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The identification of weeds and effect of herbicides in rapeseed-mustard: A review

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Abstract
The identification of weeds and type of weed flora, magnitude and duration of weed infestation competition by weeds at initial stages is a major limiting factor to its productivity of rapeseed-mustard. In the view of above facts, as used herbicides, fights against the weeds in the agriculture are very toxic to soil biota. To some extent, these herbicides are unrestrainedly used by farmers without considering the long or short term effects in soil medium. It is evident that most of these herbicides may cause the reduction of sensitive populations of certain groups of biota in soil medium. It is believe that in cases where these herbicides are used to treat soils, they are considered harmful to nematode and other biological organisms. Studies on this aspect are important because weed identification and herbicides effects are the common prey of many terrestrial vertebrate species such as birds and small mammals, and thus they play a key role in the biomagnifications process of several soil pollutants. It is now emphasized that, whereas higher concentrations of a pollutant can easily be assessed with the mortality test, contaminated soils with lower pollutant concentrations require more sensitive test methods such as reproduction test in their risk assessment. The aim of this paper was to provide the weed flora information with effects of herbicides of soil biological community.

Keywords: Weed flora, herbicides effect, soil and rapeseed-mustard

Introduction
Oilseeds constitute the second largest agricultural commodity in Indian economy after cereal accounting for nearly 6% of gross national product and 10% of the value of all agricultural product, although India is one of the leading oilseeds producing countries in the world it is not able to meet the requirement of edible oil for its vast population. Indian mustard [*Brassica juncea* (L.) Czern & Cross] is one of the major oilseed crop of the Chhattisgarh. Indian mustard, in India is cultivated in 5.77 million hectares with average production 6.59 million tones and average productivity of 1142 kg/ha. In Chhattisgarh, mustard is grown in an area of thousand hectares. Its annual production is thousand tones with an average productivity of kg/ha. Globally, India accounts for 17.27% and 9.07% of the total acreage and production of rapeseed-mustard (USDA 2016) respectively.
A review of literature of important aspects pertaining to present study is being presented in this paper. Attempt has been made to cite as much literature as possible on mustard but due to paucity of adequate experimental evidences, especially on herbicides, similar research work on other related crops has also been reviewed, wherever felt necessary.

Identification of different weeds
Effect of herbicides
Identification of weeds
Chauhan *et al*. (2005) [4] reported from Gwalior the weed flora of the experiment field as*: Chenopodium album* L., *Convolvulus arvensis* L., *Asphodelus tenuifolius* L., *Melilotus indica* L., *Anagallis arvensis* L., *Avena fatua* L., *Cynodon dactylon* (L.) Pers. and *Phalaris minor* Retz. The dicot weeds were more dominating to monocot in the field. Sharma *et al*. (2005) [22] reported from Haryana that the major weed flora present in mustard field was comprised of lamsquarters (*Chenopodium album* L.), goose foot (*Chenopodium murale* L.), wild onion (*Asphodelus tenuifolius* Cav.), sweet clover (*Melilotus alba*) and morning glory (*Convolvulus arvensis* L.). Among them lambsquarters (*Chenopodium album* L.) was dominant weed. Sharma *et al*. (2007) [20] reported from palampur, Himachal Pradesh that *Phalaris minor* Retz, *Avena fatua* L. and *Lolium temulentum* L. were dominant as grassy weeds while *Vicia sativa*

L., *Coronopus didymus* (L.) Sm. and *Anagallis arvensis* L.were present in low density. Punia *et al.* (2010) [17] reported from Hisar, Haryana that *Asphodelus tenuifolis, C. album, Melilotus indica, Trigonella polycerata, C. murale, Cynodon dactylon, Orobanche aegyptiaca, Carthamus oxycantha, A. ludoviciana* and *Convolvulus arvensis* were highly aggressive and dominating weeds in Indian mustard. Yadav *et al.* (2010) observed that Out of total 16 weed species, six weeds namely *Asphodelus tenuifolius, C. album, Melilotus indica, Trigonella polycerata, C. murale* and *Convolvulus arvensis* were found to be highly aggressive and dominating over other weed species present in Sirsa district. Bijarnia *et al.* (2017) [3] An experiment were conducted during the years of 2014-15 and 2015-16 at Bikaner, to evaluate the integrated nutrient management and weed control measures on mustard (*Brassica juncea* L.) and its residual effect on fodder pearl millet (*Pennisetum glaucum* L). The highest density and dry matter of different weeds like as *Chenopodium* species, *Rumex dentatus, Melilotus indica* and total weeds was observed under the treatment where the nutrient was supplied through FYM. Meena *et al.* (2017) [12] An Field experiment was conducted during *Rabi*, 2014-2015 at Udaipur. The crop was infested two types of weed monocot and dicot weeds predominant in the experimental sites were *Cynodon dactylon, Cyperus rotundus, Phalaris minor, Asphodelus tenuifolius, Anagallis arvensis, Chenopodium murale, Chenopodium album, Convolvulus arvensis, Fumaria parviflora* and *Melilotus indica.* Madhavilatha *et al.* (2017) [11] An experiment were conducted during *rabi* season of the year 2011-12. The crop was infested with divergent type of weed flora e.g. *Phalaris minor* (21.35%) and *Cynodon dactylon* (7.78%) of grassy, *Chenopodium album* (17.58%), *Anagallis arvensis* (27.43%), *Melilotus alba, Vicia hirsuta, Lathyrus asphaca* and *Rumex* sp. (19.22%) of broad leaved and *Cyperus rotundus* (10.61%) of sedges group.

Effect of Herbicides

Singh *et al.* (2001) [25] reported the maximum seed yield of 1705 and 1945 kg/ ha from weed-free followed by 2 manual weedings at 25 and 45 days after sowing (1593 and 1792 kg ha-1) and were most effective in controlling than that of other treatments during two years span. Sharma and Singh (2002) [21] reported that weed management practices significantly increased the yield attributes (number of siliquae per plant, number of seeds per siliqua, siliqua length, seed weight per plant and 1000-seed weight) and yield of Indian mustard over the control. Weed management practices increased the seed yield of Indian mustard by 54-80% over the weedy control (11.42 quintal/ha). Weed management practices did not exert significant influenced on oil content in seed. Yadav *et al.* (2004) [30] observed that weed dry weight decreased with increasing rates of trifluralin, fluchloralin and pendimethalin. The average seed yield decreased with increasing rates of fluchloralin but increased with increasing rates of trifluralin and pendimethalin which resulted to higher increments in seed yield compared to fluchloralin. Buttar and Tiwari *et al.* (2003) [29] reported that all weed treatments reduced the weed dry matter compared to unweeded plots. The weed dry matter was lowest in trifluralin + once hoeing (16.4 g/m2), followed by 1.00 kg trifluralin/ha (17.4 g/m2). These treatments recorded the highest weed control efficiency 86.5 and 85.6%, respectively. Weed dry matter was highest in the weedy control (123.4 g/m2), followed by 0.75 kg isoproturon/ha at 2 DAS (2.82 g/m2). Among all treatments, the weedy control recorded the lowest 1000-grain weight. The 1000-grain weight was highest in trifluralin + once hoeing, followed by 1.00 kg trifluralin/ha. The mean grain yield was highest with trifluralin + once hoeing (2274 kg/ha), followed by 1.00 kg trifluralin/ha (2259 kg/ha), weed-free control (2215 kg/ha) and 0.75 kg trifluralin/ha (2159 kg/ha) treatments. The grain yield was lowest in the weedy control (1562 kg/ha). Sarkar, *et al*. (2005) [19] conducted an experiment at Chakdara, NWFP to study the efficacy of different pre- and post-emergence herbicides for controlling weeds in rapeseed. It was concluded that for controlling weeds, pendimethalin proved to be the best, giving only 7.75 weeds m-2 followed by trifluralin (8 m-2) and S-metolachlor (12.75 m-2) as compared to weedy check (26 m-2). Yadav (2004) [30] from Morena district of M.P. observed the maximum seed yield of 17.08 q ha-1 with pre-emergence application of isoproturon 0.75 kg ha-1 + hand weeding 25 days after sowing (DAS) followed by pre-emergence application of metribuzin 0.20 kg ha-1 + hand weeding 25 DAS. Sinha *et al.* (2005) [27] observed that one hand weeding at 25 DAS gave the highest secondary branches, crop growth rate, leaf area index, 1000-seed weight and seed yield while fluchloralin gave the highest siliqua per plant. One hand weeding at 25 DAS gave the lowest weed count, weed dry weight and weed growth rate, and the highest weed control efficiency. Sharma *et al.* (2005) it was reported by that the weed control treatments viz., weed free, hand weeding at 25 DAS, hand weeding at 25 and 45 DAS, pendimethalin and trifluralin at 0.75 kg and 1.00 kg a.i./ha and pendimethalin or trifluralin + one hand weeding at 45 DAS effectively reduced dry weight of weeds at harvest by 71.2-100% compared with the control. The highest seed yield (1891 kg/ha) was obtained under weed free treatment followed by pre-plant incorporation of trifluralin at 0.75 kg a.i./ha with one hand weeding 45 DAS and were at par with 2 hand weedings at 25 and 45 DAS. Among different herbicides, pre-plant incorporation of trifluralin at 0.75 kg a.i./ha was most effective in improving the growth and yield attributes viz., number of branches per plant, number of siliquae per plant and test weight with maximum seed yield and oil yield. Chauhan *et al.* (2005) [4] registered that the application of oxyfluorfen at 0.25 kg/ha as pre-emergence, fluchloralin at 1.0 kg/ha as pre-plant application and 2 hand weedings at 25 and 40 DAS drastically reduced weed density, weed biomass and increased seed yield. The 2 hand weedings were next to weed-free in giving higher seed yield (17.55 and 17.59 q/ha during 1998 and 1999 respectively), followed by oxyfluorfen at 0.25 kg/ha as pre-emergence in both years. However, oxyfluorfen at 0.25 kg/ha was at par with fluchloralin at 1.0 kg/ha as pre-plant application and pendimethalin at 0.75 kg/ha as pre-emergence. Tanveer *et al.* (2005) [28] The effect of two soil incorporated herbicides viz., trifluralin @ 0.90,1.20,1.50 kg a.i. ha-1 and acetochlor @ 0.094, 0.124 and 0.312 kg a.i. ha-1 on weeds and yield of canola was evaluated in a field trial at Agronomic Research Area, University of Agriculture, Faisalabad. Trifluralin @ 1.50 kg a.i. ha-1 was very effective in controlling the weeds and reducing their fresh and dry weight. Application of trifluralin @ 1.5 kg a.i. ha-1 reduced the weed density (7.00m-2) significantly as compared to control (32.67m-2) reducing the weed dry weight from 8.1 gm-2 to 1.7 gm-2. Trifluralin @ 1.5 kg a.i. ha-1 showed maximum increase (34%) in canola seed yield by increasing the number of pods per plant, seeds per pod and 1000-seed weight. Sarkar *et al.* (2005) [19] conducted a field experiment at the farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during the *rabi* seasons of 2002-03 and 2003-04, to

know the bio-efficacy of pendimethalin and fluchloralin in mustard. They revealed that the total weed dry weight was reduced significantly due to herbicides compared to weedy check. Weed control efficiency of pendimethalin was higher than fluchloralin. Pendimethalin at 1.50 kg/ha had highest weed control efficiency throughout the crop growth. Weed control efficiency of fluchloralin ranged from 57.78 to 66.02% depending upon doses which were higher than the hand weeding. Hand weeding employed at 20 and 40 DAS failed to minimize the weed growth due to rapid emergence and establishment of Polygonum after hand weeding and thus resulting in poor weed control efficiency at later part of crop growth. Degra *et al*. (2006) [5] from Jaipur reported the highest seed yield (1925 kg ha-1) from repeated hand weeding plot owing to the highest weed control efficiency (86.6%). Among herbicide treatments, fluchloralin at 1.0 kg ha-1 supplemented with one hand weeding at 40 DAS achieved the highest increase in seed yield (1876 kg ha-1) over unweeded check and was closely followed by isoproturon at 0.5 kg ha-1 + one hand weeding (1859 kg ha-1). Patel *et al.* (2010) [15] conducted an experiment to study residual effect of dinitroaniline herbicide applied in mustard on succeeding summer pearl millet at Anand centre, Anand Agriculture University and found significantly the lowest germination, plant height and grain yield of succeeding pearl millet were recorded where pendimethalin applied at 0.75 kg/ha as pre-emergence and again applied at 0.50 kg/ha at 45 DAS with irrigation water for controlling Orobanche in mustard crop. Pendimethalin persisted upto 110 days in sandy loam soil in Rabi season and showed toxic effect on succeeding summer pearl millet crop. Mishta *et al*. (2011) conducted a field experiment at Adaptive Research Farm Gujranwala, Pakistan to evaluate the effect of different herbicides on weed control and yield of canola. The data revealed that the pre emergence application of pendamethalin 30 EC significantly reduced the narrow leaved weeds by 98.32 percent. The highest net return (Rs. 40820/ha) was also obtained by the application of pendamethalin 30 EC. Sandhu *et al.* (2011) [18] found that all herbicides resulted in significantly reduced density and dry matter of weeds in Indian mustard. Weed control also reduced nutrient losses caused due to heavy weed infestation. Pre emergence application of oxadiazon 0.50 kg/ha, pendimethalin 0.75 kg/ha and pre-plant incorporation of fluchloralin 0.75 kg/ha increased seed yield by 67.3, 49.8 and 36.9% respectively over the weedy check. Bhullar *et al*. (2012) [2] conducted a field experiment at Punjab Agricultural University, Ludhiana (Punjab) to know the tolerance of three canola gobhisarson cultivars *viz.*, GSC 5, GSC 6 and Hyola PAC 401 to preemergence herbicides for three cropping season of 2007-08, 2009-10 and 2010-11. Major weed flora in the field included *Phalaris minor* among grasses and *Medicago denticulata, Coronopus didymus* and *Rumex dentatus* among broadleaves. It was concluded that trifluralin 0.75 kg/ha can be safely used for controlling weeds in all the three canola gobhisarson cultivars; pendimethalin 0.50 kg/ha can be safely used in GSC 5 and GSC and its used should be avoided in Hyola PAC 401 particularly in light textured soils. Kaneria *et al*. (2013) [8] conducted an experiment "Integrated weed management studies in mustard [*Brassica juncea* (L.) Czern and Coss.]" at Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat) during rabi 2011-12. He concluded that besides weed free condition, pendimethalin @ 0.5 kg/ha PE + 1 HW at 25 DAS, was found more effective in reducing the weed population (viz., grassy, broad leaved and sedges) resulted into less dry weight of weeds (147.67 kg/ha), higher weed control efficiency (74.50%) as well as lower weed index (2.03%). Oxadiargyl @ 75 g/ha PE + 1 HW at 25 DAS was found equally effective with this respect. Sharma *et al*. (2014) conducted a field experiment at Chatha, Jammu, to assess the yield along with the monetary benefits in chickpea and Indian mustard intercropping system with different weed management practices. It was concluded that application of pendimethalin @ 1 kg/ha as pre-emergence recorded the maximum weed control efficiency (85.16%), net returns (Rs. 20,373/ha) and benefit: cost ratio (1.71). Mukherjee *et al.* (2014) [14] conducted a field trial during *rabi* winter season of 2011-12 and 2012-13 at Kalimpontg, Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Darjeeling, West Bengal on the influence of weed and fertilizer management on yield and nutrient uptake in mustard. He found that all weed management treatments significantly reduced the weed density at 60 days after sowing. The minimum weed density was recorded under pendimethalin (0.75 kg/ha) + HW at 35 DAS and was at par with the hand weeding twice, during both the years, further in second year this was statistically similar with pendimethalin (1.25 kg/ha) and alachlor (1.25 kg/ha). Maximum weed infestation was registered with the control, and was closely followed by pendimethalin (0.75 kg/ha) and alachlor (0.75 kg/ ha). Singh *et al.* (2015) conducted a field experiment during *rabi* season 2012 at research farm of Janta Vedic College Baraut (Baghpat) U.P. on "Irrigation, fertilizers and weed management for improving productivity and nutrient uptake of mustard". He found that the seed and stover yield also increased significantly due to weed management treatments. The seed yield was higher under the hand weeding and next to pendimethain over the weedy check plot. Singh S.S. (2015) studied the bio-efficacy of different herbicide treatments on the performance of mustard crop and their effect on population dynamics of beneficial soil microorganisms like Azotobacter, Bacillus and Pseudomonas were studied. They observed that higher doses of pendimethalin (@1.0 kg ha-1) and isoproturon (@1.0 kg ha-1) had toxic effect on the germination (13.33 and 17.33 m-2) and emergence of mustard crop and resulted in significantly lower plant population. Kaneria *et al.* (2016) [9] conducted a field experiment "Weed management with pre- and post-emergence herbicides in linseed" during *rabi* 2013-14 at the research farm of College of Agriculture, JNKVV, Tikamgarh (M.P.). He concluded that density and dry weight of weeds were significantly reduced by all the herbicidal treatments and hand weeding over weedy check (5.04 g/m2). The significantly lowest weed density and dry weight of weeds was recorded under hand weeding twice at 20 and 40 DAS followed by pendimethalin 1.0 kg/ha + imazethapyr 1.0 kg/ha and pendimethalin 1.0 kg/ha + imazethapyr at 0.75 kg/ ha. Gupta and Kushwah (2016) conducted an experiment at the Research Farm, College of Agriculture, Gwalior during 2013-14 on post-emergence herbicides for weed control in sesame. They revealed that the weed control practices significantly affected the yield and yield attributes in sesame crop. The highest number of capsules/ plant, grains/capsule, 1,000grain weight (g), grain yield/plant (g), grain yield (kg/ha), stalk yield (kg/ha) and harvest index (%) observed in treatment two hand weeding at 20 and 40 DAS, followed by propaquizafop 50 g/ha. Kumar *et al.* (2016) [10] conducted a field experiment at farmers' field of Yethapur Salem to evaluate suitable integrated weed management practices for improving productivity and profitability in castor hybrid under irrigated condition during *rabi* 2013-14. They revealed that the plant

height was significantly higher with pre-emerence application of pendimethalin 1.0 kg/ha + HW twice on 20 and 40 DAS and was followed by pre-emergence application of pendimethalin 1.0 kg/ha + mechanical weeding twice. Yadav *et al.* (2017) conducted an experiment during the winter season of 2014-15 and 2015-16 at Bikaner, to evaluate the integrated nutrient management and weed control measures on weed, growth, yield attributes and yield of mustard (*Brassica juncea* L.). Among the weed management sources application of 1.0 kg ha-1 pendimethalin reduced the dry matter of different weeds and enhance the growth, yield attributes and also produced the maximum seed and straw yield. Bazaya *et al.* (2017) found in experiment conducted during *rabi* season of 2014-15 at College Farm, N. M. College of Agriculture, Navsari Agricultural University aimed at study of spacing and weed management practices in mustard that significantly maximum plant height (184.10 cm), number of branches plant-1 (19.36), dry matter accumulation (84.42 g plant-1), number of siliqua plant-1 (223.31), seed yield (2085 kg ha-1) and stover yield (4230 kg ha-1) were obtained with W4 (Pendimethalin @ 1.0 kg ha-1 as PE + Quizalofop - P - ethyl @ 0.04 kg ha-1 at 20 DAS + HW and IC at 40 DAS). Yadav *et al*. (2017) [32] A field experiment was conducted with ten treatments pendimethalin 1000 g ha-1, oxadiargyl 90 g ha-1, trifluralin 750 g ha-1, oxyfluorfen 150 g ha-1, quizalofop 60 g ha-1, clodinafop 60 g ha-1, isoproturon 1000 g ha-1 (PE), isoproturon 1000 g ha-1 (PoE), Weedy and Weed free Check at Faizabad (Uttar Pradesh.) during *rabi* season of the year 2011-12.The crop was infested with divergent type of weed flora e.g. *Phalaris minor* (21.35%) and *Cynodon dactylon* (7.78%) of grassy, *Chenopodium album* (17.58%), *Anagallis arvensis* (27.43%), *Melilotus alba*, *Vicia hirsuta*, *Lathyrus asphaca* and Rumex sp. (19.22%) of broad leaved and *Cyperus rotundus* (10.61%) of sedges group. Weed density of the different weed species and total weeds affected significantly due to different weed control treatments, oxadiargyl, pendimethalin, trifluralin and oxyfluorfen were found more effective in reducing the population of *Chenopodium album* and *Anagallis arvensis*. Similarly integration of quizalofop and clodinafop effectively taken care of *Phalaris minor*. Oxadiargyl, pendimethalin and trifluralin recorded significantly lower values of nitrogen uptake. Oxadiargyl, pendimethalin and trifluralin resulted in higher yield attributes (siliquae plant-1, length of silique and seeds siliqua-1) and seed yield of mustard. Prusty *et al.* (2018) [16] conducted an field experiment to study the effect of tillage, residue and weed management practices was evaluated on weed population of *Medicago sativa*, *Chichorium intybus*, *Sonchus arvensis* and *Physalis minima* among dicots, as well as the productivity of mustard in the maize-mustard-greengram cropping system during 2015-2017. Results indicated that total weed density and biomass was maximum in the first year, and declined gradually in second years in especially *Sonchus arvensis* and *Physalis minima*. However, *Medicago sativa* and *Cichorium intybus* was gradually increased during second year at 60 DAT and maturity. The highest gross and net returns were found in Pendimethalin *fb* HW and isoproturon under CT (M)-CT (Msr) during the study period. However, net B: C ratio was maximum in isoproturon under CT (M)-CT (Msr) (4.34%) during 2015-16 and CT (M)-ZT (Msr)-ZT (G) (4.52%) during 2016-17. Application of pendimethalin at 0.75 kg ha−1 along with one hand weeding at 25 DAT recorded the lowest total weed density and biomass. This treatment also recorded higher grain yield but lower net returns compared to pendimethalin 0.75 kg ha−1 + isoproturon 1.0 kg ha−1. Overall, application of pendimethalin as PE and isoproturon as POE in ZT proved to be the most effective herbicide strategy for weed management in gobhi mustard leading to higher grain yield and net returns, irrespective of crop establishment practices. Gupta *et al.* (2018) a field experiments was conducted during two consecutive rabi seasons of 2013-14 and 2014-15 to study the effect of weed management practices on yield, weed dynamics and economics of mustard and to find out the most effective and economic weed management practice for mustard under semi arid conditions of Rajasthan. Results of the study revealed that two hand weeding at 25-30 and 40-45 days after sowing recorded minimum mean weed dry weight (39.95g m-2), highest weed control efficiency (80.94%) and maximum mean plant height (165.4 cm), siliqua plant-1 (153.7), seeds siliqua-1 (13), test weight (4.33), mustard seed and stover yield(16.16 and 50.51 q ha-1) during both years of study which was statistically at par with 1hand weeding (16.08 and 50.39 q ha-1) and pre-emergence application of pendimethalin 38.7CS (15.86 and 48.49 q ha-1). However, among chemicals pre emergence application of pendimethalin 38.7 CS (T3) proved superior as it recorded higher values of seeds per siliqua and test weight.

Conclusions

It is concluded by this review that the use of herbicides and identification of weed flora can affect the biological parameters. The present article explains that there is impact on yield and biomass after the application of herbicides at different concentrations. The extensive use of herbicides has progressively turned into a matter of environmental concern modifying the soil productivity status and the population of biota. Herbicides almost show high toxicity against earthworms, despite some exceptions. The review highlighted that some herbicides are harmful and are highly toxic to earthworms with weed flora.

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