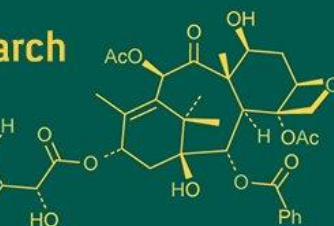
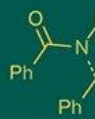


## International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693  
ISSN Online: 2617-4707  
NAAS Rating (2026): 5.29  
IJABR 2026; SP-10(8): 50-55  
[www.biochemjournal.com](http://www.biochemjournal.com)  
Received: 22-06-2026  
Accepted: 26-07-2026

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## Comparative assessment of herbicidal weed management practices on growth, nodulation, yield and economics of berseem

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Sa.9409>

### Abstract

A field experiment was conducted to evaluate the efficacy of pre and post emergence herbicides on weed management, crop growth, nodulation, forage yield, seed yield and economics of berseem at Research cum Instructional Farm, IGKV, Raipur (C.G.) during *rabi* 2019-20. The experiment comprised ten treatments, including pre-emergence (PE), early post-emergence (EPoE), post-emergence (PoE) herbicides and weedy check, arranged in a randomized block design with three replications. Among the treatments, oxyfluorfen (PE) 250 g ha<sup>-1</sup> consistently recorded the highest reduction in weed density and weed biomass throughout the crop growth period, resulting in superior plant growth, nodulation, crop growth rate, green forage yield, seed yield and economic returns. Pendimethalin (PE) 1000 g ha<sup>-1</sup> was the next best treatment, providing effective and sustained weed control. Sequential application of imazethapyr 40 g ha<sup>-1</sup> after the first and second cuttings improved late-season weed suppression and crop performance compared with single post-emergence applications. Although sodium acifluorfen + clodinafop-propargyl (PoE) 187.5 g ha<sup>-1</sup> effectively reduced weed density and biomass during the later stages, it caused temporary phytotoxicity to berseem, adversely affecting crop growth immediately after application before subsequent recovery. The weedy check recorded the highest weed infestation and the lowest growth, nodulation, forage yield, seed yield and profitability. Overall, pre-emergence application of oxyfluorfen 250 g ha<sup>-1</sup> proved to be the most effective and economically viable herbicidal option for sustainable weed management and enhanced productivity of berseem.

**Keywords:** Berseem, herbicide, oxyfluorfen, weed management, forage yield

### Introduction

India possesses one of the world's largest livestock populations, making the availability of quality fodder essential for sustaining livestock productivity. However, the country continues to face a shortage of nutritious forage to meet the feed requirements of high-producing animals. In Chhattisgarh, the situation is further aggravated as the predominance of marginal (69.4%) and small (21.75%) landholders limits the scope for fodder cultivation, with farmers primarily prioritizing food grain production. Consequently, cultivated fodder occupies only about 3% of the cropped area and livestock feeding largely depends on paddy straw <sup>[1]</sup>. Berseem (*Trifolium alexandrinum* L.) is an important winter forage legume capable of producing 70-100 t ha<sup>-1</sup> of green fodder through 5-6 cuttings between November and May <sup>[2]</sup>. Owing to its high nutritive value, berseem reduces feeding costs by lowering the requirement for mineral concentrates and an exclusive berseem ration is adequate to sustain milk yields of 6-7 l day<sup>-1</sup> in milch animals <sup>[3-4]</sup>. The crop is rich in crude protein (20%), highly digestible (up to 65%) and palatable <sup>[5-6]</sup>. Furthermore, as an efficient nitrogen-fixing legume, berseem contributes approximately 33-66 kg N ha<sup>-1</sup> through biological nitrogen fixation, thereby improving soil fertility and benefiting succeeding crops <sup>[7]</sup>.

Despite its agronomic and nutritional importance, berseem productivity is severely constrained by weed infestation during the early stages of crop growth because of its slow initial establishment, frequent irrigations and repeated cuttings, which favour the emergence of diverse grassy and broad-leaved weeds. Weed infestation can reduce green forage yield by 20-55% and contaminate the seed crop <sup>[8]</sup>, while overall yield and forage quality losses of 30-40% have also been reported in berseem <sup>[9]</sup>.

Besides reducing forage and seed yields, weed competition adversely affects crop growth, nodulation and profitability by competing for moisture, nutrients, light and space. Although manual weeding is an effective means of weed control, its adoption is increasingly constrained by labour scarcity, high wages and the difficulty of timely operations, particularly in multicut forage crops such as berseem. Consequently, herbicidal weed management has emerged as a practical and economical alternative. Pre-emergence herbicides such as oxyfluorfen and pendimethalin effectively suppress early weed flushes, whereas post-emergence herbicides, including imazethapyr and herbicide mixtures, provide broader control of weeds during later crop growth stages [10-11]. However, comparative evaluation of pre and post emergence herbicides in multicut berseem is limited. Therefore, the present study was undertaken to assess the efficacy of different herbicidal weed management practices on growth, nodulation, yield and economics of berseem.

## Materials and Methods

### Study Site Description

The experiment was performed at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), during the 2019-20 *rabi* season. Raipur is the capital of Chhattisgarh state and is situated at 21° 16' North latitude and 81° 36' East longitudes at an altitude of 298.56 meters above the mean sea level.

### Experimental details

The experiment was laid out in a Randomized Block Design with three replications of ten treatments viz. pendimethalin (PE) 1000 g ha<sup>-1</sup> (T<sub>1</sub>), pendimethalin (EPoE) at 10 DAS 1000 g ha<sup>-1</sup> (T<sub>2</sub>), oxyfluorfen (PE) 250 g ha<sup>-1</sup> (T<sub>3</sub>), imazethapyr (PoE) 40 g ha<sup>-1</sup> just after 1<sup>st</sup> cutting (T<sub>4</sub>), imazethapyr (PoE) 40 g ha<sup>-1</sup> just after 2<sup>nd</sup> cutting (T<sub>5</sub>), imazethapyr (PoE) 40 g ha<sup>-1</sup> just after 1<sup>st</sup> cutting *fb* imazethapyr (PoE) 40 g ha<sup>-1</sup> just after 2<sup>nd</sup> cutting (T<sub>6</sub>), imazamox + imazethapyr (ready mix) (PoE) 70 g ha<sup>-1</sup> just after 1<sup>st</sup> cutting (T<sub>7</sub>), imazamox + imazethapyr (ready mix) (PoE) 70 g ha<sup>-1</sup> just after 2<sup>nd</sup> cutting (T<sub>8</sub>), sodium acifluorfen + clodinafop-propargyl (ready mix) (PoE) 187.5 g ha<sup>-1</sup> just after 1<sup>st</sup> cutting (T<sub>9</sub>) and Weedy check (T<sub>10</sub>).

### Cultivation details

Berseem was sown on 29 November 2019 at a seed rate of 25 kg ha<sup>-1</sup> in 20-cm rows using a seed drill, with seeds placed 2-3 cm deep. Gap filling was done at 10 DAS to maintain uniform plant population. The crop was harvested three times, with the first cut at 55 DAS and subsequent cuttings at 30-day intervals, leaving a 5-cm stubble height. After the third cutting, the crop was retained for seed production and harvested at 155 DAS (3 May 2020). Herbicides were applied as per the treatment schedule using a knapsack sprayer fitted with a flat-fan nozzle.

### Observations recorded

The percent reduction of weed density (%RWD) and biomass ((%RWB) were calculated as per the given formula as suggested by [12].

$$\% \text{ RWD} = \left(1 - \frac{\text{Number of weeds in treated plot}}{\text{Number of weeds in weedy plot}}\right) \times 100$$

$$\% \text{ RWB} = \left(1 - \frac{\text{Weed biomass in treated plot}}{\text{Weed biomass in weedy plot}}\right) \times 100$$

**Note:** Weed density and weed biomass were recorded from a 1 m<sup>2</sup> area in each plot.

Data on the growth parameters and green forage yield of berseem were recorded at each cutting, while seed yield was recorded at final harvest. The crop growth rate (CGR) was worked out by using the following formula suggested by [13] and was expressed as g plant<sup>-1</sup>day<sup>-1</sup>.

$$\text{Crop growth rate (CGR)} = \frac{W_2 - W_1}{t_2 - t_1}$$

Where

W<sub>2</sub>-W<sub>1</sub> = Difference in oven dry biomass during the time interval, t<sub>2</sub>-t<sub>1</sub> = Time interval in days

The treatment wise economics was calculated by considering current market rates of herbicides, prevailing wages and market price of produce. Statistical analysis and interpretation of results were done by calculating values of C.D. (critical difference) at 5% level of probability through analysis of variance techniques as described by [14].

## Results

### Percent reduction of weed density and biomass (%)

The herbicidal treatments differed markedly in their effectiveness in reducing both weed density and weed biomass throughout the crop growth period (Fig.1 and 2). Oxyfluorfen (PE) 250 g ha<sup>-1</sup> consistently recorded the highest reduction in weed density (88, 79, 70 and 76%) and weed biomass (71, 57, 49 and 47%) at 20 DAS, before the first cut, before the second cut and at harvest, respectively, indicating its superior residual activity and season-long weed control. Pendimethalin applied as pre-emergence was the next most effective treatment, while its application at 10 DAS provided comparatively lower but sustained weed suppression. Sequential application of imazethapyr resulted in better reduction of weed density and biomass than single post-emergence applications, suggesting improved control of successive weed flushes. These results corroborate the findings of previous studies [15-17]. The ready-mix sodium acifluorfen + clodinafop-propargyl (PoE) 187.5 g ha<sup>-1</sup> achieved maximum weed reduction before the second cut and at harvest, indicating its greater effectiveness against later-emerging weeds (However, this treatment also caused phytotoxicity to the berseem crop). In contrast, imazethapyr applied after the second cutting and imazamox + imazethapyr applied after the second cutting were the least effective treatments.

### Effect on branching and nodulation

Herbicidal treatments significantly influenced crop growth and nodulation of berseem (Table 1 and 2). Pre-emergence application of oxyfluorfen 250 g ha<sup>-1</sup> consistently produced the highest number of branches and nodules plant<sup>-1</sup> up to the second cutting, remaining statistically at par with pendimethalin 1000 g ha<sup>-1</sup> applied either as pre-emergence or early post-emergence (10 DAS). The superior growth and nodulation under these treatments can be attributed to effective early-season weed control, which minimized crop-weed competition and improved the availability of moisture, nutrients, light and space, thereby promoting better root

development and rhizobial activity. Prior to the third cutting, imazethapyr 40 g ha<sup>-1</sup> applied twice (after the first and second cuttings) recorded the highest branching, reflecting improved weed suppression during the later stages of crop growth. Similar positive effects of these herbicides have also been reported by previous researchers [11, 18-20]. In contrast, post-emergence application of imazamox + imazethapyr after the first cutting and sodium acifluorfen + clodinafop-propargyl after the first cutting resulted in the lowest growth and nodulation, likely due to their phytotoxic effects on berseem and reduced rhizobial activity. The weedy check consistently recorded the poorest growth and nodulation because of severe crop-weed competition throughout the growing season.

#### Crop growth rate (g plant<sup>-1</sup> day<sup>-1</sup>)

Crop growth rate (CGR) of berseem was significantly influenced by herbicidal treatments at different growth stages (Fig. 3). During 55-85 DAS, the highest CGR was recorded under oxyfluorfen (PE) 250 g ha<sup>-1</sup>, reflecting effective weed suppression and enhanced biomass accumulation. Lower CGR observed under sodium acifluorfen + clodinafop-propargyl (PoE) 187.5 g ha<sup>-1</sup>, certain post-emergence herbicide treatments, and the weedy check was attributed to phytotoxic effects and severe crop-weed competition. During 85-115 DAS, CGR generally declined following successive cuttings; however, imazethapyr applied after the second cutting, imazethapyr applied twice and imazamox + imazethapyr applied after the second cutting maintained comparatively higher CGR due to effective late-season weed control and improved resource availability. The recovery of crop plants from initial herbicide-induced phytotoxicity also contributed to improved CGR under sodium acifluorfen + clodinafop-propargyl during the later growth stages.

#### Effect on green forage and seed yield

Herbicidal treatments significantly influenced green forage yield at successive cuttings, total green forage yield and

seed yield of berseem (Table 3). Pre-emergence application of oxyfluorfen 250 g ha<sup>-1</sup> consistently recorded the highest green forage yield at all cuttings and the maximum total forage and seed yields. It remained statistically at par with pendimethalin 1000 g ha<sup>-1</sup> applied as pre-emergence or early post-emergence (10 DAS) for green forage and total forage yields, but produced a significantly higher seed yield. The superior performance of these treatments was attributed to effective early-season weed control, which minimized crop-weed competition and enhanced the availability of moisture, nutrients, light and space for crop growth. These results corroborate the findings of previous researchers [15, 17, 21-22]. Sodium acifluorfen + clodinafop-propargyl 187.5 g ha<sup>-1</sup> applied after the first cutting temporarily reduced forage yield at the second cutting due to phytotoxic effects; however, crop recovery within 15-20 days resulted in improved yield at the third cutting. Imazethapyr 40 g ha<sup>-1</sup> applied twice also produced higher forage and seed yields by providing effective late-season weed control. In contrast, the weedy check recorded the lowest forage and seed yields owing to severe weed competition throughout the crop season.

#### Economics

Among the different weed management practices, pre-emergence application of oxyfluorfen 250 g ha<sup>-1</sup> recorded the highest gross returns, net returns, and benefit:cost (B:C) ratio, followed by pre-emergence application of pendimethalin 1000 g ha<sup>-1</sup> (Table 4). The superior economic performance of oxyfluorfen was primarily attributed to its effective and sustained weed control, which minimized crop-weed competition, improved crop growth and enhanced forage and seed yields. The present findings are in agreement with those reported by previous researchers [15, 18, 23]. In contrast, the weedy check recorded the lowest gross and net returns as well as the B:C ratio due to severe weed infestation, resulting in substantial yield losses and reduced profitability.

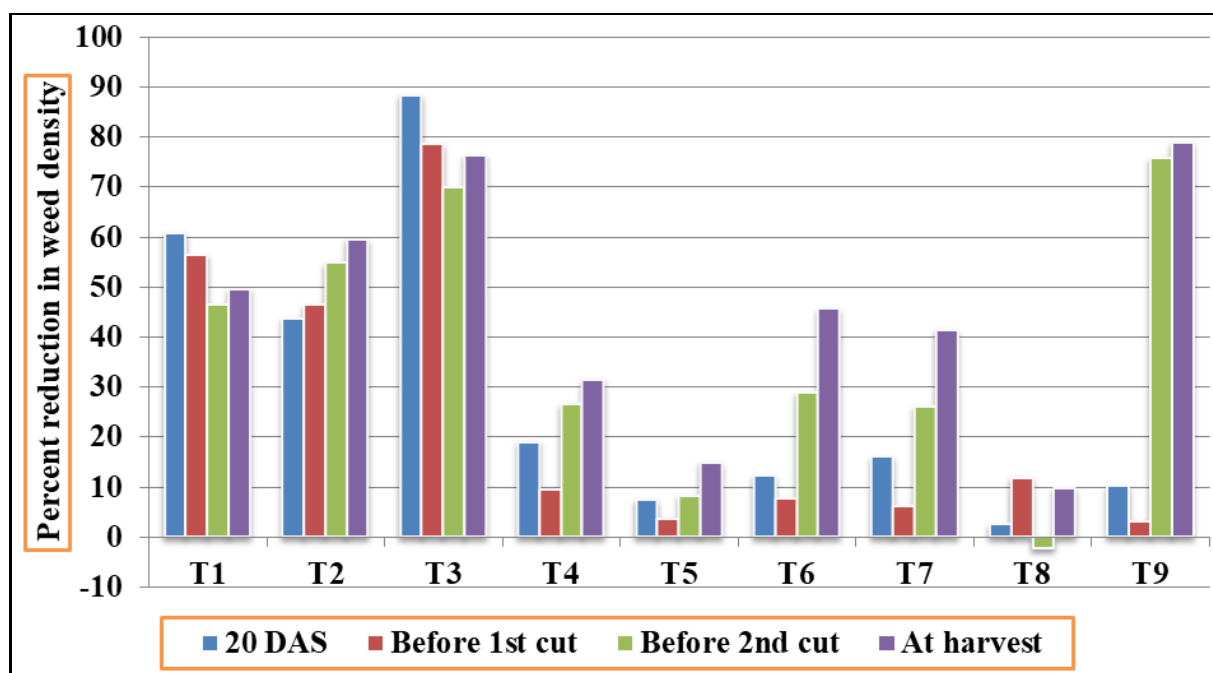


**Fig 1:** Percent reduction in weed density (% RWD) at different period of crop growth over weedy check as influenced by different herbicides in berseem

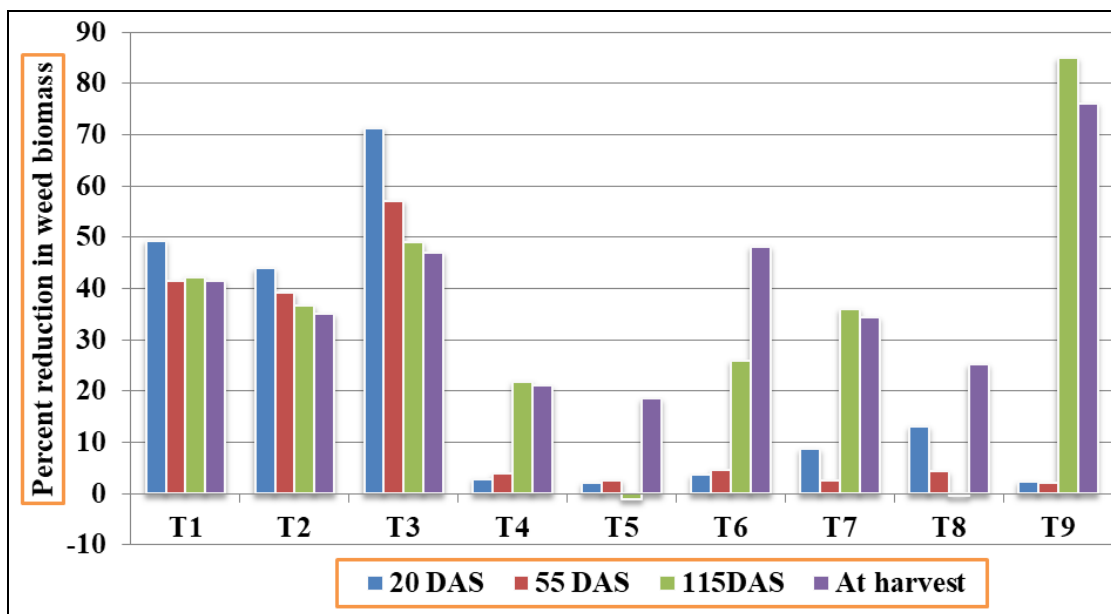


**Fig 2:** Percent reduction in weed biomass (% RWB) at different period of crop growth over weedy check as influenced by different herbicides in berseem

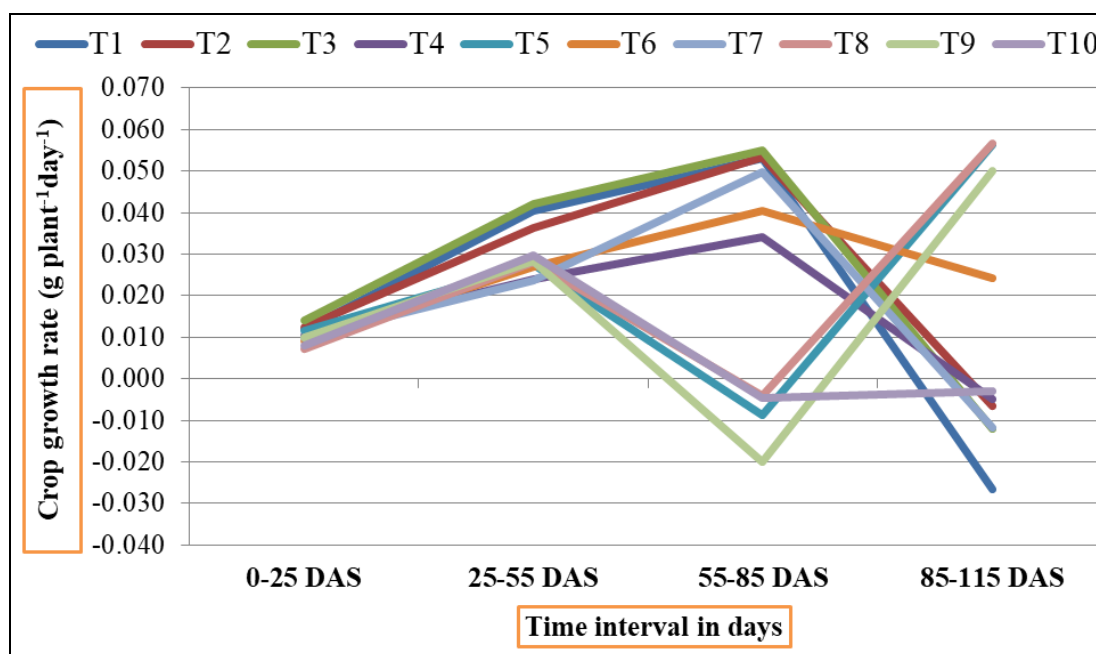


**Fig 3:** Crop growth rate (g plant<sup>-1</sup> day<sup>-1</sup>) of berseem at different intervals as influenced by different herbicidal treatments

**Table 1:** Number of branches of berseem as influenced by different herbicidal treatments

| Treatments                                                                                                                                                              | Number of branches plant <sup>-1</sup> |                                     |                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-------------------------------------|--------------------------------------|
|                                                                                                                                                                         | Before 1 <sup>st</sup> cut (55 DAS)    | Before 2 <sup>nd</sup> cut (85 DAS) | Before 3 <sup>rd</sup> cut (115 DAS) |
| T <sub>1</sub> -Pendimethalin (PE) 1000 g ha <sup>-1</sup>                                                                                                              | 4                                      | 6                                   | 5                                    |
| T <sub>2</sub> -Pendimethalin (EPoE) 1000 g ha <sup>-1</sup> at 10 DAS                                                                                                  | 4                                      | 5                                   | 5                                    |
| T <sub>3</sub> -Oxyfluorfen (PE) 250 g ha <sup>-1</sup>                                                                                                                 | 4                                      | 6                                   | 5                                    |
| T <sub>4</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                                              | 2                                      | 4                                   | 3                                    |
| T <sub>5</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                                              | 3                                      | 2                                   | 5                                    |
| T <sub>6</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting / Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting | 2                                      | 4                                   | 6                                    |
| T <sub>7</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                       | 2                                      | 5                                   | 4                                    |
| T <sub>8</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                       | 2                                      | 2                                   | 5                                    |
| T <sub>9</sub> -Sodium acifluorfen + Clodinafop-propargyl (ready mix) (PoE) 187.5 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                 | 3                                      | 1                                   | 3                                    |
| T <sub>10</sub> -Weedy check                                                                                                                                            | 2                                      | 2                                   | 1                                    |
| SEm±                                                                                                                                                                    | 0.29                                   | 0.34                                | 0.44                                 |
| CD (P = 0.05)                                                                                                                                                           | 0.85                                   | 1.01                                | 1.31                                 |

**Table 2:** Number of nodules of berseem as influenced by different herbicidal treatments

| Treatments                                                                                                                                                               | Number of nodules plant <sup>-1</sup> |                                     |                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|
|                                                                                                                                                                          | At 25 DAS                             | Before 1 <sup>st</sup> cut (55 DAS) | Before 2 <sup>nd</sup> cut (85 DAS) |
| T <sub>1</sub> -Pendimethalin (PE) 1000 g ha <sup>-1</sup>                                                                                                               | 4                                     | 12                                  | 15                                  |
| T <sub>2</sub> -Pendimethalin (EPoE) 1000 g ha <sup>-1</sup> at 10 DAS                                                                                                   | 3                                     | 12                                  | 14                                  |
| T <sub>3</sub> -Oxyfluorfen (PE) 250 g ha <sup>-1</sup>                                                                                                                  | 4                                     | 14                                  | 16                                  |
| T <sub>4</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                                               | 2                                     | 8                                   | 12                                  |
| T <sub>5</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                                               | 3                                     | 9                                   | 7                                   |
| T <sub>6</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting /b Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting | 2                                     | 8                                   | 12                                  |
| T <sub>7</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                        | 2                                     | 7                                   | 13                                  |
| T <sub>8</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                        | 3                                     | 8                                   | 7                                   |
| T <sub>9</sub> -Sodium acifluorfen + Clodinafop-propargyl (ready mix) (PoE) 187.5 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                  | 2                                     | 9                                   | 6                                   |
| T <sub>10</sub> -Weedy check                                                                                                                                             | 3                                     | 8                                   | 7                                   |
| SEm±                                                                                                                                                                     | 0.29                                  | 0.76                                | 0.78                                |
| CD (P = 0.05)                                                                                                                                                            | 0.87                                  | 2.27                                | 2.33                                |

**Table 3:** Green forage and seed yield of berseem as influenced by different herbicidal treatments

| Treatments                                                                                                                                                               | Green forage yield (t ha <sup>-1</sup> ) |                                 |                                  |                          | Seed yield (t ha <sup>-1</sup> ) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|---------------------------------|----------------------------------|--------------------------|----------------------------------|
|                                                                                                                                                                          | At 1 <sup>st</sup> cut (55 DAS)          | At 2 <sup>nd</sup> cut (85 DAS) | At 3 <sup>rd</sup> cut (115 DAS) | Total Green forage yield |                                  |
| T <sub>1</sub> -Pendimethalin (PE) 1000 g ha <sup>-1</sup>                                                                                                               | 14.69                                    | 21.22                           | 20.82                            | 56.73                    | 0.23                             |
| T <sub>2</sub> -Pendimethalin (EPoE) 1000 g ha <sup>-1</sup> at 10 DAS                                                                                                   | 13.80                                    | 21.00                           | 20.41                            | 55.21                    | 0.25                             |
| T <sub>3</sub> -Oxyfluorfen (PE) 250 g ha <sup>-1</sup>                                                                                                                  | 16.00                                    | 22.45                           | 21.67                            | 60.12                    | 0.35                             |
| T <sub>4</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                                               | 11.27                                    | 17.90                           | 16.00                            | 45.17                    | 0.18                             |
| T <sub>5</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                                               | 12.91                                    | 11.16                           | 20.18                            | 44.25                    | 0.13                             |
| T <sub>6</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting /b Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting | 12.00                                    | 18.00                           | 21.59                            | 51.59                    | 0.21                             |
| T <sub>7</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                        | 11.13                                    | 18.60                           | 17.22                            | 46.95                    | 0.19                             |
| T <sub>8</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                        | 12.00                                    | 11.25                           | 19.07                            | 42.32                    | 0.16                             |
| T <sub>9</sub> -Sodium acifluorfen + Clodinafop-propargyl (ready mix) (PoE) 187.5 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                  | 12.85                                    | 6.72                            | 16.74                            | 36.30                    | 0.05                             |
| T <sub>10</sub> -Weedy check                                                                                                                                             | 12.70                                    | 11.67                           | 11.60                            | 35.97                    | 0.04                             |
| SEm±                                                                                                                                                                     | 0.82                                     | 1.07                            | 1.22                             | 1.83                     | 0.01                             |
| CD (P = 0.05)                                                                                                                                                            | 2.43                                     | 3.20                            | 3.62                             | 5.43                     | 0.04                             |

**Table 4:** Economics of berseem as influenced by different herbicidal treatments

| Treatment                                                                                                                                                                | Cost of Cultivation (Rs ha <sup>-1</sup> ) | Gross return (Rs ha <sup>-1</sup> ) | Net return (Rs ha <sup>-1</sup> ) | B:C ratio |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------|-----------------------------------|-----------|
| T <sub>1</sub> -Pendimethalin (PE) 1000 g ha <sup>-1</sup>                                                                                                               | 32010                                      | 108095                              | 76085                             | 3.38      |
| T <sub>2</sub> -Pendimethalin (EPoE) 1000 g ha <sup>-1</sup> at 10 DAS                                                                                                   | 32010                                      | 107815                              | 75805                             | 3.37      |
| T <sub>3</sub> -Oxyfluorfen (PE) 250 g ha <sup>-1</sup>                                                                                                                  | 32570                                      | 125180                              | 92610                             | 3.84      |
| T <sub>4</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                                               | 31270                                      | 85755                               | 54485                             | 2.74      |
| T <sub>5</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                                               | 31270                                      | 79375                               | 48105                             | 2.54      |
| T <sub>6</sub> -Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting /b Imazethapyr (PoE) 40 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting | 32330                                      | 98385                               | 66055                             | 3.04      |
| T <sub>7</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                                        | 32425                                      | 89425                               | 57000                             | 2.76      |
| T <sub>8</sub> -Imazamox + Imazethapyr (ready mix) (PoE) 70 g ha <sup>-1</sup> just after 2 <sup>nd</sup> cutting                                                        | 32425                                      | 79480                               | 47055                             | 2.45      |
| T <sub>9</sub> -Sodium acifluorfen + Clodinafop-propargyl (ready mix) (PoE) 187.5 g ha <sup>-1</sup> just after 1 <sup>st</sup> cutting                                  | 31350                                      | 59450                               | 28100                             | 1.90      |
| T <sub>10</sub> -Weedy check                                                                                                                                             | 30210                                      | 57955                               | 27745                             | 1.92      |

## Conclusion

Pre-emergence application of oxyfluorfen 250 g ha<sup>-1</sup> was the most effective weed management practice, providing superior season-long weed control, crop growth, nodulation, forage yield, seed yield and economic returns in berseem. Sequential post-emergence application of imazethapyr 40 g ha<sup>-1</sup> also proved effective in suppressing later-emerging weeds and maintaining crop productivity and may be considered as an alternative option where late-season weed infestation predominates.

## Acknowledgments

We acknowledge ICAR-AICRP, Hyderabad and IGKV, Raipur, Chhattisgarh, for providing financial assistance to conduct the research work and other helps required to conduct the research.

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