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Efficacy of herbicides against diverse weed flora of wheat (*Triticum aestivum* L.)

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Abstract
The present experiment was conducted at Barrister Thakur Chhedilal College of Agriculture and research station, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during *Rabi* season 2021-22. With a view to study the Efficacy of herbicides against diverse weed flora of wheat (*Triticum aestivum* L.) In wheat. The wheat variety GW322 was used for the research and the treatments were replicated three times in a randomized block design and the treatments was consisted of thirteen treatments. Results revealed that treatment T_{11} where Weed Free at tillering and jointing stages resulted the highest plant height, number of effective tillers at harvest, number of tillers (m^{-2}) length at harvest, grain yield (q ha^{-1}), straw yield (q ha_{-1}). Which was significantly superior over other treatments but was at par with T_7 Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5 + 4 g a.i./ha^{-1} at tillering and jointing stages with grain yield (qha^{-1}) closely followed by the treatment T_5.

Keywords: Pyroxasulfone, metsulfuron, wheat, growth, yield

Introduction

Wheat (*Triticum aestivum* L.) is India's second most important food grain after rice. Wheat is known as the "King of Cereals." The term "Green revolution" refers to the series of agricultural changes that occurred after 1965 as a result of the use and exploitation of the Norin10 dwarfing gene in wheat. The impact of the green revolution enabled India to become self-sufficient in food grain production. Wheat is a self-pollinated crop in the Graminae (Poaceae) family with chromosome 42.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 m ha, with a total production of 792.40 m t and a productivity of 3.52 t ha-1 in the world. Wheat is grown on 33.61 million ha in India, producing 106.21 m t with a national average yield of 3.16 t ha-1 in 2019-20. (Anonymous, 2020) [1].Wheat is an important Rabi crop in Chhattisgarh, and the state's cropping system is primarily rainfed. Wheat covers approximately 1.12 m ha in Chhattisgarh, with a production of 1.5 m t and an average productivity of 1.34 t ha-1 (Anonymous, 2020) [1]. Weeds are undesirable plant species that grow in domesticated crops. Wheat is infested with a diverse weed flora because it is grown under various agro-climatic conditions, cropping sequences, tillage, and irrigation regimes (Chhokar *et al*. 2012) [2]. In a nutshell, they are plants that obstruct the healthy or normal growth and development of crops. They are now known to limit crop production, resulting in significant losses in grain, seed, and fruit output, among other things. Weeds are a major barrier to maintaining wheat production and productivity levels. Weeds caused an estimated yield loss of 7.7 to 23.9% worldwide, depending on the region (Kosina *et al*. 2007) [3]. In such a crisis, herbicides with different modes of action, such as Pendimethalin (pre-emergence) and metribuzin (pre-emergence or post-emergence) alone (Chhokar *et al*. 2012) [2] and in sequential or tank mix combination with post-emergence herbicides sulfosulfuron and clodinofop, pinoxaden, could be viable options (Yadav *et al*. 2016) [4]. It may also be beneficial not only to broaden the scope of weed management and control, but also to reduce selection pressure on resistant biotypes in order to avoid or postpone the development of multiple herbicide resistance and maintain wheat production. Pyroxasulfone is a relatively new herbicide (pre-emergence or post-emergence). It has been approved for use in corn, soyabean, cotton, and wheat in a number of countries.

Pyroxasulfone's herbicidal efficacy was evaluated using growth inhibition tests, greenhouse tests, and a field trial. Pyroxasulfone herbicide demonstrated excellent herbicidal activity at lower application rates than S-metolachlor and has sufficient residual activity, making it an effective tool for chemical weed management programmes.

Material and Methods

A field experiment was carried out during Rabi season of 2021-22 at Agricultural Research Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (Chhattisgarh). The test variety was GW322 sown in Third week of November and harvest in second week of ApriL. The soil of the experimental field was neutral in reaction 6.2 and clay loam soil in texture the experiment was laid out in Randomized Block Design with thirteen treatments and three replications. The treatment comprised of T_1: Pendimethalin (pre-em) 1000 g a.i./ha-1, T_2: Pendimethalin (pre-em) 1500 g a.i./ha-1, T_3: Pyroxasulfone (pre-em) 85% WG 127.5 g a.i./ha-1, T_4: Pendimethalin + Pyroxasulfone (pre-em tank mix) 1250+127.5 g a.i./ha-1, T_5: Pyroxasulfone + Metsulfuron (pre-em) 127.5+4 g a.i./ha-1, T_6: Pyroxasulfone (EPOST)127.5 g a.i./ha-1, T_7: Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5 + 4 g a.i./ha-1, T_8: Metribuzin (pre-em) 300 g a.i./ha-1, T_9: Pendimethalin + Metribuzin (pre-em tank mix) 1250 + 280 g a.i./ha-1, T_{10}: Pyroxasulfone + Metribuzin (pre em tank mix) 127.5+280 g a.i./ha-1,T_{11}: Weedy check, T_{12}: Weed free. The recommended dose of fertilizers for wheat are 120:60:40 kg of N, P2O5, K_2 O he, respectively. Full dose of P2O5, K2O and 50% of Nitrogen were applied at the time of sowing. Growth parameters were recorded just before harvesting of crop. Harvesting was done when the panicle matured and plant was dried up. The threshing of the crop was done by manually by plot wise and grain and straw where conducted separately. The grain yield was recorded as kg plot-1 and then conducted into q ha^{-1}.

Result and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Plant height

Among the applied treatments, T_{12} (Weed free) recorded significantly higher plant height (89.77 cm) as compare to other treatments at the time of harvest. However, it was at par with treatment T_7 (Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5+4 g a.i./ha-1) were at par with each other. The significantly lowest plant height (62.85 cm) was observed in treatment T_{11} (Weedy check). The similar trend was observed in each duration.

Number of total tillers (m^{-2}) at harvest

Among the applied treatments, T_{12} (Weed free) observed significantly higher number of effective tiller per meter square (418.56) as compare to other treatments at the time of harvest. However, it was at par with treatment T_7 (Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5 + 4 g a.i./ha-1).The significantly lowest number of effective tiller per meter square (271.69) was observed in treatment T_{11} (Weedy check).

Table 1: weed population (m^{-2}) & weed dry weight ($g\,m^{-2}$) in wheat as influence by different herbicides at harvest

Treatments	weed population (m^{-2})at harvest	weed dry weight ($g\,m^{-2}$)at harvest
T_1	29.22	7.47
T_2	25.96	7.09
T_3	20.58	5.67
T_4	22.54	6.14
T_5	18.89	4.14
T_6	20.13	4.47
T_7	16.24	3.31
T_8	31.85	8.28
T_9	29.32	7.88
T_{10}	24.60	6.82
T_{11}	296.08	20.61
T_{12}	0.00	0.00
SEm ±	1.32	0.41
CD (P=0.05)	3.89	1.21

Weed population (m^{-2})

At 60 DAS, all of the herbicides examined in this study were applied. Weed management techniques had a significant impact on weed population at, 90, and at harvest. The best results were obtained when Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) were applied. At 60, 90 DAS, and At harvest, respectively, this treatment measured weed population of 12.26, 13.42 and 16.24 m^{-2}. The next-2nd best method for reducing the weed population was the application of Pyroxasulfone + Metsulfuron (pre-em) (T_5), which at 60, 90 DAS and at harvest measured weed populations of 16.53, 17.26 and 18.89 m^{-2}, respectively. Maximum weed population of 108.11, 209.95, 293.37 and 296.08 m^{-2} at 30, 60, 90 DAS and at harvest respectively were recorded from weedy check treatment. At 60 and 90 DAS treatments, Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) had the significantly reduced weed population (12.26 and 13.42 m^{-2}) while (T_5) had the second-lowest weed population, followed by (T_6), (T_3), and (T_4) (T_10). And same trend followed by at harvest, and significantly lower in the weed free (0.00 m^{-2}) than the rest of the treatments.

Table 2: weed population (m^{-2}) & weed dry weight (g m^{-2}) in wheat as influence by different herbicides at harvest

Treatments	weed population (m^{-2})at harvest	weed dry weight (g m^{-2})at harvest
T_1	29.22	7.47
T_2	25.96	7.09
T_3	20.58	5.67
T_4	22.54	6.14
T_5	18.89	4.14
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T_8	31.85	8.28
T_9	29.32	7.88
T_{10}	24.60	6.82
T_{11}	296.08	20.61
T_{12}	0.00	0.00
SEm ±	1.32	0.41
CD (P=0.05)	3.89	1.21

Weed dry weight (g m^{-2})

Using Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) resulted in significantly decreased weed dry matter accumulation of 7.98, 4.33, and 3.31 g m^{-2} at 60, 90DAS and at harvest respectively. When the combination of Pyroxasulfone + Metsulfuron (pre-em) (T_5) was applied, weed dry weight was observed to be 10.09, 7.16 and 4.14 g m^{-2} at 60, 90 DAS, and at harvest respectively. In comparison to the application of Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7), the weedy check treatment recorded 95.63, 26.81 and higher weed dry weight at 60, 90 DAS, and at harvest, respectively. Different weed control measures had a considerable impact on the dry matter of weeds during harvest.

Table 3: weed population (m^{-2}) & weed dry weight (g m^{-2}) in wheat as influence by different herbicides at harvest

Treatments	weed population (m^{-2})at harvest	weed dry weight (g m^{-2})at harvest
T_1	29.22	7.47
T_2	25.96	7.09
T_3	20.58	5.67
T_4	22.54	6.14
T_5	18.89	4.14
T_6	20.13	4.47
T_7	16.24	3.31
T_8	31.85	8.28
T_9	29.32	7.88
T_{10}	24.60	6.82
T_{11}	296.08	20.61
T_{12}	0.00	0.00
SEm ±	1.32	0.41
CD (P=0.05)	3.89	1.21

Weed control efficiency (%)

The post emergence integrated application of Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) had the maximum weed control efficiency (%) at 60, 90DAS, and At harvest, respectively, with 94.14, 96.90 and 94.51 Although administration of Pyroxasulfone + Metsulfuron (pre-em) (T_5) was the next best treatment with WCE of 92.12, 94.79 and 93.62 at 60, 90, and At harvest. Metribuzin (pre-em) (T_8) was the least effective treatment for weed control at 60, 90 DAS, and at harvest with WCI of 89.56, 90.59 and 89.24. The lowest weed population seen may have been caused by the herbicides from the sulfonyl urea group, which synthesise ACT (aceto lactase compound), which causes weeds to die quickly and results in the highest

Weed index

The observation of the weed index as modified by various herbicides is shown. Application of Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) resulted in the lowest weed index (4.75), which was followed by application of Pyroxasulfone + Metsulfuron (pre-em) (T_5) (6.62). Among herbicidal weed control methods, the treatment with Metribuzin (pre-em) (T_8) reported the highest weed index (25.61). Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) recorded the lowest weed index of all the weed control methods over the course of the experimentation years, which may have been caused by a decrease in weed density compared to the other herbicide-treated plots.

Weed control index

The administration of Pyroxasulfone + Metsulfuron (pre-em) (T_5) was the 2nd best treatment with WCI of 46.82, 89.50, 73.57 and 80.02 at 30, 60, 90, and at harvest, respectively. However, the post emergence integrated application of Pyroxasulfone + Metsulfuron (EPOST tank mix) (T_7) had the maximum weed control index (%)11.18, 91.70, 84.38 and 84.09 at 30, 60, 90DAS, and At harvest, Metribuzin (pre-em) (T_8) had WCI of 37.49, 87.50, 66.82 and 59.91, making it the least effective treatment for weed control index at 60, 90 DAS, and At harvest.

Table 4: Weed control efficiency (%), Weed index (%) and Weed Control index (%) of herbicides in wheat crop as influence by different herbicides at harvest.

Treatments	Weed Control Efficiency (%)	Weed index (%)	Weed Control index (%)
T_1	90.13	17.89	63.78
T_2	91.22	16.26	65.62
T_3	93.05	11.35	72.62
T_4	92.38	13.51	70.30
T_5	93.62	6.62	80.02
T_6	93.20	10.51	78.36
T_7	94.51	4.75	84.09
T_8	89.24	25.61	59.91
T_9	90.09	23.51	61.72
T_{10}	91.69	14.70	67.16
T_{11}	0.00	49.18	0.00
T_{12}	100.00	0.00	100.00

Relative weed density

The relative density of Physalis minima weed was observed to be least (21.46%) in treatment T_1 and highest was T_2 (41.76%). The highes relative density of Phalaris minor was in treatment T_3 (41.15%) and lowest was in treatment T_10 (19.79%). The highes relative density of Parthenium hysterophorus was in treatment T_1 (39.95%) and lowest was in treatment T_8 (7.72%). The highes relative density of Cynodon dactylon was in treatment T_8 (25.34%) and lowest was in treatment T_7 (0.22%).The highes relative density of Chenopodium album was in treatment T_6 (22.45%) and lowest was in treatment T_3 (4.99%) respectively.

Table 5: Relative weed density (%) of weeds in wheat crop as influence by different herbicides

Relative weed density							
Treatment		***Physalis minima***	***Phalaris minor***	***Parthenium hysterophorus***	***Cynodon dactylon***	***Chenopodim album***
T_1	Pendimethalin (pre-em) 1000 g ha^{-1}	21.46	27.05	39.95	3.79	7.75
T_2	Pendimethalin (pre-em) 1500 g ha^{-1}	41.76	20.13	25.50	4.37	8.24
T_3	Pyroxasulfone (pre-em) 85% WG 127.5 g ha^{-1}	23.18	41.15	10.73	19.96	4.99
T_4	Pendimethalin + Pyroxasulfone (pre-em tank mix) 1250+127.5 g ha^{-1}	39.40	24.89	20.13	4.75	10.83
T_5	Pyroxasulfone + Metsulfuron (pre-em) 127.5 + 4 g ha^{-1}	25.25	39.34	0.79	21.97	12.66
T_6	Pyroxasulfone (EPOST)127.5 g ha^{-1}	26.38	30.37	14.20	6.61	22.45
T_7	Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5+4 g ha^{-1}	27.06	21.23	33.11	0.22	18.37
T_8	Metribuzin (pre-em) 300g ha^{-1}	32.78	20.96	7.72	25.34	13.20
T_9	Pendimethalin + Metribuzin (pre-em tank mix) 1250+280 g ha^{-1}	23.10	38.58	12.16	7.85	18.31
T_{10}	Pyroxasulfone + Metribuzin (pre em tank mix) 127.5+280 gha^{-1}	32.68	19.79	28.85	4.37	14.31
T_{11}	Weedy check	33.81	20.69	29.81	3.81	11.88
T_{12}	Weed free	00	00	00	00	00

Test weight (g)

At harvest, among the T_{12} (Weed free) had the higher test weight (46.81 g) which was at par with T_7 (Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5+4 g a.i./ha-1) (44.16 g) and T_5 (Pyroxasulfone + Metsulfuron (pre-em) 127.5 + 4 g a.i./ha-1) (43.74 g) significantly superior over the lowest test weight (37.28 g) was recorded under T_{11} (Weedy check).

Grain yield (qha^{-1})

Among the applied treatments, T_{12} (Weed free) observed significantly higher grain yield (45.78 q ha^{-1}) as compare to other treatments. However, it was at par with treatment T_7 (Pyroxasulfone + Metsulfuron (EPOST tank mix) 127.5+4 g a.i./ha-1). The significantly lowest grain yield (22.21 q ha^{-1}) was observed in treatment T_{11} (Weedy check).

Straw yield (q ha^{-1})

At harvest, among the application T_{12} (Weed free) had the higher straw yield (49.77 q ha^{-1}) which was significantly superior over the other treatments and the lower straw yield was recorded under T_{11} (Weedy check).

Table 6: Effect of herbicide on test weight (g), grain yield (q ha^{-1}), and Straw yield (q ha^{-1}) at harvest

Treatment	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	40.93	37.43	44.33
T_2	41.49	38.39	44.50
T_3	42.47	40.62	44.82
T_4	42.01	39.63	45.12
T_5	43.74	42.70	47.59
T_6	42.83	41.00	45.32
T_7	44.16	43.67	48.93
T_8	39.77	34.05	42.03
T_9	40.20	35.00	44.25
T_{10}	41.98	39.06	45.12
T_{11}	37.28	23.21	39.22
T_{12}	46.81	45.78	49.77
SEm ±	1.27	1.56	1.41
CD (P=0.05)	3.75	4.58	4.14

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