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Efficacy of Herbicides Against Field Dodder *(Cuscuta campestris)* in Lentil, Chickpea and Linseed

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ABSTRACT

Pre-emergence application of pendimethalin at 1000 g ha^{-1} and squadron (ready mixture of pendimethalin (240 g a. i. l^{-1})+imazaquin (40 g a. e. l^{-1}) 3000 g ha^{-1}) significantly reduced the emergence of *C. campestris* as compared to *Cuscuta* infested plot in both lentil and chickpea. Pre-plant incorporation of fluchloralin at 1000 g ha^{-1} was not effective on *Cuscuta*. Post-emergence application of imazethapyr (50 and 100 g ha^{-1}) and glyphosate (50 g ha^{-1}) killed the extended vines of *Cuscuta* and checked its growth upto 25-30 days only. Maximum seed yield of lentil (4175 and 3407 kg ha^{-1}), chickpea (3615 and 2949 kg ha^{-1}) and linseed (1994 kg ha^{-1}) was recorded in *Cuscuta* free plots. Pendimethalin at 1000 g ha^{-1} in all three crops, squadron at 3000 g ha^{-1} in chickpea and glyphosate at 50 g ha^{-1} in linseed significantly increased the seed yield. Squadron was phyto-toxic to lentil and linseed. Imazethapyr and glyphosate (except at 50 g ha^{-1} in linseed) were phyto-toxic to the crops.

INTRODUCTION

Cuscuta campestris Yuncker (field dodder), a member of the Convolvulaceae family, is an annual obligate stem parasite, and as such is totally dependent on its host plants for assimilates, nutrients and water supply. In India, it is a serious problem in lentil, chickpea, linseed, greengram and blackgram especially in rice-fallows. Yield losses to the tune of 87% in lentil, 85.7% in chickpea and 49.7% in linseed due to severe infestation of field dodder have been reported (Moorthy *et al.*, 2003). Manual removal and frequent inter row cultivation before the parasite attaches the host plant are the usual control measures. However, these methods are laborious and often not effective. Once the parasite is attached to the host it remains parasitic until harvest. Herbicides are the best option for checking the germination of *Cuscuta*. Though the promising control of dodder by pronamide and pendimethalin has been reported in niger, blackgram, alfalfa and other crops (Misra *et al.*, 1981; Dawson, 1990, Mishra *et al.*, 2005), the information on efficacy of herbicides against *C. campestris* in lentil, chickpea and linseed is lacking. Hence, the present investigation was undertaken.

MATERIALS AND METHODS

Field experiments were conducted during winter seasons of 2002-03 and 2003-04 at the National Research Centre for Weed Science, Jabalpur (23°90' N, 79°58' E, 412 m above mean sea level). The soil was clay loam (Typic Chromusterts), low in available nitrogen (235 kg ha^{-1}), medium in available phosphorus (42 kg P_2O_5 ha^{-1}), and high in available potassium (304 kg K_2O ha^{-1}), with organic carbon 0.58% and pH 7.2. Treatments (Tables 1, 2 and 3) were replicated thrice in a randomized block design and the crops were grown with recommended package of practices other than weed control. *Cuscuta* seeds were treated with concentrated sulfuric acid for 20 min before broadcasting them in the field to break seed dormancy and to facilitate proper germination. Twenty *Cuscuta* seeds were sown alongwith the crop in rows 25 cm apart in 1 m^2 micro-plots. All the weeds, except *Cuscuta*, were removed from the plots manually as and when required. Fluchloralin was incorporated in the soil before sowing. Pendimethalin and squadron (ready mixture of pendimethalin (240 g a. i. l^{-1})+imazaquin (40 g a. e. l^{-1}) were applied as pre-emergence herbicides (2

Table 1. Effect of herbicides *on C campestris* and lentil

Treatment	Dose (g ha^{-1})	*Cuscuta* density (No. m^{-2})		Lentil plants attached with *Cuscuta* (%)* (Days after sowing)						Plant height (cm)		Seed yield (kg ha^{-1})		Seed production of *Cuscuta* (No. '000 m^{-2})	
				30		60		90							
		2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Fluchloralin	1000	6	7	16.6	19.7	67.4	71.5	81.5	78.5	32.6	30.7	1557	1280	155	147
Pendimethalin	1000	2	3	5.3	5.8	20.9	21.5	42.3	42.4	45.3	41.6	2753	2216	54	42
Squadron**	3000	4	1	4.4	6.8	16.2	17.7	32.6	34.6	31.0	29.2	2275	1281	50	14
Imazethapyr	50	6	7	52.3	57.0	25.3	36.1	32.6	42.4	30.2	36.2	1153	889	60	104
Imazethapyr	100	10	6	37.0	41.0	22.0	35.0	30.9	53.9	30.0	38.1	1959	1271	50	66
Glyphosate	50	6	8	40.0	39.0	25.0	29.4	35.0	42.1	35.0	37.4	1061	797	16	111
Cuscuta infested	-	8	8	36.7	21.0	46.8	50.1	61.0	77.2	18.6	16.3	1654	0	176	33
Cuscuta free	-	0	0	4.05	4.05	4.05	4.05	4.05	4.05	51.8	45.9	4175	3407	0	0
LSD (P=0.05)	-	2	2	12.1	10.8	15.3	17.3	16.0	19.5	8.3	9.4	141	289	16	22

*Data transformed to arcsine transformation, **Ready mixture of pendimethalin (240 g a. i. l^{-1})+imazaquin (40 g a. e. l^{-1}).

Table 2. Effect of herbicides on *C. campestris* and chickpea

Treatment	Dose (g ha^{-1})	*Cuscuta* density (No. m^{-2})		Chickpea plants attached with *Cuscuta* (%)* (Days after sowing)						Plant height (cm)		Seed yield (kg ha^{-1})		Seed production of *Cuscuta* (No. '000 m^{-2})	
				30		60		90							
		2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Fluchloralin	1000	7	6	11.3	9.0	24.0	18.6	37.5	31.4	42.2	47.6	1930	1981	107	27
Pendimethalin	1000	3	2	9.0	7.2	16.3	13.6	31.5	22.3	50.6	52.0	3077	2564	31	9
Squadron**	3000	3	0	7.6	4.05	18.2	4.05	28.6	4.05	49.3	42.8	3252	2415	31	0
Imazethapyr	50	6	8	31.2	28.2	25.1	43.4	71.4	83.5	25.6	20.6	1272	51	33	92
Imazethapyr	100	10	9	35.4	23.1	30.5	26.0	89.6	85.9	31.2	39.3	1290	7	11	77
Glyphosate	50	8	8	31.0	28.6	18.0	21.0	72.0	85.9	26.0	42.8	1031	20	15	115
Cuscuta infested	-	6	9	45.5	59.2	72.3	85.9	76.5	86.9	26.5	24.9	776	0	221	35
Cuscuta free	-	0	0	0	4.05	4.05	4.05	4.05	4.05	50.6	55.6	3615	2949	0	0
LSD (P=0.05)	-	2	2	5.3	6.6	10.2	11.4	13.2	14.4	2.1	1.99	190	103	10	9

*Data transformed to arcsine transformation, **Ready mixture of pendimethalin (240 g a. i. l^{-1})+imazaquin (40 g a. e. l^{-1}).

Table 3. Effect of herbicides on *C. campestris* in linseed

Treatment	Dose (g ha^{-1})	Stage of application	Linseed population m^{-2}		Linseed plants attached with *Cuscuta* (%)*			Plant height	Branches plant^{-1}	Seed yield (kg ha^{-1})
			30 DAS	At harvest	(Days after sowing)			(cm)		
					30	60	90			
Fluchloralin	1000	PPI	88	47	14.8	24.9	21.8	48.1	5.0	908
Fluchloralin+Pendimethalin	400+600	PPI+PE	105	45	11.5	18.9	16.0	45.7	4.0	1060
Pendimethalin	1000	PE	94	67	6.9	9.5	12.1	55.3	4.8	1276
Squadron**	3000	PE	0	0	4.05	4.05	4.05	0	0	0
Glyphosate	100	30 DAS	132	101	37.4	31.4	31.3	50.7	4.1	980
Glyphosate	50	30 DAS	144	128	30.4	20.4	24.8	59.1	3.3	1264
Imazathapyr	100	30 DAS	125	53	32.2	18.2	25.2	53.9	4.0	963
Imazathapyr	50	30 DAS	116	77	32.3	24.6	26.3	52.7	4.4	980
Pendimethalin fb water spray	2500	30 DAS	110	65	36.8	25.5	19.2	37.4	3.5	983
Pendimethalin fb waler spray	1500	30 DAS	129	115	28.3	24.4	23.0	44.1	3.3	1183
Pendimethalin fb water spray	2000	30 DAS	139	51	37.3	23.2	22.0	39.4	2.3	424
Pendimethalin sand mix	2000	PE	73	19	4.05	4.05	4.05	43.0	2.0	133
Isoproturon	1000	30 DAS	138	92	35.4	85.9	85.9	31.2	4.4	256
Cuscuta infested			128	45	40.9	85.9	85.9	28.6	4.8	404
Cuscuta free			126	99	4.05	4.05	4.05	63.1	5.4	1994
LSD (P=0.05)			39	31	10.1	8.5	7.9	14.3	1.2	150

*Data transformed to arcsine transformation. **Ready mixture of pendimethalin (240 g a. i. l^{-1})+imazaquin (40 g a. e. l^{-1}).
PPI–Pre-plant soil incorporation, PE–Pre-emergence, DAS–Days after sowing, fb–followed by.

days after sowing–DAS). Imazethapyr and glyphosate were applied as post-emergence (30 DAS) as blanket application. Herbicides were applied as spray with knapsack sprayer fitted with flat fan nozzle at a spray volume of 500 l per hectare. The population of *Cuscuta* was recorded seven days after application of pre-emergence herbicides and attachment of *C. campestris* to lentil and chickpea plants was recorded at 30, 60 and 90 DAS. Plant height was recorded at harvest. Crop yields and seed production of *Cuscuta* were determined by harvesting lentil, chickpea and linseed at maturity. Two central rows were harvested, threshed, cleaned and weighed. *Cuscuta* seeds were separated during cleaning and weighed separately. Seed number was estimated based on 1000-seed weight (0.80 g) and expressed on m^{-2} basis.

RESULTS AND DISCUSSION

Effect on *C. campestris*

Pre-emergence application of pendimethalin at 1000 g ha^{-1} and squadron at 3000 g ha^{-1} significantly reduced the emergence of *C. campestris* as compared to *Cuscuta* infested plot in both lentil and chickpea (Tables 1 and 2). Liu *et al.* (1990) reported that pendimethalin inhibited the cell division and formation of spindle microtubulus in the cells of germinated *Cuscuta* seedlings. Pre-plant incorporation of fluchloralin at 1000 g ha^{-1} was not effective in reducing the *Cuscuta* emergence. Irrespective of the treatments, *C. campestris* grew upto 90 DAS, however, the rate of growth in terms of its attachment to crop plants was reduced by pendimethalin and squadron. Imazethapyr (50 and 100 g ha^{-1}) and glyphosate (50 g ha^{-1}) killed the extended vines of *Cuscuta* and checked its growth upto 25-30 days after herbicide application (DAA) in lentil and chickpea during both the years. However, after 30 DAA, the parasite grew in bunches from imbedded haustoria and infested the crop plants at later stage of growth. At 90 DAS all the herbicides, except fluchloralin in lentil significantly reduced the *Cuscuta* attachment. Infestation of *C. campestris* added 176 and 33 thousand seeds m^{-2} in soil in lentil during 2002-03 and 2003-04, respectively, in untreated plot. The respective values for chickpea were 221 and 35 thousand seeds m^{-2}. Herbicides significantly reduced the seed production of *Cuscuta* during 2002-03; however, during 2003-04, glyphosate was less effective. Kumar (2000) also reported poor efficacy of glyphosate at 50 and 70 g ha^{-1} against *Cuscuta* in blackgram. Pendimethalin and squadron were more effective in reducing seed production of *Cuscuta* compared to other herbicides.

Effect on Lentil and Chickpea

Maximum plant height of both lentil (Table 1) and chickpea (Table 2) was recorded in *Cuscuta* free plots followed by pendimethalin. The lower plant height in *Cuscuta* infested and fluchloralin treated plots was due to heavy infestation of *Cuscuta*, whereas in imazethapyr and glyphosate, the lower plant height was attributed to their toxic effect on the crop plants. Infestation of *C. campestris* caused 60.4 and 78.5% reduction in seed yield of lentil and chickpea during 2002-03, whereas during 2003-04, the parasite caused complete loss of both the crops. Maximum seed yield of lentil (4175 and 3407 kg ha^{-1}) and chickpea (3615 and 2949 kg ha^{-1}) was recorded in *Cuscuta* free plots. Among the herbicides, pendimethalin at 1000 g ha^{-1} in both the crops and squadron at 3000 g ha^{-1} in chickpea significantly increased the seed yield. Squadron was phyto-toxic to lentil. The lower yield in fluchloralin was due to its poor efficacy on *C. campestris* and in imazethapyr and glyphosate was due to their phyto-toxic effect on crop plants. Phyto-toxic effect of imazethapyr (100 g ha^{-1}) as post-emergence application in blackgram was also reported by Mishra *et al.* (2004).

Effect on Linseed

Pre-emergence application of squadron 3000 g ha^{-1} and sand mix application of pendimethalin 2000 g ha^{-1} though completely checked the germination of *Cuscuta* but proved to be highly

phyto-toxic to linseed (Table 3). Post-emergence sprays of higher doses of pendimethalin (2000 and 2500 g ha^{-1}) though checked the growth of the parasite but were toxic to the crop plants as compared to its lower dose (1500 g ha^{-1}). Pre-plant incorporation of fluchloralin, pre-emergence application of pendimethalin either with water spray or sand mix also reduced the germination of linseed. Isoproturon 1000 g ha^{-1} did not check the growth of *Cuscuta*. In *Cuscuta* infested treatment, parasite attached 85.9% linseed plants at 60 DAS. Irrespective of the stage of growth, pendimethalin 1000 g ha^{-1} applied as pre-emergence significantly checked the growth of *Cuscuta*. Fluchloralin, glyphosate and imazethapyr were also effective in checking the growth of *Cuscuta*. Infestation of *Cuscuta* significantly reduced the plant height (28.6 cm) of linseed as compared to *Cuscuta* free treatment (63.1 cm). Infestation of *Cuscuta* caused 79.7% reduction in linseed yield compared to *Cuscuta* free. The maximum seed yield of linseed (1994 kg) was obtained from *Cuscuta* free plot followed by pre-emergence application of pendimethalin 1.0 kg ha^{-1} (1276 kg), post-emergence application of glyphosate at 0.05 kg ha^{-1} (1264 kg) and pendimethalin 1.5 kg ha^{-1} followed by water spray (1183 kg). Mahere *et al.* (2000) also reported effective control of *Cuscuta* in linseed with pendimethalin 1000 g ha^{-1} applied as pre-emergence.

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