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Bioefficacy of Pre and Post Emergence Herbicides against *Coronopus didymus* and *Melilotus indicus*

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ABSTRACT

An experiment was conducted during Rabi season of 2015-16 and 2016-17 in the screen house of Agronomy Department, CCS Haryana Agricultural University, Hisar, to study the effect of herbicides as pre and post emergence on Coronopus didymus and Melilotus indicus. The treatment comprise pre-emergence application of pendimethalin (1000 gram/hectare) and pre and post emergence application of imazethapyr (50, 75, and 100 g/ha) and ready mix of imazethapyr + imazamox (50, 60 and 70 g/ha). In both years of the study, the seedling emergence, fresh and dry weight (gram/pot) of C. didymus and M. indicus was found to be significantly lower under pre-emergence application of herbicides as compared to post emergence application of similar herbicides at similar doses. Among pre emergence application of herbicides, the visual mortality of C. didymus was recorded between 80-100 per cent and between 70-90 per cent for M. indicus. Among post emergence application of herbicides, RM of imazethapyr + imazamox (70 g/ha) recorded significantly lower fresh and dry weight (g/pot) of C. didymus and M. indicus with visual mortality in range of 50 - 75 per cent. Pre-emergence application of pendimethalin, imazethapyr and RM of imazethapyr + imazamox may found to be effective in controlling emergence and growth of C. didymus and M. indicus. For post emergence management of both dicotyledonous weeds, higher dose of imazethapyr i.e. 100 g/ha and ready mix of imazethapyr + imazamox i.e. 100 and 70 g/ha, respectively, could be used, with spray at 3-4 week old seedling.

Key words: *Coronopus didymus, Imazethapyr, Imazamox, Pendimethalin, Melilotus indicus.*

INTRODUCTION

Weeds are the plants that grow at wrong place (not intentionally sown), and cause damage to agriculture ecosystem and other natural ecosystems by reducing crop yield, quality of crop produce & livestock products, increasing in cost of cultivation and input energy, harboring harmful insects, pests and diseases, check the flow of water in water bodies, secretes harmful allelopathic biochemicals, cause irritation of skin, allergy and poisoning in human beings and reduce the value of land[17,20,3,5,4]. Weeds possess many characteristics, such as abundant seed production, rapid population establishment, seed dormancy, long-term survival of buried seed, presence of vegetative reproductive structures etc that allow them to survive and spared quickly in agriculture system[1].

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Weeds have been called the most important pest among all crop pests and are a major threat to global food security as they reduce crop yields by completion for resources such as water, soil nutrients, space, and sunlight[6]. The extent of crop yield loss by weeds depends on crop type and weed type. Gharde *et al.*[7] estimated actual economic loss of about USD 11 billion due to weeds alone in 10 major crops of India. In general, weeds cause approximately 33% loss in agriculture production system.

Numerous plant species are considered weeds in agronomic cropping systems; out of these *Melilotus indicus* and *Coronopus didymus* are weeds in *Rabi* season crops in Northern India. In combination with other weeds, *M. indicus* and *C. didymus* cause invasion and severe competition with winter crops like wheat, mustard, pea, chickpea, fenugreek, berseem, lucerne, potato, oat etc.[18,22,12,11,2,5].

The choice of weed control measures depends largely on its effectiveness and economics. Due to increased cost and non availability of manual labour in required quantity for hand weeding, herbicides not only control the weeds timely and effectively but also offer great scope for minimizing the cost of weed control irrespective of situation. Use of pre-emergence and post-emergence application of herbicides would make herbicidal weed control more acceptable to farmers which without changing the existing agronomic practices, will allow for complete control of weeds. Usage of pre-emergence herbicides assumes greater importance in the view of their effectiveness from initial stages of plant growth. As the weeds interfere during the harvesting of the crop, post-emergence herbicides at about 40-45 DAS may help in avoiding the problem of weeds at later stages. Now-a-days several effective herbicides are available to control broad leaved and narrow leaved weeds in agriculture systems.

Keeping these problems in view, a pot experiment under screen house conditions was conducted to study the effect of herbicide combinations as pre and post emergence on *Coronopus didymus* and *Melilotus indicus*.

MATERIAL AND METHODS

The present experiment was conducted during *Rabi* season of 2015-16 and 2016-17 in pots in screen house of Agronomy Department, CCS Haryana Agricultural University, Hisar. The soil used for filling the pots was in the ratio of 3:1:1 with field soil, dunal sand and vermicompost. The physico-chemical properties of soil was analyzed as soil was sandy loam in texture containing 0.6 % organic carbon, 320 kg available Nitrogen, 17 kg/ha available phosphorus and 307 kg/ha available potassium with pH value of 8. Soil texture was determined by international pipette method[15], pH by glass electrode pH meter[9], organic carbon by Walkley and Black's rapid titration method[23], available nitrogen by alkaline permanganate method[19], available phosphorus by Olsen's method[13] and available potassium by flame photometric method[10].

The experiment was laid out in completely randomized design with fourteen treatments as given in Table 1 and each treatment replicated four times. For each treatment, ten seeds of both weed species (*M. indicus and C. didymus*) were placed uniformly in plastic pots (30 cm diameter) at 0.5- 1 cm depth. The soil used for filling the pots was in the ratio of 3:1:1 with field soil, dunal sand and vermicompost. Pre-emergence (PRE) application of herbicides was applied on the same day on which seeds were placed in the pots and post-emergence (POE) application of herbicide was done after 3-4 weeks of placing the seeds or sowing of seeds in pots. The data on seedling emergence of *C. didymus* and *M. indicus* was recorded at 2 and 4 week after sowing (WAS), the data of visual mortality at 1,2,3 and 4 WAT (week after treatment) and data of fresh and dry weight recorded at 5 WAT. The seedling emergence considered when cotyledons had started to appear above soil surface. The experimental data was statistically analyzed by the methods of analysis of variance (ANOVA) as described by Panse and Sukhatme[14] by using software SPSS version 17.0. The data of emergence was arcsine transformed to ensure homogeneity of variance. Significance of

various treatments mean was judged by using F test. The significance difference among treatments pairs was tested by calculating critical difference (CD) at 5% level of significance. The formula for calculating CD is given below:

CD = SE (difference) × t value at 5% error degree of freedom

Where -

CD = Critical Difference

$$\text{Standard error of difference} = \text{SE (d)} = \sqrt{\frac{2MSE}{r}}$$

MSE = Mean sum of Square of Error (Error mean square)

r = replication

t = Table t value

Table 1: Herbicides treatment details

Treatments		Dose (g /ha)	Application time
T1	Pendimethalin	1000	PRE
T2	Imazethapyr	50	PRE
T3	Imazethapyr	50	POE
T4	Imazethapyr	75	PRE
T5	Imazethapyr	75	POE
T6	Imazethapyr	100	PRE
T7	Imazethapyr	100	POE
T8	Imazethapyr + imazamox (RM)	50	PRE
T9	Imazethapyr + imazamox (RM)	50	POE
T10	Imazethapyr + imazamox (RM)	60	PRE
T11	Imazethapyr + imazamox (RM)	60	POE
T12	Imazethapyr + imazamox (RM)	70	PRE
T13	Imazethapyr + imazamox (RM)	70	POE
T14	Control	-	-

RESULTS AND DISCUSSION

The data on seedling emergence, visual mortality, fresh and dry weight of C. didymus and *M. indicus* as influenced by different herbicides has been presented in Table 2 to 5.

Seedling emergence

In both year of study, pre-emergence application of herbicide showed significant effect on emergence percentage of *C. didymus* and *M. indicus*, as compared to post-emergence application of similar herbicides treatments with similar doses (Table 2). *C. didymus* seedlings emergence was completely suppressed by pre-emergence application of imazethapyr (50, 75 and 100 g/ha) and ready mix (RM) of imazethapyr + imazamox (50, 60 and 70 g/ha). After 4 week of treatment (sowing) ≤ 20 per cent seedling of *C. didymus* were able to emerge from pendimethalin (1000 g/ha) treated pot, when it was applied as pre-emergence herbicide (Table 2). Pre-emergence application of pendimethalin (1000 g/ha), imazethapyr (50, 75 and 100 g/ha) and RM of imazethapyr + imazamox (50, 60 and 70 g/ha) decreased seedling emergence of *M. indicus* as compared to control and post emergence application of imazethapyr (50, 75 and 100 g/ha) and ready mix (RM) of imazethapyr + imazamox (50, 60 and 70 g/ha) (Table 2). Significantly lower emergence percentage of *M. indicus* was noted under PRE imazethapyr + imazamox (RM) 70 g/ha, which was at par with PRE pendimethalin 1000 g/ha. Whereas, emergence under PRE pendimethalin 1000 g/ha and PRE RM of imazethapyr + imazamox (70 g/ha) was found to be statistically similar. When pre-emergence herbicide was applied on soil, weed

seeds come in contact with herbicide molecules and seed uptake of herbicide take place along with water during germination process. *C. didymus* found to be a slow germinating weed; therefore, available contact and action timing is larger; its emergence suppressed by Imidazolinone (imazethapyr and imazamox, inhibit branched chained amino acid synthesis which need during cell division) and Dinitroaniline (pendimethalin, affects cell division by inhibiting microtubulin synthesis). These results are supported by the finding of Huffman and Jacoby JR. on buffalograss, blue grama and sideoats grama grasses and Tang *et al.*[21] on *Murdannia triquetra* where they found that different pre and post emergence application of herbicides affects germination and growth of weed species.

Visual mortality

Among *C. didymus* and *M. indicus* management treatments, pre-emergence application of herbicides treatments recorded significantly higher visual mortality compared to post-emergence application of herbicides treatments with similar doses (Table 3 & 4). Pre-emergence application of imazethapyr (50, 75 and 100 g/ha) and RM of imazethapyr + imazamox (50, 60 and 70 g/ha) recorded 100 per cent visual mortality of *C. didymus* at 1, 2, 3 and 4 WAT. PRE pendimethalin 1000 g/ha also showed higher visual mortality for *C. didymus i.e*. greater than 80 per cent, compared to post- emergence application of imazethapyr (50, 75 and 100 g/ha) and RM of imazethapyr + imazamox (50, 60 and 70 g/ha) (Table 3). As the doses of imazethapyr and RM of imazethapyr + imazamox increased, visual mortality of *M. indicus* also increased (Table 4). Therefore, significantly higher visual mortality of *M. indicus* was observed with pre-emergence application RM of imazethapyr + imazamox at 70 g/ha; which was at par with pendimethalin (1000 g/ha). Among post-emergence applied herbicides (sprayed at 3-4 WAS), application of imazethapyr (100 g/ha) and RM of imazethapyr + imazamox (70 g/ha) showed significantly higher visual mortality for *C. didymus* and *M. indicus*; which were at par with each other. These results indicate that pre-emergence application of pendimethalin, imazethapyr and ready mix of imazethapyr + imazamox were more effective against *C. didymus* and *M. indicus* as compared to post emergence application of imazethapyr and ready mix of imazethapyr + imazamox. Similar results have been reported by Punia[16], on effect of pre and post emergence herbicides on weeds in mungbean.

Fresh and dry weight (g/pot)

The fresh and dry weight (g/pot) of *C. didymus* at 5 WAT was recorded significantly lower under pre-emergence application of pendimethalin 1000 g/ha (Table 5) and in case of *M. indicus* fresh and dry weight was recorded significantly lower under PRE imazethapyr + imazamox (RM) 70 g/ha. Among post-emergence applied herbicides, significantly lower fresh and dry weight (g/pot) of *C. didymus* and *M. indicus* was obtained under RM of imazethapyr +imazamox (70 g/ha). The fresh and dry weight of seedlings per pot attributed to number of plant in pot and their shoot growth. These results are supported by the finding of Huffman and Jacoby JR. on buffalograss, blue grama and sideoats grama grasses as different pre and post emergence application of herbicides in relation to their affects on seed germination and seedling growth.

Table 2: Effect of herbicides on seedling emergence of *C. didymus and M. indicus*

Treatments	Time of application	Seedling emergence (%) of C. didymus				Seedling emergence (%) of *M. indicus*			
		2015-16		2016-17		2015-16		2016-17	
		2WAS	4WAS	2WAS	4WAS	2WAS	4WAS	2WAS	4WAS
T1	PRE	0 (9)	15 (23)	0 (9)	18 (25)	0 (9)	11 (19)	0 (9)	20 (27)
T2	PRE	0 (9)	0 (9)	0 (9)	0 (9)	14 (22)	29 (32)	15 (23)	49 (44)
T3	POE	55 (48)	78 (62)	48 (44)	75 (61)	75 (60)	96 (78)	83 (66)	96 (78)

T4	PRE	0 (9)	0 (9)	0 (9)	0 (9)	9 (17)	24 (29)	8 (16)	41 (40)
T5	POE	58 (49)	80 (64)	40 (39)	73 (59)	75 (60)	95 (77)	80 (64)	94 (75)
T6	PRE	0 (9)	0 (9)	0 (9)	0 (9)	0 (9)	16 (24)	0 (9)	15 (22)
T7	POE	48 (44)	75 (61)	45 (42)	75 (60)	74 (59)	98 (79)	79 (63)	95 (77)
T8	PRE	0 (9)	0 (9)	0 (9)	0 (9)	10 (18)	29 (32)	11 (19)	41 (40)
T9	POE	45 (42)	80 (64)	40 (39)	78 (62)	79 (63)	95 (77)	86 (69)	98 (79)
T10	PRE	0 (9)	0 (9)	0 (9)	0 (9)	6 (14)	20 (27)	8 (16)	33 (40)
T11	POE	48 (44)	80 (64)	55 (48)	80 (64)	76 (61)	95 (77)	73 (59)	96 (79)
T12	PRE	0 (9)	0 (9)	0 (9)	0 (9)	0 (9)	10 (18)	0 (9)	14 (22)
T13	POE	48 (44)	75 (61)	40 (39)	75 (61)	76 (61)	95 (76)	75 (60)	98 (79)
T14	-	43 (41)	83 (66)	55 (48)	80 (64)	78 (62)	99 (80)	80 (64)	99 (80)
Mean	-	25 (27)	40 (37)	23 (26)	40 (36)	41 (37)	58 (52)	43 (39)	64 (56)
CD at 5%	-	(4.5)	(6.8)	(5.3)	(6.2)	(4.4)	(5.4)	(4.8)	(4.6)

Arcsine transformed values are given in parenthesis, PRE- pre-emergence, POE – post-emergence

Table 3: Effect of herbicides on visual mortality of *C. didymus*

Treatments	**Time of application**	**Visual Mortality (%)**							
		2015-16				**2016-17**			
		1 WAT	**2 WAT**	**3 WAT**	**4 WAT**	**1 WAT**	**2 WAT**	**3 WAT**	**4 WAT**
T1	PRE	100.00	100.00	95.00	85.00	100.00	100.00	90.00	82.00
T2	PRE	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T3	POE	0.00	21.25	31.00	45.25	0.00	15.75	36.75	57.25
T4	PRE	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T5	POE	3.75	19.50	43.00	62.50	7.75	28.50	48.75	64.00
T6	PRE	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T7	POE	10.00	25.00	51.25	68.25	19.00	28.00	57.75	69.25
T8	PRE	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T9	POE	7.75	25.25	47.00	67.25	14.25	32.25	44.75	67.25
T10	PRE	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T11	POE	10.50	22.75	52.50	72.25	10.00	26.75	56.25	74.25
T12	PRE	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
T13	POE	14.00	25.50	62.00	77.50	18.25	36.00	67.75	80.25
T14	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	-	53.29	59.95	70.13	77.00	54.95	61.95	71.57	78.16
CD at 5%	-	3.25	4.17	5.98	4.95	3.17	4.51	5.59	4.57

Table 4: Effect of herbicides on visual mortality of *M. indicus*

Treatments	**Time of Application**	**Visual Mortality (%)**							
		2015-16				**2016-17**			
		1 WAT	**2 WAT**	**3 WAT**	**4 WAT**	**1 WAT**	**2 WAT**	**3 WAT**	**4 WAT**
T1	PRE	100.00	100.00	91.25	88.75	100.00	100.00	88.00	86.00
T2	PRE	96.25	86.25	77.50	70.00	96.25	85.00	70.00	51.25
T3	POE	0.00	7.00	20.00	31.25	0.00	5.00	17.50	28.25
T4	PRE	97.50	91.25	82.50	76.25	96.25	92.50	75.00	58.75
T5	POE	0.00	12.50	25.00	36.25	0.00	6.25	22.50	33.75
T6	PRE	100.00	97.50	85.00	81.25	100.00	98.75	93.75	85.00
T7	POE	3.75	13.75	35.00	46.25	2.50	15.00	26.25	39.25

T8	PRE	93.75	90.00	83.75	71.25	97.50	88.75	75.00	58.75
T9	POE	0.00	11.25	35.00	38.75	0.00	7.50	20.00	32.50
T10	PRE	98.75	93.75	87.50	82.50	98.75	92.50	83.75	67.50
T11	POE	0.00	15.00	36.25	43.75	0.00	11.25	30.00	36.00
T12	PRE	100.00	100.00	96.25	90.00	100.00	98.75	91.25	86.25
T13	POE	5.00	20.00	47.50	66.25	0.00	15.00	28.75	52.50
T14	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	-	49.64	52.73	57.32	58.75	49.38	51.16	51.55	51.13
CD at 5%	-	2.91	3.73	5.44	7.03	2.64	5.34	7.03	6.99

Table 5: Effect of herbicides on fresh and dry weight of *C. didymus* and *M. indicus* at 5 WAT

Treatments	**Time of application**	***C. didymus***				***M. indicus***			
		Fresh weight (g/pot)		**Dry weight (g/pot)**		**Fresh weight (g/pot)**		**Dry weight (g/pot)**	
		2015-16	**2016-17**	**2015-16**	**2016-17**	**2015-16**	**2016-17**	**2015-16**	**2016-17**
T1	PRE	1.364	1.463	0.519	0.566	1.075	1.759	0.468	0.508
T2	PRE	0.00	0.00	0.00	0.00	2.841	4.342	1.235	2.068
T3	POE	5.202	4.864	1.918	1.804	6.860	6.820	2.983	3.248
T4	PRE	0.00	0.00	0.00	0.00	2.266	3.523	0.985	1.678
T5	POE	3.332	3.764	1.267	1.318	6.181	5.812	2.688	2.768
T6	PRE	0.00	0.00	0.00	0.00	1.811	1.257	0.788	0.599
T7	POE	2.303	3.150	0.876	1.145	5.008	5.471	2.178	2.605
T8	PRE	0.00	0.00	0.00	0.00	3.025	3.812	1.315	1.815
T9	POE	2.957	3.030	1.124	1.293	6.147	6.442	2.673	3.068
T10	PRE	0.00	0.00	0.00	0.00	1.623	2.877	0.706	1.370
T11	POE	2.279	2.749	0.867	1.087	5.336	5.187	2.320	2.470
T12	PRE	0.00	0.00	0.00	0.00	0.8970	1.202	0.390	0.573
T13	POE	2.061	1.788	0.784	0.707	3.157	3.974	1.373	1.893
T14	-	8.937	10.721	3.398	4.238	10.333	9.298	4.493	4.428
Mean	-	2.031	2.252	0.768	0.868	4.040	4.413	1.757	2.078
CD at 5%	-	0.531	0.492	0.203	0.196	0.762	0.661	0.332	0.321

CONCLUSION

Based on the analysis of data, it can be concluded that pre-emergence application of herbicides is more effective against *C. didymus* and *M. indicus* as compared to post emergence application of similar herbicide at similar doses. The seedling emergence, fresh and dry weight of *C. didymus* was significantly lower in PRE pendimethalin 1000 g/ha with upto 80 per cent visual mortality, while, PRE imazethapyr (50, 75 and 100 g/ha) and RM of imazethapyr + imazamox (50, 60 and 70 g/ha) was able to controlled *C. didymus* completely with 100 per cent visual control. In case of *M. indicus*, pre-emergence application of RM of imazethapyr +imazamox (70 g/ha) and pendimethalin 1000 g/ha recorded lower seedling emergence, fresh and dry weight of seedling, with upto 86 per cent visual mortality. The post emergence application of RM of imazethapyr + imazamox (70 g/ha) recorded lower fresh and dry weight (g/pot) of *C. didymus* and *M. indicus* and provided 50-75 per cent visual mortality of both weeds.

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