | 1.1(2.7) |
| Diuron | 1000 | 0-3 DAS | 3.7((38.0) | 4.0(58.7) | 2.7(13.3) | 2.7(14.7) | 1.3(4.0) | 1.8(5.3) |
| Hand weeding | - | 20 & 40 DAS | 3.8(44.0) | 3.4(30.7) | 2.0(6.7) | 1.8(5.3) | 0.0(0.0) | 0.5(1.3) |
| Weedy check | - | | 5.0(152.0) | 4.8(122.7) | 3.5(32.0) | 3.4(32.0) | 2.9(17.3) | 2.3(9.3) |
| LSD (P=0.05) | - | | 3.7(39.3) | 0.3 | 0.7 | 1.1 | 0.6 | 0.8 |

Original values are given in parentheses; S - Surfactant

**Table 4. Effect of treatments on grassy weeds ($m^2$) at 45 days after sowing in maize**

| Treatment | Dose | Application stage | Non –grassy weeds | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | *P. niruri* | | *C. viscosa* | | *T. monogyna* | | *C. rotundus* | |
| | | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Tembotrione+S | 100+S | 15-20 DAS | 1.1(2.7) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) | 0.5(1.3) | 0.0(0.0) | 3.5(32.7) | 2.8(16.0) |
| Tembotrione+S | 110+S | 15-20 DAS | 0.5(1.3) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 3.2(22.7) | 2.3(9.3) |
| Tembotrione+S | 120+S | 15-20 DAS | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 0.0(0.0) | 2.8(16.7) | 1.8(5.3) |
| Tembotrione | 100 | 15-20 DAS | 1.9(6.0) | 1.7(4.6) | 1.7(4.6) | 1.2(4.0) | 1.7(4.6) | 1.6(4.3) | 3.9(48.7) | 3.2(30.7) |
| Tembotrione | 110 | 15-20 DAS | 1.7(4.6) | 1.6(4.0) | 1.6(4.0) | 1.1(3.3) | 1.6(4.0) | 1.5(3.6) | 3.7(41.3) | 2.7(14.7) |
| Tembotrione | 120 | 15-20 DAS | 1.5(3.6) | 1.5(3.6) | 1.4(3.0) | 1.1(3.0) | 1.5(3.6) | 1.1(3.0) | 3.6(36.0) | 2.4(10.7) |
| Atrazine | 1000 | 0-3 DAS | 1.1(2.7) | 1.1(2.7) | 1.8(5.3) | 1.1(2.7) | 0.0(0.0) | 0.0(0.0) | 4.8(116.0) | 3.7(40.0) |
| Pendimethalin | 1000 | 0-3 DAS | 2.3(9.3) | 2.0(6.7) | 2.3(9.3) | 2.0(6.7) | 2.0(6.7) | 1.8(5.3) | 4.7(109.3) | 3.7(40.7) |
| 2,4-D Na salt | 800 | 20-25 DAS | 1.1(2.0) | 1.0(2.3) | 1.2(2.3) | 0.9(2.0) | 0.6(1.0) | 0.9(2.0) | 2.8(16.0) | 2.0(6.7) |
| Diuron | 1000 | 0-3 DAS | 1.6(4.0) | 1.1(2.7) | 1.8(5.3) | 1.8(5.3) | 2.0(6.7) | 1.1(2.7) | 3.7(40.0) | 3.2(25.3) |
| Hand weeding | - | 20 & 40 DAS | 0.0(0.0) | 0.0(0.0) | 0.5(1.3) | 0.5(1.3) | 0.0(0.0) | 0.0(0.0) | 2.0(14.0) | 2.3(9.3) |
| Weedy check | - | | 2.8(16.0) | 2.7(14.7) | 2.4(10.) | 2.2(8.7) | 2.4(10.7) | 2.1(8.0) | 4.9(132.0) | 4.0(52.7) |
| LSD (P=0.05) | - | | 0.8 | 1.0 | 0.6 | 1.1 | 0.6 | 0.7 | 0.9 | 0.6 |

Original values are given in parentheses; S - Surfactant

*viscosa* were controlled effectively by the application of herbicides and manual weeding over the weedy plot. Application of tembotrione at higher dose 120g/ha + S was significantly superior to its lower doses 100 and 110 g/ha + S in reducing the density of all the weed species.

**Weed dry weight**

In general, weed dry matter was higher during the first year (2009) than the second year (2010) due to higher weed population. During both the years, the dry matter of weeds at 30 and 45 DAS was significantly reduced in all the weed control treatments over the weedy check (Figure 1 and 2). At 30 days after sowing, in 2009, the lowest weed dry matter was recorded with application of tembotrione at 120 g/ha + surfactant followed by its lower dose (110 g/ha + surfactant) and atrazine (1000 g/ha). At the same stage, during 2010, lowest weed dry matter was recorded in the hand weeding (twice) treatment which was superior to all other treatments. At 45 DAS, in both the years, the lowest weed dry weight was recorded with Tembotrione 120 g/ha + surfactant followed by its lower dose (110 g/ha + surfactant). Addition of surfactant was found to improve the bio-efficacy of Tembotrione in reducing the weed dry matter at all the doses.

**Yield performance of maize**

Weed control treatments brought about significant increases in no. of kernels per cob, kernel weight per cob and 100 kernel weight as compared to the weedy check (Table 5). In both the years the highest cob yield was recorded with the application of Tembotrione at 120 g/ha along with surfactant which was at par with tembotrione 110 g/ha + surfactant; twice hand weeding and pre emergence application of atrazine. However, no. of kernel rows per cob was unaffected by the different weed control treatments. Among the treatments, highest no. of kernel/cob was obtained with atrazine (422.5) in first year whereas in the second year, it was at par with Tembotrione along with surfactant. All the weed control treatments registered significantly higher kernel weight per cob and test weight over the weedy check.

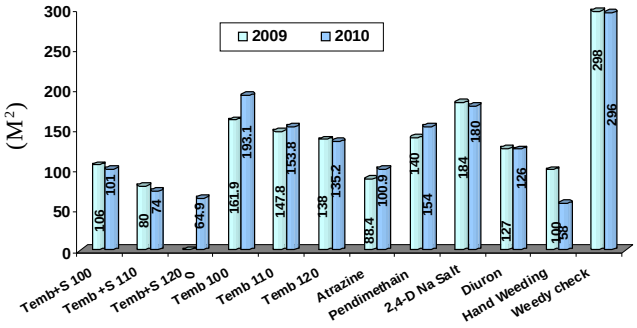


**Fig. 1. Total dry weight of weeds ($m^2$) at 30 days after sowing in maize**

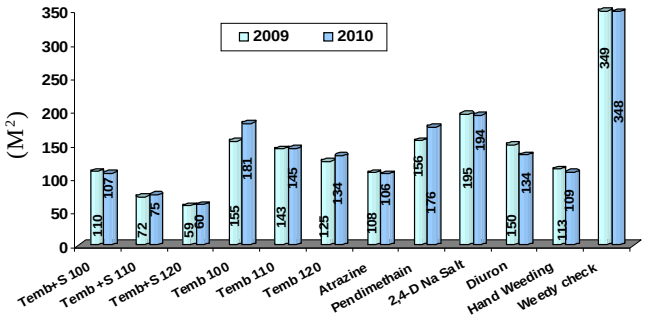


**Fig. 2. Total dry weight of weeds ($m^2$) at 45 days after sowing in maize**

**Table 5. Effect of different treatments on yield and yield attributes of maize**

| Treatment | Dose (g/ha) | Application stage | No. of kernel rows per cob | | No. of kernels per cob | | Kernel weight per cob(g) | | 100, kernel weight (g) | | Grain yield (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Tembotrione+S | 100+S | 15-20 DAS | 14.0 | 14.3 | 408.6 | 442 | 107.3 | 120.0 | 26.2 | 26.4 | 4800 | 4950 |
| Tembotrione+S | 110+S | 15-20 DAS | 14.5 | 14.4 | 417.6 | 457 | 112.7 | 130.0 | 26.6 | 26.7 | 5167 | 5300 |
| Tembotrione+S | 120+S | 15-20 DAS | 14.5 | 14.5 | 435.7 | 475 | 116.3 | 130.3 | 27.3 | 27.2 | 5333 | 5483 |
| Tembotrione | 100 | 15-20 DAS | 13.5 | 13.7 | 365.8 | 390 | 95.3 | 102.0 | 25.6 | 26.0 | 4283 | 4433 |
| Tembotrione | 110 | 15-20 DAS | 13.5 | 13.7 | 376.0 | 401 | 99.7 | 103.3 | 26.3 | 26.2 | 4492 | 4583 |
| Tembotrione | 120 | 15-20 DAS | 13.9 | 13.9 | 400.3 | 423 | 105.3 | 112.3 | 26.5 | 26.4 | 4533 | 4633 |
| Atrazine | 1000 | 0-3 DAS | 14.6 | 14.1 | 442.5 | 433 | 118.3 | 116.7 | 26.8 | 26.4 | 5267 | 5283 |
| Pendimethalin | 1000 | 0-3 DAS | 13.6 | 13.8 | 363.7 | 427 | 93.7 | 117.3 | 25.9 | 25.1 | 4667 | 4800 |
| 2,4-D Na salt | 800 | 20-25 DAS | 13.3 | 13.7 | 348.2 | 418 | 88.3 | 100.3 | 24.5 | 24.1 | 4267 | 4350 |
| Diuron | 1000 | 0-3 DAS | 13.9 | 13.9 | 385.3 | 443 | 102.7 | 110.0 | 26.5 | 25.5 | 4633 | 4783 |
| Hand weeding | | 20 & 40 DAS | 14.3 | 14.6 | 439.5 | 462 | 116.0 | 123.3 | 26.4 | 27.0 | 5150 | 5233 |
| Weedy check | - | | 12.1 | 12.5 | 280.6 | 376 | 65.3 | 84.3 | 22.0 | 22.3 | 2817 | 3017 |
| LSD (P=0.05) | - | | NS | NS | 27.5 | 19.6 | 6.8 | 12.9 | 1.6 | 2.2 | 244 | 496 |

**Table 6. Effect of treatments on germination, plant height, branches per plant and yield of succeeding mustard crop (*Rabi* 2009-10)**

| Treatment | Dose (g/ha) + surfactant | Germination (%) | | Plant height (cm) | | No. of branches /plant | | Grain yield (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| Tembotrione+S | 100+1000 | 85.7 | 87.4 | 187.3 | 190.2 | 7.0 | 7.2 | 1283 | 1291 |
| Tembotrione+S | 110+1000 | 87.5 | 88.6 | 190.7 | 191.7 | 6.3 | 6.9 | 1283 | 1312 |
| Tembotrione+S | 120+1000 | 87.9 | 88.9 | 188.0 | 191.0 | 6.8 | 7.0 | 1325 | 1354 |
| Tembotrione+S | 240+2000 | 87.1 | 87.9 | 188.3 | 191.3 | 6.7 | 7.1 | 1350 | 1291 |
| Weedy check | - | 86.0 | 87.0 | 188.3 | 190.6 | 6.3 | 7.3 | 1270 | 1254 |
| LSD (P=0.05) | - | NS | NS | NS | NS | NS | NS | NS | NS |

Application of tembotrione 100 g/ha along with surfactant was found at par with application of pendimethalin and diuron but significantly superior over the application of 2,4-D with respect to their grain yield during both the years. Weedy plots recorded 50 and 40 per cent lower grain yield as compared to highest yield producing treatments (tembotrione 120 g/ha along with surfactant) during 2009 and 2010, respectively. The kernel yield was higher in the second year (2010) as compared to first year. The possible reason for the better performance of tembotrione at 120g/ha along with surfactant in terms of grain yield could be attributed to its effect on expression of yield attributes due to better weed suppression through significant reduction in dry weed weight and weed population and consequent reduction in crop-weed competition.

**Succeeding crop**

In succeeding mustard crop, all the parameters recorded such as germination per cent, plant height, number of branches/plant and grain yield were not affected due to combined application of tembotrione + surfactant in both the years (Table 6). Among the weed management practices, application of tembotrione 120g/ha + surfactant recorded higher germination percentage. Plant height was highest in the treatment tembotrione (110 g/ha) + surfactant over the weedy check during both the years. During 2009, the highest grain yield was recorded with tembotrione at 120g/ha + surfactant whereas in 2010, it was highest at the higher dose i.e 240 g/ha + surfactant.

Based on the field studies conducted for two years, it was concluded that tembotrione 120 g/ha along with surfactant is effective for controlling the grassy and non-grassy weeds as compared to other herbicidal treatments. Addition of surfactant 1000 ml/ha formulation was found to increase the kernel yield significantly as compared to application of tembotrione without it. Application of tembotrione + surfactant in mustard crop significantly reduced the growth and development of weeds and increased the yield as compared to weedy check. Moreover, there was no phytotoxic effect on either crop.

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