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RESEARCH ARTICLE

Complex weed flora managing efficacy of herbicides in soybean and their effect on soil properties, microorganisms and productivity of succeeding mustard

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ABSTRACT

A field experiment was conducted during two consecutive *Kharif* seasons during 2019 and 2020 at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, West Bengal to study the weed management efficacy of herbicides in soybean and their effect on soil properties, microorganisms, productivity of soybean and succeeding crop. The study comprised of seven treatments which was replicated thrice in a randomized block design. Weed free resulted significantly higher soybean seed yield. Pre-emergence application (PE) of metolachlor 1.25 kg/ha was most effective in controlling different grassy and broad-leaved weeds resulting in higher growth, yield attributes and yield of soybean (1.56 t/ha) and B:C, in comparison with other herbicides. The tested weed management treatments did not significantly affect the soil physicochemical properties and caused no significant impact on succeeding crop (mustard) yield. Soil microflora population increased at the time of harvest of the crop compared to the initial count.

Keywords: Metolachlor, Soil microflora, Soil properties, Soybean, Weed management

INTRODUCTION

Soybean (*Glycine max* (L.) Merill) is the most important oilseed crop next to groundnut which plays the vital role in boosting oilseed production of India (Sangeetha *et al.* 2013). The major limiting factor in soybean production is crop yield loss due to weeds which may range from 31 to 84% (Kachroo *et al.* 2003). First six weeks after sowing is most critical period during which weeds should be managed (Prachand *et al.* 2015). Among the different weed management strategies hand weeding or conventional practice of weed management is very effective but it is costly due to high wages and non-availability of labour during the critical weeding period. Beside this, mechanical weeding disturbs the physical conditions of the soil and may cause mechanical injury to roots and shoots of the plant. Therefore, alternate weed management options particularly use of safer herbicides are being experimented as an alternative to costly hand weeding (Poddar *et al.* 2017). At present several pre-emergence (PE), post-emergence (PoE) or early post-emergence (EPoE) herbicides like pendimethalin, imazethapyr, alachlor, quizalofop-p-ethyl, chlorimuon, fluthiacet-methyl *etc.* are being used for controlling the weeds in soybean crop but their efficacy was found unsatisfactory because of -their inefficacy on many broad-leaved weeds in soybean (Sangeetha *et al.* 2013; Upadhyay *et al.* 2012; Ghosh *et al.* 2017; Singh *et al.* 2013; Andhale and Kathmale 2019). Thus, identification of effective herbicides is necessary for management of complex weed flora in soybean field. Metolachlor 50 EC is a new formulation whose efficacy needs to be tested. Thus, the present study was conducted with it at different doses and compared it with other marketed herbicides to quantify their efficacy against complex weed flora in soybean and yield along with its impact on soil properties, behavior of soil microorganism and the yield of succeeding mustard crop.

MATERIALS AND METHODS

This experiment was carried out at the Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal, India (22°97´ N latitude and 88°43' E longitude with the 9.75 m above MSL) during two consecutive *Kharif* seasons of 2019 and 2020. The land was medium in slope having deep tube well facility for irrigation. The soil of the experimental site was sandy

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loam in texture having 53.42% sand, 21.84% silt and 24.74% clay with a pH of 6.85 and bulk density of 1.33 g/cc. It contained 0.674% organic C, 123.46 kg available N/ha, 23.2 kg available P/ha and 131.31 kg available K/ha. The climate of the study site was sub-tropical humid. There were seven treatments, *viz*. metolachlor 750 g/ha; metolachlor 1.0 kg/ha; metolachlor 1.25 kg/ha; pendimethalin 1.0 kg/ha; alachlor 2.50 kg/ha; weedy check and weed free. A randomized block design with three replication was used. The pre-emergence application (PE) of herbicides was done at two days after sowing (DAS). Herbicides were applied using a spray volume 400 l/ha by knapsack sprayer fitted with flat fan deflector nozzle under moist soil. Soybean variety 'Bragg' was sown at 45 × 5 cm spacing on 5 × 4 m (20 m^2) area at the end of June in each of the experimental year. The recommended dose of fertilizers, *i.e.* 20 kg N, 40 kg P and 40 kg K/ha was applied before sowing in the seed row zone. Nitrogen, P and K were applied through urea, SSP and MOP, respectively. Different categories of individual weeds (grass, sedge and broad-leaved) were counted separately from each plot. Weed density (no.) and biomass (g)/m^2 in different plots were estimated using quadrat of 0.5 × 0.5 m placed randomly at three places in each plot at 15, 30 and 45 days after herbicide application (DAA). Different categories-wise weed/m^2 were calculated. After counting, the weed samples were uprooted washed in tap water and these weeds were sundried for two days and then kept in an oven at 70 °C for 48 h for recording weed biomass. Weed control efficiency (WCE), weed persistence index (WPI), herbicide efficiency index (HEI), weed index (WI) and weed management index (WMI) were calculated using the following equations (Kundu *et al.* 2021):

$$\text{WCE} = \frac{\text{WDMc} - \text{WDMt}}{\text{WDMc}}$$

Where, WDMc is the dry matter of weed (g/m^2) in control plot; WDMt is the weed dry matter (g/m^2) in treated plot.

$$\text{WPI} = \frac{\text{WDMt}}{\text{WDMc}} \times \frac{\text{WDc}}{\text{WDt}}$$

Where, WDc is weed density in control plot; WCt= Weed density in treated plot.

$$\text{HEI} = \frac{\text{Yt} - \text{Yc}}{\text{Yt}} \times \frac{\text{WDMc}}{\text{WDMt}}$$

Where, Yt is crop yield from the treated plot; Yc is crop yield from the control plot; WDMc is the weed dry matter weight (g/m^2) in control plot; WDMt is the weed dry matter weight (g/m^2) in treated plot.

$$\text{WI} = \frac{\text{Yf} - \text{Yt}}{\text{Yf}} \times 100$$

Where,Yf is weed-free plot yield; Yt is treated plot yield.

$$\text{WMI} = \frac{\text{Per cent yield over control}}{\text{Per cent control of weeds}}$$

The crop harvested from the net plot area was dried, threshed and pods were weighed to obtain the seed yield per plot wise. These observations were then used to get the seed yield in kg/ha at 14% moisture content.

The harvest index (HI) was calculated by using the formula (Kundu *et al.* 2021).

$$\text{HI (\%)} = \frac{\text{Seed yield}}{\text{Total biological yield}} \times 100$$

The physico-chemical properties of experimental soil: texture, bulk density (BD), water holding capacity (WHC), pH, electrical conductivity (EC), organic carbon, available nitrogen, available phosphorus and available potassium content were estimated by combined glass electrode pH meter method, Walkley and Black's rapid titration method, modified macro Kjeldahl method, Olsen's method and flame photometer method, respectively (Jackson 1967).

Soil samples were taken at a depth of 0–15 cm from the space in between the rows at different dates, *viz.* initial (pretreatment), 1 DAA, 7 DAA, 15 DAA, 30 DAA and at harvest for microbial analysis by serial dilution technique and pour plate method (Pramer and Schmidt 1965). The counts were taken at 3^{rd} day of incubation.

Residual toxicity of tested herbicides applied in soybean on succeeding mustard was done assessed by calculating mustard (cv. Vinoy) on the same plot without disturbing the previous field lay-out. Recommended agronomic practices were adopted in all plots for growing mustard crop. Germination % along with the plant population of mustard crop was recorded at 30 days after sowing (DAS). Mustard yield was recorded by harvesting the mustard.

Mean values of two years research data on crops and weeds were jointly analyzed by analysis of variance method (Gomez and Gomez 1984). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through unweighted analysis. The values wherever necessary were transformed into square root values (Panse and Sukhatme 1978).

RESULTS AND DISCUSSION

Effect on weeds

The major weeds in the experimental field were: *Dactyloctenium aegyptium, Digitaria sanguinalis, Echinochloa colona and Eleusine indica* among grassy weeds, *Cyperus difformis* the sedge and *Digera arvensis, Euphorbia hirta, Phyllanthus niruri, Scoparia dulcis and Physalis minima* among broad-leaved weeds. Among the different categories of weeds, *Cyperus difformis* was more dominant among the all monocot and dicot weeds followed by *Eleusine indica*. The relative density of grassy weeds was 42.60 and 39.30% at 15 DAA and at 30 DAA, respectively which was more predominant than broad-leaved weeds (29.52% at 15 DAA and 31.50% at 30 DAA) and sedges (27.87% at 15 DAA and 29.20% at 30 DAA) in the weed check plot of the experimental field (**Figure 1**). Similar observations in soybean field were made earlier by Meena *et al.* (2022).

The dominant weed flora in the experimental site was in the order of grass>broad-leaved weeds>sedges at all date of observation. The lowest density and biomass of different categories of weed was recorded in weed free whereas highest in weedy check irrespective of time of observation (**Table 1**). In general weed population increased with the advancement of crop growth. Among the different herbicide treatments, higher dose of metolachlor 1.25 kg/ha resulted in significantly lower weed density and biomass, higher weed control efficiency than pendimethalin or alachlor along with its lower doses. Pendimethalin 1.25 kg/ha efficacy was statistically at par with alachlor 2.50 kg/ha in reducing density of different categories of weeds, irrespective of time of observation though at 15 DAA grassy weed density was significantly different among these two treatments. Higher doses of herbicides helped in reducing weed density and biomass conforming the findings of Singh *et al.* (2013)

In general, sedges were controlled less effectively than grasses and BLW. Pendimethalin and alachlor caused WCE similar to metolachlor 1.0 kg/ha. WPI also followed the similar trend as like WCE and the descending order of WPI during 15 DAA for all categories of weeds was metolachlor 1.25 kg/ha >alachlor 2.50 kg/ha >pendimethalin 1.0 kg/ha > metolachlor 1.0 kg/ha > metolachlor 750 g/ha (**Table 2**).

Metolachlor 1.25 kg/ha recorded comparatively higher HEI (1.12) which was followed by metolachlor 1.0 kg/ha (0.98) and alachlor 2.50 kg/ha (0.97) (**Figure 2)**. There was greater variation in WMI among the different treatments, among which metolachlor 1.0 kg/ha was the best with lowest WMI value (0.27 and was followed by lower dose of 1.0 kg/ha (WMI of 0.31) of same herbicide. Weed index was maximum in weedy check (45.7) and minimum with metolachlor 1.25 kg/ha (18.6). The other herbicidal treatments like pendimethalin or alachlor recorded numerically similar values as metolachlor 1.0 kg/ha. Variations in different weed indices due to different weed management approaches through various herbicides were also previously described by Poddar *et al.* (2017) and Kundu *et al.* (2021).

Table 1. Effect of different treatments on different categories weeds density (pooled data of two years)

Treatment	Weed density (no./m^2)									Weeds biomass (g/m^2)								
	Grassy weeds			Sedges			Broad-leaved weeds			Grassy weeds			Sedges			Broad-leaved weeds		
	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA
Metolachlor 0.75 kg/ha	64.46 (8.06)	82.98 (9.14)	103.98 (10.22)	51.55 (7.21)	64.91 (8.09)	82.67 (9.12)	45.22 (6.76)	58.36 (7.67)	70.65 (8.44)	7.56	11.20	18.60	6.46	8.89	14.68	2.02	6.34	16.01
Metolachlor 1.00 kg/ha	50.05 (7.11)	66.49 (8.18)	80.44 (9.00)	45.09 (6.75)	55.32 (7.47)	68.01 (8.28)	33.82 (5.86)	41.06 (6.45)	55.72 (7.50)	5.62	9.63	17.42	5.97	8.06	13.25	1.87	5.88	14.89
Metolachlor 1.25 kg/ha	33.91 (5.87)	55.44 (7.48)	69.93 (8.39)	36.65 (6.10)	49.79 (7.09)	56.62 (7.56)	26.50 (5.20)	35.79 (6.02)	45.85 (6.81)	4.89	8.59	16.56	5.60	7.61	13.21	1.63	5.52	13.78
Pendimethalin 1.00 kg/ha	42.91 (6.59)	58.85 (7.70)	79.37 (8.94)	40.84 (6.43)	51.58 (7.22)	62.60 (7.94)	31.40 (5.65)	39.55 (6.33)	53.05 (7.32)	5.46	9.54	17.14	6.01	7.91	13.38	1.80	5.81	14.26
Alachlor 2.50 kg/ha	37.66 (6.18)	58.08 (7.65)	74.73 (8.67)	39.52 (6.33)	50.60 (7.15)	60.76 (7.83)	31.51 (5.66)	38.53 (6.25)	52.33 (7.27)	5.23	9.22	17.00	5.93	7.85	13.34	1.77	5.82	14.45
Weedy check	93.73 (9.71)	107.50 (10.39)	125.03 (11.20)	61.32 (7.86)	79.88 (8.97)	106.03 (10.32)	64.95 (8.09)	86.16 (9.31)	103.84 (10.21)	16.17	21.65	31.87	9.55	12.44	19.59	5.27	14.56	31.92
Weed free	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LSD (p=0.05)	2.41	2.90	4.38	4.15	3.80	4.73	1.55	2.19	2.74	0.27	0.19	0.63	0.44	0.23	0.57	0.09	0.26	0.72

#Data are subjected to square root transformation ($\sqrt{x+0.5}$); values in the parentheses are transformed value

Effect on crop growth, yield and economics

The growth and yield parameters like crop dry matter accumulation, pods/plant, seeds/pod and seed yield were significantly higher in weed free check whereas the lowest values were observed in weedy check (**Table 3**). Among the different herbicide treatments, metolachlor 1.25 kg/ha was the next best in terms of crop dry matter accumulation (527.36 g/ m^2) which was 43.9% higher than weedy check treatment. There was a net gain of 12.5 to 59.6% more dry matter in soybean due to different weed management treatments. Weed management helps in creating a less completion environment to the crop plant which helped them to utilize more natural resources efficiently and thus produced more dry matter than weedy check (Poddar *et al.* 2017; Kundu *et al.* 2021). Number of pods/plant and seeds/pod also followed the similar trends. Variation in yield attributes due to different weed management in soybean was also reported previously by Singh *et al.* (2014) and Andhale and Kathmale (2019).

There was a significant variation in seed yield of soybean due to different weed management treatments (**Table 3**). Different weed management treatments resulted in 33.8 to 61.9% higher seed yield of soybean when compared with weedy check. The weed free recorded significantly highest seed yield (1.68 t/ha) which was followed by metolachlor 1.25 kg/ha (1.56 t/ha) > metolachlor 1.0 kg/ha (1.54 t/ha) > alachlor 2.50 kg/ha (1.52 t/ha) in the order of decreasing seed yield of soybean. However, all the herbicide applied treatments showed statistically at par result in terms of seed yield except metolachlor 750 g/ha. The weed free environment in the weed free check helped the crop to grow more vigorously reslting in greater yield attributes which ultimately resulted in higher seed yield (Poddar *et al.* 2014; Kundu *et al.* 2021). Lowest seed yield was recorded in weedy check plot (1.04 t/ha). Stover yield also followed the similar trend like seed yield of soybean. Harvest index did not differ significantly amongst the various weed management approaches.

Table 2. Effect of different treatments on weed control efficiency and weed persistency index of different categories of weeds

Treatment	Weed control efficiency (%)									Weed persistency index (WPI)								
	Grassy weeds			Sedges			Broad-leaved weeds			Grassy weeds			Sedges			Broad-leaved weeds		
	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA	15 DAA	30 DAA	45 DAA
Metolachlor 0.75 kg/ha	53.23	32.27	61.72	48.29	28.53	56.42	41.65	24.93	49.84	0.68	0.67	0.70	0.80	0.88	0.96	0.55	0.64	0.74
Metolachlor 1.00 kg/ha	65.22	37.43	64.57	55.50	35.22	59.58	45.37	32.37	53.33	0.65	0.72	0.85	0.85	0.94	1.05	0.68	0.85	0.87
Metolachlor 1.25 kg/ha	69.74	41.24	69.07	60.33	38.82	62.04	48.02	32.58	56.77	0.84	0.77	0.93	0.98	0.98	1.26	0.76	0.91	0.98
Pendimethalin 1.00 kg/ha	66.21	36.95	65.91	55.95	36.39	60.07	46.21	31.69	55.29	0.74	0.80	0.85	0.94	0.98	1.16	0.71	0.87	0.87
Alachlor 2.50 kg/ha	67.68	37.81	66.50	57.44	36.91	60.00	46.67	31.84	54.69	0.80	0.79	0.89	0.96	1.00	1.19	0.69	0.89	0.90
Weedy check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Weed free	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	-	-	-	-	-	-	-	-	-

Table 3. Effect of different treatments on seed yield of soybean (pooled data of two years)

Treatment	Crop dry matter (g/m^2)	Pods/ plant	Seeds/ pod	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	B:C
Metolachlor 0.75 kg/ha	412.33	14.6	1.89	1.39	2.13	39.45	1.34
Metolachlor 1.00 kg/ha	439.54	15.3	2.00	1.54	2.31	39.93	1.92
Metolachlor 1.25 kg/ha	527.36	16.7	2.33	1.56	2.37	39.64	2.03
Pendimethalin 1.00 kg/ha	472.51	15.4	2.00	1.51	2.33	39.29	1.77
Alachlor 2.50 kg/ha	489.85	15.7	2.11	1.52	2.30	39.72	1.80
Weedy check	366.42	13.2	1.67	1.04	1.62	39.14	1.12
Weed free	584.76	17.5	2.33	1.68	2.55	39.74	1.79
LSD (p=0.05)	12.71	0.41	0.05	0.054	0.012	NS	-

Table 4. Physical and chemical properties of the experimental field soil at harvest (pooled data of two years)

Treatment	BD (g/cc)	WHC (%)	Sand (%)	Silt (%)	Clay (%)	pH	EC (dS/m)	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Metolachlor 0.75 kg/ha	1.343	45.29	55.31	23.55	21.14	6.82	0.164	0.674	123.42	23.43	132.96
Metolachlor 1.00 kg/ha	1.334	45.38	55.18	23.06	21.76	6.85	0.165	0.665	124.15	23.54	131.89
Metolachlor 1.25 kg/ha	1.341	45.35	55.43	23.11	21.46	6.79	0.165	0.673	123.88	24.14	132.82
Pendimethalin 1.00 kg/ha	1.340	45.37	55.42	23.25	21.33	6.80	0.166	0.677	124.52	23.86	131.44
Alachlor 2.50 kg/ha	1.332	45.30	54.72	23.2	22.08	6.82	0.165	0.665	124.38	23.71	131.09
Weedy check	1.330	45.38	55.23	23.36	21.41	6.76	0.166	0.677	124.49	23.62	132.11
Weed free	1.335	45.36	55.32	23.16	21.52	6.79	0.165	0.674	123.23	23.45	131.06
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The lowest B:C (1.12) was with weedy check while metolachlor 1.25 kg/ha recorded highest value (2.03) followed by its lower doses of 1.0 kg/ha (1.92). Weed free check ranked fourth in terms of B:C (1.79) due to higher cultivation cost associated with higher for labour wages.

Effect on soil physico-chemical properties

Different physical properties of soil like sand, silt and clay contents; bulk density, water holding capacity along with various chemical properties like pH, electrical conductivity (EC), organic carbon (%), total nitrogen content, available phosphorus (P) and potash (K) contents of the harvested soil of the experimental field were estimated (**Tables 4)**. There were no significant variation indifferent physical and chemical properties of the soil due to herbicide treatments and is the conformity of the finding of Bera and Ghosh (2013).

Effect on soil microorganism

Different soil microorganism like total bacteria, actinomycetes and fungi population counting was done at initial or before spraying of herbicides and 1 DAA, 7 DAA, 15 DAA, 30 DAA and at harvest (**Table 5)**. Total bacteria, fungi and actinomycetes population did not differ significantly among the treatments before spraying or in initial soil sample. Weedy check treatment did not show much variation in counting different microorganism at different dates of observation. After application of herbicides all the microorganism population gradually decreased with maximum reduction at 30 DAA. Later reverse trend occurred with the increase in the counting at harvesting which was higher than that of initial. The decrease in the bacterial population was due to competitive influence and the toxic effect of chemicals in soil. Herbicidal treatments plots recorded 22.6 to 28.8% higher population of bacteria, 12.3 to 19.1% higher population of fungi and 7.8 to 12.8% higher population of actinomycetes than the weedy check at the time of harvesting of soybean crop. Microorganisms have the ability of degradation of herbicides and utilize them as a source of biogenic elements for their own physiological processes and they multiply rapidly (Bera and Ghosh 2013; Pal *et al.* 2013).

Effect on succeeding crop

After harvesting of soybean crop the succeeding crop mustard was sown in the plot without disturbing the layout of the experiment. There was no significant impact of different herbicidal treatments on germination %, population/m^2 and seed yield of mustard (**Table 6**). Lack of adverse effects of

Table 5. Influence of herbicides on soil microorganisms population (pooled data of two years)

Treatment	Total bacteria (CFU x 10^6/g of soil) Initial	Herbicide application 1 DAA	7 DAA	15 DAA	30 DAA	At Harvest	Fungi (CFU x 10^4/g of soil) Initial	Herbicide application 1 DAA	7 DAA	15 DAA	30 DAA	At Harvest	Actinomycetes (CFU x 10^5/g of soil) Initial	Herbicide application 1 DAA	7 DAA	15 DAA	30 DAA	At Harvest
Metolachlor 0.75 kg/ha	40.11	28.47	25.67	23.11	21.11	60.33	25.11	16.11	15.33	14.67	12.11	33.67	80.67	56.67	52.67	47.33	44.67	92.33
Metolachlor 1.00 kg/ha	40.33	27.33	24.33	22.67	20.33	61.33	24.33	16.33	15.67	14.67	12.67	34.33	79.00	55.33	52.00	46.00	42.33	96.67
Metolachlor 1.25 kg/ha	39.67	26.67	23.33	21.00	20.11	62.67	25.33	16.11	15.33	14.33	12.33	35.33	78.67	53.00	48.00	44.67	41.67	96.33
Pendimethalin 1.00 kg/ha	40.17	26.11	25.33	21.67	22.33	59.67	25.00	16.67	15.00	14.11	12.00	34.67	79.33	56.67	49.67	48.00	44.67	95.00
Alachlor 2.50 kg/ha	40.33	26.67	25.11	22.33	21.67	60.00	24.67	16.33	15.67	14.67	12.33	33.33	78.33	55.67	51.33	47.67	43.33	96.33
Weedy check	39.67	44.33	43.67	44.33	45.33	48.67	24.33	25.33	25.00	26.00	27.67	29.67	78.67	80.00	80.67	81.67	84.00	85.67
Weed free	40.33	43.67	44.33	45.11	46.67	49.33	24.67	25.67	25.33	26.67	27.33	30.33	79.33	80.33	81.00	82.33	84.67	87.33
LSD (p=0.05)	NS	1.62	1.12	1.54	1.86	1.44	NS	1.16	1.12	1.42	1.36	1.92	NS	1.66	2.38	2.72	1.86	2.42

Table 6. Effect of different weed management on germination %, population and seed yield of succeeding crop (mustard)

Treatment	Germination %	Population /m^2 (30 DAS)	Seed yield (t/ha)
Metolachlor 0.75 kg/ha	79.8	19.28	1.53
Metolachlor 1.00 kg/ha	78.9	19.85	1.54
Metolachlor 1.25 kg/ha	78.3	19.80	1.55
Pendimethalin 1.00 kg/ha	79.8	19.52	1.51
Alachlor 2.50 kg/ha	78.4	19.58	1.54
Weedy check	79.6	19.98	1.50
Weed free	80.3	19.95	1.60
LSD (p=0.05)	NS	NS	NS

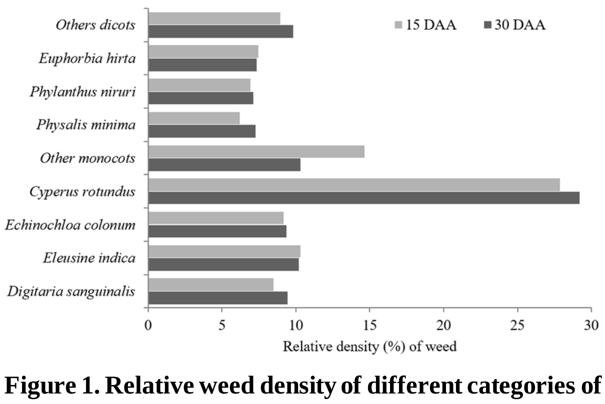
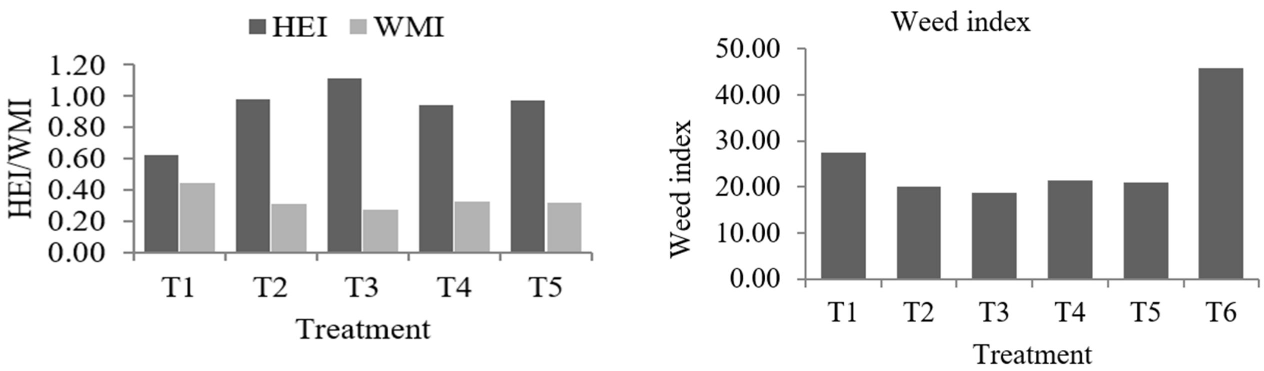


Figure 1. Relative weed density of different categories of weeds in weedy check plot at 15 days after application (DAA) and 30 DAA in soybean field



Where, T_1: metolachlor 750 g/ha, T_2: metolachlor 1.0 kg/ha, T_3: metolachlor 1.25 kg/ha, T_4: pendimethalin 1.0 kg/ha, T_5: alachlor 2.50 kg/ha; T_6: weedy check

Figure 2. Effect of weed management treatments on herbicide efficiency index (HEI), weed index (WI) and weed management index (WMI)

different herbicides on succeeding crops on seed yield were reported earlier also by Poddar *et al.* (2014).

Conclusion

It may be concluded that metolachlor 1.25 kg/ha as PE was very effective in managing different categories of weeds and also produced higher seed yield and maximum profit in soybean without hampering soil physico-chemical properties and activity of soil microorganism. The next best treatment was metolachlor 1.0 kg/ha.

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