Original Research Article

Herbicidal management of *Cuscuta spp.*In Berseem(*Trifoliumalexandrinum* L.)

ABSTRACT

Aims: To correlate the efficiency of heribicides towards control of cuscuta and green forage and seed yield of berseem crop.
Study design: Randomized block design (RBD)
Place and Duration of Study: Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the *rabi* season of 2019-20.
Methodology: The experiment consisting of three replications and ten treatments as follows : pendimethalin (PE) 1000 g/ha (T_1), pendimethalin (EPoE) at 10 DAS 1000 g/ha (T_2), oxyfluorfen (PE) 250 g/ha (T_3), imazethapyr (PoE) 40 g/ha just after 1st cutting (T_4), imazethapyr (PoE) 40 g/ha just after 2nd cutting (T_5), imazethapyr (PoE) 40 g/ha just after 1st and 2nd cutting (T_6), imazamox 35 % + imazethapyr 35 % (ready mix) (PoE) 70 g/ha just after 1st cutting (T_7), imazamox 35 % + imazethapyr 35 % (ready mix) (PoE) 70 g/ha just after 2nd cutting (T_8), sodium acifluorfen 16.5 % + clodinafop-propargyl 8 % (ready mix) (PoE) 187.5 g/ha just after 1st cutting (T_9) and control (T_{10}).
Results: No cuscuta infestation observed during the experimentation under any treatments (T_1, T_2, T_3). Highest cuscuta length (41.20 cm), threads (3.00/m^2), and dry weight (0.49 g/m^2) recorded just before 1st cutting with treatment (T_7). Just before 2nd cutting, highest cuscuta length (46.32 cm), threads (4.00/m^2), and dry weight (0.74 g/m^2)recoreded with treatment (T_5) and before 3rd cutting, highest cuscuta length (53.11 cm), threads (5.00/m^2), and dry weight (1.06 g/m^2) recorded under control (T_{10}). No cuscuta infestation after herbicide application in all treatments.The significantly highest total green forage and seed yield
60.12 ton/ha and 0.35 ton/ha was recorded under the PE application of oxyfluorfen250 g/ha (T_3) as compared to rest of the treatments.
Conclusion: The selective action of oxyflourfen, pendimethalin, and imazethapyr on berseem and non-selective control of weeds, including *cuscuta spp.,* resulted in minimal weed competition during critical growth stages. This created a favorable environment for berseem, leading to improved growth, yield quality, and overall crop productivity. The effective herbicidal treatments played a vital role in enhancing berseem yield.

Keywords: berseem, herbicide, cuscuta spp., PE (pre-emergence), EPoE (early post-emergence), PoE (post-emergence).

Comment [A1]: spelling

1. INTRODUCTION

Comment [A2]: include the prevailing method for control of cuscutta

Berseem (*Trifoliumalexandrinum* L.) is a prominent winter season forage crop in India, covering an extensive area of 1.9 million hectares with a yield ranging from 60 to 110 tons per hectare [1]. Although not native to Chhattisgarh, it has been gaining popularity among farmers due to its ability to provide high-quality green forage with a protein content of 15-25%, along with valuable minerals (11-19%) and carotene [2]. However, like other crops, Berseem faces significant competition from weeds during its initial growth stages, especially within the first 30-40 days after sowing (DAS) and sometimes even up to the first cutting. In

subsequent cuttings, the weeds are naturally suppressed by the dense branching and rapid growth of berseem. However, it is important to note that during earlier stages, weeds can cause significant losses in both fodder yield (estimated at 23-30%) and seed yield (estimated at 50%) [3][4]. In India, Cuscuta, commonly known as dodder, presents challenges in various oilseeds such as niger (*Guizotiaabyssinica* L.) and linseed (*Linumusitatissimum* L.), as well as pulses like blackgram (*Vignamungo* L.), greengram (*Vignaradiata* L.), lentil (*Lens culinaris* L.), and chickpea (*Cicer arietinum* L.). It particularly affects rice-fallow areas and fodder crops like lucerne (*Medicago sativa* L.) and berseem (*Trifolium spp*.) in states such as Andhra Pradesh, Chhattisgarh, parts of Madhya Pradesh, Orissa, Gujarat, and West Bengal, both in rainfed and irrigated conditions. Dodder (Cuscuta spp.) is classified as a "declared noxious weed" in 25 countries, which prohibits the importation and movement of its seeds and plant material. In the United States, it stands as the only weed seed whose transportation is banned in all states. The presence of cuscuta poses significant challenges in crop seed production, as its intertwining nature makes it difficult to separate its seeds when crops are sorted out during grading, leading to a reduction in both yield and quality. Consequently, this results in increased harvesting and cleaning expenses.

Comment [A3]: providescientific name of cuscuta

2. MATERIAL AND METHODS

The experiment was conducted at the Research cum Instructional Farm, IGKV, Raipur (C.G.), during the *rabi* season of 2019-20. The soil of the experimental field had a clayey texture and slightly alkaline pH (7.4). The available nutrient levels in the soil were as follows: low for nitrogen (N) at 189.64 kg/ha, medium for phosphorus (P) at 12.30 kg/ha, and high for potassium (K) at 257.60 kg/ha.Berseemmulticut cv SS-51 seeds were sown at a rate of 25 kg/ha, with a sowing depth of 2-3 cm. The sowing was performed using a tractor drawn seed cum fertilizer drill, maintaining a row to row spacing of 20 cm. To ensure proper seeding, the seeds were mixed with sand in a 1:1 ratio. In order to achieve a consistent plant population across all treatments, gap filling was carried out at 10 days after sowing (DAS). At the time of sowing, the required amount of fertilizer (20 kg of nitrogen, 50 kg of phosphorus, and 20 kg of potassium per hectare) was applied as a basal dose using a seed cum fertilizer drill. The experiment was set up in a randomized block design with three replications. Details of the treatments and their scheduling can be found in Table 1. For herbicide application, a knapsack sprayer fitted with a flat fan nozzle was used to spray the required quantity of herbicides. The observations on number of threads, length of threads and dry weight of cuscuta was observed before 1st, 2nd and 3rd cut (*i.e.* 55, 85 and 115 DAS, respectively) of berseem. For counting number of threads a quadrat of 0.25 m^2 (0.5m x 0.5m) was placed randomly at four places in each plot and then cuscuta threads were counted. The data thus obtained, were average out and expressed in number/m^2. For measuring length of threads, five threads were randomly selected and then with the help of metre scale length were measured. Thereafter average length of threads (cm/thread) was work out by dividing the summation of five. The cuscuta threads were collected randomly from four places with the help of quadrat of 0.25 m^2 in each plot. The collected stems were placed into individual paper bags and then dried in an oven at 60°C until a constant weight was achieved. Thereafter, dry weight of cuscuta stems were recorded and reported in g/m^2 after conversion.

Comment [A4]: mention species of cuscuta that is used in exp.
Either use scientific name or common name of cuscuta. This has to be followed through out manuscript

3. RESULTS AND DISCUSSION

Comment [A5]: Results need to be discussed moe efficently.

Herbicidaleffect on *Cuscuta spp.*

The data on number of cuscuta threads/m^2, length of cuscuta threads (cm/threads) and dry weight of cuscuta threads (g/m^2) were recorded before 1st, 2nd and 3rd cutting (*i.e.* 55, 85 and 115 DAS, respectively) of berseem and presented in **Table 2, 3 and 4**, respectively.

The first appearance of cuscuta in the experimental field was observed 30 DAS of berseem where the herbicide applied only after 1st cutting and 2nd cutting. The data shows that there was no infestation of cuscuta observed throughout the experimentation under the treatments *viz.* pendimethalin1000 g/ha applied as PE (T_1), pendimethalin 1000 g/ha applied at 10 DAS as EPoE (T_2) and oxyfluorfen 250 g applied as PE (T_3). Liu *et al.* [5] reported that pendimethalin inhibits the cell division and formation of spindle microtubules in the cells of germinated cuscuta seedlings. It clearly showed that herbicides disturbed mitosis, cytokinesis and production of microtubules on shoot tips and effectively controlled cuscuta in berseem.

Just before 1st cutting of berseem, highest average length (41.20 cm) of cuscuta thread with highest average number of threads (3.00/m^2) and dry weight of cuscuta (0.49 g/m^2) were recorded under the treatment imazamox 35 % + imazethapyr 35 % (ready mix) 70 g/ha applied just after 1st cutting (T_7). Just before 2nd cutting of berseem, highest average length (46.32 cm) of cuscuta thread with highest average number of threads (4.00/m^2) and dry weight of cuscuta (0.74 g/m^2) were recorded under the treatment imazethapyr 40 g/ha applied just after 2nd cutting as PoE (T_5). While, before 3rd cutting the highest average length (53.11 cm) of cuscuta thread with highest average number of threads (5.00/m^2) and dry weight of cuscuta (1.06 g/m^2) was recorded under the treatment control (T_{10}). However, under all the herbicidal treatments the infestation of cuscuta was not observed after the application of herbicides. Yadav *et. al*.[6]Reported that the combined application of oxyfluorfen at 100 g ai/ha and imazethapyr at 15 g ai/ha after the first and second cutting effectively suppressed the growth of *Cuscutareflexa* and other weeds.Zarouge*t.al.* [7] reported that Post-attachment application of stomp (pendimethalin) at 0.36 kg a.i. feddan^{-1}, goal (oxyfluorfen) at 0.1 kg a.i. feddan^{-1}controlled field dodder by 86%-100%, 76%-85% respectively in onion. Similarly pendimethalin 0.5-1.5 kg/ha applied as pre-emergence effectively controlled cuscuta in niger Mishra *et.al.* [8], blackgramMishra *et.al*. [9], linseed Mahere *et.al*. [10], onion Rao and Rao [11].

Total green forage yield and seed yield

Total green forage yield was also affected significantly by different herbicidal treatments as shown in **table 5**. The total green forage yield was lowest (35.97 tons/ha) under control (T_{10}), when weeds were allowed to grow throughout the crop season and it increased substantially when herbicides were applied as per the plan of experimentation in berseem. The significantly highest total green forage yield, amounting to 60.12 tons/ha was observed in the application of oxyfluorfen at 250 g/ha (T3) and it was found at par with pendimethalin at 1000 g/ha as pre-emergence (PE) (T1) and early post-emergence (EPoE) at 10 days after sowing (DAS) (T2). All treatments, including the mentioned ones, showed significant superiority over the control (T10). The weed-free condition created a favourable environment for the crops by eliminating competition from weeds for light, nutrients, and moisture. This led to enhanced crop growth, increased nutrient uptake, and consequently, a higher green forage yield. Wasnik *et. al*. [12] observed that the application of oxyfluorfen at 0.04 kg a.i./ha resulted in the highest recorded yields of green fodder (360.83 q/ha), seed (2.66 q/ha), and straw (21.44 q/ha) among the pre-emergence herbicides tested.Kauthale*et al.* [13] found that employing oxyflourfen at 0.10 kg/ha pre-emergence, followed by post-emergence application of imazethapyr at 0.10 kg/ha immediately after the first cut's harvest, resulted in significantly increased green fodder yields.Similar results were also found by Kumar *et .al*. [14], Pathan *et. al.* [15], kantwa*et. al*.[16].

Effect of different treatments on seed yield of berseem is presented in **Table 5**. The lowest seed yield (0.04 tons/ha) was found under control (T_{10}). Whereas, the significantly highest seed yield (0.35 tons/ha) was recorded under the PE application of oxyfluorfen250 g/ha (T_3)

as compared to rest of the treatments. It was followed subsequently by the EPoE application of pendimethalin1000 g/ha at 10 DAS (T_2), PE application of pendimethalin1000 g/ha (T_1) and PoE application of imazethapyr 40 g/ha applied twice just after 1st and 2nd cutting (T_6) (0.25, 0.23 and 0.21 tons/ha, respectively). Prajapati *et. al.* [17] reported significantly higher seed yield with the application of oxyflourfen 0.10 kg/ha + imazethapyr 0.15 kg/ha (immediate after 1st cut) *i.e.* 0.67 tons/ha compared to remaining herbicidal treatments.The similar results were also reported by Tamrakar *et al*. [18], Tiwana *et al*. [19], Pathan and Kamble [20], and Pathan *et al*. [21].

Table: 1 Treatment details

Treatment no.	Treatments	Dose (g/ha)
1	Pendimethalin (PE)	1000
2	Pendimethalin (EPoE) at 10 DAS	1000
3	Oxyfluorfen (PE)	250
4	Imazethapyr (PoE) just after 1st cutting	40
5	Imazethapyr (PoE) just after 2nd cutting	40
6	Imazethapyr (PoE) just after 1st cutting *fb** Imazethapyr (PoE) just after 2nd cutting (applied twice)	40
7	Imazamox 35 % + Imazethapyr 35 % (ready mix) (PoE) just after 1st cutting	70
8	Imazamox 35 % + Imazethapyr 35 % (ready mix) (PoE) just after 2nd cutting	70
9	Sodium acifluorfen 16.5% + Clodinafop-propargyl 8% (ready mix) (PoE) just after 1st cutting	187.5
10	Control	--

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Table 2: Herbicidal effect on number of threads of *cuscuta spp.* in berseem

Treatment	Number of threads of cuscuta/m^2		
	Before 1st cut (55 DAS)	**Before 2nd cut (85 DAS)**	**Before 3rd cut (115 DAS)**
T_1-Pendimethalin (PE) 1000 g/ha	Nil	Nil	Nil
T_2- Pendimethalin (EPoE) 1000 g/ha at 10 DAS	Nil	Nil	Nil
T_3-Oxyfluorfen (PE) 250 g/ha	Nil	Nil	Nil
T_4-Imazethapyr (PoE) 40 g/ha just after 1st cutting	2.67	Nil	Nil
T_5-Imazethapyr (PoE) 40 g/ha just after 2nd cutting	2.00	4.00	Nil
T_6-Imazethapyr (PoE) 40 g/ha just after 1st cutting *fb* Imazethapyr (PoE) 40 g/ha just after 2nd cutting	2.00	Nil	Nil
T_7-Imazamox 35% + Imazethapyr 35% (ready mix) (PoE) 70 g/ha just after 1st cutting	3.00	Nil	Nil
T_8-Imazamox 35% + Imazethapyr 35% (ready mix) (PoE) 70 g/ha just after 2nd cutting	2.33	3.67	Nil
T_9-Sodium acifluorfen 16.5% + Clodinafop-propargyl 8 % (ready mix) (PoE) 187.5 g/ha just after 1st cutting	2.67	Nil	Nil
T_{10}-Control	2.67	3.33	5.00

Table 3: Herbicidal effect on length of thread of *cuscuta spp.* in berseem

Treatment	Length of thread (cm/thread)		
	Before 1st cut (55 DAS)	**Before 2nd cut (85 DAS)**	**Before 3rd cut (115 DAS)**
T_1-Pendimethalin (PE) 1000 g/ha	Nil	Nil	Nil
T_2- Pendimethalin (EPoE) 1000 g/ha at 10 DAS	Nil	Nil	Nil
T_3-Oxyfluorfen (PE) 250 g/ha	Nil	Nil	Nil
T_4-Imazethapyr (PoE) 40 g/ha just after 1st cutting	40.32	Nil	Nil
T_5-Imazethapyr (PoE) 40 g/ha just after 2nd cutting	38.70	46.32	Nil
T_6-Imazethapyr (PoE) 40 g/ha just after 1st cutting *fb* Imazethapyr (PoE) 40 g/ha just after 2nd cutting	39.20	Nil	Nil
T_7-Imazamox 35% + Imazethapyr 35% (ready mix) (PoE) 70 g/ha just after 1st cutting	41.20	Nil	Nil
T_8-Imazamox 35% + Imazethapyr 35% (ready mix) (PoE) 70 g/ha just after 2nd cutting	39.56	44.61	Nil
T_9-Sodium acifluorfen 16.5% + Clodinafop-propargyl 8 % (ready mix) (PoE) 187.5 g/ha just after 1st cutting	39.00	Nil	Nil
T_{10}-Control	38.34	45.23	53.11

Table 4: Herbicidal effect dry weight of cuscuta in berseem

Treatment	Dry weight of cuscuta (g/m^2)		
	Before 1st cut (55 DAS)	Before 2nd cut (85 DAS)	Before 3rd cut (115 DAS)
T_1-Pendimethalin (PE) 1000 g/ha	Nil	Nil	Nil
T_2- Pendimethalin (EPoE) 1000 g/ha at 10 DAS	Nil	Nil	Nil
T_3-Oxyfluorfen (PE) 250 g/ha	Nil	Nil	Nil
T_4-Imazethapyr (PoE) 40 g/ha just after 1st cutting	0.44	Nil	Nil
T_5-Imazethapyr (PoE) 40 g/ha just after 2nd cutting	0.31	0.74	Nil
T_6-Imazethapyr (PoE) 40 g/ha just after 1st cutting *fb* Imazethapyr (PoE) 40 g/ha just after 2nd cutting	0.34	Nil	Nil
T_7-Imazamox 35% + Imazethapyr 35% (ready mix)(PoE) 70 g/ha just after 1st cutting	0.49	Nil	Nil
T_8-Imazamox 35% + Imazethapyr 35% (ready mix)(PoE) 70 g/ha just after 2nd cutting	0.37	0.65	Nil
T_9-Sodium acifluorfen 16.5% + Clodinafop-propargyl 8 % (ready mix) (PoE) 187.5 g/ha just after 1st cutting	0.43	Nil	Nil
T_{10}-Control	0.41	0.60	1.06

Table 5: Total green forage and yield of berseem

Treatment	Total Green forage yield (tons/ha)	Seed yield (tons/ha)
T_1-Pendimethalin (PE) 1000 g/ha	56.73	0.23
T_2- Pendimethalin (EPoE) 1000 g/ha at 10 DAS	55.21	0.25
T_3-Oxyfluorfen (PE) 250 g/ha	60.12	0.35
T_4-Imazethapyr (PoE) 40 g/ha just after 1st cutting	45.17	0.18
T_5-Imazethapyr (PoE) 40 g/ha just after 2nd cutting	44.25	0.13
T_6-Imazethapyr (PoE) 40 g/ha just after 1st cutting *fb* Imazethapyr (PoE) 40 g/ha just after 2nd cutting	51.59	0.21
T_7-Imazamox 35% + Imazethapyr 35% (ready mix)(PoE) 70 g/ha just after 1st cutting	46.95	0.19
T_8-Imazamox 35% + Imazethapyr 35% (ready mix)(PoE) 70 g/ha just after 2nd cutting	42.32	0.16
T_9-Sodium acifluorfen 16.5% + Clodinafop-propargyl 8 % (ready mix) (PoE) 187.5 g/ha just after 1st cutting	36.30	0.05
T_{10}-Control	35.97	0.04
SEm±	**1.83**	**0.01**
CD (P=0.05)	**5.43**	**0.04**

4. CONCLUSION

Comment [A6]: Must compare all the herbicide and suggest the better among all for the control of cuscuta

The selective nature of oxyflourfen, pendimethalin, and imazethapyr towards berseem and their non-selective mode against weed flora contributed to effective control of cuscuta sp. (dodder) and other grassy and broad-leaved weeds. As a result, there was minimal competition from weeds during the critical crop growth period, ensuring the crop had sufficient access to moisture, space, sunlight, and nutrients. This favourable environment led to improved growth and development of the crop, ultimately enhancing yield quality parameters and overall yield.

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