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Effect of weed control practices on fodder and seed productivity of Berseem in Kymore plateau and Satpura hill zone of Madhya Pradesh

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Abstract
Field experiment was conducted during *Rabi* 2011 -12 and 2012- 13 to find out most suitable weed management practices in berseem (*Trifolium alexandrinum* L). *Cichorium intybus*, *Medicago denticulata*, *Medicago hispida and Cornopus didymus* were predominant weeds in berseem. The pre emergence application of oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.15 kg a.i./ha recorded significantly lowest total weed intensity (6.17/ m^2) and dry weight (5.92 g/m^2) of weeds as compared to other treatments. It also recorded higher weed control efficiency (72.31%). The same treatment also recorded significantly higher green fodder yield (632.9 q/ha), dry fodder yield (95.6q/ha), crude protein yield (14.878), net monetary returns (Rs. 84163) and benefit: cost ratio (2.98) as compared to other treatments after the weed free treatment.

Keywords: Berseem, Economics, Fodder yield, Seed yield, Weed management

Abbreviations: CFY: Crude fibre yield; **CP:** Crude protein; **CPY:** Crude protein yield; **DAS:** Days after sowing; **HW:**Hand weeding; **WCE:** Weed control efficiency; **WAS:** Week after sowing

Introduction

Berseem is the most important legume forage crop of *rabi* season cultivated on about 2 million ha area in the country (Hazra, 1996). It is widely accepted because of multicut, fast regeneration high fodder yield and provides the nutritious fodder to livestock from November to April. Berseem is an also important forage crop for irrigated areas of Kymore plateau and Satpura hills of the state, where dairy farming is one of the main occupation of the farmers. Congenial soil moisture due to frequent irrigations coupled with suitable temperature as well as better nutrient availability not only increases the fodder production but also provide unique opportunity to weeds particularly *Cichorium intybus, Medicago denticulata, Trifolium flagiferum, Cyperus rotundus* and *Alternanthera sessilis etc*. to appear simultaneously and compete with crop for essential nutrients, light, moisture, space and causing substantial reduction in green forage yield (Jain, 1998). Among the different weeds, *Cichorium intybus* is one of the major obnoxious weed found associated with berseem and used to give more competition stress (Kewat *et al.,* 2005). Consequently, it causes substantial reduction (30-40%) in tonnage besides deteriorating the quality of seeds. Manual removal and frequent inter row cultivation are the usual control measures. However, these methods are laborious and often not effective. Therefore, the present study was conducted to find out the most selective and potent herbicide for curbing the menace of weeds in berseem.

Materials and Methods

A Field experiment was conducted during *Rabi* season 2011-12 and 2012-13 under All India Coordinated Project on Forage Crops at JNKVV, Jabalpur (23^0 90ôN latitude and 79^0 58ôE longitudes at an altitude of 411.78 meter above the mean sea level). It falls under subtropical climatic conditions, which is characterized by the features of hot dry summers and cool dry winters. The soil of the experimental field was sandy clay loam in texture, neutral in reaction (pH 7.2), and low in organic carbon (0.53%) and available nitrogen (232 kg/ha), medium available phosphorus (17.18 kg/ha) and medium available potassium (315 kg/ha) with normal electrical conductivity (0.34). The eleven treatments namely, T_1-weedy check, T_2 -weed free check, T_3 -One hoeing at 3 week after sowing (WAS) and one HW (hand weeding) at 5 WAS, T_4- pendimethalin @ 1.00 kg a.i./ha, T_5- pendimethalin@ 1.00 kg a.i./ha + one HW at 5 WAS, T_6- oxyfluorfen @ 0.100 kg a.i./ha, T_7- oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS, T_8- pendimethalin @ 1.00 kg a.i./ha + imazethapyr

@ 0.150 kg a.i./ha (Immediate after 1st cut), **T_9** - oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (immediate after 1st cut), **T_{10}** -imazethapyr @ 0.150 kg a.i./ha (immediate after 1st & 2nd cut), and **T_{11}**- hand weeding twice at 20 and 40 days after sowing (DAS) were tested in a randomized block design with three replications. Pendimethalin and oxyfluorfen were applied as pre-emergence (one day after sowing) and imazethapyr was applied as post emergence (immediately after 1st & 2nd cut). The spraying of herbicides was done by mixing with 500 litres of water. The measured quantity of herbicides and water for each plot was mixed thoroughly before spraying. Knapsack sprayer of 15 litre capacity with fine mist spray nozzle was used. The berseem variety JB-5 was sown on the flat beds in line sowing at row to row distance of 30 cm on 15th November, 2011 and 10th November, 2012, respectively using seed rate of 25 kg/ ha. The seed was treated with *Rhizobium meliloti* and 20 N, 60 P_2O_5 and 20 K_2O kg /ha were applied as basal dose through urea, single super phosphate and muriate of potash. Various observations were recorded on weed and crop parameters. The quadrate of 0.25 m^2 (0.5 m × 0.5 m) was randomly placed at four places in each plot and then the species wise and total weed count was recorded. The weed control efficiency and weed index were worked out as per formula given by Mani *et al.*(1968) and Gill and Kumar (1969). Total 3 cuttings were taken at about 5-7 cm height for better re-growth. The first cutting was done 55 DAS and subsequent two cuttings were done at 30 days intervals when the crop attained the height of around 45 cm from the ground. The yield from three cuttings was summed up to get the total green forage yield under each treatment in both the years. The crop was left for seed production after the third cutting and given light irrigations until flowering and seed setting. Crop was harvested in the last week of May and the grain and stover yields were recorded. The selling rate of green fodder and seed was Rs.100 and 10,000/ quintal, respectively. Weed density and weed dry matter values were subjected to square root transformation $\sqrt{(x + 0.5)}$ before statistical analysis to normalize data distribution. Experimental data were analyzed using standard statistical procedures for randomized block design.

Result and Discussion

Effect on weeds

Weed density and dry weight: The weed density and dry weight of weeds were significantly influenced by the different weed control practices (Table 1). The highest weed density (14.94/m^2) and dry weight (10.98 g/m^2) were recorded in weedy check. Among the herbicidal treatment the pre emergence application of oxyfluorfen @ 0.100 kg a.i./ha+ imazethapyr @ 0.150 kg a.i./ha (Immediate after harvest of 1st cut) was found to be more effective in reducing the density (6.17 /m^2) and dry weight (5.92 / gm^2) of weeds, followed by hand weeding twice at 20, and 40 DAS (6.38 and 5.98 g/m^2) and oxyfluorfen @ 0.100 kg a.i./ha + one hand weeding at 5 WAS (6.43 and 6.27g /m^2) over other treatments. The application of pendimethalin @ 1.00 kg a.i./ha alone significantly reduced the weed density, dry weight and also efficiency enhanced when it is applied with hand weeding and followed by post emergence application of imazethapyr @ 0.150 kg a.i./ha.

Weed control efficiency: The pre emergence application of oxyfluorfen @ 0.100 kg a.i./ha+ imazethapyr @ 0.150 kg a.i./ha attained the higher weed control efficiency (72.31%) followed by hand weeding at 20 and 40 DAS (71.79%) and oxyfluorfen 0.100 kg a.i./ha + one hand weeding at 5 WAS (69.29%). The WCE of pendimethalin @ 1.00 kg a.i./ha + imazethapyr @0.150 kg a.i./ha (63.57 %), one hoeing at 3 WAS + one hand weeding at 5 WAS (68.66%), post emerge application of imazethapyr @ 0.150 kg a.i./ha (67.82%) were equally good over weedy check.

Effect on crop

Yield attributes and yields: The green fodder, dry matter and seed yield and yield attributes *viz*, plant height, L: S ratio, branches/plant, length of head, seeds/capsule were significantly influenced by weed control treatments (Table 2). Pendimethalin @ 1.00 kg a.i./ha, recorded lowest fodder and seed yield. Barevadia *et al.* (1998) also reported that application of pendimethalin at 0.50 kg /ha and above as preï emergence showed severe phyto-toxicity to lucerne and berseem seedlings. The highest values of the yield attributes were noted in weed free plots. The lowest green forage (265.9 q/ha) and dry matter yield (35.1 q/ha) were recorded when weeds were not controlled in Berseem. Among the herbicidal treatments, the maximum green and dry matter yield (632.90 and 95.6 q/ ha, respectively) was recorded when weeds were controlled with oxyfluorfen @ 0.100 kg a.i./ha+ imazethapyr @ 0.150 kg a.i./ha followed by hand weeding at 20 and 40 DAS and oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS (Table 3). The application of pendimethalin @ 1.00 kg a.i./ha exerted its phytotoxic effect on germination and growth of berseem and significantly decreased the green fodder and dry matter yield to the extent of 16.0 and 22.0%, respectively than weed free treatment. The highest yield under these treatments could

be attributed to better control of weeds right from crop emergence up to critical period of crop weed competition which led to efficient utilization of growth resources by the crop plants and ultimately recorded higher green forage and seed yield. Similar results also reported by Sharma and Chander (2006). Treatments had significant effect on the seed yield, yield attributes *viz*., length of head, capsule/plants and seeds/capsules seed and stover yields (Table 3). The maximum value of length of head (2.70 cm), capsules (16.25), seeds /capsule (30.21) and seed yields (4.24 q/ha) was obtained in T_2. The results are in conformity with the findings of Kewat *et al.* (2005) and Mishra (2012).

Effect on quality parameters: The total crude protein and crude fiber yield were higher under weed free treatment followed by oxyfluorfen @ 0.100 kg a.i./ha+ imazethapyr @ 0.150 kg a.i./ha, hand weeding at 20 and 40 DAS and oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS and all these proved significantly superior over rest of the treatments. Pre emergence application of Pendimethalin @ 1.00 kg a.i./ha + one HW at 5 WAS and oxyflourfen @ 1.00 kg a.i./ha also produced higher total crude protein yield and crude fiber yield over weedy check but the difference between above the treatments were not significant.

Table 1. Weed density and weed dry weight as influenced by different treatments in berseem

Treatment	Weed density (m^2)					Weed dry weight (g / m^2)					Weed control efficiency (%)
	Cichorium intybus	*Medicago denticulata*	*Cornopus didymus*	Other weeds	Total weed density	*Cichorium intybus*	*Medicago denticulata*	*Cornopus didymus*	Other weeds	Total dry weight	
T_1	71.83	53.83	39.67	58.33	223.67	30.32	27.77	29.21	39.38	120.68	0.00
	(8.49)	(7.35)	(6.31)	(7.66)	(14.94)	(5.55)	(5.32)	(5.45)	(5.67)	(10.98)	
T_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	(0.71)	
T_3	14.67	12.34	10.00	12.17	49.17	10.45	9.04	7.81	9.54	36.83	68.66
	(3.89)	(3.57)	(3.24)	(3.56)	(7.04)	(3.20)	(3.09)	(2.87)	(3.16)	(6.10)	
T_4	24.50	18.67	13.83	13.83	70.33	14.04	12.46	12.52	14.49	53.16	57.63
	(5.08)	(4.14)	(3.75)	(3.78)	(8.36)	(3.81)	(3.60)	(3.60)	(3.83)	(7.32)	
T_5	15.83	16.34	13.50	13.17	55.50	12.61	11.51	12.16	12.00	48.32	61.68
	(3.52)	(4.07)	(3.69)	(3.68)	(7.45)	(3.61)	(3.46)	(2.55)	(3.53)	(6.97)	
T_6	13.83	12.00	9.34	12.83	48.00	13.18	12.53	11.82	11.62	49.11	60.36
	(3.75)	(3.51)	(3.11)	(3.62)	(6.90)	(3.68)	(3.60)	(2.49)	(3.47)	(7.02)	
T_7	9.33	10.17	11.83	12.00	41.67	10.40	9.65	9.83	9.56	39.42	69.29
	(3.09)	(3.23)	(3.25)	(3.52)	(6.43)	(3.28)	(3.17)	(3.19)	(3.15)	(6.27)	
T_8	11.00	10.67	9.34	17.33	50.00	11.33	9.03	10.12	11.40	41.87	63.57
	(3.62)	(3.32)	(3.30)	(4.15)	(7.09)	(3.44)	(3.07)	(3.26)	(3.45)	(6.50)	
T_9	11.17	8.34	6.67	10.17	38.00	10.05	9.30	5.82	9.69	34.69	72.31
	(3.65)	(2.91)	(2.62)	(3.23)	(6.17)	(3.22)	(3.13)	(2.50)	(3.19)	(5.92)	
T_{10}	17.34	14.67	11.83	16.67	60.50	11.98	11.11	11.04	11.19	45.32	67.82
	(4.04)	(3.78)	(3.42)	(3.90)	(7.49)	(3.51)	(3.40)	(3.37)	(3.39)	(6.73)	
T_{11}	8.15	10.10	10.00	11.95	40.20	10.00	9.39	7.52	8.44	35.35	71.79
	(2.94)	(3.26)	(3.24)	(3.53)	(6.38)	(3.23)	(3.14)	(2.82)	(2.99)	(5.98)	
CD (P<0.05)	1.31	1.01	0.95	1.23	2.04	0.49	0.42	0.54	0.98	1.00	

Data subjected to square root (x + 0.5) transformation; **T_1**-weedy check, **T_2** -weed free check, **T_3** -One hoeing at 3 week after sowing (WAS) and one HW (hand weeding) at 5 WAS, **T_4**- pendimethalin @ 1.00 kg a.i./ha, **T_5**- pendimethalin@ 1.00 kg a.i./ha + one HW at 5 WAS, **T_6**- oxyfluorfen @ 0.100 kg a.i./ha, **T_7**- oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS, **T_8**- pendimethalin @ 1.00 kg a.i./ ha + imazethapyr @ 0.150 kg a.i./ha (Immediate after 1st cut), **T_9** - oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (immediate after 1st cut), **T_{10}** -imazethapyr @ 0.150 kg a.i./ha (immediate after 1st & 2nd cut), and **T_{11}**- hand weeding twice at 20 and 40 days after sowing (DAS)

Table 2. Yield attributing characters of fodder and seed yield and quality parameter and economics of berseem as influenced by different treatments (Mean of two years)

Treatment	Plant population / m row length	Av. plant height (cm)	Av. L:S ratio	No. of branches / plant	Length of head (cm)	No. of capsules / plants	No. of seeds / capsules
T_1	137.7	38.8	0.64	8.65	1.75	10.08	18.85
T_2	139.0	55.2	0.94	12.63	2.70	16.25	30.21
T_3	138.0	54.4	0.90	11.05	2.28	15.15	28.52
T_4	134.8	44.8	0.70	10.40	1.90	13.45	25.05
T_5	135.4	45.5	0.70	10.44	1.95	13.51	26.26
T_6	138.8	47.2	0.79	10.75	2.08	14.36	28.18
T_7	138.4	51.2	0.81	10.85	2.22	14.66	28.50
T_8	135.2	46.1	0.73	10.52	2.02	13.75	26.48
T_9	138.9	54.1	0.90	11.28	2.35	15.50	28.86
T_{10}	138.0	49.6	0.80	10.78	2.15	14.60	27.37
T_{11}	139.0	53.0	0.92	11.42	2.46	15.85	28.65
CD (P<0.05)	0.54	1.23	0.02	0.32	0.08	0.98	1.10

Treatment	C P (%)	CPY (q/ha)	CF (%)	CFY (q/ha)	Cost of cultivation (Rs/ha)	Net monetary returns (Rs/ha)	Benefit cost ratio
T_1	14.18	5.07	18.78	6.71	33736	19444	1.58
T_2	15.64	14.84	18.23	17.30	55804	72216	2.29
T_3	15.54	14.13	18.20	16.56	41225	81275	2.97
T_4	15.03	11.39	18.58	14.08	40225	66035	2.64
T_5	15.03	11.74	18.56	14.52	43302	65398	2.51
T_6	15.30	12.72	18.46	15.35	41310	72850	2.76
T_7	15.42	13.63	18.35	16.20	44931	74869	2.67
T_8	15.21	12.23	18.50	14.88	41160	69820	2.70
T_9	15.65	14.78	18.08	17.17	42417	84163	2.98
T_{10}	15.32	12.82	18.08	15.40	41488	73212	2.76
T_{11}	15.68	15.31	18.01	17.58	42425	82355	2.94
CD (P<0.05)	0.21	1.14	0.22	1.13			

Av. ï Mean data of three cuttings, CPY- Crude protein yield , CFY- Crude fiber yield , HW- hand weeding , WAS- week after sowing , DAS- days after sowing , T_1-weedy check, T_2 -Weed free, T_3 -One hoeing at 3 week after sowing (WAS) and one HW at 5 WAS, T_4- pendimethalin @ 1.00 kg a.i./ha, T_5- pendimethalin@ 1.00 kg a.i./ha + one HW at 5 WAS, T_6- oxyfluorfen @ 0.100 kg a.i./ha, T_7- oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS, T_8- pendimethalin @ 1.00 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (Immediate after 1st cut), T_9 - oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (immediate after 1st cut), T_{10} -imazethapyr @ 0.150 kg a.i./ha (immediate after 1st & 2nd cut), and T_{11}- hand weeding twice at 20 and 40 days after sowing (DAS)

Economics

Economical analysis on the basis of prevailing input and out put market prices revealed that the oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha treatment recorded the highest net profit of Rs 84163/ha. However, hand weeding at 20 and 40 DAS and; oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS also gave maximum net monetary returns and benefit -cost ratio than rest of the treatments. Sharma and Chander (2006) also reported superiority of chemical weed control to traditional manual weeding with respect benefit: cost ratio. Pre emergence application of pendimethalin@ 1.00 kg a.i./ ha reduced the net returns and benefit : cost ratio due to lower fodder and seed yields.

Table 3. Effect of different weed control treatments on yield of berseem

Treatments	Green fodder yield (q/ha)			Dry matter yield (q/ha)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean
T1	268.20	263.50	265.90	35.77	34.34	35.1
T2	640.60	639.60	640.10	97.63	96.37	97.0
T3	616.70	608.20	612.50	91.01	89.61	90.3
T4	534.10	528.50	531.30	75.82	74.36	75.1
T5	546.30	540.60	543.50	78.27	76.79	77.5
T6	575.70	565.80	570.80	83.17	81.69	82.4
T7	602.70	595.30	599.00	88.32	86.86	87.6
T8	559.80	550.00	554.90	80.48	78.99	79.7
T9	635.60	630.20	632.90	96.32	94.91	95.6
T10	578.20	568.80	573.50	83.79	82.30	83.0
T11	627.21	620.60	623.90	94.97	93.54	94.3
CD (P<0.05)	30.60	29.56	28.90	14.70	12.50	16.7

Treatments	Seed yield (q/ha)			Stover yield (q/ha)			Weed Index
	2011-12	2012-13	Mean	2011-12	2012-13	Mean	
T1	1.55	1.58	1.57	27.75	28.15	27.95	63.09
T2	4.30	4.18	4.24	50.36	54.23	52.30	0.00
T3	4.20	3.27	3.74	51.85	52.06	51.96	11.91
T4	3.07	2.10	2.59	48.17	49.32	48.75	39.03
T5	3.99	3.46	3.73	49.0	50.25	49.63	12.15
T6	4.08	3.08	3.58	47.35	48.06	47.71	15.57
T7	4.14	3.20	3.67	51.45	51.96	51.71	13.44
T8	4.08	3.10	3.59	48.58	49.06	48.82	15.33
T9	4.23	4.11	4.17	51.45	52.00	51.73	1.65
T10	4.09	3.13	3.61	49.80	50.56	50.18	14.86
T11	4.32	3.38	3.85	53.07	53.80	53.44	9.20
CD (P<0.05)	0.21	0.31	0.32	1.92	2.10	1.89	-

HW- hand weeding , WAS- week after sowing, DAS- days after sowing, T_1-weedy check, T_2 -weed free check, T_3 -One hoeing at 3 week after sowing (WAS) and one HW (hand weeding) at 5 WAS, T_4- pendimethalin @ 1.00 kg a.i./ha, T_5- pendimethalin@ 1.00 kg a.i./ha + one HW at 5 WAS, T_6- oxyfluorfen @ 0.100 kg a.i./ha, T_7- oxyfluorfen @ 0.100 kg/ha + one HW at 5 WAS, T_8- pendimethalin @ 1.00 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (Immediate after 1st cut), T_9 - oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (immediate after 1st cut), T_{10} -imazethapyr @ 0.150 kg a.i./ha (immediate after 1st & 2nd cut), and T_{11}- hand weeding twice at 20 and 40 days after sowing (DAS)

Based on two years study, it can be concluded that menace of broad leaved weeds could be curbed selectively and economically with pre emergence application of oxyfluorfen @ 0.100 kg a.i./ha + imazethapyr @ 0.150 kg a.i./ha (immediate after harvest of 1st cut) in berseem in irrigated condition of Kymore plateau and Satpura hill zone of Madhya Pradesh, India.

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