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Economic feasibility of wheat cultivation under different herbicides doses at Dehradun condition

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Abstract
The field experiments entitled "Economic feasibility of wheat cultivation under different herbicides doses at Dehradun Condition" was conducted during *Rabi* season of 2021-22 at the SIPS, Dehradun to obtain the information on relative performance on wheat crop and weeds under different herbicides. The experiment consisted of 11 treatments i.e. Pendimethalin (pre-emergence) @ 1lit ai. ha^{-1}, Pyroxasulfone (pre-emergence) @ 127.5g ai. ha^{-1}, Metsulfuron (post-emergence) @ 4g ai. ha^{-1}, Sulfosulfuron (post-emergence) @ 25g ai. ha^{-1}, Pendimethalin (1lit ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Pendimethalin (1lit ai. ha^{-1}) *fb* Metsulfuron (4g ai. ha^{-1}), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Metsulfuron (4g ai. ha^{-1}), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}), Weed free and Weed check was laid out in Randomized block design with three replications. It concluded that highest grain yield (50 q ha^{-1}) recorded under weed free treatment which was at par with Sulfosulfuron (25g ai. ha-1) + Metsulfuron (4g ai. ha-1), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Pendimethalin (1lit ai. ha-1) *fb* Sulfosulfuron (25g ai. ha^{-1}) and Sulfosulfuron (post-emergence) 25g ai. ha^{-1} while significantly higher than rest of treatments. It concluded that highest straw yield (70.20 q ha^{-1}) recorded under weed free treatment. Maximum cost of cultivation (Rs. 57911 ha^{-1}) found with weed free treatment whereas minimum under the weedy check treatment. Higher gross return (Rs.141770.50 ha^{-1}) and net return (Rs. 87947.00 ha^{-1}) recorded under weed free treatment. Whereas highest B: C (1:2.80) ratio recorded under Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}). Thus Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) may be recommended for better weed control, higher wheat yield and profit.

Keywords: Grain yield, straw yield, Cost of cultivation, gross income, net income, B:C ratio, weedicides etc.

Introduction
Wheat (*Triticum aestivum* L.) is India's second most important food grain. Wheat is known as the "King of Cereals." Wheat is a reliable food source for over one billion people in 43 nations across the world. It supplies around 20% of a human's total calorie intake. Wheat is farmed on around 224.49 million hectare throughout the world, with nearly half of it in poor nations. Today, it is one of India's grain crops wheat is the second-largest crop in terms of acreage and output after rice. Wheat is a member of the Poaceae family and is thought to have originated in South-West Asia.

On a global scale, India is the second largest producer of wheat, accounting for approximately 12% of global wheat production. It is also the second largest consumer of wheat after China, with a rapidly growing demand. Wheat has occupied an area of 224.49 million hectare, with a total production of 792.40 million tonnes and a productivity of 3.52 t ha^{-1} in the world. In India, it is grown by 31.61 million hectare (13.43% global area) with a production of 109.52 million tonnes (1.3% rise from the previous year) and productivity of about 3464 kg ha^{-1} (Anonymous, 2021).Weed infestation is one of the main reasons that wheat yields are low not only in India but all over the world. Weed infestation reduces wheat yield by 37 to 50 percent, but it can be reduced even more by following proper weed management practices. There are a lot of different ways to get rid of weeds, but no one is 100% sure. Manual weeding other than costly and torments taking can't be polished until weeds set forth adequate vegetative development.

The use of herbicides has made it possible to effectively control a wide range of wheat weeds. Herbicides like Sulfosulfuron + Metsulfuron @ 0.096 g ha^{-1} enlisted the most noteworthy weed control efficiency of 82.27% (Singh *et al*., 2015) [10].

Materials and Methods

The present field experiments conducted entitled "Economic feasibility of wheat cultivation under different herbicides doses at Dehradun Condition" was carried out during the *rabi* season of 2021-22. The details of materials used and techniques adopted during the experiments described as;-

Table 1: Detail of treatments with their symbols

Symbol	Treatment
T_1	Pendimethalin (pre-emergence) @ 1 lit a.i. ha^{-1}
T_2	Pyroxasulfone (pre-emergence) @ 127.5 g a.i. ha^{-1}
T_3	Metsulfuron (post-emergence) @ 4 g a.i. ha^{-1}
T_4	Sulfosulfuron (post-emergence) @ 25 g a.i. ha-1
T_5	Pendimethalin *fb* Sulfosulfuron @ (1lit. a.i. ha^{-1} *fb* 25 g a.i. g $ha^{-1)}$
T_6	Pendimethalin *fb* Metsulfuron @ (1lit. a.i. ha^{-1} *fb* 4 g a.i. g ha^{-1})
T_7	Pyroxasulfone *fb* Metsulfuron @ (127.5 g a.i. ha^{-1} *fb* 4g a.i. g ha^{-1})
T_8	Pyroxasulfone *fb* Sulfosulfuron @ (127.5 g a.i. ha^{-1} *fb* 25 g a.i. g ha^{-1})
T_9	Sulfosulfuron + Metsulfuron @ (25 g a.i. g ha^{-1} + 4g a.i. g ha^{-1})
T_{10}	Weed free
T_{11}	Weed check

Experimental design and layout

The treatments were laid out in Randomized Block Design (RBD) being treatments (11) with three replications and the basic principles of randomization were followed.

1.	Design adapted	Randomized Block Design
2.	Variety	HD-2967
3.	Number of replications	3
4.	Number of treatments	11
5.	Total number of plots	3 × 11 = 33
6.	Gross plot size	4.5m × 6m = 27m-2
7.	Net plot size	4.10m × 5m= 20.5m-2
8.	Plot border	0.5 m
9.	Block border	1.0 m
10.	Field border	1.0 m
11.	Main irrigation channel	1.5 m
12.	Sub-irrigation channel	1.0 m
13.	Row-to-row spacing	20 cm

Observation recorded

Grain yield (q ha^{-1})

After taking the weight of total biomass, yield of each net plot was threshed separated and clean grains were sun-dried to maintain 12% moisture. The grain yield was recorded in kg $plot^{-1}$ and finally, the values were converted into q ha^{-1}.

Straw yield (q ha^{-1})

The weight of total produce per net plot was recorded before threshing. The straw yield was calculated by subtracting the grain yield from the weight of the total produce of the net plot and expressed in quintals per hectare.

Economic Analysis

Cost of Cultivation (Rs ha^{-1}): The cost of cultivation of wheat crops was calculated including treatment cost on the basis of local market price of different inputs used in cultivation.

Gross returns (Rs ha^{-1})

The monetary value of grain and straw yield was computed in rupees using the support price of outputs. Gross return was obtained by adding the monetary values of grains and straw.

Gross Return (Rs ha^{-1}) = Grain yield (q ha^{-1}) × price (Rs. q^{-1}) + Straw yield (q ha^{-1}) × price (Rs. q^{-1})

Net returns (Rs ha^{-1})

The net return for each treatment combination was calculated by deducting the cost of cultivation from the respective grass return.

Net Return (Rs. ha^{-1}) = Gross return – Cost of cultivation

Benefit: Cost ratio

The net benefit: cost ratio was computed for the crop as well as for the system by the following formula:

Benefit: Cost ratio = Net return (Rs./ha)Cost of cultivation (Rs./ ha)

Statistical Analysis

The data recorded on different observations were analyzed statistically by using the analysis of variance (ANOVA) technique as suggested by Gomez and Gomez (1984) [11]. A critical difference at 0.05 probability level was worked out to compare the treatments when F-test was found significant.

Note

SEm ±: The standard error of the mean for different main effects was calculated with the help of the following Formula;

$$S.Em \pm = \sqrt{2VEr} \times 100$$

Where,
Where, VE = error variance,
r = no. of observation

Critical difference (CD): It was calculated by the following formula

CD = S.Em± ×√2×t value at error degree freedom at 5%

Coefficient of variance (CV) %

It was calculated by the following formula:

CV (%) =SDMean×100

Where,

CV	=	Coefficient of variance
CD	=	Critical difference
S.Em	=	Error sum of means
SD	=	Standard deviation

Result and Discussion

Yield studies

Grain yield (q ha^{-1})

The data related to grain yield of wheat depicted in Table-2 and graphically depicted in Fig.1, it clearly indicate that all the treatments had significantly affect on grain yield. Data further revealed that the maximum grain yield (50.08 q ha^{-1})

recorded under weed free treatment which was at par with Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) T_9, Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}) T_8, Pendimethalin (1lit ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}) T_5. Among the herbicides highest grain yield (48.20 q ha^{-1}) was recorded with Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) T_9. This might be due to the smothering effect of respective herbicides, which result more translocation of food from source to sink in treatment enhanced more growth and development of wheat.

Straw yield (q ha^{-1})

The data pertaining to straw yield of wheat given in Table-2 and graphically depicted in Fig-1, clearly indicate that all the treatments had significantly affect on straw yield. Data further reveled that highest straw yield (70.21 q ha^{-1}) recorded under weed free treatment (T_{10})which was at par with Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) T_9, Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}) T_8, Pendimethalin (1lit ai. ha-1) *fb* Sulfosulfuron (25g ai. ha^{-1}) T_5.

Economics

Cost of cultivation (Rs. ha^{-1}): Among all treatments maximum cost of cultivation (Rs.57911 ha^{-1}) found with weed free treatment whereas minimum under the weedy check treatment T_{10}.

Gross return (Rs. ha^{-1})

All treatment resulted higher gross return over weedy check. Data depicted that weed free treatment gave higher gross return (Rs.141770.50 $ha^{-1)}$ T_{10} while minimum in weedy check (Rs.100692.50 ha^{-1}) T_{11}.

Net return (Rs. ha^{-1})

All treatments gave higher net return than weedy check. Maximum net return (Rs. ha^{-1}) recorded under the treatment Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) T_9 Rs. 87947.00.

Benefit cost ratio (B:C ratio)

All the treatments had effect on the benefit cost ratio. Maximum B: C ratio recorded under the treatment (T_9) Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) (1:2.80).

The weed free was not found to be economical in comparison to other herbicidal treatments because of high expenditure involved in keeping weed free of plot. In the herbicides the better net return and B: C ratio was mainly due to less increase in cost of cultivation with these treatments compare to weed free.

Table 2: Effect of different herbicides on grain yield and straw yield of wheat.

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Pendimethalin (pre-emergence) @ 1 lit a.i. ha^{-1} (T_1)	40.40	58.30	48580	115115	66535	1:2.37
Pyroxasulfone (pre-emergence) @ 127.5 g a.i. ha^{-1} (T_2)	40.70	58.65	51950	115932.5	63982.50	1:2.23
Metsulfuron (post-emergence) @ 4 g a.i. ha^{-1} (T_3)	38.10	57.48	47665	109686	62021	1:2.30
Sulfosulfuron (post-emergence) @ 25 g a.i. ha-1 (T_4)	45.52	64.54	48512	129187	80675	1:2.66
Pendimethalin *fb* Sulfosulfuron @ (1lit. a.i. ha^{-1} *fb* 25 g a.i. g $ha^{-1)}$ (T_5)	46.44	65.76	49629	131760	82131	1:2.65
Pendimethalin *fb* Metsulfuron @ (1lit. a.i. ha^{-1} *fb* 4 g a.i. g ha^{-1}) (T_6)	41.96	58.49	48793	118632.5	69839.50	1:2.43
Pyroxasulfone *fb* Metsulfuron @ (127.5 g a.i. ha^{-1} *fb* 4g a.i. g ha^{-1}) (T_7)	43.15	60.03	52172	121943.5	69771.50	1:2.34
Pyroxasulfone *fb* Sulfosulfuron @ (127.5 g a.i. ha^{-1} *fb* 25 g a.i. g ha^{-1}) (T_8)	47.80	67.46	53003	135517	82514	1:2.56
Sulfosulfuron + Metsulfuron @ (25 g a.i. g ha^{-1} + 4g a.i. g ha^{-1}) (T_9)	48.25	67.88	48749	136696	87947	1:2.80
Weed free (T_{10})	50.08	70.21	57911	141770.5	83859.50	1:2.45
Weed check (T_{11})	34.82	53.53	47413	100692.5	53279.50	1:2.12

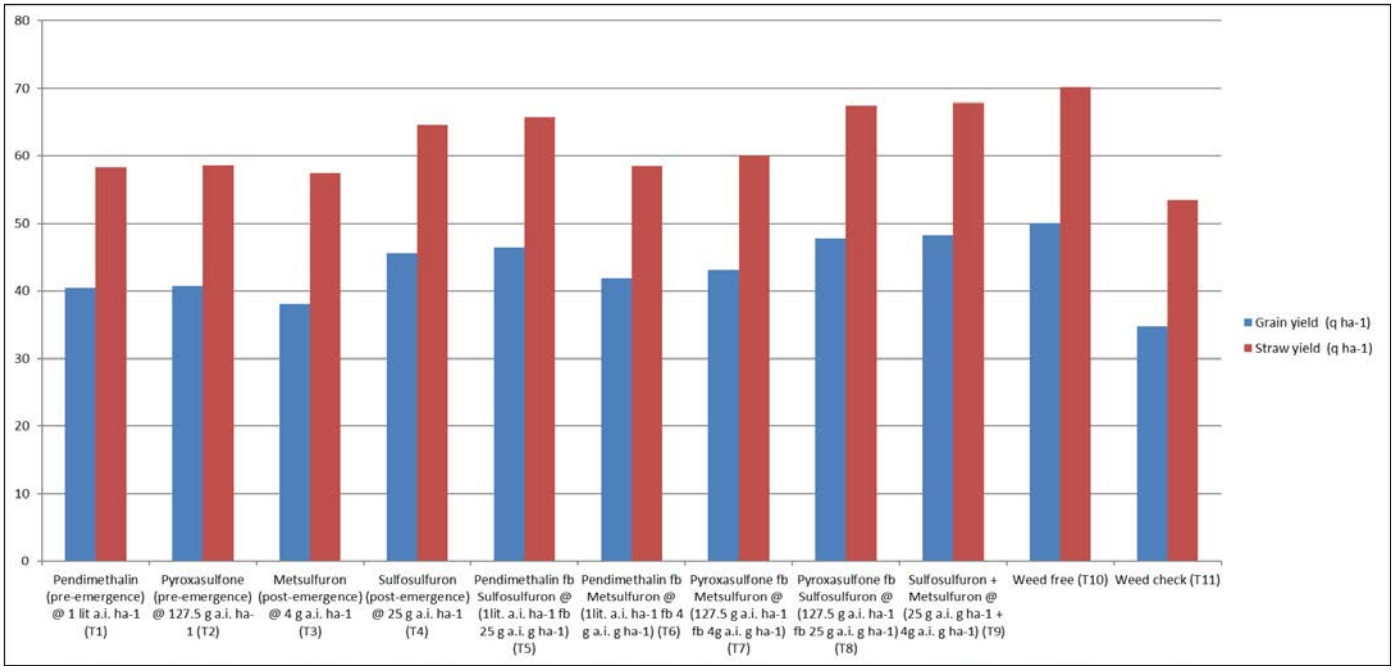

Fig 1(I): Grain and Straw yield of wheat influenced by different treatments

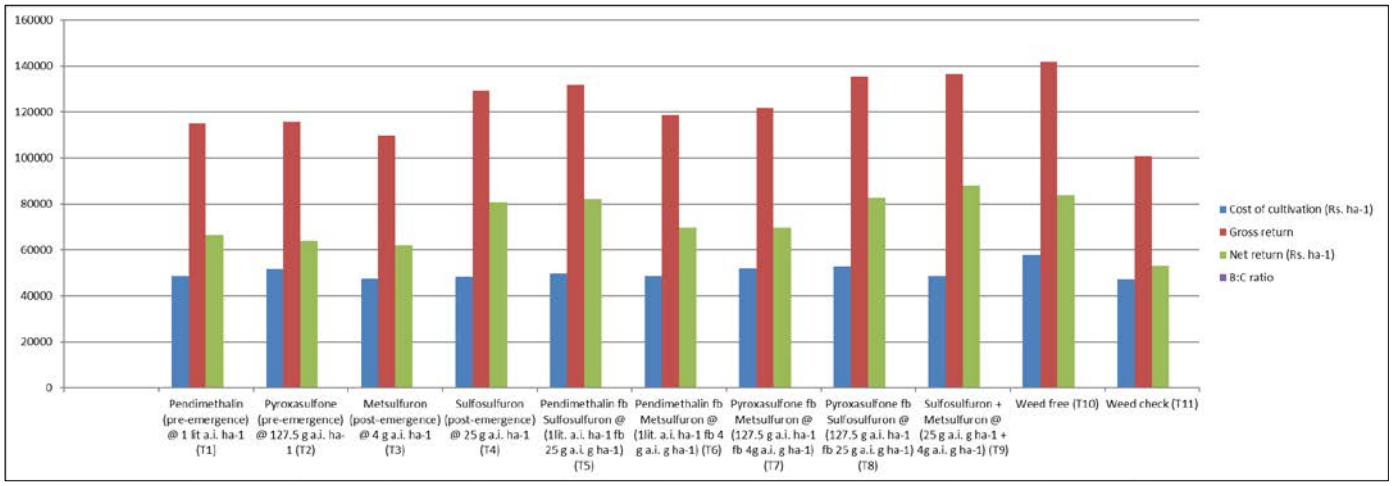

Fig 1(II): Economics feasibility of wheat influenced by different treatments

Summary and conclusion

The field experiments entitled "Economic feasibility of wheat cultivation under different herbicides doses at Dehradun Condition" was conducted during *Rabi* season of 2021-22 at the SIPS, Dehradun to obtain the information on relative performance on wheat crop and weeds under different herbicides. The experiment consisted of 11 treatments i.e. Pendimethalin (pre-emergence) @ 1lit ai. ha^{-1}, Pyroxasulfone (pre-emergence) @ 127.5g ai. ha^{-1}, Metsulfuron (post-emergence) @ 4g ai. ha^{-1}, Sulfosulfuron (post-emergence) @ 25g ai. ha^{-1}, Pendimethalin (1lit ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Pendimethalin (1lit ai. ha^{-1}) *fb* Metsulfuron (4g ai. ha^{-1}), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Metsulfuron (4g ai. ha^{-1}), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}), Weed free and Weed check was laid out in Randomized block design with three replications. The results summarized as:

It concluded that highest grain yield (50 q ha^{-1}) recorded under weed free treatment which was at par with Sulfosulfuron (25g ai. ha-1) + Metsulfuron (4g ai. ha-1), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Pendimethalin (1lit ai. ha-1) *fb* Sulfosulfuron (25g ai. ha^{-1}) and Sulfosulfuron (post-emergence) 25g ai. ha^{-1} while significantly higher than rest of treatments. It concluded that highest straw yield (70.20 q ha^{-1}) recorded under weed free treatment which was at par with Sulfosulfuron (25g ai. ha-1) + Metsulfuron (4g ai. ha^{-1}), Pyroxasulfone (127.5g ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}), Pendimethalin (1lit ai. ha^{-1}) *fb* Sulfosulfuron (25g ai. ha^{-1}) and Sulfosulfuron (post-emergence) 25g ai. ha^{-1} while significantly higher than rest of treatments. Maximum cost of cultivation (Rs. 57911 ha^{-1}) found with weed free treatment whereas minimum under the weedy check treatment. Higher gross return (Rs.141770.50 ha^{-1}) and net return (Rs. 87947.00 ha^{-1}) recorded under weed free treatment. Whereas highest B: C (1:2.80) ratio recorded under Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}). Post emergence application of Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) was found most effective for better crop growth, maximum yield attributes and grain yield of wheat crop. The highest net return (Rs. 87947.00 ha^{-1}) and B:C (1:2.80) ratio was recorded under the treatment (T9) Sulfosulfuron (25g ai. ha-1) + Metsulfuron (4g ai. ha^{-1}). Thus Sulfosulfuron (25g ai. ha^{-1}) + Metsulfuron (4g ai. ha^{-1}) may be recommended for better weed control, higher wheat yield and profit.

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