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Herbicides performance for managing weeds in berseem under sub-mountainous conditions of Punjab

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ABSTRACT

A field experiment was conducted at farmer's field of district Gurdaspur during the winter seasons of 2014-15 and 2015-16 to assess the performance of various herbicides for managing weeds in berseem under sub-mountainous conditions of Punjab. The experiment was laid out in a randomized block design having three replications and comprised of eight treatments, *viz.* fluchloralin 0.45 kg/ha, pendimethalin 0.75 kg/ha, imazethapyr 0.075 kg/ha, oxyfluorfen 0.1 kg/ha, fluchloralin 0.45 kg/ha followed by (*fb*) imazethapyr 0.075 kg/ha, pendimethalin 0.75 kg/ha *fb* imazethapyr 0.075 kg/ha, oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha and a weedy check. All the weed control treatments caused significant reduction in weed density and biomass as compared to weedy check. The lowest weed density, weed biomass, maximum weed control efficiency, more number of tillers, maximum pooled green fodder and pooled seed yield and highest net returns were observed with fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha, which was closely followed by application of oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha.

INTRODUCTION

Berseem (*Trifolium alexandrinum* L.) is one of the prominent winter season forage crop grown in 1.9 mha area in India with a productivity of 60-110 t/ha (ICAR 2012). It is a fast growing annual legume which provides high quality green forage, rich in protein (15-25%), minerals (11-19% and carotene (Sharma and Murdia 1974). Berseem thrives well in a wide range of soils, though grows better in fertile (loamy to clay) soil with mild acidic to alkaline pH (6.5-8) conditions, possesses the ability for cold tolerance, short drought, flooding and mild tolerance to salinity. Being a winter season crop, several weeds infest into it. Common weeds found in berseem are *Cichorium intybus*, *Cornopus didimus*, *Spergula arvensis*, *Chenopodium album*, *Rumex dentatus, Melilotus indica*, *Medicago denticulata*, *Lathyrus aphaca* among broad-leaf weeds and *Phalaris minor*, *Polypogon monspeliensis* and *Poa annua* among the grassy weeds. These weeds not only deteriorate fodder quality but also decrease fodder yield (23-30%) and seed yield up to 50% (Joshi and Bhilare 2006, Alfred 2012). The contamination of produce with the weeds and weed seeds deteriorate the crop quality, if not controlled during critical period of crop-weed competition. Weeds decrease the acceptability of fodder and also pose problems in harvesting of the crop (Walia 2003). Due to several cuttings, it can suppress many weeds, but some weeds like *C. intybus*, *C. didymus* and *P. minor* survive and compete to reduce its growth and also lower the quality. *C. intybus* weed particularly found associated with berseem and gives more competitive stress and has lower protein content and is less palatable due to high silica content and crude fiber, thus adversely affecting the quality of berseem forage (Relwani 1979). Similarly, presence of *C. didymus* in the forage provides an offensive smell, which is repulsive to animals. Even, mechanical methods of weed control are very costly, labour intensive. As berseem is sown by broadcasting, manual weeding is not practicable in a dense crop. Hence, herbicides offer a better alternative to manual weeding. It is the major challenge to control the berseem weeds for enhancement of productivity and quality of fodder and seed yield. Hence, the current study was undertaken to evaluate different pre- and post-emergence herbicides and their combinations for their efficacy on weeds and crop selectivity in berseem.

MATERIALS AND METHODS

The field experiment was conducted at farmer's field of district Gurdaspur ($31^0$56` 43.4" N Latitude, $75^0$13` 39.5" E Longitude and 265.17 m Altitude from mean sea level) during two consecutive winter seasons 2014-15 and 2015-16 in the sub-mountaineous region of Punjab. The soil of experimental site was clay loam in texture, medium in organic carbon (0.72%), high in available phosphorus (35 kg/ha) and low in potassium (80 kg/ ha) at 0-15 cm soil depth. The soil was neutral in reaction (pH - 7.1) with normal electrical conductivity (0.61 ds/m). The experiment was laid out in a randomized block design having three replications and comprised of eight treatments, *viz*. fluchloralin 0.45 kg/ha, pendimethalin 0.75 kg/ha, imazethapyr 0.075 kg/ha, oxyfluorfen 0.1 kg/ha, fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha, pendimethalin 0.75 kg/ha *fb* imazethapyr 0.075 kg/ha, oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha and a weedy check. Berseem var. *'BL 10'* was sown at 20 kg/ha seed rate on 11th October and 9th October during 2014-15 and 2015-16, respectively. Seed was inoculated with *Rhizobium trifolii* and then broadcasted in standing water. The crop was fertilized with the recommended dose of fertilizer 25 kg N, 75 kg P_2O_5 per ha in the form of urea and single super phosphate, respectively. The first irrigation was given on 8th day after sowing (DAS). Afterwards it was applied within 8-10 days in summer and 10-15 days during winter and 30 days interval in spring. Overall 17 irrigations were applied to the crop. The herbicidal treatment fluchloralin 0.45 kg/ha was applied as pre-plant and sprayed on a well prepared seed bed just before sowing of berseem. The pre-emergence herbicide pendimethalin 0.75 kg/ha and oxyfluorfen 0.1 kg/ha were sprayed within 48 hours and seven days after sowing of berseem, respectively. Imazethapyr 0.075 kg/ha was applied as post-emergence at 20 DAS. Similarly, the pre-emergence herbicides followed by post-emergence herbicides were applied at their respective doses as per treatments. Herbicides were applied with manually operated knapsack sprayer fitted with flat-fan nozzle using 500 litres of water/ha. Four cuttings of fodder were taken during both the years of study, thereafter the crop was left for seed production and harvesting of seed was done on 10th June and 8th June during during 2014-15 and 2015-16, respectively. The data on weed density (number/ m^2) and biomass (g/m^2) were recorded at 55 days after sowing from each plot by using a quadrate measuring $1m^2$. The weed density and biomass values were transformed to $(\sqrt{x+1})$ for statistical analysis. Weed control efficiency (WCE) (%) of different weedicides alone was also calculated as per the standard formula suggested by Gill and Vijaykumar 1969.

$$WCE = (DMC-DMT)/ DMC \times 100$$

Where, DMC is the weeds biomass in weedy check plots and DMT is the weeds biomass in a particular treatment.

The data on yield attributes, green fodder and seed yield of berseem crop were recorded at harvest. Economics was computed using the prevailing market price of inputs and outputs such as berseem green fodder at ` 1400/- per tonne while seed of berseem at ` 185000/- per tonne (Pooled price of two years). All data were analyzed statistically. 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 Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Weed flora and weed control efficiency

The prominent weed species observed in the experimental field included *Cichorium intybus*, *Cornopus didimus*, *Spergula arvensis*, *Chenopodium album*, *Rumex dentatus*, *Melilotus indica*, *Medicago denticulata*, *Lathyrus aphaca* among broad-leaf weeds and *Phalaris minor*, *Polypogon monspeliensis* and *Poa annua* among the grassy weeds during both the years of study. The pooled data of two years indicated that weed infestation as referred in terms of total weed density and biomass were significantly affected by application of various pre-plant, pre-emergence and post-emergence herbicides. All the weed control treatments caused significant reduction in weed density and biomass as compared to weedy check. The lowest weed density (13.5 weeds/m^2) and biomass (10.2 g/m^2) were observed under fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha closely followed by application of oxyfluorfen 0.1 kg/ ha *fb* imazethapyr 0.075 kg/ha, which were significantly lower than all other herbicidal treatments (**Table 1**). The results were in conformity with the findings of Kumar and Shivadhar (2008). Pre-plant application of fluchloralin 0.45 kg/ha followed by post-emergence application of imazethapyr 0.075 kg/ ha recorded maximum weed control efficiency (82.8%), which was closely followed by the application of oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha (77.5%). Tiwana *et al.* (1985) observed successful control of *Poa annua* in Egyptian clover

Table 1. Effect of herbicide treatments on weed density and biomass in berseem (pooled data of 2014-15 and 2015-16)

Treatment	Weed density (no./ m^2)	Weed biomass (g/ m^2)	Weed control efficiency (%)
Fluchloralin 0.45 kg/ha	6.8 (45.4)	6.0 (35.3)	40.4
Pendimethalin 0.75 kg/ha	8.6 (72.5)	7.0 (48.5)	18.1
Imazethapyr 0.075 kg/ha	5.6 (30.9)	5.2 (26.2)	55.7
Oxyfluorfen 0.10 kg/ha	7.3 (52.6)	6.2 (37.1)	37.3
Fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha	3.8 (13.5)	3.3 (10.2)	82.8
Pendimethalin 0.75 kg/ha *fb* imazethapyr 0.075 kg/ha	5.1 (25.4)	5.1 (25.0)	57.8
Oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha	4.1 (16.0)	3.8 (13.3)	77.5
Weedy check	15.0 (224.8)	7.8 (59.2)	-
LSD (p=0.05)	0.8	0.7	-

Figures in parentheses indicate original values and data is transformed to $(\sqrt{x+1})$.

with fluchloralin. Weed control efficiency was highest with pendimethalin but it had toxic effect on the Egyptian clover. Prajapati *et al.* (2015) reported that weed biomass was significantly less due to application of pendimethalin 1.0 kg/ha *fb* imazethapyr 0.15 kg/ha. Singh (2012) reported that even after nine days of spraying isoproturon, oxyfluorfen and atrazine exhibited 77 to 100% crop injury. The lowest dose of pendimethalin (0.25 kg/ha) was also phototoxic to crop as it caused 90% injury 35 days after treatment which recovered to 70% by 60 days after treatment.

Effect on crop growth, green fodder and seed yield

The herbicidal treatments did not show significant effect on plant height of berseem at first cutting. Among the herbicidal treatments, fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha, being at par with oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ ha recorded significantly more number of tillers as compared to all other herbicidal treatments. This indicates that effective weed control might have created favourable environment for the development of tillers which led to increase in green fodder and seed yield. The maximum pooled green fodder (98.64 t/ha) and pooled seed yield (700 kg/ha) were recorded with fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ ha, which was closely followed by the application of oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha (**Table 2**). These results were in agreement with the findings of Pathan *et al.* (2013). However, pendimethalin 0.75 kg/ha *fb* imazethapyr 0.075 kg/ha and imazethapyr 0.075 kg/ha caused significant enhancement in green fodder and seed yield as compared to remaining herbicidal treatments. Significantly superior green fodder and seed yield were noticed under fluchloralin 0.45 kg/ha and oxyfluorfen 0.1 kg/ha as compared to the application of pendimethalin 0.75 kg/ha. Kumar *et al.* (2003) observed that fluchloralin 1.12 kg/ha gave significantly higher green fodder of berseem than pendimethalin 1.0-1.5 kg/ha. It may be inferred that weed free environment can facilitate better growth and crop development and ultimately through herbicides with higher berseem green forage and seed yield. These results are corroborating with the findings of Tamrakar *et al.* (2002) and Tiwana *et al.* (2002).

Economics

Owing to higher fodder and seed yield and timely management of weeds with the application of fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha resulted in attaining maximum net returns (` 1,98,856 /ha) and benefit: cost ratio (2.89) over all other weed control methods which was closely followed by oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha for obtaining net returns (` 1,95,151/ha) and and benefit: cost ratio (2.83) (**Table 3**). The minimum net return (` 1,18,951/ha) and benefit: cost ratio (1.79) was

Table 2. Effect of herbicide treatments on growth parameters and yield of berseem (pooled data of 2014-15 and 2015-16)

Treatment	Plant height (cm)	Tillers (no./m^2)	Green fodder yield (t/ha)			Seed yield (kg/ha)		
			2014-15	2015-16	Pooled mean	2014-15	2015-16	Pooled mean
Fluchloralin 0.45 kg/ha	86.5	761.2	83.83	86.54	85.19	544	569	556
Pendimethalin 0.75 kg/ha	84.1	723.6	73.53	75.97	74.75	469	512	491
Imazethapyr 0.075 kg/ha	87.1	788.9	89.12	91.34	90.23	600	627	614
Oxyfluorfen 0.1 kg/ha	86.7	756.7	82.05	85.18	83.62	531	559	545
Fluchloralin 0.45 kg/ha *fb* Imazethapyr 0.075 kg/ha	88.6	839.3	97.17	100.10	98.64	686	714	700
Pendimethalin 0.75 kg/ha *fb* Imazethapyr 0.075 kg/ha	85.3	796.8	90.60	92.53	91.57	613	631	622
Oxyfluorfen 0.1 kg/ha *fb* Imazethapyr 0.075 kg/ha	88.5	833.6	95.38	97.90	96.64	684	707	696
Weedy check	84.2	695.3	66.39	69.58	67.99	474	501	488
LSD (p=0.05)	NS	20.9	2.75	2.92	2.75	38	43	30

Table 3. Effect of herbicide treatments on economics of berseem (pooled data of 2014-15 and 2015-16)

Treatment	Gross returns (x10^3 `/ ha)	Cost of cultivation (x10^3 `/ ha)	Net returns (x10^3 `/ha)	B:C ratio
Fluchloralin 0.45 kg/ha	222.1	67.1	155.0	2.31
Pendimethalin 0.75 kg/ha	195.5	67.8	127.7	1.88
Imazethapyr 0.075 kg/ha	239.9	68.1	171.8	2.52
Oxyfluorfen 0.10 kg/ha	217.9	67.3	150.6	2.24
Fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha	267.6	68.7	198.9	2.89
Pendimethalin 0.75 kg/ha *fb* imazethapyr 0.075 kg/ha	243.3	69.4	173.9	2.51
Oxyfluorfen 0.1 kg/ha *fb* imazethapyr 0.075 kg/ha	264.1	68.9	195.2	2.83
Weedy check	185.5	66.5	119.0	1.79

associated with weedy check. The lower crop yields in weedy check were the reasons for lower net return in this treatment.

Based on two years' data, it was concluded that application of fluchloralin 0.45 kg/ha *fb* imazethapyr 0.075 kg/ha closely followed by oxyfluorfen 0.1 kg/ ha *fb* imazethapyr 0.075 kg/ha appeared to be productive and profitable for effective weed control in berseem which resulted in maximum green fodder and seed yield.

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