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JR Hazarika
Assistant Agronomist, AAU-ZRS, Shillongani, Nagaon, Assam, India

PK Bordoloi
Principal Scientist, AAU-ZRS, Shillongani, Nagaon, Assam, India

Bhabesh Gogoi
Scientist, AICRP on IFS, AAU, Jorhat, Assam, India

TP Saikia
Chief Scientist, AAU-SMAPRS, Buralikson, Golaghat, Assam, India

B Kalita
Scientist, AAU-ZRS, Shillongani, Nagaon

B Borah
Scientist, AAU-ZRS, Shillongani, Nagaon, Assam, India

AM Deka
Senior Scientist, AAU-ZRS, Shillongani, Nagaon, Assam, India

A Gogoi
Scientist, AAU-ZRS, Shillongani, Nagaon, Assam, Assam, India

Corresponding Author:
JR Hazarika
Assistant Agronomist, AAU-ZRS, Shillongani, Nagaon, Assam, India

Efficiency of pre and post-emergence herbicides to control weeds and enhancing yield of wheat (*Triticum aestivum*) in North-East India

JR Hazarika, PK Bordoloi, Bhabesh Gogoi, TP Saikia, B Kalita, B Borah, AM Deka and A Gogoi

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Abstract
A field experiment was conducted in *rabi* season during 2021 – 22 and 2022 – 23 at Tokowbari research farm of Assam Agricultural University-Zonal Research Station, Shillongani, Nagaon, Assam to find out a suitable and economically viable herbicide alone or in combination to control weeds as well as to increase productivity of wheat (*Triticum aestivum* L.). The effect of herbicides on weeds were analyzed by different indices such as Weed Control Efficiency (67.10), Treatment Efficiency Index (2.02), Crop Resistant Index (4.00) were highest and Weed Persistant Index (0.84) were lowest with pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha (T_{10}) and Weed Index was highest in T_{11}(Weedy check). Likewise significantly highest grain yield (32.99 q/ha) were recorded in case of weed free treatment (T_{12}) followed by 31.12 q/ha with pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha (T_{10}) which was at par (30.83 q/ha) with Pre-emergence tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha (T_9). But the highest B:C (2.39) ratio was achieved in T_4 (pre-emergence tank mix application of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha) followed by T_7 (EPOST tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha).

Keywords: Tank mix, pre-emergence, early-post-emergence herbicides, impact indices, WCE, WI

1. Introduction
In India, wheat (*Triticum aestivum* L.) is a staple food and the second most significant crop after rice and contributes about one-third of the full cereal production. wheat is cultivated in about 31.82 m ha area of India and produces 112.74 million tones with national average productivity of 35.43q/ha in the year 2022-23 (III Advance Estimate, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, India). The productivity of wheat in India is mostly lowered because of weed infestation and pre harvest sprouting during pre - monsoon rain (Sharma *et al*., 2020; Choudhary and Sharma, 2022) [14, 2]. Weed caused about 80% loss of grain yield (Mitra *et al*., 2019) [8]. Timely control of weeds faces the problem of labour scarcity and too low or high soil moisture, which hinders the intercultural operations (Choudhary *et al*., 2021; Nayak *et al*., 2022) [1, 10]. Over the years, efficacy of the herbicides has started declining and there is possibility of development of cross resistance (Singh *et al*., 2018) [13].

In north-eastern region (NER) of India, with the advantage of considerable area under rice-fallow system as well as residual moisture in the field, a good wheat crop fits into the system. However, the area (33.9 thousand ha) and production (44.2 thousand tones) of wheat in Assam (www.ceicdata.com.India) [15] of NER is low as compared to the other states of India. This is mainly because of weed problem causing substantial yield losses in upland crops during *rabi* season under Assam conditions (Kalita *et al*., 2014) [7]. Under direct sown condition, weeds pose serious competition to the crop in the early stage and cause heavy reduction in crop yield (Kalita *et al*., 2014) [7]. In case of wheat also, the seedlings compete with different weed species from their emergence and this may lead to reduction in potential yield up to 30.3% and actual yield loss 18.6% (Gharde and Singh, 2018) [4].

Uncontrolled weeds resulted in about 80% reduction in grain yield and sometimes result in complete failure of crop (Pandey *et al*., 2000; Gopinath and Kundu, 2008; Kalita *et al*., 2014) [11, 5, 7]. Thus, due to high weed pressure, weed management in wheat has been a huge challenge for the researchers and farmers as well. The conventional method of weed control (hoeing or hand weeding) is laborious, expensive, time consuming and sometime causes damages to crop (Ram, *et al*, 2011) [12]. Chemical weed control certainly has its merits over such existing methods

To manage the dynamic and complex weed flora of wheat there is need to evaluate different herbicides to have a broad-spectrum for weed control **(**Chopra *et al*., 2015) [3]. Herbicidal control, on the other hand, will prevent the costly input being eaten up by weeds and thus, save the management time and cost and will increase the yield and results in higher profit (Singh *et al*., 2018) [13]. Now-a-days, use of both pre and post-emergence (PoE) herbicides alone or in combination as tank mixed are popular among the farmers (Jat and Singh, 2021) [6]. But literatures regarding tolerance of herbicides for combination as well as method of application are limited. Therefore, a study was made to find out suitable herbicide along with proper time of application for efficient weed-management in wheat. We also reported the yield and yield attributing parameters of wheat as affected by the application of herbicides under Assam situation.

2. Materials and Methods

A field study was conducted in *rabi* season of 2021-22 and 2022-23 at sub tropical climate of Tokowbari Research farm of Assam Agricultural University- Zonal Research Station, Shillongani, Nagaon, Assam situated at $26^0 22'$ N latitude, $92^0 38'$E longitude and 50.2 M above mean sea level.The soil was sandy loam with pH 5.51, organic carbon (OC- 1.15%), available nitrogen (248.8 kg/ha), available phosphorus (15.18 kg/ha) and potassium(128.5kg/ha). The experiment was conducted in a Randomized Block Design with three replications and twelve treatments consecutively for two years. The treatments were T_1:Pre-emergence application of Pendimethalin@1000g a.i./ha, T_2:Pre-emergence application of Pendimethalin @ 1500 g a.i./ha, T_3: Pre -emergence application of Pyroxasulfone 85% WG @ 127.5 g a.i./ha, T_4: Pre-emergence application tank mix appllication of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha, T_5: Pre- emergence application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha, T_6: Early-post emergence (EPOST) application of Pyroxasulfone @ 127.5 g a.i./ha, T_7: Early-post tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha, T_8: Pre-emergence application of Metribuzin @ 300 g a.i./ha, T_9: Pre-emergence tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha, $T_{10:}$ Pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha,T_{11}: Weedy Check and T_{12}: Weed free (weeding now and then).The land was ploughed for four times followed by laddering. Fertilizers were applied @ 60, 45 and 42 kg N, P_2O_5 ad K_2O/ha, respectively. Half of nitrogen and full quantity of phosphorus was applied as basal and remaining half of nitrogen was applied at Crown Root Initiation (CRI) stage. Two irrigations of 6 cm depth were applied at CRI and heading stage. The variety used in this experiment was HD2967. Herbicides were sprayed as per treatment. Observations on weed (number and weight) were taken with the help of 1.0 m^2 quadrate and Fresh weight was taken immediately and for recording dry weight of weeds (g/m^2), the collected weeds were first air-dried for 3 days and then oven-dried at 65 ± 5°C until constant dry weight were achieved and then only recorded the weight. Weedy check plots remained infected with native population of weeds till harvest. Weed free plots were weeded now and then to keep it weed free. The data on weed density and weed dry weight were subjected to transformation by the factor ($\sqrt{X+0.5}$) before statistical analysis to minimize the error. Means were compared at 5% level of significance as per Tukey's Honest Significant Difference Test. The relationships between seed yield and weed density and dry weight were evaluated using linear regression analysis. Different impact indices, *viz*. weed-persistence index (WPI), Crop-Resistance Index (CRI), and Herbicide/ Treatment Efficiency Index (TEI) were worked out at harvest. Weed Persistent Index (WPI)= [WDC / WDT] × [WDMT / WDMC], where WDT and WDC, weed density (no./m^2) in treated and weedy check plot and WDMT and WDMC, weed dry weight (g/m^2) in treated and weedy check plot respectively. Crop-Resistance Index (CRI)= (CDMT ÷ CDMC) × (WDMC ÷ WDMT),where CDMT and CDMC, crop dry weight (g/m^2) in treated and unweeded plot respectively Herbicide/ Treatment Efficiency Index (TEI) were worked out as: TEI = [(YT – YC)/YT] ÷ (WDMT / WDMC) where YT and YC are the yields in treated and weedy check plot; Yield parameters (earhead/m^2, gains/earhead, plants/m^2, 1,000-grain weight) were recorded from one square meter area randomly from each plot. Grain and stover yields (kg/ha) were recorded based on the yield obtained from the net plot (1.4 m × 7 m). Economics was computed based on prevailing market prices of crop produce, agroinputs, labour, and machinery rent. The economic threshold based on weed density at harvest was worked out as per following equation. Weed-Control Efficiency (WCE) and Weed Index (WI) were calculated by using the standard formula suggested by Mani *et al*. (1973) [9].

3. Results and Discussion

3.1 Effects on weeds

Data (Table 1) revealed that all the treatments proved significantly superior than weedy check in respect of reducing the weed population and their dry matter yield which had the maximum total weed density (103.41 no./m^2) and dry weight (46.58 g/m^2). The lowest weed population, weed dry weight and lowest total weeds were obtained with weed free treatment and this was found significantly superior as compared to other treatments. Pre-emergence tank mix application of T_9:Pendimethalin + metribuzin@1250 + 280 g a.i./ha caused more reduction in density (31.40 no./m^2) and dry weight (15.20 g/m^2) of weeds, but the reduction was more pronounced with T_{10}:pre-emergence tank mix application of Pyroxasulfone + metribuzin@127.5 + 280 g a.i./ha (30.33 no./m^2 and14.38 g/m^2 respectively).The combine absorption and translocation of herbicides Pyroxasulfone and Metribuzin at the site of action at lethal concentration, caused more reduction in weed density and dry weight followed by the combination of Pendimethalin + metribuzin. In both the treatment concenratin of metribuzin was same. Therefore superiority of Pyroxasulfone over Pendimethalin may be attributed to the result of less weed density and weed dry weight in T_{10}: (Pyroxasulfone + metribuzin@127.5 + 280 g a.i./ha). Different weed control treatments brought about a 70.7 – 32.94% reductionin total weeds density and 69.13– 22.30% in weed dry weight at harvest compared to weedy check.

Table 1: Two years pooled data on weed density, weed dry weight, weed control efficiency (WCE) % and weed index (WI)

Treatments	Weed density (no./m^2)				Weed dry wet (g/m^2)				WCE (%)	WI
	30 DAS	60 DAS	At harvest	Total	30 DAS	60 DAS	At harvest	Total		
T_1	12.13 (147.67)	16.63 (279.00)	16.29 (265.33)	45.05 (692.00)	4.77 (22.33)	7.85 (61.33)	9.59 (92.00)	22.21 (175.66)	49.66	22.79
T_2	9.72 (94.00)	14.33 (206.00)	10.26 (105.33)	34.31 (405.33)	4.22 (17.33)	5.53 (30.67)	5.51 (30.33)	15.26 (78.33)	52.49	19.85
T_3	15.59 (243.00)	21.40 (458.67)	19.58 (385.67)	56.57 (1087.34)	5.52 (30.00)	10.79 (116.00)	12.84 (165.00)	29.15 (311.00)	46.11	11.76
T_4	9.66 (93.00)	10.97 (120.00)	14.62 (215.00)	35.25 (428.00)	4.14 (16.67)	4.74 (22.00)	9.09 (83.00)	18.07 (12.67)	59.76	7.18
T_5	15.94 (254.00)	25.50 (650.67)	26.93 (725.00)	68.37 (1629.67)	6.72 (44.67)	10.43 (108.33)	17.62 (310.00)	34.77 (463.00)	25.87	15.82
T_6	14.28 *(203.67)	23.55 (554.33)	21.90 (479.33)	59.73 (1237.33)	5.98 (35.33)	10.00 (99.67)	11.41 (130.00)	2.39 (265.00)	39.72	14.79
T_7	23.90 (570.67)	28.54 (814.00)	26.35 (694.00)	69.35 (2078.67)	6.69 (44.33)	14.40 (207.00)	15.10 (227.67)	36.19 (479.03)	55.00	8.43
T_8	16.58 (274.67)	16.38 (268.67)	18.44 (340.33)	51.40 (883.67)	5.18 (26.33)	6.53 (42.33)	10.97 (120.00)	22.50 (188.66)	49.24	27.74
T_9	8.27 (68.00)	8.79 (77.33)	14.34 (209.33)	31.40 (354.66)	3.53 (12.00)	5.21 (26.67)	6.46 (41.33)	15.20 (80.00)	60.53	6.55
T_{10}	9.11 (82.67)	9.27 (85.67)	11.95 (144.00)	30.33 (312.34)	3.57 (12.33)	5.11 (25.67)	5.70 (32.00)	14.38 (70.00)	67.11	5.67
T_{11}	32.47 (1056.67)	34.61 (1197.33)	36.33 (1321.00)	103.41 (3575.00)	10.24 (104.33)	16.97 (287.33)	19.37 (375.00)	46.58 (766.66)	0.00	61.87
T_{12}	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	100.0	0.00
S.Em ±	0.98	0.62	0.76	1.03	0.14	0.26	0.35	0.68	4.05	1.34
CD5%	2.80	1.77	2.17	2.95	0.40	0.74	0.92	1.03	10.21	2.75

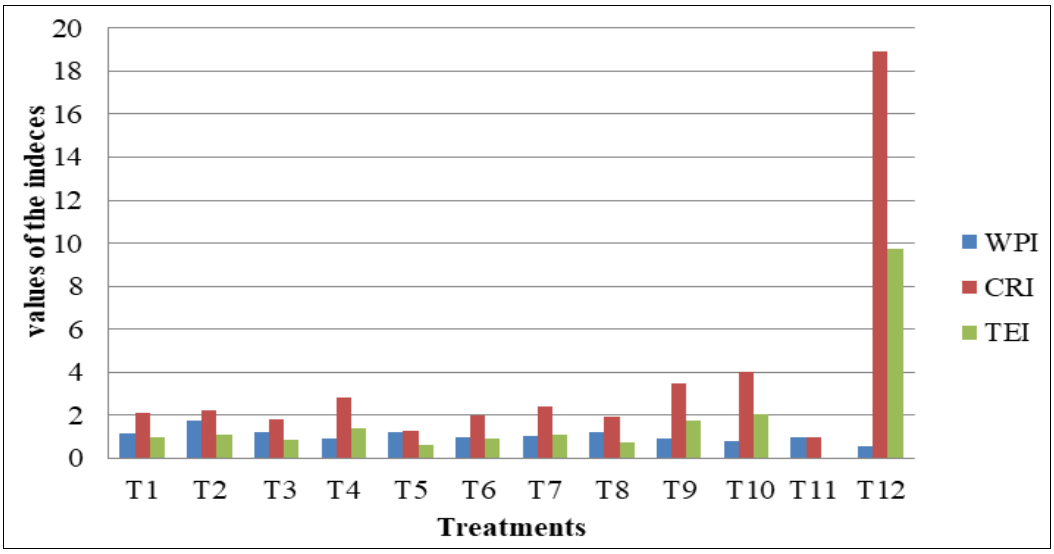
*Values in parentheses are the means of original values; T_1:Pre-emergence application of Pendimethalin@1000g a.i./ha, T_2:Pre-emergence application of Pendimethalin @ 1500 g a.i./ha, T_3: Pre -emergence application of Pyroxasulfone 85% WG @ 127.5 g a.i./ha, T_4: Pre-emergence application tank mix appllication of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha, T_5: Pre- emergence application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha, T_6: Early-post emergence (EPOST) application of Pyroxasulfone @ 127.5 g a.i./ha, T_7: Early-post tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha, T_8: Pre-emergence application of Metribuzin @ 300 g a.i./ha, T_9: Pre-emergence tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha, T_{10}: Pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha,T_{11}: Weedy Check and T_{12}: Weed free (weeding now and then).

3.2 Weed-control efficiency and weed Index

Weed-control efficiency (WCE) of treatments was negatively co-related with weed density and dry weight. Therefore, the trend of treatments for increased WCE was in order of lower weed density and dry weight. The maximum weed-control efficiency excluding the weed free treatment, was obtained in case of pre-emergence tank mix application of Pyroxasulfone and metribuzin (67.11 %) which was followed by pre-emergence tank mix application of pendimethalin + metribuzin (60.5). Boththe treatments reduced the weeds effectively and resulted in the lowest weed dry weight which may be the main reason for higher WCE under those treatments. Among the other treatments the lowest weed-control efficiency (25.87 %) was recorded with application of pre-emergence application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha. Though Pyroxasulfone was applied in both the treatment in same concentration due to pooractivity of the chemicals (metsulfuron) as compared to (metribuzin) may be the reasons for less control of mixed weed flora of wheat by T_5 (pre- emergence application of (Pyroxasulfone + metsulfuron).The significant difference in weed dry weight in different weed management practices was depicted in terms of WCE and WI (Table 1). Weed index was highest in weedy plot (61.87) and lowest with application of Pyroxasulfone and metribuzin(5.67) followed by pendimethalin + metribuzin(6.55). The better weed control under T_{10} (Pyroxasulfone and metribuzin) a T_9 (pendimethalin + metribuzin) treatment resulted in higher WCE and lower WI.

3.3 Impact assessment

The values of different indices like Weed Persistence Index (WPI), Crop Resistance Index (CRI) and Treatment Efficiency Index (TEI) were depicted in Fig.1. The data on WPI indicates the relative weed dry matter accumulation per weeds count in comparison to control. WPI was highest (1.74) in T_2 (Pre-em application of Pendimethalin @ 1500 g a.i./ha) indicating highest resistance of the escaped weeds to particular control measure/ treatment. The lowest (except the weed free treatments) WPI (0.78) was achieved with T_{10} (Pre-emergence tank mix application of Pyroxasulfone + metribuzin @ 127.5 + 280 g a.i./ha) followed by (0.87) T_9 (Pre-emergence tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha). Crop Resistance Index (CRI) indicates growth of the wheat plants due to particular treatment or the particular herbicide had less negative impact on the crop plants. CRI was highest (4.0) in T_{10} (Pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha)) followed by T_9 (Pre-em tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha) which had the value (3.5).However the lowest value (1.3) of CRI was observed with T_5 (Pre-emergence application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha**)** indicating lowest vigour of crop plants due to particular herbicide or their combination. TEI indicates the yield advantage by adopting the treatment over the control concerning reducing weed dry matter as compared to control.T_{10} treatment showed the highest TEI value (2.02) depicting the yield advantage due to control of weed dry matter in this treatment as compared to weedy check. The lowest TEI (0.60) was recorded with T_5 (Pre-em application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha) showing the least yield advantage over control due to control of weed dry matter.



T_1:Pre-emergence application of Pendimethalin@1000g a.i./ha, T_2:Pre-emergence application of Pendimethalin @ 1500 g a.i./ha, T_3: Pre -emergence application of Pyroxasulfone 85% WG @ 127.5 g a.i./ha, T_4: Pre-emergence application tank mix appllication of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha, T_5: Pre- emergence application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha, T_6: Early-post emergence (EPOST) application of Pyroxasulfone @ 127.5 g a.i./ha, T_7: Early-post tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha, T_8: Pre-emergence application of Metribuzin @ 300 g a.i./ha, T_9: Pre-emergence tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha, T_{10}: Pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha,T_{11}: Weedy Check and T_{12}: Weed free (weeding now and then)

Fig 1: Impact assessment Indices of different weed management treatment in wheat

3.4 Yield reduction

Yield reduction was maximumin weedy check plot (61.86 %) as compared to weed free plot. Application of (pendimethalin + metribuzin) and (pyroxasulfone + metibuzin) as early post emergence scaled down the yield reduction to the tune of 6.55% and 5.67 % respectively as compared to the weed free. Likewise yield reduction was arrested to the tune of 8.43% with T5: post emergence tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha and upto7.18% with T_{10}: Pre-emergence tank mix application of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha.

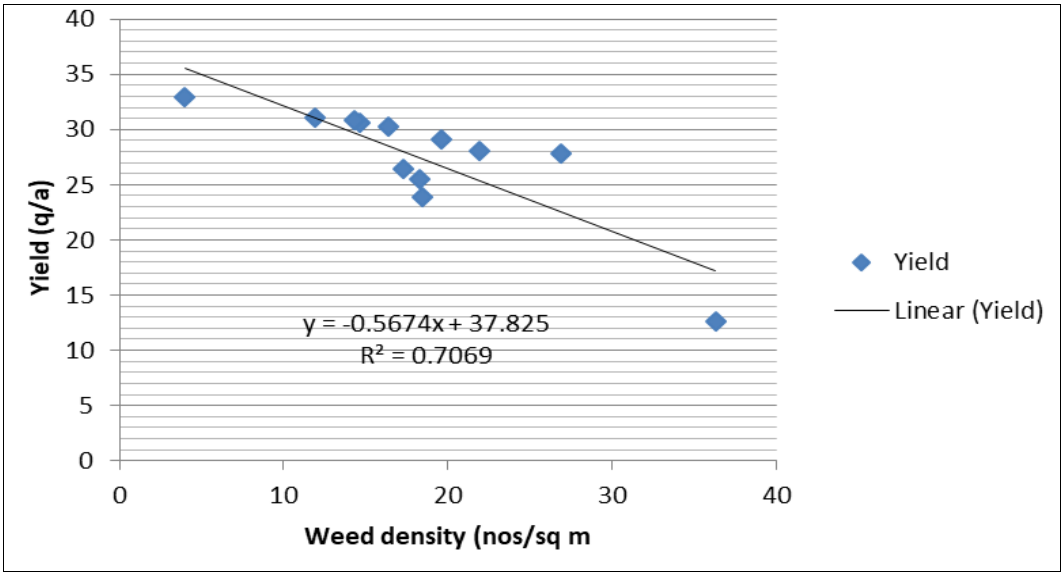


Fig 2: (a) Co-relation of weed density and grain yield of wheat

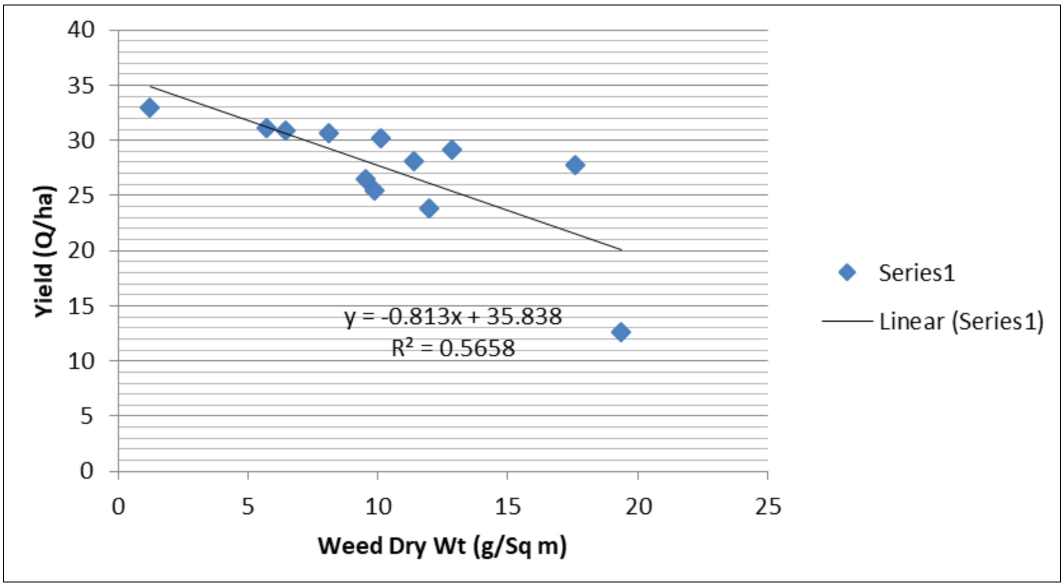


Fig 2: (b) Co-relation of weed dry weight and grain yield of wheat

Yield-attributes and grain yield were affected significantly by different weed-control treatments (Table 2). The values of yield-attributing traits of wheat such as stand count/m.^{2}, earhead/m^2, grains/earhead and thousand grains weight were superior under T_{10}: pre-emergence tank mix application of Pyroxasulfone + metribuzin@127.5 + 280 g a.i./ha followed by T_9: pre-em tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha. The grain and biomass yield were increased appreciably when the weeds were controlled by herbicides in the same trend as that of yield attributes. The grain and total biomass yield (12.58 q/ha and 52.14q/ha) were low in weedy check treatment dueto heavy infestation of weeds.

Table 2: Growth parameters, yield attributes, and yield of wheat as influenced by different weed management practices (mean of 2 years)

Treatments	Plat height (cm)	Stand Count/m^2	Earhead /m^2	Grains/ Earhead	1000 Grains Wt (g)	Yield (q/ha)	Biomass (q/ha)	B:C ratio
T_1	97.40	60.33	139.83	42.67	45.24	25.47	60.47	2.35
T_2	101.45	61.67	142.67	44.67	44.78	26.44	61.17	2.29
T_3	101.20	58.67	127.17	46.00	45.02	27.11	56.57	2.32
T_4	99.53	65.00	218.83	52.00	45.24	30.62	61.07	2.39
T_5	99.87	56.67	174.00	55.67	45.01	27.77	60.06	2.23
T_6	100.73	60.67	150.00	50.00	45.31	28.11	60.92	2.34
T_7	101.00	63.33	174.10	50.33	45.38	30.21	60.93	2.37
T_8	102.93	50.67	127.17	47.33	42.82	23.84	61.34	2.07
T_9	102.20	69.00	220.33	54.37	45.29	30.83	61.68	2.33
T_{10}	107.50	71.00	225.83	55.63	45.65	31.12	62.01	2.27
T_{11}	93.87	31.00	134.33	45.67	29.18	12.58	52.14	1.55
T_{12}	103.43	83.67	247.00	58.00	46.16	32.99	62.37	2.33
S.Em ±	15.07	1.15	10.21	3.23	1.15	1.27	5.09	-
CD 5%	43.25	3.33	29.31	9.28	3.29	3.95	14.62	-

T_1:Pre-emergence application of Pendimethalin@1000g a.i./ha, T_2:Pre-emergence application of Pendimethalin @ 1500 g a.i./ha, T_3: Pre -emergence application of Pyroxasulfone 85% WG @ 127.5 g a.i./ha, T_4: Pre-emergence application tank mix appllication of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha, T_5: Pre- emergence application of Pyroxasulfone @ 127.5 g a.i./ha + metsulfuron 4 g a.i./ha, T_6: Early-post emergence (EPOST) application of Pyroxasulfone @ 127.5 g a.i./ha, T_7: Early-post tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha, T_8: Pre-emergence application of Metribuzin @ 300 g a.i./ha, T_9: Pre-emergence tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha, T_{10}: Pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha,T_{11}: Weedy Check and T_{12}: Weed free (weeding now and then).

Grain (31.12 q/ha) and biomass (62.01 q/ha) yield were highest with T_5: early post emergence tank mixapplication of Pyroxasulfone + metsulfuron @ 127.5 + 4 g a.i./ha which was at par with T_{10}: pre-em tank mix application of Pendimethalin + metribuzin@1250 + 280 g a.i./ha (30.83 q/ha and 61.8 q/ha of grain and biomass yield respectively).Regression analyses revealed that the grain yield of wheat was negatively associated with weed densityand weed dry weight. Regression equations in Fig. 1 indicated that with every unit increase in weed density (no/ m^2) and weed dry weight (g/m^2), grain yield of wheatis reduced by 1.50 q/ha and 2.24q/ha, respectively. These linear equations could explain the variation in grain yield of wheat due to weed density and weed dry weight by 70.68 % and 56.58 % respectively. Thus, higher grain yield in respective herbicide-treated plots may be an outcome of efficientweed control.

3.5 Economics

The maximum benefit: cost ratio (2.39) were achieved underT_4 (Pre-emergence tank mix application of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha) and minimum (1.55) in weedy check plots. Comparatively lower price of chemicals along with higher yield of grain and straw may leads to high B:C rato in T_4. However, the benefit cost ratio was mostly affected by the price of the herbicides in other treatments. Though yield of grain and straw were highest in T_{10}(Pre-emergence tank mix application of Pyroxasulfone + metribuzin @ 127.5 + 280 g a.i./ha), due to high price of Pyroxasulfone and metribuzin, B:C ratio was only 2.27.Though TEI, CRI and yield were highest with T_{10} (pre-emergence tank mix application of Pyroxasulfone + metribuzin@ 127.5 + 280 g a.i./ha), these advantages of different indices unde T_{10} were nullified by T_4 (pre-em tank mix applicaion of Pendimethallin + Pyroxasulfone@ 1250 + 127.5 g a.i./ha) through high benefit cost ratio.

4. Conclusion
The study revealed that pre- emergence tank mix application of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha was more viable herbicides to control the diverse weed flora of wheat having WCE(67.11%), Treatment Efficiency Index (2.02), Crop Resistant Index (4.00) and lowest Weed Persistant Index (0.84) with highest grain yield of 31.12 q/ha and B:C ratio of 2.27. However, considering the higher value of B:C ratio(2.39) pre-emergence application tank mix appllication of Pendimethallin + Pyroxasulfone @ 1250 + 127.5 g a.i./ha (T_4) and EPOST tank mix application of Pyroxasulfone + metsulfuron@ 127.5 + 4 g a.i./ha (T_7) having B:C ratio 2.37 may also be alternative weed management practices for economically weaker section of wheat growers of North-East India.

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6. References
1. Choudhary AK, Yadav DS, Sood P, Rahi S, Arya K, Thakur SK, *et al*. Post-emergence herbicides for effective weed management, enhanced wheat productivity, profitability and quality in North-Western Himalayas: A ‘participatory-mode’ technology development and dissemination. Sustainability. 2021;13(10):425.
2. Choudhary C, Sharma AR. Effect of tillage and weed management on performance of wheat (*Triticum aestivum*) in sequence with greengram (*Vigna radiata*). Indian J Agron. 2022;67(2):204-207.
3. Chopra NK, Chopra N, Choudhary D. Bioefficacy of sole and tank mix of pinoxaden and clodinofop with carfentazone and metsulfuron for control of complex weed flora in wheat. Indian J Agron. 2015;60(1):104-108.
4. Gharde Y, Singh PK. Yield and Economic Losses Due to Weeds in India. Jabalpur: ICAR-Directorate of Weed Research; Technical Bulletin No; c2018. p. 17-22. Available from: http://www.dwr.org.in.
5. Gopinath KA, Kundu S. Evaluation of metsulfuron-methyl + chlorimuron-ethyl for weed control in direct seeded rice (Oryza sativa). Indian J Agric Sci. 2008;78(5):466-469.
6. Jat NK, Singh DV. Weed control efficacy of different post-emergence herbicides in mungbean (*Vigna radiata*) in hot arid regions. Indian J Agron. 2021;66(4):438-443.
7. Kalita J, Gogoi B, Kalita B, Barua NG. Tillage and weeding effect on performance of direct sown Autumn rice (O*ryza sativa* L.). Middle East J Agric Res. 2014;3(1):27-31.
8. Mitra B, Barman R, Mondal T. Control of broad-leaved weeds in wheat under eastern sub-Himalayan plains. Indian J Weed Sci. 2019;51:27-31.
9. Mani VS, Malla MC, Gautam KC, Bhagwant S. Weed killing chemicals in potato cultivars. Indian Farming. 1973;32:17-18.
10. Nayak A, Khanda CM, Das S, Mohanty SK, Sahoo BB, Nayak BS. Enhancing hybrid maize (*Zea mays*) productivity, profitability and energetic through tillage and weed-management practices in Eastern India. Indian J Agron. 2022;67(2):152-157.
11. Pandey AK, Prakash V, Singh K, Prasad K, Singh RD, Mani VP. Weed management in major crops of North-Western Himalayas. Almora: VPKAS. Technical Bulletin No. 2000;16:66.
12. Ram B, Punia SS, Meena DS, Tetarwal JP. Bio-efficacy of post-emergence herbicides to manage weeds in fieldpea. J Food Legumes. 2011;24:254-257.
13. Singh A, Gupta D, Singh L, Singh SB. Bioefficacy of sole and tankmix herbicides for control of complex weed flora in wheat (*Triticum aestivum*). Ann Plant Soil Res. 2018;20(2):203-209.
14. Sharma AK, Mishra CN, Singh BP, Singh SK, Singh GP. Perspective of enhancing wheat production and productivity in Uttar Pradesh by improving varietal replacement rate. J Cereal Res. 2020;12(1):19-22.
15. CEIC Data. India [Internet]. Available from: https://www.ceicdata.com [cited 2023 Dec 22].