Original Research Article

Effect of tank mix post-emergence herbicides on soil dehydrogenase activity and its phytotoxicity on wheat

ABSTRACT

Aims: The study was conductedto evaluate the efficacy of tank mix post emergence herbicides on soil dehydrogenase activity and its phytotoxic effect on wheat.

Study design: The experiment consists of ten treatments and was laid out in randomised complete block design with three replications.

Place and duration of study: The present investigation was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka, during *rabi* 2020-21.

Methodology: Weed control and phyto-toxicity ratings were recorded at 7, 14 and 21 days after herbicide application in each treatment on 0-10 scale on the basis of visual observations. Dehydrogenase activity in the soil samples was determined and expressedas µg TPF formed per g soil for 24 hrs.

Results: Among the post-emergence herbicides, metsulfuron-methyl + carfentrazone-ethyl (8.00) recorded good weed control being on par with post-emergence herbicide tank mixture of metsulfuron-methyl + sulfosulfuron (7.83) at 14 DAHA. At 7 DAHA, slight phytotoxic injury to crop was noticed with the post-emergence application of metsulfuron-methyl + pinoxaden (0.5), metsulfuron-methyl + sulfosulfuron (0.5), 2,4-D sodium salt (0.5), metsulfuron-methyl + carfentrazone-ethyl (1.00) and metsulfuron-methyl + 2,4-D sodium salt (1.00). There was no phytotoxic injury to the crop with any of the post-emergence herbicides at 14 and at 21 DAHA. Soil dehydrogenase activity was found to be higher (41.02 µg TPF g^{-1} day^{-1}) before herbicide application, whereas the activity was reduced upon herbicide application. Among the herbicide treatments, higher dehydrogenase activity of soil was found with the application of metsulfuron-methyl + pinoxaden (34.07 µg TPF g^{-1} day^{-1}).

Conclusion: Post-emergence tank mix application of metsulfuron-methyl + carfentrazone-ethyl @ 4+20 g ha^{-1} was found to be better in controlling weeds and recorded higher weed control rating. The herbicides or herbicide mixtures used in the present study did not cause any injury, hence it has no phytotoxic effect on wheat crop.However, soil dehydrogenase activity was higher before the application of herbicides, whereas herbicide application resulted in reduced dehydrogenase activity.

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Key words:Dehydrogenase, phytotoxicity, post-emergence, wheat

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is India's second most important cereal crop after rice and is called as king of cereals. There are many factors affect the yield of wheat but weed infestation is one of the most serious causes for low yield in irrigated wheat due to severe competition between weeds and crop plants for moisture, nutrient, light and space. The wheat crop is invaded by grass and broad-leaved weeds which can reduce the grain yield up to 80 per cent [1]. Wheat is generally infested by both grassy weeds *viz.,Phalaris minor* and *Avena* spp. and broad leaf weeds *i.e. Chenopodium album*, *Fumaria parviflora*, *Melilotus indica*, *Anagalles arvensis*, *Cirsium arvense*, *Lathyrus aphaca* and *Vicia sativa*. Chemical weed control is a preferred practice due to scare and costly labour as well as lesser feasibility of mechanical or manual methods. Herbicide combination offers certain advantage like broad spectrum of weed control, enhance herbicide efficiency through synergistic or additive effect, reduced quantity, reduce cost of weed management, arrest weed shifts, prevent herbicide resistance in weeds and facilitate improvement in overall weed management.

Soil enzymes also play a vital role in maintaining the physical and chemical properties of soil and thus, conserving soil ecology as well as soil health [2,3]. The activity of the dehydrogenase (DHA) enzyme in the soil is closely linked with microbial functionality that serves as indicators of changes in soil properties [4]. One of the general criteria used to determine microbial activity and biomass in soil is dehydrogenase activity. Dehydrogenase activity increase with increase in microbial populations following amendments of soils with nutrients [5]. Keeping these points in view, a field experiment with post-emergence herbicide mixtures was conducted to achieve broad spectrum weed control and to evaluate their effect on soil dehydrogenase activity and phytotoxic effects of herbicide mixtures on wheat crop.

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2. MATERIAL AND METHODS

2.1Field experiment A field experiment was conducted during *rabi* (winter) 2020-21 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka. The experiment consisted of ten treatments and was laid out in randomised complete block design (RCBD) with three replications on *vertisols* with pH of 7.21, EC of 0.21 dS/m and available major nutrients of 134, 8 and 145 kg ha^{-1} of N, P_2O_5, K_2O, respectively. Treatments were tank mixture of T_1 : Metsulfuron-methyl 20% WP + 2,4 – D sodium Salt 80% WP @ 4+ 500 g ha^{-1}, T_2 : Metsulfuron-methyl 20% WP + Pinoxaden 5.1% EC @ 4 + 60 g ha^{-1}, T_3 : Metsulfuron-methyl 20% WP + Sulfosulfuron 75% WG @ 4 + 25 g ha^{-1}, T_4 : Metsulfuron-methyl 20% WP + Carfentrazone-ethyl 20% DF @ 4 + 20 g ha^{-1},while pre mix herbicide *i.e*., T_5 : Clodinofop-propargyl 15% WP + Metsulfuron-methyl 1% WP @ 60 + 4 g $ha^{-1}$and individual application of T_6 : Metsulfuron-methyl 20% WP @ 4 g ha^{-1}, T_7 : 2,4 – D sodium salt 80% WP @ 2.0 kg $ha^{-1}$and recommended weed management practice (RWMP) of T_8 : Pendimethalin 30% EC 1 kg ha^{-1} as PE + one hand weeding, T_9 : Weed free check and T_{10}: Weedy check. The wheat variety UAS 304 at the rate of 150 kg ha^{-1} after treating with *Azospirillium* (1250 g ha^{-1}) were drilled evenly in the furrows at 22.5 cm row spacing and covered with soil manually. Recommended doses of nitrogen, phosphorus and potassium were given in the form of urea, di-ammonium phosphate and muriate of potash, respectively. Half of the recommended dose of N (50 kg ha^{-1}) and full dose of P_20_5 (75 kg ha^{-1}) and K_2O (50 kg ha^{-1}) were applied as basal and the remaining nitrogen (50 kg ha^{-1}) was applied 30 DAS. Experimental site was uniformly irrigated prior to sowing of seeds and application of fertilizers. Then subsequent irrigations were given at an interval of 10-15 days till the crop reaches physiological maturity so as to maintain adequate soil moisture in root zone.

2.2Herbicide application: All the herbicides were applied at 28 days after sowing with the help of knapsack sprayer with a spray volume of 500 lit $ha^{-1}$with minimum trampling. In T_8, pre-emergence herbicide was sprayed a day after sowing. The weed free plot was maintained by repeated manual weeding. The crop was harvested at maturity leaving the border row plants and then the produce from net plots were collected and sun dried for two days.

2.3Weed parameter: The weed density was recorded at pre-treatment, 20 DAHA and 40 DAHA (days after herbicide application) with the help of 1 m^2 quadrate and data on weed density were subjected to square root transformation before statistical analysis. Weed control rating and Phyto-toxicity ratings (phytotoxic effects of post-emergence herbicides on crop) was recorded at 7, 14 and 21 DAHA (days after herbicide application) in each treatment on 0-10 scale [6] on the basis of visual observations (Table 1 and 2 respectively).

2.4Enzymatic activity: Dehydrogenase activity in the soil samples was determined as per the procedure as described [7]. Moist soil samples (4 g) were placed in 16 × 150 mm^2test tubes to which was added 1 ml of 3% aqueous solution of 2,3,5-triphenyl tetrazolium chloride, 40 mg $CaCO_3$and 2.5 ml distilled water. The contents of each tube were then mixed with a glass rod and incubated for 4 hrs at 37ºC. Triphenyl formazan (TPF) was extracted by transferring the soil with the aid of methanol from each tube to a funnel plugged with absorbent cotton and the colour intensity determined in a spectrophotometer at a wave length of 485 nm. The dehydrogenase activity was expressed as µg TPF formed per g soil for 24hrs.

2.5Statistical analysis: Analysis of variance was conducted in order to examine the impact of herbicides on soil dehydrogenase and phytotoxicity rating. Data obtained were statistically analysed using the F-test procedure as given by [8]. The level of significance used in “F” test was P=0.05. Standard error (SE) and critical difference (CD) were worked out for comparing treatment means of the studied variables of crop and weeds.

Table 1. Qualitative description of treatment effects on weeds

Effect	Rating	Weed
None	0	No control
Slight	1	Very poor control
	2	Poor control
	3	Poor to deficient Control
Moderate	4	Deficient control
	5	Deficient to moderate Control
	6	Moderate control
Severe	7	Control
	8	Good control
	9	Good to excellent
Complete	10	Complete control

Table 2. Qualitative description of treatment effects on crop (Phytotoxicity rating) in the visual scoring scale of 0 to 10

Effect	Rating	Crop
None	0	No injury, normal
Slight	1	Slight stunting, injury or discoloration
	2	Some stand loss, stunting or discoloration
	3	Injury more pronounced but not persistent
Moderate	4	Moderate injury, recovery possible
	5	Injury more persistent, recovery doubtful
	6	Near severe injury, no recovery possible
Severe	7	Severe injury stand loss
	8	Almost destroyed, few plants surviving
	9	Very few plants alive
Complete	10	Complete destruction

3 RESULTS AND DISCUSSION

3.1 Effect of herbicides on weed control rating

The post emergence herbicides were sprayed at 28 DAS and visual observations on weed control rating showed marked differences among the different weed management practices recorded at 7, 14 and 21 DAHA and are presented in Table 3.

At 7 DAHA, the recommended weed management practice of pendimethalin (PE) + one hand weeding (RWMP) recorded good weed control (9.17). Among the post-emergence herbicide treatments, Metsulfuron-methyl + Carfentrazone-ethyl (6.00) followed by Metsulfuron-methyl + Sulfosulfuron (4.83) were found to be better in controlling weeds. These two treatments found to be superior over post emergence tank mixture application of Metsulfuron-methyl + 2,4-D sodium salt (4.00), Metsulfuron-methyl + Pinoxaden (2.83) and pre mix of Clodinofop-propargyl + Metsulfuron-methyl (2.17). All the herbicide mixtures recorded good weed control rating compared to individual application of Metsulfuron-methyl (2.17). However, weed free check recorded statistically superior weed control rating (10.00) and in contrast weedy check recorded lower rating (0.00).

Table 3: Weed control rating (0-10) as influenced by weed management practices in wheat

Comment [WU3]: This discussion is not in depth.
There has been no discussion regarding:
1. Why
2. How
3. When
4. what

In the discussion you should discuss things related to "how could this happen?"

what causes this to happen?

What type of chemical has the greatest effect on inhibiting weed growth and why?

Why does Metsulfuron -methyl 20% WP + Carfentrazone -ethyl 20% DF have a big effect on weed growth failure? What is the failure percentage?
please add physiological and morphological influences on weeds from the beginning until the weeds cannot grow.

This must be explained scientifically and reinforced with research results or other people's literature.

Treatments	Weed control rating (0-10)		
	7 DAHA	14 DAHA	21 DAHA
T_1 : Metsulfuron-methyl 20% WP + 2,4 – D Sodium salt 80% WP (Tank Mix) @ 4 + 500 g ha^{-1} PoE at 25-30 DAS	4.00	7.00	6.83
T_2 : Metsulfuron-methyl 20% WP + Pinoxaden 5.1% EC (Tank Mix) @ 4 + 60 g ha^{-1} PoE at 25-30 DAS	2.83	6.83	6.50
T_3 : Metsulfuron-methyl 20% WP + Sulfosulfuron 75% WG (Tank Mix) @ 4 + 25 g ha^{-1} PoE at 25-30 DAS	4.83	7.83	7.50
T_4 : Metsulfuron-methyl 20% WP + Carfentrazone-ethyl 20% DF (Tank Mix) @ 4 + 20 g ha^{-1} at 25-30 DAS	6.00	8.00	7.83
T_5 : Clodinofop-propargyl 15% WP + Metsulfuron-methyl 1% WP (Pre mix) @ 60 + 4 g ha^{-1} PoE at 25-30 DAS	2.17	7.33	6.83
T_6 : Metsulfuron-methyl 20% WP @ 4 g ha^{-1} PoE at 25-30 DAS	2.17	6.00	5.67
T_7 : 2,4 – D Sodium salt 80% WP @ 2.0 kg ha^{-1} PoE at 25-30 DAS	2.00	6.83	5.83
T_8 : Pendimethalin 30% EC 1 kg ha^{-1} as Pre emergence + one hand weeding (RWMP)	9.17	8.83	8.00
T_9 : Weed free check	10.00	10.00	10.00
T_{10} : Weedy check	0.00	0.00	0.00

PE : Pre-emergence herbicide
PoE : Post emergence herbicide
DAS: Days after sowing
DAHA: Days after herbicide application

At 14 DAHA, weed free check recorded statistically superior weed control rating (10.00). The recommended weed management practice of Pendimethalin (PE) + one hand weeding (RWMP) recorded higher weed control rating (8.83). Among the post-emergence herbicide tank mixtures, Metsulfuron-methyl + Carfentrazone-ethyl (8.00) recorded good weed control being on par with post-emergence herbicide tank mixture of Metsulfuron-methyl + Sulfosulfuron (7.83) and pre mix Clodinofop-propargyl + Metsulfuron-methyl (7.33). These treatments found to be superior over post emergence tank mixture of Metsulfuron-methyl + 2,4-D sodium salt (7.00), Metsulfuron-methyl + Pinoxaden (6.83). All the herbicide mixtures recorded higher weed control rating compared to individual application of Metsulfuron-methyl (6.00). However, weedy check treatment (0.00) recorded least weed control compared to all other treatments.

At 21 DAHS, the recommended weed management practice of pendimethalin (PE) + one hand weeding (RWMP) recorded higher weed control rating (8.00) and was found to be on par with post-emergence tank mixture of Metsulfuron-methyl + Carfentrazone-ethyl (7.83) and Metsulfuron + Sulfosulfuron (7.50). These two treatments were found to be superior over tank mixture of Metsulfuron-methyl + 2,4-D sodium salt (6.83), Metsulfuron-methyl + Pinoxaden (6.50) and pre mix of Clodinofop-propargyl + Metsulfuron-methyl (6.83). All the herbicide mixtures recorded higher weed control rating compared to application of Metsulfuron-methyl (5.67) alone. However, weed free check recorded statistically superior weed control rating (10.00) and in contrast weedy check recorded lower ratings of weed control (0.00).

At 7 DAHA, treatment receiving Metsulfuron-methyl + Carfentrazone-ethyl recorded less control of weeds (6.00) but at 14 DAHA, Metsulfuron-methyl + Carfentrazone-ethyl recorded good control of weeds (8.00). Metsulfuron-methyl alone showed less control of weeds (6.00). But Metsulfuron-methyl tank mixed with Carfentrazone-ethyl was best treatment among the herbicide treated plot. This was due to the fact that Carfentrazone-ethyl, belonging to aryl triazolinone family

has been found effective in controlling BLWs and sedge weeds (in cereals) by inhibiting the activity of protoporphyrinogen oxidase in chlorophyll biosynthetic pathway. Metsulfuron-methyl being systemic herbicide, effective in killing broad leaf weeds and some annual grasses. Hence tank mixture of these herbicides resulted in broad spectrum weed control. Similar findings were also observed by [9].

3.2 Effect of post-emergent herbicides on phytotoxicity rating on wheat

Comment [WU4]: It has not been explained how to create a 0-10 scale for phytotoxicity. Please explain

Visual observation on crop toxicity rating (0-10) recorded at 7, 14 and 21 DAHA are presented in Table 4. At 7 DAHA, slight phytotoxic injury to crop was noticed with the post-emergence application of Metsulfuron-methyl + Pinoxaden (0.5), Metsulfuron-methyl + Sulfosulfuron (0.5), 2,4-D sodium salt (0.5), Metsulfuron-methyl + Carfentrazone-ethyl (1.00) and Metsulfuron-methyl + 2,4-D sodium salt (1.00). There was no phytotoxic injury to the crop with any of the post-emergence herbicides at 14 and at 21 DAHA. The treatments *viz*., Metsulfuron-methyl + Pinoxaden, metsulfuron-methyl + Sulfosulfuron, 2,4-D sodium salt, Metsulfuron-methyl + Carfentrazone-ethyl and Metsulfuron-methyl + 2,4-D sodium salt did not cause any injury to the crop from 14 to 21 DAHA.

Table 4: Phytotoxicity rating (0-10) as influenced by weed management practices in wheat

Treatments	Phytotoxicity rating (0-10)		
	7 DAHA	14 DAHA	21 DAHA
T_1 : Metsulfuron-methyl 20% WP + 2,4 – D Sodium salt 80% WP (Tank Mix) @ 4 + 500 g ha^{-1} PoE at 25-30 DAS	1	0	0
T_2 : Metsulfuron-methyl 20% WP + Pinoxaden 5.1% EC (Tank Mix) @ 4 + 60 g ha^{-1} PoE at 25-30 DAS	0.5	0	0
T_3 : Metsulfuron-methyl 20% WP + Sulfosulfuron 75% WG (Tank Mix) @ 4 + 25 g ha^{-1} PoE at 25-30 DAS	0.5	0	0
T_4 : Metsulfuron-methyl 20% WP + Carfentrazone-ethyl 20% DF (Tank Mix) @ 4 + 20 g ha^{-1} at 25-30 DAS	1	0	0
T_5 : Clodinofop-propargyl 15% WP + Metsulfuron-methyl 1% WP (Pre mix) @ 60 + 4 g ha^{-1} PoE at 25-30 DAS	0	0	0
T_6 : Metsulfuron-methyl 20% WP @ 4 g ha^{-1} PoE at 25-30 DAS	0	0	0
T_7 : 2,4 – D Sodium salt 80% WP @ 2.0 kg ha^{-1} PoE at 25-30 DAS	0.5	0	0
T_8 : Pendimethalin 30% EC 1 kg ha^{-1} (PE) + one hand weeding (RWMP)	0	0	0
T_9 : Weed free check	-	-	-
T_{10} : Weedy check	-	-	-

PE : Pre-emergence herbicide
PoE : Post emergence herbicide
DAS: Days after sowing
DAHA: Days after herbicide application

The herbicides or herbicide mixtures used in the present studies did not cause any injury to the wheat crop at 14 and 21 DAHA (Table 4). But at 7 DAHA, Metsulfuron-methyl + 2,4-D sodium salt and Metsulfuron-methyl + Carfentrazone-ethyl showed moderate yellowing and recovered after few days of herbicide application, there by indicating that all the herbicides are safe and there was no phytotoxicity to wheat crop growth (Table 4). Similar observations on phytotoxicity on Carfentrazone-ethyl and Metsulfuron-methyl were observed in wheat [9,10].Pinoxaden at the recommended rate caused 1.5% average wheat phytotoxicity [11]. There was no phytotoxicity recorded in Pendimethalin 30 % EC @ 1 kg a.i. ha^{-1} as PE (Table 4). Similar effect of herbicide was reported in Soybean [12].

3.3 Effect of post-emergent herbicides on soil dehydrogenase activity

The dehydrogenase activity of soil markedly differed with different weed management treatments (Table 5). Soil enzymes play a key role in biochemical functions in the overall process of organic matter decomposition, mineralization and transport of nutrients in the soil systems. They are important in catalyzing several reactions necessary for the life process of micro-organisms in soils and stabilization of soil structure, organic matter formation, nutrient cycling. These enzymes are constantly being synthesized, accumulated and deposited in soil. The dehydrogenase activity is commonly used as an indicator of soil biological activity. This enzyme is known to oxidize soil organic matter by transferring electrons and protons from substrates to acceptors. These processes are the part of the respiration pathways of soil micro-organisms. It is an indicative of the potential status of the soil to support biochemical processes.

Table 5: Dehydrogenase activity of soil as influenced by weed management practices in wheat

Treatments	**Soil dehydrogenase activity (μg TPF g^{-1} day^{-1}) at 45 DAS**
T_1 : Metsulfuron-methyl 20% WP + 2,4 – D Sodium salt 80% WP (Tank Mix) @ 4 + 500 g ha^{-1} PoE at 25-30 DAS	21.33
T_2 : Metsulfuron-methyl 20% WP + Pinoxaden 5.1% EC (Tank Mix) @ 4 + 60 g ha^{-1} PoE at 25-30 DAS	34.07
T_3 : Metsulfuron-methyl 20% WP + Sulfosulfuron 75% WG (Tank Mix) @ 4 + 25 g ha^{-1} PoE at 25-30 DAS	23.77
T_4 : Metsulfuron-methyl 20% WP + Carfentrazone-ethyl 20% DF (Tank Mix) @ 4 + 20 g ha^{-1} at 25-30 DAS	32.40
T_5 : Clodinofop-propargyl 15% WP + Metsulfuron-methyl 1% WP (Pre mix) @ 60 + 4 g ha^{-1} PoE at 25-30 DAS	21.37
T_6 : Metsulfuron-methyl 20% WP @ 4 g ha^{-1} PoE at 25-30 DAS	24.97
T_7 : 2,4 – D Sodium salt 80% WP @ 2.0 kg ha^{-1} PoE at 25-30 DAS	24.00
T_8 : Pendimethalin 30% EC 1 kg ha^{-1} as Pre emergence + one hand weeding (RWMP)	18.60
T_9 : Weed free check	48.28
T_{10} : Weedy check	50.33
S. Em. ±	0.77
C. D. at 5%	2.28

PE : Pre-emergence herbicide
PoE : Post- emergence herbicide
DAS: Days after sowing

Initially, (before the application of post emergence herbicides) the dehydrogenase activity of soil was around 41.02 µg TPF g^{-1} day^{-1}. At 45 DAS, weedy check treatment recorded statistically superior dehydrogenase activity of soil (50.33 µg TPF g^{-1} day^{-1}) and was found on par with weed free treatment (48.28 µg TPF g^{-1} day^{-1}). Among the herbicide treatments higher dehydrogenase activity was recorded with post-emergence tank mixture application of Metsulfuron-methyl + Pinoxaden

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(34.07 µg TPF g^{-1} day^{-1}) and was found on par with Metsulfuron-methyl + Carfentrazone-ethyl (32.40 µg TPF g^{-1} day^{-1}). However, recommended weed management practice of pendimethalin (PE) + one hand weeding (18.60 µg TPF g^{-1} day^{-1}) recorded lower dehydrogenase activity of soil.

Before the application of post-emergence herbicides, the soil dehydrogenase activity was found to be higher (41.02 µg TPF g^{-1} day^{-1}). Application of herbicides reduced the dehydrogenase activity, further post-emergence herbicides have less impact on soil dehydrogenase activity than pre-emergence herbicides (Table 5). Among the weed management practices, weedy check recorded the highest dehydrogenase activity at 45 DAS (50.33 µg TPF g^{-1} day^{-1}) found on par with weed free treatment (48.28 µg TPF g^{-1} day^{-1}). This is mainly because there was no herbicidal effect on soil micro-organisms in these treatments. Among the herbicidal treatments, higher dehydrogenase was found with Metsulfuron-methyl + Pinoxaden (34.07 µg TPF g^{-1} day^{-1}) followed by Metsulfuron-methyl + Carfentrazone-ethyl (32.40 µg TPF g^{-1} day^{-1}) indicating that these two herbicides have less impact on dehydrogenase activity. The increase in dehydrogenase activity was mainly due decrease in the effect of herbicides over lapse of time period. But, recommended weed management practice of pendimethalin (PE) + one hand weeding (18.60 µg TPF g^{-1} day^{-1}) recorded lower dehydrogenase activity compared to other treatments. This might be due to the fact that pre-emergence herbicides are directly sprayed on the soil surface which affect the soil micro-organisms there by affecting the soil dehydrogenase activity. Whereas, post-emergence herbicides are usually sprayed on the foliage which results in the less contact of herbicides with soil surface and these post-emergence herbicides are usually sprayed at 25-30 DAS, where there will be sufficient buildup of soil micro-organisms leading to higher dehydrogenase activity.Also, the herbicides used at recommended dosage were non-inhibitory on dehydrogenase activity [13].

4. CONCLUSION

It was inferred that among the chemical treatments, tank mix post emergence application of Metsulfuron-methyl 20% WP + Carfentrazone-ethyl 20% DF @ 4 + 20 g ha-1 was found effective in controlling weeds and resulted in higher weed control rating. Metsulfuron-methyl + 2,4-D sodium salt and Metsulfuron-methyl + Carfentrazone-ethyl showed little yellowing and recovered after few days of herbicide application, which indicates that the herbicide mixtures are safe and found no phytotoxicity to wheat crop growth. Higher dehydrogenase activity was found with weed free check followed by weedy check, application of herbicides resulted in reduced soil dehydrogenase activity. The following experiment unraveled the toxic effect of herbicides on soil microbiomes. Tank mixture of new generation herbicides proved no phytotoxicity on wheat.

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Comment [WU7]: Please tidy up the bibliography, according to the journal's guidelines.

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